

National foreword

This British Standard is the UK implementation of EN ISO 20743:2021. It is identical to ISO 20743:2021. It supersedes BS EN ISO 20743:2013, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee TCI/80/-/7, Testing methods for antimicrobial activity and odour.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 539 11961 9

ICS 07.100.99; 59.080.01

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2021.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

EUROPEAN STANDARD

EN ISO 20743

NORME EUROPÉENNE

EUROPÄISCHE NORM

June 2021

ICS 07.100.99; 59.080.01

Supersedes EN ISO 20743:2013

English Version

Textiles - Determination of antibacterial activity of textile products (ISO 20743:2021)

Textiles - Détermination de l'activité antibactérienne
des produits textiles (ISO 20743:2021)

Textilien - Bestimmung der
antibakteriellen Wirksamkeit von textilen
Produkten (ISO 20743:2021)

This European Standard was approved by CEN on 4 June 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

This document (EN ISO 20743:2021) has been prepared by Technical Committee "NA" in collaboration with Technical Committee CEN/TC 248 "Textiles and textile products" the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 20743:2013.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 20743:2021 has been approved by CEN as EN ISO 20743:2021 without any modification.

Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Safety precaution	2
5 Apparatus	2
5.26 Aluminium foil.....	4
5.27 Reciprocal incubation shaker.....	4
6 Reagents and culture media	4
6.1 Water.....	4
6.2 Tryptone soya broth (TSB).....	4
6.3 Tryptone soya agar (TSA).....	4
6.4 Agar for transfer.....	5
6.5 Nutrient broth (NB).....	5
6.6 Peptone salt solution.....	5
6.7 Physiological saline.....	5
6.8 Soybean-Casein Digest Broth with Lecithin & Polysorbate 80 (SCDLP) medium.....	5
6.9 Dilution buffer for shake-out bacterial suspension.....	6
6.10 Neutralizing solution.....	6
6.11 Enumeration agar (EA).....	6
6.12 Agar for printing.....	7
6.13 Cryoprotective solution for bacterial species.....	7
6.14 Stock solution of ATP standard reagent.....	7
6.15 Buffer solution for ATP luminescent reagent.....	7
6.16 ATP luminescent reagent.....	8
6.17 ATP extracting reagent.....	8
6.18 ATP eliminating reagent.....	8
6.19 SCDLP or other medium for preparing ATP reference solution.....	9
6.20 Shake-out physiological saline.....	9
7 Reference strains	9
7.1 Strains.....	9
7.2 Restoration and storage of strains.....	9
7.2.1 General.....	9
7.2.2 Ceramic bead method.....	9
7.2.3 Glycerol suspension method.....	10
8 Test procedures	10
8.1 Absorption method (see Annex E).....	10
8.1.1 Incubation of test strain.....	10
8.1.2 Preparation of test inoculum.....	11
8.1.3 Preparation of test specimens.....	11
8.1.4 Test operation.....	12
8.1.5 Test results.....	13
8.2 Transfer method (see Annex E).....	14
8.2.1 Preparation of test inoculum.....	14
8.2.2 Preparation of specimens.....	15
8.2.3 Test operation.....	15
8.2.4 Test results.....	16
8.3 Printing method (see Annex E).....	17
8.3.1 Incubation of test strain.....	17
8.3.2 Preparation of test inoculum.....	18

8.3.3	Pretreatment of specimen	18
8.3.4	Test operation.....	18
8.3.5	Test results.....	21
9	Judgement of antibacterial efficacy.....	21
10	Test report.....	21
Annex A	(normative) Strain numbers.....	23
Annex B	(normative) Shaking method	24
Annex C	(normative) Quantitative measurement by plate count method.....	25
Annex D	(normative) Quantitative measurement by luminescence method.....	26
Annex E	(informative) Testing examples.....	28
Annex F	(informative) Efficacy of antibacterial activity.....	31
Bibliography	32

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 38, *Textiles*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 248, *Textiles and textile products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition ([ISO 20743:2013](http://www.iso.org/iso/20743:2013)), which has been technically revised.

The main changes compared to the previous edition are as follows:

- [Clause 2](#) has been updated;
- some NOTES have been changed to regular text;
- [Annex F](#) has been updated.

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.

Introduction

Specialty products of antibacterial-treated textiles have been introduced in the market and are expanding year by year in various applications. These textiles meet the consumer's requirement to seek prevention of, and protection from, the negative effects caused by bacteria, which in turn secures the quality of life.

This established a substantial need for an International Standard which covers test methods to determine the antibacterial activity for antibacterial textile products.

A qualitative test method for antibacterial activity was developed as [ISO 20645](#). At the time, there were no testing standards for the quantitative method which gives more objective information for the antibacterial activity of the textile products.

Although there are 6 ways for the combination of inoculation methods and quantitative measurements to execute this test, the choice of the ways depends on the user's availability and consensus between the concerned parties.

Textiles — Determination of antibacterial activity of textile products

1 Scope

This document specifies quantitative test methods to determine the antibacterial activity of all antibacterial textile products including nonwovens.

This document is applicable to all textile products, including cloth, wadding, thread and material for clothing, bedclothes, home furnishings and miscellaneous goods, regardless of the type of antibacterial agent used (organic, inorganic, natural or man-made) or the method of application (built-in, after-treatment or grafting).

This document covers three inoculation methods for the determination of antibacterial activity:

- a) absorption method (an evaluation method in which the test bacterial suspension is inoculated directly onto specimens);
- b) transfer method (an evaluation method in which test bacteria are placed on an agar plate and transferred onto specimens);
- c) printing method (an evaluation method in which test bacteria are placed on a filter and printed onto specimens).

NOTE Based on the intended application and on the environment in which the textile product is to be used, and also on the surface properties of the textile properties, the user can select the most suitable inoculation method.

This document also specifies the colony plate count method and the adenosine triphosphate (ATP) luminescence method for measuring the enumeration of bacteria.

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 6330](#), *Textiles — Domestic washing and drying procedures for textile testing*

3 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

control fabric

fabric used to validate the growth condition of test bacteria and validate the test

Note 1 to entry: The same fabric as the fabric to be tested but without antibacterial treatment or a 100 % cotton fabric without fluorescent brighteners or other finish can be used.

3.2
antibacterial agent

product designed to prevent or mitigate the growth of bacteria, to reduce the number of bacteria or to kill bacteria

3.3
antibacterial finish

treatment designed to prevent or mitigate the growth of bacteria, to reduce the number of bacteria or to kill bacteria

3.4
antibacterial activity

activity of an *antibacterial finish* (3.3) used to prevent or mitigate the growth of bacteria, to reduce the number of bacteria or to kill bacteria

3.5
plate count method

method in which the number of bacteria present after incubation is calculated by counting the number of colonies according to a ten-time dilution method

Note 1 to entry: The results are expressed in "CFU (Colony Forming Unit)".

3.6
luminescence method

method in which the amount of ATP contained in bacterial cells is measured

Note 1 to entry: The results are expressed in "moles of ATP".

3.7
neutralizer

chemical agents used to inactivate, neutralize or quench the antibacterial properties of *antibacterial agents* (3.2)

4 Safety precaution

The test methods specified in this document require the use of bacteria.

These tests should be carried out by persons with training and experience in the use of microbiological techniques.

Appropriate safety precautions should be observed with due consideration given to country-specific regulations.

5 Apparatus

Usual laboratory apparatus and, in particular, the following.

5.1 Spectrophotometer, capable of measuring at a 620 nm to 660 nm wavelength, or McFarland's nephelometer.

5.2 Incubator, capable of maintaining a constant temperature of 37 °C ± 2 °C.

5.3 Water baths, one capable of maintaining a constant temperature of 46 °C ± 2 °C and another capable of maintaining a temperature of 70 °C to 90 °C.

5.4 Mixer, producing a vortex shaking action.

- 5.5 Stomacher**, capable of speeds of 6 blows per second to 8 blows per second, with the corresponding disposable containers.
- 5.6 Clean bench**, for microbial test.
- 5.7 Washing machine**, in accordance with the specifications of [ISO 6330](#).
- 5.8 Humidity chamber**, tropical chamber or other container capable of maintaining a high-humidity more than 70 % RH atmospheric condition.
- 5.9 Luminescence photometer**, capable of measuring ATP of 10^{-12} mol/l to 10^{-7} mol/l at 300 nm to 650 nm with a luminescence-measuring reagent.
- 5.10 Printing apparatus**, capable of applying a 4 N load to a test specimen and rotating the specimen 180° in one direction for a period of 3,0 s.
- 5.11 Refrigerator**, capable of maintaining a temperature of between 2 °C and 8 °C.
- 5.12 Freezers**, one adjustable to a temperature below -70°C and another to a temperature below -20°C .
- 5.13 Balance**, with the resolution of 0,01 g or better and 0,1 mg or better
- 5.14 Filtering apparatus**, consisting of an upper container equipped with a membrane filter and a lower container equipped with a suction opening.
- 5.15 Pipette**, having the most suitable volume for each use, with a tip made of glass or plastic, and with a tolerance of 0,5 % or less.
- 5.16 Vials, 30 ml glass bottles**, with screw openings, polytetrafluoroethylene or silicone packing and caps made of polypropylene, polycarbonate or another suitable material.
- 5.17 Petri dishes**, that have been sterilized, made of glass or plastic, in diameter sizes of 90 mm to 100 mm or 55 mm to 60 mm.
- 5.18 Glass rod**, with a diameter of approximately 18 mm.
- 5.19 Anti-bumping granules (glass beads)**, with a diameter of 3 mm to 4 mm.
- 5.20 Erlenmeyer flask**, of capacity 100 ml.
- 5.21 Cutting template**, made of a sterilizable material (stainless steel or glass) one with a diameter of $38\text{ mm} \pm 1\text{ mm}$ and the other with the diameter $60\text{ mm} \pm 1\text{ mm}$.
- 5.22 Disposable plastic bags**, sterile bags suitable for containing food products, to be used for one of the shaking methods of the specimens.
- 5.23 Tweezers**, made of a material which can be sterilized.
- 5.24 Stainless-steel cylinder**, with a mass of $200\text{ g} \pm 10\text{ g}$ and a diameter of $35\text{ mm} \pm 1\text{ mm}$.
- 5.25 Metal wire basket**, for autoclaving.

- 5.5 Stomacher**, capable of speeds of 6 blows per second to 8 blows per second, with the corresponding disposable containers.
- 5.6 Clean bench**, for microbial test.
- 5.7 Washing machine**, in accordance with the specifications of [ISO 6330](#).
- 5.8 Humidity chamber**, tropical chamber or other container capable of maintaining a high-humidity more than 70 % RH atmospheric condition.
- 5.9 Luminescence photometer**, capable of measuring ATP of 10^{-12} mol/l to 10^{-7} mol/l at 300 nm to 650 nm with a luminescence-measuring reagent.
- 5.10 Printing apparatus**, capable of applying a 4 N load to a test specimen and rotating the specimen 180° in one direction for a period of 3,0 s.
- 5.11 Refrigerator**, capable of maintaining a temperature of between 2 °C and 8 °C.
- 5.12 Freezers**, one adjustable to a temperature below -70°C and another to a temperature below -20°C .
- 5.13 Balance**, with the resolution of 0,01 g or better and 0,1 mg or better
- 5.14 Filtering apparatus**, consisting of an upper container equipped with a membrane filter and a lower container equipped with a suction opening.
- 5.15 Pipette**, having the most suitable volume for each use, with a tip made of glass or plastic, and with a tolerance of 0,5 % or less.
- 5.16 Vials, 30 ml glass bottles**, with screw openings, polytetrafluoroethylene or silicone packing and caps made of polypropylene, polycarbonate or another suitable material.
- 5.17 Petri dishes**, that have been sterilized, made of glass or plastic, in diameter sizes of 90 mm to 100 mm or 55 mm to 60 mm.
- 5.18 Glass rod**, with a diameter of approximately 18 mm.
- 5.19 Anti-bumping granules (glass beads)**, with a diameter of 3 mm to 4 mm.
- 5.20 Erlenmeyer flask**, of capacity 100 ml.
- 5.21 Cutting template**, made of a sterilizable material (stainless steel or glass) one with a diameter of $38\text{ mm} \pm 1\text{ mm}$ and the other with the diameter $60\text{ mm} \pm 1\text{ mm}$.
- 5.22 Disposable plastic bags**, sterile bags suitable for containing food products, to be used for one of the shaking methods of the specimens.
- 5.23 Tweezers**, made of a material which can be sterilized.
- 5.24 Stainless-steel cylinder**, with a mass of $200\text{ g} \pm 10\text{ g}$ and a diameter of $35\text{ mm} \pm 1\text{ mm}$.
- 5.25 Metal wire basket**, for autoclaving.

6.4 Agar for transfer

Tryptone, pancreatic digest of casein	0,75 g
Soya peptone, papain digest of soya	0,25 g
Sodium chloride (NaCl)	5 g
Agar	15 g
Water	1 000 ml
Mix well and adjust pH, then sterilize by autoclave (5.28).	7,2 ± 0,2

6.5 Nutrient broth (NB)

Beef extract	3 g
Peptone	5 g
Water	1 000 ml
Mix well and adjust pH, then sterilize by autoclave (5.28).	6,9 ± 0,2

6.6 Peptone salt solution

Peptone, pancreatic digest of casein	1 g
Sodium chloride (NaCl)	8,5 g
Water	1 000 ml
Mix well and adjust pH, then sterilize by autoclave (5.28).	6,9 ± 0,2

6.7 Physiological saline

Sodium chloride (NaCl)	8,5 g
Water	1 000 ml
Mix well, then sterilize by autoclave (5.28).	

6.8 Soybean-Casein Digest Broth with Lecithin & Polysorbate 80 (SCDLP) medium

Peptone, digest of casein	17 g
Peptone, digest of soybean	3 g
Sodium chloride (NaCl)	5 g
Dipotassium hydrogenphosphate	2,5 g
Glucose	2,5 g

Lecithin	1 g
Polysorbate 80	7 g
Water	1 000 ml
Mix well and adjust pH,	7,2 ± 0,2

then sterilize by autoclave ([5.28](#)).

If the neutralizing power is insufficient, the content of polysorbate 80 or lecithin may be adjusted or another neutralizing agent may be added. The use of any unspecified neutralizer shall be recorded along with the name and concentration.

6.9 Dilution buffer for shake-out bacterial suspension

This buffer solution consists of 0,005 mol/l sodium dihydrogenphosphate containing 0,037 % sucrose.

pH	7,2 ± 0,2
----	-----------

6.10 Neutralizing solution

The composition of the standard neutralizing solution shall be as follows.

Polysorbate 80	30 g
Egg-yolk lecithin	3 g
Histidine hydrochloride	1 g
Meat or casein peptone	1 g
Sodium chloride (NaCl)	4,3 g
Monopotassium phosphate	3,6 g
Disodium phosphate dihydrate	7,2 g
Water	1 000 ml

Mix well and sterilize by autoclave ([5.28](#)).

If the neutralizing power is insufficient, the content of polysorbate 80 or lecithin may be adjusted or another neutralizing agent may be added. The use of any unspecified neutralizer shall be recorded along with the name and concentration.

6.11 Enumeration agar (EA)

Dehydrated yeast extract	2,5 g
Casein tryptone	5,0 g
Glucose	1,0 g
Agar	12 g to 18 g (depending on the gel strength of the product)
Water	1 000 ml
Mix well and adjust pH,	7,2 ± 0,2

then sterilize by autoclave ([5.28](#)).

6.12 Agar for printing

Agar	20 g
Water	1 000 ml

Mix well and sterilize by autoclave (5.28).

6.13 Cryoprotective solution for bacterial species

For freezing, a cryoprotective solution containing 150 g/l of glycerol or 100 g/l of dimethylsulfoxide shall be used and prepared as follows

TSB (6.2) or NB (6.5): 1 000 ml

Add,

Glycerol: 150 g

or

dimethylsulfoxide: 100 g

Mix well and sterilize by autoclave (5.28).

For solutions containing glycerol, sterilize the mixed solution by autoclave (5.28). For solutions containing dimethylsulfoxide, sterilize the mixed solution by using 0,22 µm membrane filter.

Any commercially available product can be used as long as it is a cryoprotective solution or preserving system that contains glycerol or dimethylsulfoxide and allows preservation of the strains in the same manner as the specified solutions.

6.14 Stock solution of ATP standard reagent

The concentration of ATP standard reagent is 1×10^{-4} mol/l which is obtained by the following mixing.

Adenosine-disodium 5'-triphosphate trihydrate	60,5 mg
Water	1 000 ml (final volume)

After preparation, the solution shall be placed in a tightly sealed container and cryopreserved at a temperature of -20 °C or lower. The solution shall be used no later than 6 months from the date of preparation.

The suitable amount of adenosine-disodium 5'-triphosphate trihydrate can be calculated from the ATP content of each commercial product.

6.15 Buffer solution for ATP luminescent reagent

N-[Tris (hydroxymethyl) methyl] glycine	1 117 mg
Ethylenediamine disodium tetraacetate dihydrate	183 mg
Magnesium acetate tetrahydrate	808 mg
DL-dithiothreitol	6,7 mg

Dextrin	25 000 mg
Sucrose	925 mg
Water	250 ml (final volume)
pH	7,5 ± 0,2

6.16 ATP luminescent reagent

Luciferase (EC: 1.13.12.7)	16,0 mg
D-luciferin	12,6 mg
Bovine serum albumin	56 mg
Buffer solution (6.15)	30 ml

Once fully dissolved, let sit at room temperature for 15 min before use. Use within 3 h of preparation.

When a different ATP luminescent reagent is used, its composition shall be recorded.

6.17 ATP extracting reagent

<i>N</i> -[Tris (hydroxymethyl) methyl] glycine	45 mg
10 % aqueous benzalkonium chloride	0,2 ml
Water	9,8 ml
pH	12,0 ± 0,5

When a different ATP extraction reagent is used, its composition shall be recorded.

6.18 ATP eliminating reagent

An agent to reduce the ATP in NB (6.5) to less than 10⁻¹³ mol/l within 15 min.

Use within 8 h of preparation.

Apyrase (EC: 3.6.1.5)	4,6 international units/ml
Adenosine phosphate deaminase (EC: 3.5.4.6 or EC 3.5.4.17)	46 international units/ml
Sucrose	37 mg
Bovine serum albumin	20 mg
0,05 mol/l buffer solution of 2-morpholinoethanesulfonicacid, monohydrate	10 ml
pH	6,0 ± 0,5

When a different eliminating reagent is used, its composition shall be recorded.

NOTE Commercially available reagent.

6.19 SCDLP or other medium for preparing ATP reference solution

SCDLP (6.8) or other medium	10 ml
ATP eliminating agent (6.18)	1 ml

After mixing, maintain at 30 °C to 37 °C for 1 h to prevent microbiological contamination.

Next, transfer to a hot-water bath at 70 °C to 90 °C for 1 h and cool down to room temperature.

Preserve the solution under refrigeration and use within 24 h.

An ATP reference solution should be prepared if the addition of neutralizing agents causes the ATP content in the shake-out solution to exceed 10^{-11} mol/l.

6.20 Shake-out physiological saline

Sodium chloride (NaCl)	8,5 g
Polysorbate 80	2,0 g
Water	1 000 ml

Mix well and sterilize by autoclave ([5.28](#)).

7 Reference strains

7.1 Strains

The following strains shall be used in all antibacterial activity tests. The strain numbers shall be as described in [Annex A](#).

- *Staphylococcus aureus*
- *Klebsiella pneumoniae*

7.2 Restoration and storage of strains

7.2.1 General

The strains shall be restored and stored in accordance with the supplier's recommendations.

Alternatively, the preservation method as described in [EN 12353](#) can also be used.

7.2.2 Ceramic bead method

From a sample of the freeze-dried bacterial strain and following the recommendations supplied with the culture, resuspend it in 5 ml of TSB ([6.2](#)). Take sample of the suspension and isolate it in a Petri dish ([5.17](#)) containing TSA ([6.3](#)). Incubate the cultures for 18 h to 24 h at $37\text{ °C} \pm 2\text{ °C}$.

After incubation, use the culture isolated in the Petri dish to verify the purity of the strain.

After verification, prepare the stock cultures.

Sample 0,7 ml of the broth culture and spread it over the surface of the Petri dish containing the TSA. Incubate the culture on plates for 18 h to 24 h at $37\text{ °C} \pm 2\text{ °C}$.

Add 10 ml of cryoprotective solution (6.13) to the surface of the TSA plate culture and resuspend the cells in the solution using a sterile glass spreader. Sample the suspended cells from the surface of the agar, dilute them in 100 ml of cryoprotective solution and incubate for 30 min at 20 °C.

Using a pipette (5.15), sample 1 ml of the suspension and transfer it to a cryogenic vial (5.16) containing the beads (5.19). Shake the vial in order to spread the suspended cells around the beads.

- Where a cryoprotective solution containing dimethylsulfoxide is used, do not let it stand longer than 1 min at ambient temperature.
- Where a cryoprotective solution containing glycerol is used, let it stand for 30 min at 20 °C.
- Withdraw the excess cryoprotective solution with a sterile pipette. Place the cryogenic vials in a freezer (5.12) set at -70 °C or lower.

Prepare 10⁻⁶ and 10⁻⁷ dilutions of the suspension using the serial dilution method. Take a 1,0 ml sample of each dilution and transfer it to separate Petri dishes. Add 12 ml to 15 ml of nutritive solution, cooled down to 45 °C ± 1 °C. Incubate for 18 h to 24 h under the conditions specified for the strain. Enumerate the plate cultures and confirm that the suspension contains less than 5 × 10⁸ CFU/ml.

Store the cryogenic vials in a freezer at a temperature below -70 °C.

7.2.3 Glycerol suspension method

Inoculate a 15 ml culture tube containing 5 ml of appropriate medium with a freshly grown isolated colony. Incubate, usually, for 5 h to overnight at 37 °C until the bacteria culture seems to reach the late logarithm or stationary phase in the growth curve.

For each strain to be stored below -70 °C, for the archives, prepare a sterile, labelled cryogenic vial. Place 225 µl of sterile 80 % glycerol in a cryogenic vial. Add 1,0 ml of the bacterial culture (frozen stock shall be 15 % glycerol). Mix well using the vortex mixer (5.4) and store in a tube at -70 °C or lower.

For each strain to be stored at -20 °C, as liquid glycerol working stock, pipette equal volumes of 80 % glycerol and bacterial culture into a labelled polypropylene tube. Mix the contents well to avoid formation of ice crystals that will decrease the viability of the cells. Place the tube in a freezer at -20 °C. Check the viability of the cells after 1 week if possible.

To recover a strain from the glycerol stock stored below -70 °C, use a sterile toothpick to scrape pieces of the solid substance, then streak the cells onto the appropriate medium. The frozen stock shall not be thawed because each freeze-thaw cycle will result in a 50 % loss in cell viability.

To use the -20 °C working stock, pipette 50 µl to 100 µl as inoculum for a 5 ml overnight culture.

8 Test procedures

8.1 Absorption method (see Annex E)

8.1.1 Incubation of test strain

8.1.1.1 Obtain the strain preserved as stock culture using an inoculating loop, streak onto the plate of EA (6.11) or TSA (6.3) and incubate at 37 °C ± 2 °C for 24 h to 48 h.

The plate is kept at 5 °C to 10 °C and should be used within 1 week from the date of preparation.

8.1.1.2 Pour 20 ml of NB (6.5) or TSB (6.2) into a 100 ml Erlenmeyer flask. Apply an inoculating loop to pick one colony up from the incubation as specified in 8.1.1.1 and inoculate it in the broth. Incubate under the following conditions:

Temperature: 37 °C ± 2 °C

Rate of shaking: 110 min⁻¹ and 3 cm width by reciprocal incubation shaker (5.27)

Incubation time: 18 h to 24 h

8.1.1.3 Pour 20 ml of NB (6.5) or TSB (6.2) into a 100 ml Erlenmeyer flask. Add 0,4 ml of the inoculum from the incubation as specified in 8.1.1.2 that contains 1 × 10⁸ CFU/ml to 3 × 10⁸ CFU/ml in bacteria concentration or an ATP concentration of 1 × 10⁻⁶ mol/l to 3 × 10⁻⁶ mol/l to the flask and incubate under the following conditions:

Temperature: 37 °C ± 2 °C

Rate of shaking: 110 min⁻¹ and 3 cm width by reciprocal incubation shaker (5.27)

Incubation time: 3 h ± 1 h

Target CFU or ATP concentration after incubation: 10⁷ CFU/ml or 10⁻⁷ mol/l.

The prepared inoculum shall be preserved by ice-cooling and used within 8 h.

8.1.2 Preparation of test inoculum

Adjust the bacteria to a concentration of 1 × 10⁵ CFU/ml to 3 × 10⁵ CFU/ml by a spectrophotometer or McFarland's nephelometer (5.1);

or

adjust the ATP to a concentration of 1 × 10⁻⁹ mol/l to 3 × 10⁻⁹ mol/l by the luminescence method using NB (6.5) or TSB (6.2) after it has been diluted 20 times with water at room temperature.

The prepared inoculum shall be preserved by ice-cooling and used within 4 h.

8.1.3 Preparation of test specimens

8.1.3.1 Mass and shape of test specimens

8.1.3.1.1 Obtain test specimens with a mass of 0,40 g ± 0,05 g and cut to a suitable size for test specimens.

8.1.3.1.2 Obtain six test specimens of the antibacterial testing sample and six test specimens of the control fabric or untreated fabric if available.

Three of the control specimens and three of the antibacterial testing specimens are used for zero time, immediately after inoculation. The remaining six specimens are used for the contact time after 18 h to 24 h incubation.

8.1.3.2 Setting the test specimen

Place each of the test specimens in separate vials by selecting the following method appropriate to the nature of the test sample.

- a) If specimens tend to curl easily, or if it contains wadding or down, place a glass rod (5.18) onto the specimen in the vial. Alternatively, lace up both ends of the specimen with thread.
- b) If the specimen is yarn, arrange the yarn in a bundle and place a glass rod onto the specimen in the vial.

- c) If the specimen is from a carpet or a similar construction, cut the pile and place a glass rod onto the specimen in the vial.

When necessary, test samples may be washed in accordance with [ISO 6330](#) or another suitable method, and after the final washing, the samples are rinsed with water to eliminate the washing detergent. The use of an unspecified method shall be recorded.

8.1.3.3 Sterilization

8.1.3.3.1 General

When contamination is suspected or was found, sterilize test specimens by autoclave ([5.28](#)) according to the following procedure.

8.1.3.3.2 Procedure

8.1.3.3.2.1 Wrap the opening of vials containing specimens with aluminium foil ([5.26](#)).

8.1.3.3.2.2 Place the wrapped vials in a metal wire basket ([5.25](#)) for autoclaving.

8.1.3.3.2.3 Wrap the vial caps with aluminium foil and place them in the wire basket.

8.1.3.3.2.4 Sterilize the caps and the vials containing the test specimens by autoclave for 15 min to 20 min.

8.1.3.3.2.5 After sterilization, remove the aluminium foil and allow the specimens in the vials to dry for 60 min or more by placing them on a clean bench ([5.6](#)) or any other place where there is no risk of airborne contamination.

8.1.3.3.2.6 Cap the vials securely.

When autoclaving is not possible, sterilization may be accomplished by ethylene oxide gas, γ -ray or another suitable method. The use of alternative methods shall be recorded.

8.1.4 Test operation

8.1.4.1 Inoculation of test specimens

Accurately pipette 0,2 ml of the inoculum prepared in [8.1.2](#) at several points on each test specimen prepared in [8.1.3.2](#) to ensure that no inoculum touches the surface of the vial and cap the vials.

8.1.4.2 Shake-out after inoculation

Immediately after the inoculation of [8.1.4.1](#), add 20 ml of SCDLP medium ([6.8](#)) or the neutralizing solution ([6.10](#)) or the shake-out physiological saline ([6.20](#)) into each of the six vials in which a control specimen and an antibacterial testing specimen have been placed, cap the vials and shake out as specified in [Annex B](#) by hand or mixer ([5.4](#)) or stomacher ([5.5](#)) by transferring specimen a sterile bag ([5.22](#)).

8.1.4.3 Incubation

Incubate the six vials (three control specimens, three testing specimens) at $37\text{ °C} \pm 2\text{ °C}$ for 18 h to 24 h.

8.1.4.4 Shake-out after incubation

After the incubation of 8.1.4.3, add 20 ml of SCDLP medium (6.8) or of the neutralizing solution (6.10) or the shake-out physiological saline (6.20) to each of the six vials, cap the vials and shake out as specified in Annex B by hand or mixer (5.4) or stomacher (5.5) by transferring the specimen in a sterile bag (5.22).

8.1.4.5 Calculation of number of bacteria or amount of ATP

8.1.4.5.1 General

Obtain the number of bacteria or amount of the ATP as specified in 8.1.4.2 and 8.1.4.4 from the bacteria concentration or the ATP concentration obtained by the quantitative measurement methods in Annex C or Annex D according to Formulae (1) and (2).

NOTE ATP measuring device measures both living bacteria and dead bacteria.

8.1.4.5.2 Number of bacteria

$$M = c_B \times 20 \quad (1)$$

where

- M is the number of bacteria per specimen;
- c_B is the bacteria concentration obtained in Annex C;
- 20 is the volume of the shake-out solution, in millilitres (ml).

8.1.4.5.3 Amount of ATP

$$M' = c_{ATP'} \times 20 \quad (2)$$

where

- M' is the amount of ATP per specimen;
- $c_{ATP'}$ is the ATP concentration obtained in Annex D;
- 20 is the volume of the shake-out solution, in millilitres (ml).

8.1.5 Test results

8.1.5.1 Judgement of test effectiveness with the control specimen

When the conditions of a), b) and c) or a), b) and d) are satisfied, the test is judged to be effective. When the test is judged to be ineffective, a retest shall be carried out.

- a) The test inoculum of 8.1.2 shall be 1×10^5 CFU/ml to 3×10^5 CFU/ml or the ATP concentration shall be 1×10^{-9} mol/l to 3×10^{-9} mol/l.
- b) The difference in common logarithm in extremes of the number of bacteria, or the amount of ATP for the three control specimens immediately after inoculation and after incubation, respectively, shall be less than one.
- c) The growth value obtained according to the following formula shall be equal or more than 1,0 in the plate count method.
- d) The growth value obtained according to Formula (3) shall be equal or more than 0,5 in the luminescence method.

$$F = \lg C_t - \lg C_0 \quad (3)$$

where

- F is the growth value on the control specimen;
- $\lg C_t$ is the common logarithm of arithmetic average of the numbers of bacteria, or the amount of ATP, obtained from three control specimens after an 18 h to 24 h incubation;
- $\lg C_0$ is the common logarithm of arithmetic average of the numbers of bacteria, or the amount of ATP, obtained from three control specimens immediately after inoculation.

8.1.5.2 Calculation of antibacterial activity value

When the condition in the next paragraph is satisfied, the test is judged to be effective. When the test is judged to be ineffective, a retest shall be carried out.

The difference in common logarithm in extreme of the number of bacteria, or the amount of ATP for the three antibacterial testing specimens immediately after inoculation and after incubation, respectively, shall be less than two.

To validate the test, it is necessary that the difference in logarithm of extremes for the specimens of the treated sample is less than 2 after inoculation and incubation. To repeat the testing because the neutralizer is not effective, it is necessary to know from the manufacturer how to neutralize the antibacterial agent.

When the test has been judged to be effective, obtain the antibacterial activity value according to [Formula \(4\)](#), in case of $C_0 > T_0$, substitute C_0 for T_0 .

$$A = (\lg C_t - \lg C_0) - (\lg T_t - \lg T_0) = F - G \quad (4)$$

where

- A is the antibacterial activity value;
- F is the growth value on the control specimen ($F = \lg C_t - \lg C_0$);
- G is the growth value on the antibacterial testing specimen ($G = \lg T_t - \lg T_0$);
- $\lg T_t$ is the common logarithm of arithmetic average of the numbers of bacteria, or the amount of ATP, obtained from three antibacterial testing specimens after an 18 h to 24 h incubation;
- $\lg T_0$ is the common logarithm of arithmetic average of the numbers of bacteria, or the amount of ATP, obtained from three antibacterial testing specimens immediately after inoculation.

8.2 Transfer method (see Annex E)

8.2.1 Preparation of test inoculum

8.2.1.1 Incubation of test strain

Obtain the strain preserved as stock culture using an inoculating loop, streak onto the plate of TSA ([6.3](#)) and incubate at $37\text{ °C} \pm 2\text{ °C}$ for 18 h to 24 h. After incubation, extract a colony from the plate, streak onto another plate of TSA and incubate at $37\text{ °C} \pm 2\text{ °C}$ for 18 h to 24 h.

NOTE The second transfer constitutes the working culture(s).

When inoculation cannot be completed within a single day, a 48-h culture may be used for the subsequent inoculation, provided that the culture is stored in an incubator ([5.2](#)) for 48 h. In this event, a new 24-h subculture shall be prepared prior to performing the test. A fourth subculture shall not be used.

8.2.1.2 Preparation of test inoculum

Obtain a colony from the second transferred TSA using an inoculating loop, place it in the Peptone-salt solution (6.6) and mix well with the vortex mixer (5.4). Adjust the number of bacteria to a concentration of 1×10^8 CFU/ml to 3×10^8 CFU/ml or an ATP concentration of 2×10^{-7} mol/l to 6×10^{-7} mol/l using the Peptone-salt solution (6.6) by the spectrophotometer or McFarland's nephelometer (5.1) or luminescence method. Dilute the inoculum to a concentration of 1×10^6 CFU/ml to 3×10^6 CFU/ml or an ATP concentration of 2×10^{-9} mol/l to 6×10^{-9} mol/l using the Peptone-salt solution (6.6). The final number of bacteria shall be checked by the quantitative measurement method specified in Annex C and Annex D.

8.2.2 Preparation of specimens

Cut the test specimens by using a template with the diameter $38 \text{ mm} \pm 1 \text{ mm}$ (5.21).

The test specimens shall not contain any seams, selvages, embroidery, fasteners, etc.

A sufficient number of specimens should be prepared to allow for repeat tests, with a minimum of $0,5 \text{ m}^2$ in size from the same batch and without from selvages or stemming.

When necessary, test samples may be washed in accordance with ISO 6330 or another suitable method, and after the final washing, the samples are rinsed with water to eliminate the washing detergent. The use of an unspecified method shall be recorded.

When contamination is suspected or was found, the specimens for test shall be sterilized by autoclave (5.28). The ethylene oxide gas, γ -ray or any other suitable method can be used with recording in the test report.

8.2.3 Test operation

8.2.3.1 Inoculation to agar plates

Prepare 12 plates of the agar for transfer (6.4). Inoculate 1 ml of the test inoculum of 8.2.1.2 on the agar, inclining the plate in several directions so as to completely flood the surface of the plate. Suck up as much of the excess liquid as possible. Let stand for $5 \text{ min} \pm 30 \text{ s}$.

8.2.3.2 Transfer to specimens

Prepare three control specimens and three antibacterial testing specimens for using immediately after transfer (six specimens) and after incubation (six specimens), respectively. Set each specimen on the agar surface of 8.2.3.1 and weigh down with a 200 g stainless-steel cylinder (5.24) for $60 \text{ s} \pm 5 \text{ s}$. Place each specimen in a 55 mm to 60 mm in diameter Petri dish (5.17) with the transferred surface face up. Incubate in a humidity chamber (5.8) for 18 h to 24 h at $37 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$.

8.2.3.3 Shake-out after transfer

Immediately after transfer, place each specimen in a sterile bag or a vial containing 20 ml of the neutralizing solution (6.10) and shake out as specified in Annex B by hand, mixer (5.4), or stomacher (5.5).

8.2.3.4 Shake-out after incubation

After incubation, place each specimen in a sterile bag or a vial containing 20 ml of the neutralizing solution (6.10) and shake out as specified in Annex B, by hand, mixer (5.4) or stomacher (5.5).

8.2.3.5 Calculation of number of bacteria or amount of ATP

8.2.3.5.1 General

Obtain the number of bacteria or the amount of ATP from [8.2.3.3](#) and [8.2.3.4](#) from the bacteria concentration or ATP concentration obtained by the quantitative measurement methods in [Annex C](#) and [Annex D](#) according to [Formulae \(5\)](#) and [\(6\)](#).

8.2.3.5.2 Number of bacteria

$$M = c_B \times 20 \quad (5)$$

where

- M is the number of bacteria per specimen;
- c_B is the bacteria concentration obtained in [Annex C](#);
- 20 is the volume of the shake-out solution, in millilitres (ml).

8.2.3.5.3 Amount of ATP

$$M' = c_{ATP'} \times 20 \quad (6)$$

where

- M' is the amount of ATP per specimen;
- $c_{ATP'}$ is the ATP concentration obtained in [Annex D](#);
- 20 is the volume of the shake-out solution, in millilitres (ml).

8.2.4 Test results

8.2.4.1 Judgement of test effectiveness with the control specimen

When the conditions of a), b) and c) or a), b) and d) are satisfied, the test is judged to be effective. When the test is judged to be ineffective, a retest shall be carried out.

- a) The test inoculum of [8.2.1.2](#) shall have a concentration of 1×10^6 CFU/ml to 3×10^6 CFU/ml or the ATP concentration shall be 2×10^{-9} mol/l to 6×10^{-9} mol/l.
- b) The difference in logarithm in extremes of the numbers of bacteria, or the amount of ATP for the three control fabrics immediately after transfer and after incubation, respectively, shall be less than one.
- c) The growth value obtained according to the following formula shall be equal or more than 1,0 in the plate count method.
- d) The growth value obtained according to [Formula \(7\)](#) shall be equal or more than 0,5 in the luminescence method.

$$F = \lg C_t - \lg C_0 \quad (7)$$

where

- $\lg C_t$ is the common logarithm of the arithmetic average of the numbers of bacteria or for the amount of ATP, obtained from three control specimens after an 18 h to 24 h incubation;

$\lg C_0$ is the common logarithm of the arithmetic average of the numbers of bacteria or for the amount of ATP, obtained from three control specimens immediately after transfer to the control fabric.

8.2.4.2 Calculation of antibacterial activity value

When the condition in the next paragraph is satisfied, the test is judged to be effective. When the test is judged to be ineffective, a retest shall be carried out.

The difference in common logarithm in extremes of the numbers of bacteria, or the amount of ATP for the three antibacterial testing specimens immediately after inoculation and after incubation, respectively, shall be less than two.

To validate the test, it is necessary that the difference in logarithm of extremes for the specimens of the treated sample is less than 2 after inoculation and incubation. To repeat the testing because the neutralizer is not effective, it is necessary to know from the manufacturer how to neutralize the antibacterial agent.

When the test has been judged to be effective, obtain the antibacterial activity value according to [Formula \(8\)](#):

$$A = (\lg C_t - \lg C_0) - (\lg T_t - \lg T_0) = F - G \quad (8)$$

where

A is the antibacterial activity value;

F is the growth value on the control specimen ($F = \lg C_t - \lg C_0$);

G is the growth value on the antibacterial testing specimen ($G = \lg T_t - \lg T_0$);

$\lg T_t$ is the common logarithm of the arithmetic average of the numbers of bacteria or for the amount of ATP, obtained from three antibacterial testing specimens after an 18 h to 24 h incubation;

$\lg T_0$ is the common logarithm of the arithmetic average of the numbers of bacteria or for the amount of ATP, obtained from three antibacterial testing specimens immediately after transfer.

8.3 Printing method (see Annex E)

8.3.1 Incubation of test strain

8.3.1.1 Obtain the strain preserved as stock culture using an inoculating loop, streak onto the plate of EA ([6.11](#)) or TSA ([6.3](#)) and incubate at $37\text{ °C} \pm 2\text{ °C}$ for 24 h to 48 h.

The plate is kept at 5 °C to 10 °C and should be used within 1 week from the date of preparation.

8.3.1.2 Pour 20 ml of NB ([6.5](#)) into a 100 ml Erlenmeyer flask. Apply an inoculating loop to pick one colony up from the incubation A as specified in [8.3.1.1](#) and inoculate it in the broth. Incubate under the following conditions:

Temperature: $37\text{ °C} \pm 2\text{ °C}$

Rate of shaking: 110 min^{-1} and 3 cm width by reciprocal incubation shaker ([5.27](#))

Incubation time: 18 h to 24 h

8.3.1.3 Pour 20 ml of NB ([6.5](#)) into a 100 ml Erlenmeyer flask. Add 0,4 ml of the inoculum from the incubation as specified in [8.3.1.2](#) that contains 1×10^8 CFU/ml to 3×10^8 CFU/ml in bacteria concentration or an ATP concentration of 1×10^{-6} mol/l to 3×10^{-6} mol/l to the flask and incubate under the following conditions:

Temperature: 37 °C ± 2 °C

Rate of shaking: 110 min⁻¹ and 3 cm width by reciprocal incubation shaker (5.27)

Incubation time: 3 h ± 1 h

Target CFU or ATP concentration after incubation: 10⁷ CFU/ml or 10⁻⁷ mol/l

The prepared inoculum shall be preserved by ice cooling and used within 8 h.

8.3.2 Preparation of test inoculum

Adjust the inoculum to a concentration of 1 × 10⁷ CFU/ml to 3 × 10⁷ CFU/ml by the spectrophotometer or McFarland's nephelometer (5.1) method or an ATP concentration of 1 × 10⁻⁷ mol/l to 3 × 10⁻⁷ mol/l by the luminescence method using a 20 times dilution with NB (6.5) at room temperature.

The prepared inoculum shall be preserved by ice cooling and used within 4 h.

8.3.3 Pretreatment of specimen

8.3.3.1 Sampling

When necessary, samples may be washed in accordance with ISO 6330 or another suitable method, and after the final washing, the samples are rinsed with water to eliminate the washing detergent. The use of an unspecified method shall be recorded.

Cut six control test specimens and six antibacterial test specimens by using a template with the diameter 60 mm ± 1 mm (5.21)

NOTE Three of the control specimens and three of the antibacterial testing specimens are used to measure the number of bacteria immediately after the printing of test bacteria. The remaining specimens are used to measure the number of bacteria after incubation (total of six).

8.3.3.2 Sterilization of test specimens

Place the specimens in a Petri dish (5.17), cover with aluminium foil and sterilize by autoclave (5.28) for 15 min to 20 min. After sterilizing, remove the foil, place on a clean bench (5.6) or any other place where there is no risk of airborne contamination and dry for 60 min or more.

When autoclaving is not possible, sterilization may be accomplished by ethylene oxide gas, γ -ray or another suitable method. The use of alternative methods shall be recorded.

8.3.3.3 Humidity conditioning of specimens

Pour 10 ml of the agar for printing (6.12) into a Petri dish (5.17). Place the uncovered dish on a clean bench (5.6) to cool and solidify. Cool to room temperature avoiding dew formation. When the agar solidifies, turn the dish upside down. Place the specimen on the inside of the dish lid and condition the humidity of the specimen for 18 h to 24 h in humidity chamber (5.8) at a temperature of 20 °C ± 2 °C and a humidity of more than 70 % RH.

8.3.4 Test operation

8.3.4.1 Filtering of test bacteria

Set a membrane filter on a filtering apparatus sterilized by autoclave on a clean bench (5.6).

Pour 5 ml of NB (6.5) after it has been diluted 20 times on the membrane filter, add 2 ml of the test inoculum prepared in 8.3.2, and filtrate under aspiration. Continue the aspiration for approximately 1 min after the liquid on the membrane filter disappears.

NOTE 1 The sterilization for the membrane filter is not carried out because the pore size is changed by sterilization.

NOTE 2 A sintered glass or polytetrafluoroethylene-coated net is placed under the membrane filter when using the filtering apparatus. An aspirator, small air pump or other simple apparatus is used for aspiration.

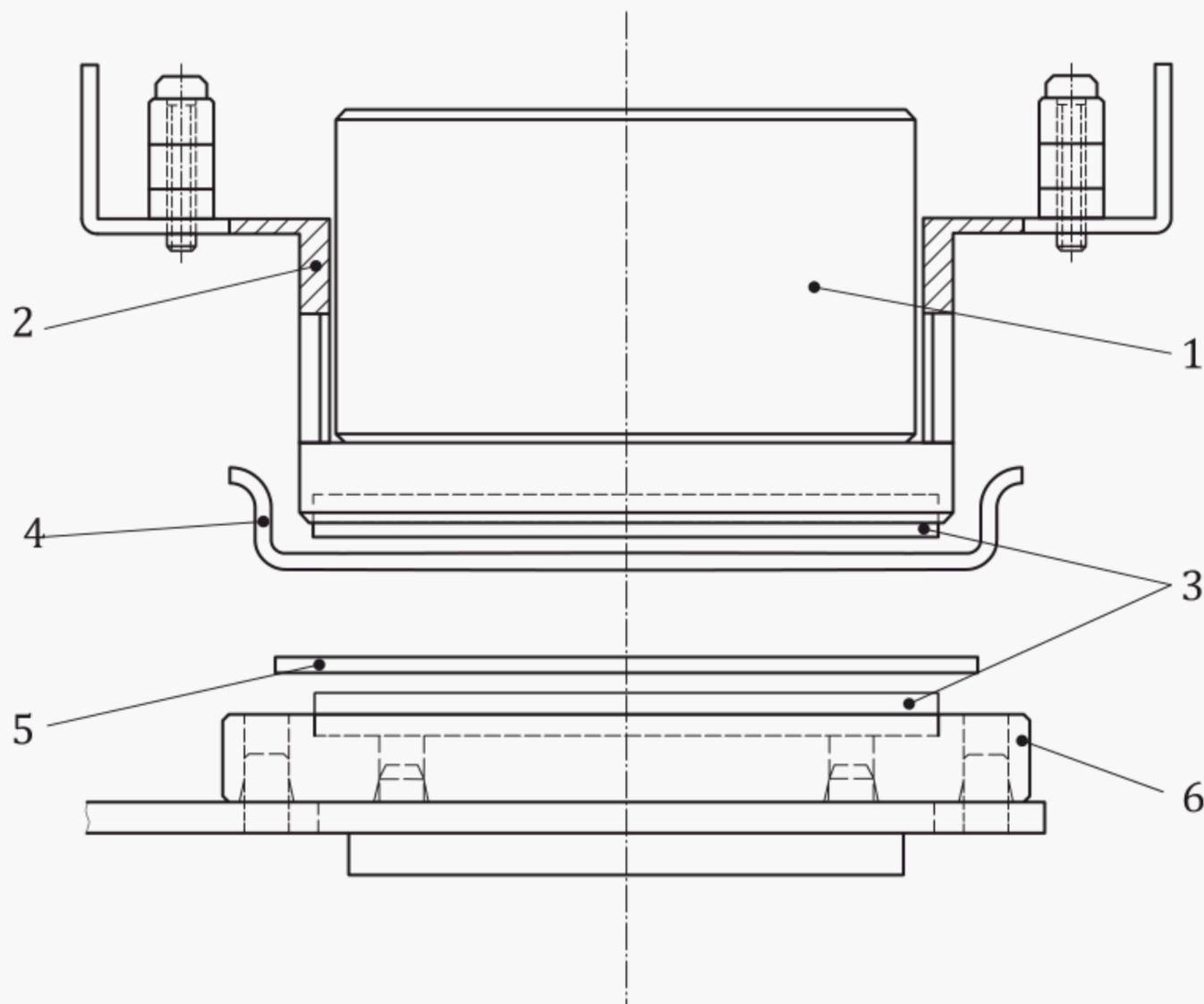
8.3.4.2 Printing of test bacteria

8.3.4.2.1 Remove the membrane filter collecting the test bacteria from the filtering apparatus using sterilized tweezers (5.23), place on the rotating table of the printing apparatus (5.10) with the bacteria facing upwards as shown in Figure 1.

8.3.4.2.2 Remove the specimen of 8.3.3.3 from the Petri dish (5.17) using sterilized tweezers (5.23). Place on the membrane filter facing downwards.

8.3.4.2.3 Place the weight on the weighting plate, and print the bacteria on the membrane filter by rotating the table by 180° in one direction for 3,0 s.

8.3.4.2.4 Immediately after printing, transfer the specimen to the lid for the Petri dish containing the agar of 8.3.3.3 with the printed surface facing upwards and let it stand for 1 h to 4 h in an incubator (5.2).



Key

- | | | | |
|---|---------------------------|---|---|
| 1 | weight (17 kg) | 4 | specimen (Ø 60 mm) |
| 2 | weighting plate | 5 | membrane filter (Ø 47 mm) |
| 3 | silicone rubber (Ø 42 mm) | 6 | turn plate (Ø 54 mm) (anticlockwise rotation) |

NOTE This figure illustrates the side of the printing apparatus (5.10). External dimensions: height 170 mm, width 160 mm, depth 150 mm.

Figure 1 — Printing apparatus¹⁾

8.3.4.3 Incubation test

Incubate the printed specimen in the Petri dish of 8.3.4.2.4 in an incubator (5.2) conditioned at $20\text{ °C} \pm 2\text{ °C}$ and 70 % RH or more for a period of $1,0\text{ h} \pm 0,1\text{ h}$, $2,0\text{ h} \pm 0,1\text{ h}$, $3,0\text{ h} \pm 0,1\text{ h}$, or $4,0\text{ h} \pm 0,1\text{ h}$. The incubation time is determined by specific test condition requirements which shall be recorded.

8.3.4.4 Shake-out after printing

Immediately after printing, transfer each specimen of the control fabric of 8.3.4.2 to a vial containing 20 ml of the SCDLP medium (6.8), and shake out the bacteria from each specimen as specified in Annex B by hand or mixer (5.4).

8.3.4.5 Shake-out after incubation

After incubation, transfer each specimen of 8.3.4.3 to a vial containing 20 ml of the SCDLP medium (6.8), and shake out the bacteria from each specimen as specified in Annex B by hand or mixer (5.4).

8.3.4.6 Calculation of number of bacteria or amount of ATP

8.3.4.6.1 General

Obtain the number of bacteria or amount of ATP from 8.3.4.4 and 8.3.4.5 from the bacteria concentration or ATP concentration obtained by the quantitative measurement methods in Annex C and Annex D according to Formulae (9) to (10).

8.3.4.6.2 Number of bacteria

$$M = c_B \times 20 \quad (9)$$

where

- M is the number of bacteria per specimen;
- c_B is the bacteria concentration obtained in Annex C;
- 20 is the volume of the shake-out solution, in millilitres (ml).

8.3.4.6.3 Amount of ATP

$$M' = c_{ATP} \times 20 \quad (10)$$

where

- M' is the amount of ATP per specimen;
- c_{ATP} is the ATP concentration obtained in Annex D;
- 20 is the volume of the shake-out solution, in millilitres (ml).

1) This apparatus is available from Aloka Co., Ltd. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

8.3.5 Test results

8.3.5.1 Judgement of test effectiveness

When the following two items are satisfied, the test is judged to be effective. When the test is judged to be ineffective, a retest shall be carried out.

- a) The number of test bacteria or amount of ATP printed on the control fabric shall not be less than $1,0 \times 10^6$ CFU or $1,0 \times 10^{-11}$ mol.
- b) The amount of increase or decrease on the control specimen, F , obtained according to [Formula \(11\)](#), shall be +0,5 to -0,5.

$$F = \lg C_t - \lg C_0 \quad (11)$$

where

- F is the value of increase or decrease on the control specimen;
- $\lg C_t$ is the common logarithm of the arithmetic average of the numbers of bacteria, or the average amount of ATP, obtained from three control specimens after a 1 h to 4 h incubation;
- $\lg C_0$ is the common logarithm of the arithmetic average of the numbers of bacteria, or the average amount of ATP, obtained from three control specimens immediately after printing.

8.3.5.2 Calculation of antibacterial activity value

When the test is determined to be effective, obtain the antibacterial activity value according to [Formula \(12\)](#):

$$A = \lg C_t - \lg T_t \quad (12)$$

where

- A is the antibacterial activity value;
- $\lg C_t$ is the common logarithm of the arithmetic average of the numbers of bacteria or for the average amount of ATP, obtained from three control specimens after a 1 h to 4 h incubation;
- $\lg T_t$ is the common logarithm of the arithmetic average of the numbers bacteria or for the average amount of ATP, obtained from three antibacterial testing specimens after a 1 h to 4 h incubation.

9 Judgement of antibacterial efficacy

The obtained value may be judged as the level of antibacterial efficacy as shown in [Annex F](#).

10 Test report

The test report shall contain the following information:

- a) a reference to this document, i.e. ISO 20743:2021;
- b) details of the test specimens;
- c) name of the test bacteria;
- d) strain number;
- e) inoculation method;

- f) concentration inoculum;
- g) antibacterial activity value;
- h) quantitative measurement method;
- i) any deviation from this document;
- j) date of test.

Annex A (normative)

Strain numbers

A.1 General

The bacteria to be used in the test shall be identical to those listed in [Table A.1](#), which are preserved by the members of the World Federation of Culture Collection (WFCC). The strains used in the test shall be stated in the test report together with their supply sources.

A.2 List of bacteria

Table A.1 — Bacteria for testing

Bacteria type	WDCM code
<i>Staphylococcus aureus</i>	00193 http://refs.wdcm.org/getinfo.htm?sid=WDCM_00193
<i>Klebsiella pneumoniae</i>	00192 http://refs.wdcm.org/getinfo.htm?sid=WDCM_00192
NOTE 1 Other bacteria can be used after appropriate validation.	
NOTE 2 Refer to WDCM ^a .	
^a World Data Centre for Microorganisms. Available at: http://refs.wdcm.org/search.htm	

Annex B (normative)

Shaking method

B.1 General

There are three methods to shake-out the bacteria from specimen, which are shaking by vortex mixer, shaking by hand and shaking by stomacher (5.5).

B.2 Shaking by vortex mixer

Press the bottom portion of the test tubes or bottles on the plate or rubber holder of the vortex mixer (5.4) and mix for 5 s in 5 cycles.

B.3 Shaking by hand

Take the test tube or bottle by hand and shake in an arc of approximately 300 mm for 30 s.

B.4 Shaking by Stomacher

Place the designated disposable bag (5.22) in the Stomacher machine (5.5) and run the machine for 1 min on each face of the bag.

Annex C (normative)

Quantitative measurement by plate count method

C.1 General

This annex specifies the test procedure for quantitative measurement by the plate count method.

C.2 Test procedure

C.2.1 Take 1 ml of the inoculum which is shake-out bacteria suspension from specimens using a pipette (5.15), add it to a test tube containing 9,0 ml ± 0,1 ml of NB (6.5) or the peptone-salt solution (6.6) and shake well.

C.2.2 Take 1 ml of this solution using a new pipette, add it to a separate test tube containing 9,0 ml ± 0,1 ml of the medium and shake well. Repeat the procedure successively and prepare a dilution series so that the dilutions are undertaken 5 times in total. If required, additional dilutions can be applied after agreement between interested parties. Ensure that 1 ml of each dilution is pipetted into two Petri dishes.

C.2.3 Warm approximately 15 ml of EA (6.11) or TSA (6.3) to a temperature of 45 °C to 46 °C using a water bath (5.3), add to the dishes and mix well. Maintain at room temperature and, when the medium solidifies, turn the dishes upside down and incubate at 37 °C ± 2 °C for 24 h to 48 h.

C.2.4 After incubation, count the number of colonies on the Petri dishes of dilution series on which 30 CFU to 300 CFU have appeared. When the number of viable bacteria is less than 30 CFU in the Petri dishes with 1 ml of shake-out bacteria solution, the number of CFU is used to calculate the average number. When the number of viable bacteria is less than 1 in the Petri dishes with 1 ml of shake-out bacteria suspension, the average number is taken as 1.

C.2.5 Obtain the bacteria concentration in the solution according to [Formula \(C.1\)](#):

$$c_B = Z \times R \tag{C.1}$$

where

- c_B is the bacteria concentration, in Colony Forming Units per millilitre (CFU/ml);
- Z is the average value of two Petri dishes in Colony Forming Units (CFU) per 1 ml of inoculum;
- R is the dilution rate.

Annex D (normative)

Quantitative measurement by luminescence method

D.1 General

This annex specifies the test procedure for quantitative measurement by the luminescence method.

D.2 Test procedure

D.2.1 Calibration curve formula

D.2.1.1 Prepare the ATP standard reagent (6.14), and dilution medium, such as the physiological saline (6.7), the SCDLP medium (6.8) or another suitable medium, and prepare three dilution solutions with ATP concentration of 2×10^{-8} mol/l, 2×10^{-9} mol/l and 2×10^{-10} mol/l, respectively.

D.2.1.2 Pour 0,1 ml of each solution specified above into three separate test tubes. Add 0,9 ml of the dilution buffer (6.9) to each tube and shake amply. Pour 0,1 ml of each solution into three separate test tubes and designate them as specimens for measuring the diluted standard reagent.

D.2.1.3 Pour 0,1 ml of physiological saline (6.7), SCDLP (6.8) or another suitable medium, 0,8 ml of the dilution buffer (6.9), and 0,1 ml of ATP eliminating reagent (6.18) into a plastic test tube. Shake amply and pour 0,1 ml portions into three separate test tubes. Let them stand for 5 min to 30 min and designate them as specimens for measuring the blank.

D.2.1.4 Add to a test tube containing the specimen for measuring the blank, 0,1 ml of ATP extracting reagent (6.17) and shake. Add 0,1 ml of ATP luminescent reagent (6.16), shake again and immediately apply a luminescence photometer (5.9) to determine the quantities of luminescence.

D.2.1.5 Add to the specimens for measuring the diluted standard reagent, 0,1 ml portions of ATP extracting reagent (6.17) in order, starting from the lowest concentration, and shake. Then add 0,1 ml of ATP luminescent reagent (6.16), shake again and immediately apply a luminescence photometer (5.9) to determine the quantities of luminescence.

D.2.1.6 Divide the ATP concentration by the average of the quantity of luminescence obtained from the measurement of diluted standard reagent (2×10^{-8} mol/l, 2×10^{-9} mol/l and 2×10^{-10} mol/l), and record this value as the average value of the gradient a .

D.2.1.7 Obtain the coefficient b by substituting gradient a , and $c_{\text{ATP}} = 0$ into the following calibration curve formula, see [Formula \(D.1\)](#):

$$c_{\text{ATP}} = a \times X + b \quad (\text{D.1})$$

where

- c_{ATP} is the ATP concentration, in moles per litre (mol/l);
- X is the quantity of luminescence, in relative light units (RLU);
- a is the gradient of linear calibration curve;
- b is the coefficient value of linear calibration curve at $X = 0$.

NOTE The correlation coefficient between c_{ATP} and X is $R^2 \geq 0,9$ and the confidence level is $> 0,95$.

D.2.2 ATP concentration of the bacterial suspension

D.2.2.1 Prepare one test tube for the ATP eliminating treatment and three test tubes for measuring.

D.2.2.2 Pour 0,1 ml of the shake-out bacterial suspension, 0,8 ml of the dilution buffer (6.9) and 0,1 ml of the ATP eliminating agent (6.18) into the test tube designated for the ATP eliminating treatment and shake amply. Pour 0,1 ml portions of the solution into the three test tubes designated for measuring and let them stand for 5 min to 30 min.

D.2.2.3 Add 0,1 ml of the ATP extracting reagent (6.17) to each measuring test tube and shake amply. Add 0,1 ml of the ATP luminescent reagent (6.16), shake again and immediately apply a luminescence photometer (5.9) to determine the quantities of luminescence.

D.2.2.4 Obtain the ATP concentration, $c_{\text{ATP}'}$ according to the formula specified in D.2.1.7 and obtain the concentration of ATP in the shake-out bacterial suspension according to Formula (D.2):

$$c_{\text{ATP}'} = \frac{c_{\text{ATP}}}{1\,000} \quad (\text{D.2})$$

where $c_{\text{ATP}'}$ is the ATP concentration, in moles per millilitre (mol/ml), in the shake-out bacterial suspension.

Annex E (informative)

Testing examples

E.1 Absorption method

See [Tables E.1](#) and [E.2](#).

Table E.1 — Example of testing by absorption method measured by plate count method

Bacteria	<i>Staphylococcus aureus</i>		<i>Klebsiella pneumoniae</i>	
Strain number	ATCC© 6538™		ATCC© 4352™	
Concentration of inoculum (CFU/ml)	$1,2 \times 10^5$		$1,1 \times 10^5$	
Difference of extremes for three control specimens (lg) (condition: less than 1)	0 h	20 h	0 h	20 h
	0,4	0,3	0,5	0,4
Difference of extremes for three antibacterial testing specimens (lg) (condition: less than 2)	0 h	20 h	0 h	20 h
	0,6	0,5	0,7	0,6
Growth value of F ($F = \lg C_t - \lg C_0$)	+2,7: ($\lg C_t$: +7,0, $\lg C_0$: +4,3)		+3,2: ($\lg C_t$: +7,5, $\lg C_0$: +4,3)	
Growth value of G ($G = \lg T_t - \lg T_0$)	-1,0: ($\lg T_t$: +3,2, $\lg T_0$: +4,2)		+0,7: ($\lg T_t$: +4,9, $\lg T_0$: +4,2)	
Antibacterial activity value ($A = F - G$)	3,8		2,6	
Measuring method	Plate count method			
Type of sample material	Socks: Cotton 100 %			
Sterilization method	Autoclave			
Incubation time	20 h			

Table E.2 — Example of testing by absorption method measured by luminescence method

Bacteria	<i>Staphylococcus aureus</i>		<i>Klebsiella pneumoniae</i>	
Strain number	ATCC© 6538™		ATCC© 4352™	
Concentration of inoculum (mol/l)	$1,2 \times 10^{-9}$		$1,9 \times 10^{-9}$	
Difference of extremes for three control specimens (lg) (condition: less than 1)	0 h	20 h	0 h	20 h
	0,5	0,6	0,5	0,4
Difference of extremes for three antibacterial testing specimens (lg) (condition: less than 2)	0 h	20 h	0 h	20 h
	0,5	0,7	0,6	0,8
Growth value of F ($F = \lg C_t - \lg C_0$)	+1,7: ($\lg C_t$: -11,0, $\lg C_0$: -12,7)		+2,1: ($\lg C_t$: -10,4, $\lg C_0$: -12,5)	
Growth value of G ($G = \lg T_t - \lg T_0$)	-0,8: ($\lg T_t$: -13,6, $\lg T_0$: -12,8)		-0,1: ($\lg T_t$: -12,6, $\lg T_0$: -12,5)	
Antibacterial activity value ($A = F - G$)	2,6		2,2	
Measuring method	Luminescence method			
Type of sample material	Curtain: Polyester 100 %			
Sterilization method	Ethylene oxide gas			
Incubation time	20 h			

E.2 Transfer method

See [Tables E.3](#) and [E.4](#).

Table E.3 — Example of testing by transfer method measured by plate count method

Name of test bacteria	<i>Staphylococcus aureus</i>		<i>Klebsiella pneumoniae</i>	
Strain number	ATCC® 6538™		ATCC® 4352™	
Concentration of inoculum (CFU/ml)	$2,2 \times 10^6$		$1,1 \times 10^6$	
Difference of extremes for three control specimens (lg) (condition: less than 1)	0 h	22 h	0 h	22 h
	0,3	0,4	0,2	0,3
Difference of extremes for three antibacterial testing specimens (lg) (condition: less than 2)	0 h	22 h	0 h	22 h
	0,6	0,5	0,7	0,6
Growth value of F ($F = \lg C_t - \lg C_0$)	+2,9: ($\lg C_t$: +8,5, $\lg C_0$: +5,6)		+2,7: ($\lg C_t$: +8,1, $\lg C_0$: +5,4)	
Growth value of G ($G = \lg T_t - \lg T_0$)	-1,7: ($\lg T_t$: +3,8, $\lg T_0$: +5,5)		-2,5: ($\lg T_t$: +2,8, $\lg T_0$: +5,3)	
Antibacterial activity value ($A = F - G$)	4,6		5,2	
Measuring method	Plate count method			
Type of sample material	Socks: Cotton 100 %			
Sterilization method	Autoclave			
Incubation time	22 h			

Table E.4 — Example of testing by transfer method measured by luminescence method

Bacteria	<i>Staphylococcus aureus</i>		<i>Klebsiella pneumoniae</i>	
Strain number	ATCC® 6538™		ATCC® 4352™	
Concentration of inoculum (mol/l)	$3,2 \times 10^{-9}$		$4,9 \times 10^{-9}$	
Difference of extremes for three control specimens (lg) (condition: less than 1)	0 h	22 h	0 h	22 h
	0,5	0,6	0,4	0,3
Difference of extremes for three antibacterial testing specimens (lg) (condition: less than 2)	0 h	22 h	0 h	22 h
	0,4	0,7	0,5	0,6
Growth value of F ($F = \lg C_t - \lg C_0$)	+3,1: ($\lg C_t$: -9,1, $\lg C_0$: -12,2)		+2,6: ($\lg C_t$: -9,4, $\lg C_0$: -12,0)	
Growth value of G ($G = \lg T_t - \lg T_0$)	-2,2: ($\lg T_t$: -14,5, $\lg T_0$: -12,3)		-2,2: ($\lg T_t$: -14,1, $\lg T_0$: -11,9)	
Antibacterial activity value ($A = F - G$)	5,3		4,8	
Measuring method	Luminescence method			
Type of sample material	Curtain: Polyester 100 %			
Type of neutralizing agent & concentration	Egg-yolk lecithin 0,5 % of the total volume			
Sterilization method	γ -ray			
Incubation time	22 h			

E.3 Printing method

See [Tables E.5](#) and [E.6](#).

Table E.5 — Example of testing by printing method measured by plate count method

Bacteria	<i>Staphylococcus aureus</i>	<i>Klebsiella pneumoniae</i>
Strain number	ATCC® 6538™	ATCC® 4352™
Number of bacteria on filter (CFU)	$3,0 \times 10^7$	$3,6 \times 10^7$

Bacteria	<i>Staphylococcus aureus</i>	<i>Klebsiella pneumoniae</i>
Number of bacteria on control specimen immediately after printing (CFU)	$4,2 \times 10^6$	$6,4 \times 10^6$
Antibacterial activity value ($A = \lg C_t - \lg T_t$)	1,7: ($\lg C_t: +6,7, \lg T_t: +5,0$)	1,1: ($\lg C_t: +6,7, \lg T_t: +5,6$)
Measuring method	Plate count method	
Type of sample material	Curtain: Polyester 100 %	
Sterilization method	Autoclave	
Incubation time	4 h	

Table E.6 — Example of testing by printing method measured by luminescence method

Bacteria	<i>Staphylococcus aureus</i>	<i>Klebsiella pneumoniae</i>
Strain number	ATCC© 6538™	ATCC© 4352™
Amount of ATP on filter (mol)	$2,9 \times 10^{-10}$	$1,7 \times 10^{-10}$
Amount of ATP on control specimen immediately after printing (mol)	$4,0 \times 10^{-11}$	$3,0 \times 10^{-11}$
Antibacterial activity value ($A = \lg C_t - \lg T_t$)	1,7: ($\lg C_t: -10,4, \lg T_t: -12,1$)	1,1: ($\lg C_t: -10,6, \lg T_t: -11,7$)
Measuring method	Luminescence method	
Type of sample material	Curtain: Polyester 100 %	
Sterilization method	Ethylene oxide gas	
Incubation time	2 h	

Annex F (informative)

Efficacy of antibacterial activity

From the testing result, the efficacy of antibacterial property of the test fabric can be considered as shown in [Table F.1](#).

Table F.1 — Efficacy of antibacterial property

Efficacy of antibacterial property	Antibacterial value: <i>A</i>
Low	$A < 2$
Significant	$2 \leq A < 3$
Strong	$A \geq 3$

For the efficacy of antibacterial property, taking into account variation in testing methods, operators, and testing laboratories, antibacterial value of 2,0 or greater is considered a level at which definite antibacterial effects can be confirmed, and is defined as a “significant effect.”

Since different countries perceive antibacterial effects in different ways, this information has been provided in the annex not as a regulation but rather as reference information.

Bibliography

- [1] ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*
- [2] [ISO 5725-1](#), *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*
- [3] [ISO 5725-2](#), *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*
- [4] [ISO 5725-3](#), *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*
- [5] [ISO 5725-4](#), *Accuracy (trueness and precision) of measurement methods and results — Part 4: Basic methods for the determination of the trueness of a standard measurement method*
- [6] [ISO 5725-6](#), *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*
- [7] [ISO 20645](#), *Textile fabrics — Determination of antibacterial activity — Agar diffusion plate test*
- [8] [EN 12353](#), *Chemical disinfectants and antiseptics - Preservation of test organisms used for the determination of bactericidal (including Legionella), mycobactericidal, sporicidal, fungicidal and virucidal (including bacteriophages) activity*

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services

Tel: +44 345 086 9001

Email: cservices@bsigroup.com

Subscriptions

Tel: +44 345 086 9001

Email: subscriptions@bsigroup.com

Knowledge Centre

Tel: +44 20 8996 7004

Email: knowledgecentre@bsigroup.com

Copyright & Licensing

Tel: +44 20 8996 7070

Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK