

Technical Information Report

AAMI TIR16: 2023

Microbiological aspects of ethylene oxide
sterilization

Microbiological aspects of ethylene oxide sterilization

Approved 18 December 2023 by
AAMI

Abstract: Addresses various microbiological aspects of the development and validation of an ethylene oxide sterilization process. Does not address the various factors that can have an effect on the bioburden of the product and on the sterilization process. Provides additional guidance to ANSI/AAMI/ISO 11135:2014 for medical device manufacturers, including those that use contract sterilization facilities or contract sterilization operations.

Keywords: sterilization, microbiological aspects, validation, ethylene oxide, bioburden, performance qualification

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This technical information report was developed by the AAMI Industrial Ethylene Oxide Sterilization Working Group under the auspices of the AAMI Sterilization Standards Committee. Approval of the technical information report does not necessarily mean that all working group members voted for its approval.

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Foreword

This document is part of a series of technical information reports (TIRs) intended for use in conjunction with ANSI/AAMI/ISO 11135:2014. The other reports in the series are listed below:

- AAMI TIR14, *Contract sterilization using ethylene oxide*.
- AAMI TIR15, *Physical aspects of ethylene oxide sterilization*.
- AAMI TIR28, *Product adoption and process equivalence for ethylene oxide sterilization*.
- AAMI TIR56, *Guidance for the development, validation and routine control of an ethylene oxide sterilization process utilizing flexible bag systems for the sterilization of medical devices*.

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- “might” and “might not” are used to express possibility;
- “must” is used for external constraints or obligations defined outside the document; “must” is not an alternative for “shall.”

Suggestions for improving this technical information report are invited. Comments and suggested revisions should be sent to AAMI, 901 N Glebe Road, Suite 300, Arlington, VA 22203 or standards@aami.org.

NOTE This foreword does not contain provisions of AAMI TIR16:2023, *Microbiological aspects of ethylene oxide sterilization*, but it does provide important information about the development and intended use of the document.

Introduction

The original TIR16, along with other AAMI TIRs, provided additional guidance to the 1994 edition of the industrial EO sterilization standard 11135, which was revised in 2007 under a new designation, ANSI/AAMI/ISO 11135-1:2007, *Sterilization of health care products—Ethylene oxide—Part 1: Requirements for the development, validation and routine control of a sterilization process for medical devices*. In 2008, ISO published its own guidance document for the 11135 standard, ISO/TR 11135-2:2008, *Sterilization of health care products—Ethylene oxide—Part 2: Guidance on the application of ISO 11135-1*, which was based to a great extent on the earlier AAMI technical information reports. ANSI/AAMI/ISO 11135-1:2007 and ISO/TIR 11135-2:2008 were revised into a single document: ISO 11135:2014.

This TIR provides guidance related to the microbiological aspects of EO sterilization and is designed to provide information that will assist in design and qualification for BI or parametric release processes. Parametric release is desired for routine processing, but this TIR also includes guidance on the use of PCDs for routine processing when BI release is used. This TIR condenses pertinent information that may be available from a variety of sources into one location and is based on practices that have been found to be used successfully within the United States. This TIR contains guidelines that are not intended to be absolute or to apply in all circumstances. One should use judgment in applying the information in this TIR.

Microbiological aspects of ethylene oxide sterilization

NOTE This technical information report is not a standard, and the material contained herein is not normative in nature. The committee has used the term "shall" in a few instances, based on their knowledge of requirements contained in relevant standards and regulatory requirements.

1 Scope

This technical information report (TIR) addresses various microbiological aspects of the development and validation of an ethylene oxide (EO) sterilization process. It does not cover the various factors that can have an effect on the bioburden of the product and on the sterilization process. This TIR provides additional guidance to ANSI/AAMI/ISO 11135 for medical device manufacturers, including those that use contract sterilization facilities or contract sterilization operations.

Although the information presented was developed for application to medical devices, the content of this guideline may also be applied to other relevant products or materials.

NOTE Products that have been used in a healthcare setting and are being presented for resterilization in accordance with the manufacturer's instructions (see ANSI/AAMI/ISO 17664-1 and 17664-2) are a special case. There is the potential for such products to possess a wide range of contaminating microorganisms and residual inorganic and/or organic contamination in spite of the application of a cleaning process. Hence, it is important to pay particular attention to the validation and control of the cleaning and disinfection (if used) processes used during reprocessing. Healthcare facilities are encouraged to review ANSI/AAMI ST79, ANSI/AAMI ST98, and AAMI TIR34 for additional information on handling reusable or non-sterile devices requiring sterilization processing at the healthcare facility.

2 Normative references

No normative references were used in the development of this TIR. References referred to in the text are listed in the Bibliography.

3 Terms and definitions

For the purposes of this document, the terms, and definitions in ANSI/AAMI/ISO 11135 and the following apply.

3.1

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]

3.2

EO dwell

period for which the process parameters are maintained within their specified tolerances

Note to entry: It is the period of time between the end of sterilant injection (or nitrogen injection if following the sterilant injection) and the beginning of EO removal (See Figure 1).

3.3

exposure phase

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

[SOURCE: ISO 11139:2018, 3.111]

Note to entry: See Figure 1.

3.4

inoculated carrier

supporting material on or in which a specified number of viable test microorganisms has been deposited

[SOURCE: ISO 11139:2018, 3.144]

3.5

spore log reduction

SLR

negative exponent to the base 10 describing the decrease in the number of spores

Note 1 to entry: It is expressed as a logarithm.

[SOURCE: ISO 11139:2018, 3.260]

Note 2 to entry: Describing the reduction in the number of spores on a biological indicator or inoculated item produced by exposure to specified conditions.

Note 3 to entry: Spore log reduction can be calculated based on actual reduction in population of viable spores; that information is then used to determine the theoretical spore log reduction.

4 Process and equipment characterization

4.1 Sterilization equipment

Guidelines for equipment selection can be found in AAMI TIR15 and EN 1422. Careful selection of the sterilizing equipment and development of the facility design will enable a manufacturer to process a product safely and effectively.

4.2 Process characterization—Physical parameters

4.2.1 Introduction

The physical parameters that have a significant effect on the lethality of an ethylene oxide (EO) sterilization process are EO concentration, temperature, EO dwell time, and humidity. These parameters are interrelated and a change in one can often be compensated for by a change in another. Other aspects that could affect lethality are the rate of sterilant injection, vacuum depth, and rate of evacuations during the sterilant-removal phases as these aspects could impact the overall exposure phase time. Evacuations can be affected by chamber temperature, humidity, sterilant levels, vacuum pump performance, and/or product load configuration.

4.2.2 EO concentration

Studies have shown that there is a direct relationship between EO concentration and lethality such that as EO concentration increases, lethality also increases. However, at higher EO concentrations there can be minimal increases in lethal rate ([17], [20], and [22]). Studies have shown that EO concentrations above 50 mg/L can achieve microbiological lethality ([21], [25], and [30]). For some products, it could be necessary to increase either EO dwell time or temperature of the process to achieve the selected sterility assurance level (SAL).

EO gas can be supplied in a gas mix or in its pure form (commonly referred to as 100 % EO). Premixed gases can have differing lethality from 100 % EO ([24]). This can also be seen in situations where an inert gas is used to maintain the pressure of the chamber during EO dwell. This effect can be minimized by the use of recirculation and compensating for the lower concentration of EO with an increase in the initial concentration or an increase in temperature.

When an inert gas is used to maintain the chamber pressure, it is important that the chamber recirculation system be sufficient to minimize risk and magnitude of stratification of the inert gas (e.g., nitrogen) and EO gas. In mixed sterilant gas processes, the makeup gas will replace a fraction of the EO absorbed, and the EO concentration in the chamber could decrease with time. EO concentration can be calculated as described in AAMI TIR15, or it can be directly measured.