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Chemical disinfectants and antiseptics — Quantitative suspension test for the evaluation of bactericidal activity of chemical disinfectants and antiseptics used in food, industrial, domestic and institutional areas — Test method and requirements (phase 2, step 1)

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National foreword

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Chemical disinfectants and antiseptics - Quantitative suspension test for the evaluation of bactericidal activity of chemical disinfectants and antiseptics used in food, industrial, domestic and institutional areas - Test method and requirements (phase 2, step 1)

Antiseptiques et désinfectants chimiques - Essai quantitatif de suspension pour l'évaluation de l'activité bactéricide des antiseptiques et des désinfectants chimiques utilisés dans le domaine de l'agro-alimentaire, dans l'industrie, dans les domaines domestiques et en collectivité - Méthode d'essai et prescriptions (phase 2, étape 1)

Chemische Desinfektionsmittel und Antiseptika - Quantitativer Suspensionsversuch zur Bestimmung der bakteriziden Wirkung chemischer Desinfektionsmittel und Antiseptika in den Bereichen Lebensmittel, Industrie, Haushalt und öffentliche Einrichtungen - Prüfverfahren und Anforderungen (Phase 2, Stufe 1)

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

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European foreword

This document (EN 1276:2019) has been prepared by Technical Committee CEN/TC 216 "Chemical disinfectants and antiseptics", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by February 2020 and conflicting national standards shall be withdrawn at the latest by February 2020.

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 1276:2009.

Data obtained by using the latest version of EN 1276 are still valid.

The main changes in relation to EN 1276:2009 are:

— handrub and handwash test conditions and test requirements have been harmonized with EN 13727;

— interfering substance for breweries, soft drinks, cosmetics and cleaning in place have been deleted. A sentence to allow additional interfering substance for specific applications has been added;

— the obligatory conditions (temperature and contact time) have been deleted. The text has been harmonized with EN 13727 keeping specified time intervals and temperature steps;

— test conditions for temperatures ≥ 40 °C have been added.

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Introduction

This document describes a suspension test for establishing whether a chemical disinfectant or antiseptic has or does not have bactericidal activity in the fields described in the scope.

This laboratory test takes into account practical conditions of application of the product, including contact time, temperature, test organisms and interfering substance, i.e. conditions which may influence its action in practical situations.

The conditions are intended to cover general purposes and to allow reference between laboratories and product types. Each utilization concentration of the chemical disinfectant or antiseptic found by this test corresponds to defined test conditions. However, for some applications, the recommendations of use of a product can differ and therefore additional test conditions need to be used.

1 Scope

This document specifies a test method and the minimum requirements for bactericidal activity of chemical disinfectant and antiseptic products that form a homogeneous, physically stable preparation when diluted with hard water or - in the case of ready-to-use products - with water. Products can only be tested at a concentration of 80 % or less, as some dilution is always produced by adding the test organisms and interfering substance.

This document applies to products that are used in food, industrial, domestic and institutional areas excluding areas and situations where disinfection is medically indicated and excluding products used on living tissues except those for hand hygiene in the above considered areas. The following areas are at least included:

a) processing, distribution and retailing of:

   1) food of animal origin:

      — milk and milk products;

      — meat and meat products;

      — fish, seafood, and related products;

      — eggs and egg products;

      — animal feeds;

      — etc.

   2) food of vegetable origin:

      — beverages;

      — fruits, vegetables and derivatives (including sugar, distillery, etc.);

      — flour, milling and baking;

      — animal feeds;

      — etc.

b) institutional and domestic areas:

   — catering establishments;

   — public areas;

   — public transports;

   — schools;

   — nurseries;

   — shops;

   — sports rooms;

   — waste containers (bins, etc.);

— hotels;

— dwellings;

— clinically non sensitive areas of hospitals;

— offices;

— etc.

c) other industrial areas:

— packaging material;

— biotechnology (yeast, proteins, enzymes, etc.);

— pharmaceutical;

— cosmetics and toiletries;

— textiles;

— space industry, computer industry;

— etc.

EN 14885 specifies in detail the relationship of the various tests to one another and to "use recommendations".

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.

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*

EN 14885:2018, *Chemical disinfectants and antiseptics - Application of European Standards for chemical disinfectants and antiseptics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14885:2018 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 https://www.iso.org/obp

4 Requirements

The product shall demonstrate at least a 5 decimal logarithm (lg) reduction (3 lg for handwashes) when diluted with hard water (5.2.2.7) or - in the case of ready-to-use products - with water (5.2.2.2) and tested in accordance with Clause 5 under simulated clean conditions (0,3 g/l bovine albumin solution- 5.2.2.8.2) or simulated dirty conditions (3 g/l bovine albumin solution - 5.2.2.8.3) according to its practical applications and under the suitable test conditions as described in 5.5.1.1, Tables 1 and 2 here below.

Table 1 — Test conditions for general purpose disinfection

Test Conditions	**Bactericidal activity**
Test organism (see 5.2.1) **obligatory**	*Enterococcus hirae* *Escherichia coli* *Pseudomonas aeruginosa* *Staphylococcus aureus* *E. faecium* (for temperatures ≥ 40 °C)
Example of additional test microorganisms	*Salmonella Typhimurium* *Lactobacillus brevis* *Enterobacter cloacae*
Test temperature	in a range from 4 °C to 60 °C
Contact time	in a range from 1 min to 60 min (from 1 min to 5 min at intervals of 1 min and from 5 min to 60 min at intervals of 5 min)
Clean conditions	0,3 g/l Bovine Albumin for *Staphylococcus aureus*, *Enterococcus hirae, Escherichia coli* and *Pseudomonas aeruginosa*
Dirty conditions	3,0 g/l Bovine Albumin for *Staphylococcus aureus*, *Enterococcus hirae, Pseudomonas aeruginosa* and *Escherichia coli*
additional	any relevant substance
Log reduction (decimal lg)	≥ 5 lg
The recommended contact time for the use of the product is within the responsibility of the manufacturer.	

Table 2 — Test conditions for hand hygiene

Test Conditions	Bactericidal activity
Test organisms (see 5.2.1) **obligatory**	*Enterococcus hirae* *Escherichia coli K12* (NCTC 10538) *Pseudomonas aeruginosa* *Staphylococcus aureus*
Test temperature	20 °C
Contact time	30 s or 60 s
clean conditions (for hygienic handrubs)	0,3 g/l Bovine Albumin
Dirty conditions (for hygienic handwashes)	3,0 g/l Bovine Albumin
Log reduction (decimal lg)	≥ 5 lg for handrubs ≥ 3 lg for handwashes

Where indicated, additional specific bactericidal activity shall be determined applying other interfering substances and test organisms (in accordance with 5.2.1, 5.2.2.8 and 5.5.1.1) in order to take into account intended specific use conditions.

5 Test method

5.1 Principle

5.1.1 A sample of the product as delivered and/or diluted with hard water (or water for ready-to-use products with the exception of handwash products whose first dilution is done in hard water (5.4.2)) is added to a test suspension of bacteria in a solution of an interfering substance. The mixture is maintained at the chosen test temperature for the adopted contact time. At the end of this contact time, an aliquot is taken, and the bactericidal and/or the bacteriostatic activity in this portion is immediately neutralized or suppressed by a validated method. The method of choice is dilution-neutralization. If a suitable neutralizer cannot be found, membrane filtration is used. The numbers of surviving bacteria in each sample are determined and the reduction is calculated.

5.1.2 The test is performed using *Pseudomonas aeruginosa, Escherichia coli*, *Staphylococcus aureus and Enterococcus hirae* as test organisms. For temperatures ≥ 40 °C only *Enterococcus faecium* shall be used.

For testing of hand hygiene products, *Pseudomonas aeruginosa, Escherichia coli K12*, *Staphylococcus aureus and Enterococcus hirae* are used as test organisms.

5.1.3 Additional test organisms can be used.

5.2 Materials and reagents

5.2.1 Test organisms

The bactericidal activity shall be evaluated using the following strains as test organisms:

— *Pseudomonas aeruginosa* ATCC 15442;

— *Escherichia coli* ATCC 10536;

— *Staphylococcus aureus* ATCC 6538;

— *Enterococcus hirae* ATCC 10541;

— *Escherichia coli K12* NCTC 10538;

— *Enterococcus faecium* ATCC 6057.

If required for specific applications, additional strains may be chosen, for example from:

— *Salmonella Typhimurium* ATCC 13311;

— *Lactobacillus brevis* DSM 6235;

— *Enterobacter cloacae* DSM 6234.

Refer to Annex A for strain references in some other culture collections.

The required temperature for growing these test organisms is (36 ± 1) °C or (37 ± 1) °C (5.3.2.3). The same temperature (either 36 °C or 37 °C) shall be used for all incubations for growing microorganisms performed during a test and its control and validation.

If additional test organisms are used, they shall be incubated under optimum growth conditions (temperature, time, atmosphere, media) noted in the test report. If the additional test organisms selected do not correspond to the specified strains, their suitability for supplying the required inocula shall be verified. If these additional test organisms are not classified at a reference centre, their identification characteristics shall be stated. In addition, they shall be held by the testing laboratory or national culture collection under a reference for five years.

5.2.2 Culture media and reagents

5.2.2.1 General

All weights of chemical substances given in this European Standard refer to the anhydrous salts. Hydrated forms may be used as an alternative, but the weights required shall be adjusted to allow for consequent molecular weight differences.

The reagents shall be of analytical grade and/or appropriate for microbiological purposes. They shall be free from substances that are toxic or inhibitory to the test organisms.

To improve reproducibility, it is recommended that commercially available dehydrated material is used for the preparation of culture media. The manufacturer's instructions relating to the preparation of these products are to be rigorously followed.

NOTE For each culture medium and reagent, a limitation for use is to be fixed.

5.2.2.2 Water

The water shall be freshly glass-distilled water and not demineralized water.

Sterilize in the autoclave (see 5.3.2.1 a).

NOTE 1 Sterilization is not necessary if the water is used, e.g. for preparation of culture media and subsequently sterilized.

NOTE 2 If distilled water of adequate quality is not available, water for injections can be used.

See 5.2.2.7 for the procedure to prepare hard water.

5.2.2.3 Tryptone Soya Agar (TSA)

Tryptone soya agar, consisting of:

Tryptone, pancreatic digest of casein	15,0 g
Soya peptone, papaic digest of soybean meal	5,0 g
Sodium chloride (NaCl)	5,0 g
Agar	15,0 g
Water (5.2.2.2)	to 1 000,0 ml

Sterilize in the autoclave (5.3.2.1 a). After sterilization the pH of the medium shall be equivalent to 7,2 ± 0,2 when measured at (20 ± 1) °C.

NOTE In the case of encountering problems with neutralization (5.5.1.2 and 5.5.1.3), it can be necessary to add neutralizer to the TSA. Annex B gives guidance on the neutralizers that can be used.

5.2.2.4 Diluent

Tryptone sodium chloride solution, consisting of:

Tryptone, pancreatic digest of casein	1,0 g
Sodium chloride (NaCl)	8,5 g
Water (5.2.2.2)	to 1 000,0 ml

Sterilize in the autoclave (5.3.2.1 a). After sterilization, the pH of the diluent shall be equivalent to 7,0 ± 0,2 when measured at (20 ± 1) °C.

5.2.2.5 Neutralizer

The neutralizer shall be validated for the product being tested in accordance with 5.5.1.2, 5.5.1.3 and 5.5.2. It shall be sterile.

NOTE Information on neutralizers that have been found to be suitable for some categories of products is given in Annex B.

5.2.2.6 Rinsing liquid (for membrane filtration)

The rinsing liquid shall be validated for the product being tested in accordance with 5.5.1.2, 5.5.1.3 and 5.5.3. It shall be sterile, compatible with the filter membrane and capable of filtration through the filter membrane under the test conditions described in 5.5.3.

NOTE Information on rinsing liquids that have been found to be suitable for some categories of products is given in Annex B.

5.2.2.7 Hard water for dilution of products

For the preparation of 1 000 ml of hard water, the procedure is as follows:

— prepare solution A: dissolve 19,84 g magnesium chloride ($MgCl_2$) and 46,24 g calcium chloride ($CaCl_2$) in water (5.2.2.2) and dilute to 1 000 ml. Sterilize by membrane filtration (5.3.2.7) or in the autoclave (5.3.2.1 a). Autoclaving – if used - may cause a loss of liquid. In this case, make up to 1 000 ml with water (5.2.2.2) under aseptic conditions. Store the solution in the refrigerator (5.3.2.8) for no longer than one month;

— prepare solution B: dissolve 35,02 g sodium bicarbonate ($NaHCO_3$) in water (5.2.2.2) and dilute to 1 000 ml. Sterilize by membrane filtration (5.3.2.7). Store the solution in the refrigerator (5.3.2.8) for no longer than one week;

— place 600 ml to 700 ml of water (5.2.2.2) in a 1 000 ml volumetric flask (5.3.2.12) and add 6,0 ml (5.3.2.9) of solution A, then 8,0 ml of solution B. Mix and dilute to 1 000 ml with water (5.2.2.2). The pH of the hard water shall be 7,0 ± 0,2, when measured at (20 ± 1) °C (5.3.2.4). If necessary, adjust the pH by using a solution of approximately 40 g/l (about 1 mol/l) of sodium hydroxide (NaOH) or approximately 36,5 g/l (about 1 mol/l) of hydrochloric acid (HCl).

The hard water shall be freshly prepared under aseptic conditions and used within 12 h.

When preparing the product test solutions (5.4.2), the addition of the product to the hard water produces a different final water hardness in each test tube. In any case, the final hardness is lower than 375 mg/l of calcium carbonate (CaCO3) in the test tube.

5.2.2.8 Interfering substance

5.2.2.8.1 General

The interfering substance shall be chosen according to the conditions of use laid down for the product.

The interfering substance shall be sterile and prepared at 10 times its final concentration in the test.

The ionic composition (e.g. pH, calcium and/or magnesium hardness) and chemical composition (e.g. mineral substances, protein, carbohydrates, lipids and detergents) shall be defined.

NOTE The term “interfering substance” is used even if it contains more than one substance.

5.2.2.8.2 Clean conditions (bovine albumin solution – low concentration)

Dissolve 0,3 g of bovine albumin fraction V (suitable for microbiological purposes) in 100 ml of water (5.2.2.2).

Sterilize by membrane filtration (5.3.2.7), keep in the refrigerator (5.3.2.8) and use within one month.

The final concentration of bovine albumin in the test procedure (5.5) is 0,3 g/l.

5.2.2.8.3 Dirty conditions (bovine albumin solution – high concentration)

Dissolve 3,0 g of bovine albumin fraction V (suitable for microbiological purposes) in 100 ml of water (5.2.2.2).

Sterilize by membrane filtration (5.3.2.7), keep in the refrigerator (5.3.2.8) and use within one month.

The final concentration of bovine albumin in the test procedure (5.5) is 3,0 g/l.

5.2.2.8.4 Milk (dairies, etc.)

Skimmed milk, guaranteed free of antibiotics and additives and reconstituted at a rate of 100 g powder per litre of water (5.2.2.2), shall be prepared as follows:

— prepare a solution of 10,0 % (v/v) in water (5.2.2.2) by adding 10 parts of reconstituted milk to 90 parts of water. Heat for 30 min at (105 ± 3) °C [or 5 min at (121 ± 3) °C].

The final concentration of reconstituted milk in the test procedure (5.5) is 1,0 % (v/v) of reconstituted milk.

5.3 Apparatus and glassware

5.3.1 General

Sterilize all glassware and parts of the apparatus that will come into contact with the culture media and reagents or the sample, except those which are supplied sterile, by one of the following methods:

a) by moist heat, in the autoclave (5.3.2.1 a);

b) by dry heat, in the hot air oven (5.3.2.1 b).

5.3.2 Usual microbiological laboratory equipment[1)] and, in particular, the following

5.3.2.1 Apparatus for sterilization:

a) for moist heat sterilization, an autoclave capable of being maintained at $(121\ ^{+3}_{0})$ °C for a minimum holding time of 15 min;

b) for dry heat sterilization, a hot air oven capable of being maintained at $(180\ ^{+5}_{0})$ °C for a minimum holding time of 30 min, at (170^{+5}_{0}) °C for a minimum holding time of 1 h or at $(160\ ^{+5}_{0})$ °C for a minimum holding time of 2 h.

5.3.2.2 **Water baths**, capable of being controlled at (20 ± 1) °C, at (45 ± 1) °C (to maintain melted TSA in case of pour plate technique) and at additional test temperatures ± 1 °C (5.5.1).

5.3.2.3 **Incubator**, capable of being controlled either at (36 ± 1) °C or (37 ± 1) °C (5.2.1).

5.3.2.4 **pH-meter**, having an inaccuracy of calibration of no more than ± 0,1 pH units at (20 ± 1) °C.

NOTE A puncture electrode or a flat membrane electrode are to be used for measuring the pH of the agar media (5.2.2.3).

1) Disposable sterile equipment is an acceptable alternative to reusable glassware.

5.3.2.5 Stopwatch

5.3.2.6 Shaker

a) **Electromechanical agitator**, e.g. Vortex® mixer[2)].

b) **Mechanical shaker**

5.3.2.7 Membrane filtration apparatus, constructed of a material compatible with the substances to be filtered.

The apparatus shall have a filter holder of at least 50 ml volume. It shall be suitable for use with filters of diameter 47 mm to 50 mm and 0,45 μm pore size for sterilization of hard water (5.2.2.7), bovine albumin (5.2.2.8.2 and 5.2.2.8.3), and if the membrane filtration method is used (5.5.3).

The vacuum source used shall give an even filtration flow rate. In order to obtain a uniform distribution of the microorganisms over the membrane and to prevent overlong filtration, the device shall be set so as to obtain the filtration of 100 ml of rinsing liquid in 20 s to 40 s.

5.3.2.8 Refrigerator, capable of being controlled at 2 °C to 8 °C.

5.3.2.9 Graduated pipettes, of nominal capacities 10 ml and 1 ml and 0,1 ml, or calibrated automatic pipettes.

5.3.2.10 Petri dishes, (plates) of size 90 mm to 100 mm.

5.3.2.11 Glass beads, 3 mm to 4 mm in diameter.

5.3.2.12 Volumetric flasks

5.4 Preparation of test organism suspensions and product test solutions

5.4.1 Test organism suspensions (test and validation suspension)

5.4.1.1 General

For each test organism, two different suspensions shall be prepared: the “test suspension” to perform the test and the “validation suspension” to perform the controls and method validation.

5.4.1.2 Preservation and stock cultures of test organisms

The test organisms and their stock cultures shall be prepared and kept in accordance with EN 12353.

5.4.1.3 Working culture of test organisms

In order to prepare the working culture of the test organisms (5.2.1), prepare a subculture from the stock culture (5.4.1.2) by streaking onto TSA slopes (5.2.2.3) or plates (5.3.2.10) and incubate (5.3.2.3). After 18 h to 24 h prepare a second subculture from the first subculture in the same way and incubate for 18 h to 24 h. From this second subculture, a third subculture may be produced in the same way. The second and (if produced) third subcultures are the working cultures.

2) Vortex® is an example of a suitable product available commercially. This information is given for the convenience of users of this standard and does not constitute an endorsement by CEN of this product.

If it is not possible to prepare the second subculture on a particular day, a 48 h subculture may be used for subsequent subculturing, provided that the subculture has been kept in the incubator (5.3.2.3) during the 48 h period.

Never produce and use a fourth subculture.

For additional test organisms, any departure from this method of culturing the test organisms or preparing the suspensions shall be noted, giving the reasons in the test report.

5.4.1.4 Test suspension ("N")

a) Take 10 ml of diluent (5.2.2.4) and place in a 100 ml flask with 5 g of glass beads (5.3.2.11). Take the working culture (5.4.1.3) and transfer loopfuls of the cells into the diluent (5.2.2.4). The cells should be suspended in the diluent by rubbing the loop against the wet wall of the flask to dislodge the cells before immersing in the diluent. Shake the flask for 3 min using a mechanical shaker (5.3.2.6 b). Aspirate the suspension from the glass beads and transfer to another tube.

   Adjust the number of cells in the suspension to ($1{,}5 \times 10^8$) cfu/ml[3)] to (5×10^8) cfu/ml using diluent (5.2.2.4), estimating the number of cfu by any suitable means. Maintain this test suspension in the water bath at the test temperature θ ± 1 °C (5.5.1.1) and use within 2 h.

   The use of spectrophotometer for adjusting the number of cells is highly recommended (approximately 620 nm wavelength - cuvette 10 mm path length). Therefore each laboratory produces calibration data for each test organism knowing that suitable values of optical density are generally found between 0,150 and 0,460. A colourimeter is a suitable alternative.

b) For counting, prepare 10^{-6} and 10^{-7} dilutions of the test suspension using diluent (5.2.2.4). Mix (5.3.2.6 a). Take a sample of 1,0 ml of each dilution in duplicate and inoculate using the pour plate or the spread plate technique.

   1) When using the pour plate technique, transfer each 1,0 ml sample into separate Petri dishes and add 15 ml to 20 ml melted TSA (5.2.2.3), cooled to (45 ± 1) °C.

   2) When using the spread plate technique, spread each 1,0 ml sample – divided into portions of approximately equal size – on an appropriate number (at least two) of surface dried plates containing TSA (5.2.2.3).

For incubation and counting, see 5.4.1.6.

5.4.1.5 Validation suspension ("*Nv*")

a) To prepare the validation suspension, dilute the test suspension (5.4.1.4) with the diluent (5.2.2.4) to obtain the bacterial count of ($3{,}0 \times 10^2$) cfu/ml to ($1{,}6 \times 10^3$) cfu/ml [about one fourth (1 + 3) of the 10^{-5} dilution].

b) For counting, prepare a 10^{-1}dilution with diluent (5.2.2.4). Mix (5.3.2.6 a). Take a sample of 1,0 ml in duplicate and inoculate using the pour plate or the spread plate technique (5.4.1.4).

For incubation and counting, see 5.4.1.6.

5.4.1.6 Incubation and counting of the test and the validation suspensions

For incubation and counting of the test and validation suspension, the procedure is as follows:

3) cfu/ml = colony forming unit(s) per millilitre.

a) Incubate (5.3.2.3) the plates for 20 h to 24 h. Discard any plates that are not countable for any reason. Count the cfu on the plates to determine the total number of cfu. Incubate the plates for a further 20 h to 24 h. Do not recount plates that no longer show well-separated colonies. Recount the remaining plates. If the number has increased, use only the higher number for further evaluation.

b) Note for each plate the exact number of colonies but record "> 330" for any counts higher than 330 and determine the *Vc* values according to 5.6.2.2.

c) Calculate the numbers of cfu/ml in the test suspension "*N*" and in the validation suspension "*Nv*" using the methods given in 5.6.2.3 and 5.6.2.5. Verify according to 5.7.

5.4.2 Product test solutions

The concentration of a product test solution shall be 1,25 times the desired test concentration because it is diluted to 80 % during the test and the method validation (5.5.2 or 5.5.3). Product test solutions shall be prepared in hard water (5.2.2.7) at a minimum of three different concentrations to include one concentration in the active range and one concentration in the non-active range (5.8.2). The product received may be used as one of the product test solutions, in this case the highest tested concentration is 80 %.

Dilutions of ready-to-use products, i.e. products that are not diluted when applied, shall be prepared in water (5.2.2.2).

Handwash products shall be tested at 50 % concentration as highest concentration (1:1 dilution, in order to simulate real use conditions) and therefore shall be pre-diluted in hard water (5.2.2.7) at 62,5 % concentration. Such a product is nevertheless regarded as a ready-to-use product and the subsequent dilutions shall be performed with water (5.2.2.2).

For solid products, dissolve the product as received by weighing at least 1,0 g ± 10 mg of the product in a volumetric flask and filling up with hard water (5.2.2.7). Subsequent dilutions (lower concentrations) shall be prepared in volumetric flasks (5.3.2.12) on a volume/volume basis in hard water (5.2.2.7).

For liquid products, dilutions of the product shall be prepared with hard water (5.2.2.7) on a volume/volume basis using volumetric flasks (5.3.2.12).

The product test solutions shall be prepared freshly and used in the test within 2 h. They shall give a physically homogeneous preparation that is stable during the whole procedure. If during the procedure a visible inhomogeneity appears due to the formation of a precipitate or flocculent (for example, through the addition of the interfering substance), it shall be recorded in the test report.

NOTE Counting microorganisms embedded in a precipitate or flocculent is difficult and unreliable.

The concentration of the product stated in the test report shall be the desired test concentration. Record the test concentration in terms of mass per volume or volume per volume and details of the product sample as received.

5.5 Procedure for assessing the bactericidal activity of the product

5.5.1 General

5.5.1.1 Experimental conditions

For general purpose disinfection and hand hygiene, the experimental conditions in Table 1 and Table 2 apply:

The recommended contact time for the use of the product is within the responsibility of the manufacturer.

For contact times equal or below 1 min, 5 s tolerance shall apply. For longer contact times, 10 s tolerance shall apply.

5.5.1.2 Choice of test method (dilution-neutralization or membrane filtration)

The method of choice is the dilution-neutralization method (5.5.2). To determine a suitable neutralizer, carry out the validation of the dilution neutralization method (5.5.2.3, 5.5.2.4 and 5.5.2.5 in connection with 5.5.2.6) using a neutralizer, chosen according to laboratory experience and published data.

If this neutralizer is not valid, repeat the validation test using an alternative neutralizer taking into account the information given in Annex B.

If both neutralizers are found to be invalid, the membrane filtration method (5.5.3) may be used.

NOTE In special circumstances, it can be necessary to add neutralizer to TSA (5.2.2.3).

5.5.1.3 General instructions for validation and control procedures

The neutralization and/or removal of the bactericidal and/or bacteriostatic activity of the product shall be controlled and validated - only for the highest product test concentration - for each of the used test organisms and for each experimental condition (interfering substance, temperature, contact time). These procedures (experimental condition control, neutralizer or filtration control and method validation) shall be performed at the same time with the test and with the same neutralizer – or rinsing liquid – used in the test.

In the case of ready-to-use-products, use water (5.2.2.2) instead of hard water.

If because of problems with neutralization, a neutralizer has been added to TSA (5.5.1.2) used for the validation and control procedures, the TSA used for the test shall contain the same amount of this neutralizer as well.

5.5.1.4 Equilibration of temperature

Prior to testing, equilibrate all reagents (product test solutions (5.4.2), test suspension (5.4.1.4), validation suspension (5.4.1.5), diluent (5.2.2.4), hard water (5.2.2.7) and interfering substance (5.2.2.8)) to the test temperature (θ ± 1) °C (5.5.1.1) using the water bath (5.3.2.2) controlled at (θ ± 1)°C.

Check that the temperature of the reagents is stabilized at (θ ± 1) °C.

The neutralizer (5.2.2.5) or the rinsing liquid (5.2.2.6) and water (5.2.2.2) shall be equilibrated at (20 ± 1) °C.

In the case of ready-to-use-products, water (5.2.2.2) shall be additionally equilibrated to (20± 1) °C.

5.5.1.5 Precautions for manipulation of test organisms

Do not touch the upper part of the test tube sides when adding the test or the validation suspensions (5.4.1).

5.5.2 Dilution-neutralization method[4)]

5.5.2.1 General

The test and the control and validation procedures (5.5.2.2 through 5.5.2.5) shall be carried out in parallel and separately for each experimental condition (5.5.1.1).

4) For a graphical representation of this method, see Annex C, C.1.

5.5.2.2 Test "*Na*" – determination of bactericidal concentrations

The procedure for determining bactericidal concentrations is as follows.

a) Pipette 1,0 ml of the interfering substance (5.2.2.8) into a tube. Add 1,0 ml of the test suspension (5.4.1.4). Start the stopwatch (5.3.2.5) immediately, mix (5.3.2.6 a)) and place the tube in a water bath controlled at the chosen test temperature θ ± 1°C (5.5.1.1) for 2 min ± 10 s.

   At the end of this time, add 8,0 ml of one of the product test solutions (5.4.2). Restart the stopwatch at the beginning of the addition. Mix (5.3.2.6 a) and place the tube in a water bath controlled at θ for the chosen contact time *t* (5.5.1.1). Just before the end of *t*, mix (5.3.2.6 a) again.

b) At the end of *t*, take a 1,0 ml sample of the test mixture "Na" and transfer into a tube containing 8,0 ml neutralizer (5.2.2.5) and 1,0 ml water (5.2.2.2). Mix (5.3.2.6a)) and place in a water bath controlled at the chosen temperature. After a neutralization time of 5 min ± 10 s (in case of contact times of 10 min or shorter only (10 ± 1)s), mix and immediately take a sample of 1,0 ml of the neutralized test mixture "Na" (containing neutralizer, product test solution, interfering substance and test suspension) in duplicate and inoculate using the pour plate or spread plate technique.

   1) When using the pour plate technique, pipette each 1,0 ml sample into separate Petri dishes and add 15 ml to 20 ml of melted TSA (5.2.2.3), cooled to (45 ± 1) °C.

   2) When using the spread plate technique, spread each 1,0 ml sample – divided into portions of approximately equal size – on an appropriate number (at least two) of surface dried plates containing TSA (5.2.2.3).

For incubation and counting, see 5.5.2.6.

c) Perform the procedures a) and b) using the other product test solutions at the same time.

d) Perform the procedures a) to c) applying the chosen experimental conditions (5.5.1.1).

For handwashes, two additional decimal dilution shall be plated.

5.5.2.3 Experimental conditions control "A" – validation of the selected experimental conditions and/or verification of the absence of any lethal effect in the test conditions

To validate the selected experimental conditions and/or verify the absence of any lethal effect in the test conditions, the procedure is as follows.

a) Pipette 1,0 ml of the interfering substance used in the test (5.5.2.2) into a tube. Add 1,0 ml of the validation suspension (5.4.1.5). Start the stopwatch immediately, mix (5.3.2.6 a)) and place the tube in a water bath controlled at the chosen temperature (θ ± 1) °C for 2 min ± 10 s.

   At the end of this time, add 8,0 ml of hard water (5.2.2.7) [In the case of ready-to-use products: water (5.2.2.2) instead of hard water]. Restart the stopwatch at the beginning of the addition. Mix (5.3.2.6 a)) and place the tube in a water bath controlled at the chosen temperature (θ ± 1) °C for *t*. Just before the end of *t*, mix (5.3.2.6 a)) again.

b) At the end of *t*, take a sample of 1,0 ml of this mixture "*A*" in duplicate and inoculate using the pour plate or the spread plate technique (5.5.2.2 b)).

For incubation and counting, see 5.5.2.6.

5.5.2.4 Neutralizer control "*B*" – verification of the absence of toxicity of the neutralizer

To verify the absence of toxicity of the neutralizer, the procedure is as follows.

a) Pipette 8,0 ml of the neutralizer – used in the test (5.5.2.2) — and 1,0 ml of water (5.2.2.2) into a tube. Add 1,0 ml of the validation suspension (5.4.1.5). Start the stopwatch at the beginning of the addition, mix (5.3.2.6 a)), and place the tube in a water bath controlled at the chosen temperature (θ ± 1) °C for 5 min ± 10 s (10 s ± 1 s for contact times equal to or shorter than 10 min). Just before the end of this time, mix (5.3.2.6 a)).

b) At the end of this time, take a sample of 1,0 ml of this mixture "*B*" in duplicate and inoculate using the pour plate or the spread plate technique (5.5.2.2 b)).

For incubation and counting, see 5.5.2.6.

5.5.2.5 Method validation "*C*" – dilution-neutralization validation

To validate the dilution neutralization method, the procedure is as follows.

a) Pipette 1,0 ml of the interfering substance used in the test (5.5.2.2) into a tube. Add 1,0 ml of the diluent (5.2.2.4) and then, starting a stopwatch, add 8,0 ml of the product test solution only of the highest concentration used in the test (5.5.2.2). Mix (5.3.2.6 a)) and place the tube in a water bath controlled at the chosen temperature (θ ± 1) °C for *t*. Just before the end of *t*, mix (5.3.2.6 a)) again.

b) At the end of *t* transfer 1,0 ml of the mixture into a tube containing 8,0 ml of neutralizer (used in 5.5.2.2). Restart the stopwatch immediately at the beginning of the addition. Mix (5.3.2.6 a)) and place the tube in a water bath controlled at the chosen temperature (θ ± 1) °C for 5 min ± 10 s ((10 ± 1) s for contact times equal or shorter than 10 min). Add 1,0 ml of the validation suspension (5.4.1.5). Start a stopwatch at the beginning of the addition and mix (5.3.2.6 a)). Place the tube in a water bath controlled at (20 ± 1) °C for (30 ± 1) min. Just before the end of this time, mix (5.3.2.6 a)) again. At the end of this time, take a sample of 1,0 ml of the mixture "*C*" in duplicate and inoculate using the pour plate or the spread plate technique (5.5.2.2 b)).

For incubation and counting, see 5.5.2.6.

5.5.2.6 Incubation and counting of the test mixture and the control and validation mixtures

For incubation and counting of the test mixture and the control and validation mixtures, the procedure is as follows.

a) Incubate (5.3.2.3) the plates for 20 h to 24 h. Discard any plates that are not countable (for any reason). Count the cfu on the plates to determine the total number of colony forming units. Incubate the plates for a further 20 h to 24 h. Do not recount plates that no longer show well separated colonies. Recount the remaining plates. If the number has increased, use only the higher number for further evaluation.

b) Note for each plate the exact number of colonies but record > 330 for any counts higher than 330 and determine the *Vc* values according to 5.6.2.2.

c) Calculate the numbers of cfu/ml in the test mixture "*Na*" and in the validation mixtures "*A*", "*B*" and "*C*" using the method given in 5.6.2.4 and 5.6.2.6. Verify according to 5.7.

5.5.3 Membrane filtration method[5)]

5.5.3.1 General

The test and the control and validation procedures (5.5.3.2 through 5.5.3.5) shall be carried out in parallel and separately for each experimental condition (5.5.1.1).

Each membrane filtration apparatus shall be equipped with a membrane of 0,45 μm pore size and 47 mm to 50 mm diameter (5.3.2.7) and filled with 50 ml of the rinsing liquid (5.2.2.6). The time required for filtering — if longer than one minute in exceptional cases — shall be recorded in the test report. When transferring the membranes to the surface of an agar plate, care should be taken to ensure that the test organisms are on the upper side of the membrane when placed on the plate, and to avoid trapping air between the membrane and agar surface.

5.5.3.2 Test "*Na*" – determination of the bactericidal concentrations

The procedure for determining the bactericidal concentrations is as follows:

a) See 5.5.2.2 a).

b) At the end of *t*, take a sample of 0,1 ml of the test mixture "*Na*" in duplicate and transfer each 0,1 ml sample into a separate membrane filtration apparatus (5.5.3.1). Filter immediately. Filter through at least 150 ml but no more than 500 ml of rinsing liquid (5.2.2.6). If the rinsing liquid is not water, complete the procedure by filtering 50 ml of water (5.2.2.2). Then transfer each of the membranes to the surface of separate TSA plates.

   For handwash products at the end of *t* take a sample of 0,1 ml of the test mixture *Na* and dilute in 100-fold with 9,9 ml of rinsing liquid (5.2.2.6). Mix and transfer 0,1 ml sample in duplicate into two separate membrane filtration apparatus (5.5.3.1). Filter immediately. Filter through at least 150 ml but no more than 500 ml of rinsing liquid (5.2.2.6). If the rinsing liquid is not water, complete the procedure by filtering 50 ml of water (5.2.2.2). Then transfer each of the membranes to the surface of separate TSA plates. Validation of non-toxicity of the neutralizing agent shall be performed according to 5.5.3.4 for handwash products.

For incubation and counting, see 5.5.3.6.

c) See 5.5.2.2 c).

d) See 5.5.2.2 d).

5.5.3.3 Experimental conditions control "A" – validation of the selected experimental conditions and/or verification of the absence of any lethal effect in the test conditions

To validate the selected experimental conditions and/or verify the absence of any lethal effect in the test conditions, the procedure is as follows:

a) See 5.5.2.3 a).

b) At the end of *t*, take a sample of 1,0 ml of this mixture "*A*" in duplicate and transfer each 1,0 ml sample into a separate membrane filtration apparatus (5.5.3.1). Filter immediately and additionally with 50 ml of water (5.2.2.2). Then transfer each of the membranes to the surface of separate TSA plates (5.2.2.3).

For incubation and counting, see 5.5.3.6.

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5) For a graphical representation of this method, see Annex C, C.2.

5.5.3.4 Filtration control "*B*" – validation of the filtration procedure

To validate the filtration procedure, proceed as follows.

Take 0,1 ml of the validation suspension (5.4.1.5) in duplicate (suspension for control "*B*") and transfer each 0,1 ml sample into a separate membrane filtration apparatus (5.5.3.1).

For handwash products take a sample of 0,1 ml of the validation suspension (5.4.1.5) in duplicate and dilute 100-fold with 9,9 ml of rinsing liquid (5.2.2.6). Mix and filter each sample into a separate membrane filtration apparatus (5.5.3.1).

Filter immediately. Filter through the rinsing liquid (5.2.2.6) the same way as in the test (5.5.3.2 b)). If the rinsing liquid is not water, complete the procedure by filtering 50 ml of water (5.2.2.2). Then transfer each of the membranes to the surface of separate TSA plates (5.2.2.3).

For incubation and counting, see 5.5.3.6.

5.5.3.5 Method validation "*C*" – validation of the membrane filtration method or counting of the bacteria on the membranes which have previously been in contact with the mixture of product and interfering substance

For validation of the membrane filtration method or counting of the bacteria on the membranes that have previously been in contact with the mixture of product and interfering substance, the procedure is as follows.

a) See 5.5.2.5 a).

b) At the end of *t*, take 0,1 ml of the validation mixture "*C*" in duplicate and transfer each 0,1 ml sample into a separate membrane filtration apparatus (5.5.3.1). Filter immediately. Filter through the rinsing liquid (5.2.2.6) the same way as in the test (5.5.3.2 b)), then cover the membranes with 50 ml of the rinsing liquid (5.2.2.6) and add 0,1 ml of the validation suspension (5.4.1.5). Filter immediately again and additionally with 50 ml of water (5.2.2.2), then transfer each of the membranes to the surface of separate TSA plates (5.2.2.3).

For incubation and counting, see 5.5.3.6.

5.5.3.6 Incubation and counting of test mixture and the control and the validation mixtures

For incubation and counting of the test mixture and the control and validation mixtures, the procedure is as follows.

a) Incubate (5.3.2.3) the plates for 20 h to 24 h. Discard any plates that are not countable (for any reason). Count the colonies on the membranes. Incubate the plates for a further 20 h to 24 h. Do not recount plates that no longer show well separated colonies. Recount the remaining plates. If the number has increased use only the higher number for further evaluation.

b) Note for each plate the exact number of colonies but record "> 165" for any counts higher than 165 and determine the *Vc* values according to 5.6.2.2.

c) Calculate the numbers of cfu/ml in the test mixture "*Na*" and in the validation mixtures "*A*", "*B*" and "*C*" using the method given in 5.6.2.4 and 5.6.2.6. Verify according to 5.7.

5.6 Experimental data and calculation

5.6.1 Explanation of terms and abbreviations

5.6.1.1 Overview of the different suspensions and test mixtures

N and *Nv* represent the bacterial suspensions, *Na* represents the bactericidal test mixture, *A* (experimental conditions control), *B* (neutralizer or filtration control), *C* (method validation) represent the different control test mixtures.

N, *Nv*, N_0, Nv_0, *Na* and *A*, *B* and *C* represent the number of cells counted per ml in the different test mixtures in accordance with Table 3.

Table 3 — Number of cells counted per ml in the different test mixtures

	Number of cells per ml in the bacterial suspensions	**Number of cells per ml in the test mixtures at the beginning of the contact time (time = 0)**	**Number of survivors per ml in the test mixtures at the end of the contact time t (*A*) or 5 min or 10 s (*B*) or 30 min (*C*)**
Test	*N* Test suspension	N_0 (= *N*/10)	Na (before neutralization or filtration)
Controls	*Nv* Validation suspension	Nv_0 (= *Nv*/10)	*A*, *B*, *C*

5.6.1.2 *Vc* values

All experimental data are reported as *Vc* values:

— in the dilution-neutralization method (test and controls), a *Vc* value is the number of colony-forming units counted per 1,0 ml sample;

— in the membrane filtration method, a *Vc* value is the number of colony-forming units counted per 0,1 ml sample of test mixture "*Na*" and per 1,0 ml sample in the controls. 1 ml for "A" and 0,1 ml for "B" and "C".

5.6.2 Calculation

5.6.2.1 General

The first step in the calculation is the determination of the *Vc* values, the second the calculation of *N*, N_o, *Na*, *Nv*, Nv_o, *A*, *B* and *C*. The third step is the calculation of the reduction *R* (5.8).

5.6.2.2 Determination of *Vc* values

The *Vc* values are determined as follows.

a) The usual limits for counting bacteria on agar plates are between 15 and 300. In this standard, a deviation of 10 % is accepted, so the limits are 14 and 330. On membranes, the usual upper limits are different: 150, therefore with the 10 % deviation, the limit is 165.

NOTE 1 The lower limit (14) is based on the fact that the variability is increasing the smaller the number counted in the sample (1 ml or 0,1 ml) is, and therefore subsequent calculations can lead to wrong results. The lower limit refers only to the sample (and not necessarily to the counting on one plate), e.g. three plates per 1 ml

sample with 3 cfu, 8 cfu and 5 cfu give a *Vc* value of 16. The upper limits (330, 165) reflect the imprecision of counting confluent colonies and growth inhibition due to nutriment depletion. They refer only to the counting on one plate and not necessarily to the sample.

b) For counting the test suspension "*N*" (5.4.1.6*)*, the validation suspension "*Nv*" (5.4.1.6) and for all countings of the dilution-neutralization method (5.5.2.6), determine and record the *Vc* values according to the number of plates used per 1 ml sample (5.6.1.2).

   If more than one plate per 1 ml sample has been used to determine the Vc value, the countings per plate are to be noted.

   If the count on one plate is higher than 330, report the number as "> 330". If more than one plate per 1 ml sample has been used and at least one of them shows a number higher than 330, report this *Vc* value as "> sum of the counts" (e.g. for "> 330, 310, 302", report "> 942").

   If a *Vc* value is lower than 14, report the number but substitute by "< 14" for further calculation (in the case of *Na*).

   For the membrane-filtration method (5.5.3), the counts on the membranes are the *Vc* values (5.6.1.2). Report the *Vc* values below the lower limit (14) or above the upper limit (165) as described above.

c) Only *Vc* values within the respective counting limits are taken into account for further calculation, except in the case of *Na* (5.6.2.4).

5.6.2.3 Calculation of *N* and N_0

N is the number of cells per ml in the test suspension (5.4.1.4, 5.6.1.1).

Since two dilutions of the test suspension (5.4.1.4 in connection with 5.4.1.6) are evaluated, calculate the number of cfu/ml as the weighted mean count using the following Formula (1):

$$N = \frac{c}{\left(n_1 + 0,1 n_2\right) 10^{-6}} \qquad (1)$$

where

c is the sum of *Vc* values taken into account;

n_1 is the number of *Vc* values taken into account in the lower dilution, i.e. 10^{-6};

n_2 is the number of *Vc* values taken into account in the higher dilution, i.e. 10^{-7};

10^{-6} is the dilution factor corresponding to the lower dilution.

Round off the results calculated to two significant figures. For this, if the last figure is below 5, the preceding figure is not modified; if the last figure is more than 5, the preceding figure is increased by one unit; if the last figure is equal to 5, round off the preceding figure to the next nearest even figure. Proceed stepwise until two significant figures are obtained. As a result, the number of cfu/ml is expressed by a number between 1,0 and 9,9 multiplied by the appropriate power of 10.

EXAMPLE

$$\frac{168 + 215 + 14 + 25}{(2 + 0,1 \times 2)\ 10^{-6}} = \frac{422}{2,2 \times 10^{-6}} = 1,9182 \times 10^{8} = 1,9\ x\ 10^{8} \text{ (in cfu/ml)}$$

N_0 is the number of cells per ml in the test mixture (5.5.2.2 a) at the beginning of the contact time (time "zero" = 0). It is one-tenth of the weighted mean of *N* due to the tenfold dilution by the addition of the product and interfering substance.

5.6.2.4 Calculation of *Na*

Na is the number of survivors per ml in the test mixture (5.5.2.2 a) or (5.5.3.2 a) at the end of the contact time and before neutralization or membrane filtration. It is tenfold higher than the *Vc* values due to the addition of neutralizer and water (5.5.2.2 b) or the sample volume of 0,1 ml (5.5.3.2 b) in the membrane filtration method.

Calculate *Na* using the following Formula (2):

$$Na = 10\ c/n \tag{2}$$

where

c is the sum of *Vc* values taken into account;

n is the number of *Vc* values taken into account.

If one or both of the duplicate *Vc* values are either below the lower or above the upper limit, express the results as "less than" or "more than".

EXAMPLE

a) duplicate *Vc* values: 2, 16

$$Na = \frac{(<14+16)\,\mathrm{x}\,10}{2} \leq 150$$

b) duplicate *Vc* values (membrane filtration): > 165, > 165

$$Na = \frac{(>165+>165)\ \mathrm{x}\ 10}{2} \geq 1\ 650$$

c) duplicate *Vc* values (two spread plates per 1,0 ml sample): > 660, 600

$$Na = \frac{(>660+600)\,\mathrm{x}\,10}{2} \geq 6\ 300$$

5.6.2.5 Calculation of *Nv* and Nv_0

Nv is the number of cells per ml in the validation suspension (5.4.1.5 a). It is tenfold higher than the counts in terms of *Vc* values due to the dilution step of 10^{-1} (5.4.1.5 b).

Nv_0 is the number of cells per ml in the mixtures "*A*", "*B*" and "*C*" at the beginning of the contact time (time 0) (5.6.1.1). It is one-tenth of the mean of the *Vc* values of *Nv* (5.4.1.6 c) taken into account.

Calculate *Nv* and Nv_0 using the following Formulae (3) and (4):

$$Nv = 10\mathrm{c}/\mathrm{n} \tag{3}$$

$$Nv_0 = \mathrm{c}/\mathrm{n} \tag{4}$$

where

c is the sum of *Vc* values taken into account;

n is the number of *Vc* values taken into account.

5.6.2.6 Calculation of *A*, *B* and *C*

A, *B* and *C* are the numbers of survivors in the experimental conditions control "*A*" (5.5.2.3 or 5.5.3.3), neutralizer control "*B*" (5.5.2.4) or filtration control "B" (5.5.3.4) and method validation "*C*" (5.5.2.5 or 5.5.3.5) at the end of the contact time *t* (*A*) or the defined times 5 min (*B*) and 30 min (*C*). They correspond to the mean of the *Vc* values of the mixtures "*A*", "*B*" and "*C*" taken into account.

Calculate *A*, *B* and *C* using the following Formula (5):

$$A, B, C = c/n \quad (5)$$

where

c is the sum of *Vc* values taken into account;

n is the number of *Vc* values taken into account.

5.7 Verification of methodology

5.7.1 General

A test is valid if:

— all results meet the criteria of 5.7.3 and

— the requirements of 5.8.2 are fulfilled.

5.7.2 Control of weighted mean counts

For results calculated by weighted mean of two subsequent dilutions (e.g. "*N*"), the quotient of the mean of the two results shall be not higher than 15 and not lower than 5. Results below the lower limit are taken as the lower limit number (14). Results above the respective upper limit (5.6.2.2 b) are taken as the upper limit number.

EXAMPLE

For $N\ 10^{-6}$ dilution: 168 cfu/ml + 215 cfu/ml, 10^{-7} dilution: 20 cfu/ml + < 14 cfu/ml; (168 + 215) / (20 + 14) = 383/34 = 11,26 therefore between 5 and 15.

NOTE When the counts obtained on plates are out of limts fixed for the determination of *Vc* values (5.6.2.2 b), check for the weighted mean as mentioned above but use only the *Vc* values within the counting limits for the calculation of *N*.

5.7.3 Basic limits

For each test organism check that:

a) *N* is between $1{,}5 \times 10^8$ and $5{,}0 \times 10^8$ ($8{,}17 \leq lg\ N \leq 8{,}70$)

N_0 is between $1{,}5 \times 10^7$ and $5{,}0 \times 10^7$ ($7{,}17 \leq lg\ N_0 \leq 7{,}70$)

b) *Nv* is between 300 and 1600 ($3{,}0 \times 10^2$ and $1{,}6 \times 10^3$)

(Nv_0 is between $3{,}0 \times 10^1$ and $1{,}6 \times 10^2$)

c) *A,B,C* are equal to or greater than $0{,}5 \times Nv_0$.

d) control of weighted mean counts (5.7.2): quotient is not lower than 5 and not higher than 15.

5.8 Expression of results and precision

5.8.1 Reduction

The reduction ($R = N_0/Na$) is expressed in logarithm.

For each test organism record the number of cfu/ml in the test suspension N (5.6.2.3) and the test Na (5.6.2.4). Calculate N_0 (5.6.2.3).

For each product concentration and each experimental condition, calculate and record the decimal log reduction (lg) separately using the following Formula (6):

$$\lg R = \lg N_0 - \lg Na \qquad (6)$$

For the controls and validation of the dilution-neutralization method or membrane filtration method, record Nv_0 (5.6.2.5), the results of A, B and C (5.6.2.6) and their comparison with Nv_0 (5.7.3 c).

5.8.2 Control of active and non-active product test solution (5.4.2)

At least one concentration per test (5.5.2.2 a - c or 5.5.3.2 a - c) shall demonstrate a 5 lg or more reduction and at least one concentration shall demonstrate a lg reduction of less than 5.

Handwashes shall demonstrate only a 3 lg or more reduction at in test concentration of 50 % or less and at least one concentration shall demonstrate a lg reduction of less than 3.

5.8.3 Limiting test organism and bactericidal concentration

For each test organism, record the lowest concentration of the product which passes the test.

(lg $R \geq 5$ or ≥ 3 for handwashes). Record as the limiting test organism the test organism requiring the highest of these concentrations (it is the least susceptible to the product in the chosen experimental conditions).

The lowest concentration of the product active on the limiting test organism is the bactericidal concentration determined according to this standard.

5.8.4 Precision, replicates

Taking into account the precision of the methodology determined by a statistical analysis based on data provided by a collaborative study, replication of the test (nine replicates for a precision of ± 1 lg in reduction) is recommended (Annex E). The number of replicate tests shall be decided according to the required level of precision, taking into account the intended use of the test results.

Replication means the complete test procedure with separately prepared test - and validation suspensions. The replicate of the test may be restricted to the limiting test organism. The mean of the results of the replicates - not each single result - shall demonstrate at least a 5 lg reduction (3 lg for handwashes) and shall also be calculated and recorded.

5.9 Interpretation of results - conclusion

5.9.1 General

According to the chosen experimental conditions, the bactericidal concentrations determined according to this standard can differ (Clause 4).

5.9.2 Bactericidal activity for general purposes

The product shall be deemed to have passed the EN 1276 standard if it demonstrates in a valid test at least a 5 lg reduction within the adopted test conditions as described in Tables 1 and 2 with the chosen interfering substance simulating clean or dirty conditions defined by this standard when the test

organisms are *Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus* and *Enterococcus hirae* (*E. faecium* when the test temperature is ≥ 40 °C).

5.9.3 Bactericidal activity for hand hygiene

The bactericidal concentration for hand hygiene is the concentration of the tested product for which at least a 5 lg reduction for hygienic handrub and 3 lg reduction for hygienic handwash (at 50 % in test concentration or less) is demonstrated in a valid test under the chosen test conditions. The product shall have passed the EN 1276 standard under the adopted test conditions as described in Tables 1 and 2.

The bactericidal concentration is the concentration active on the limiting strain.

5.10 Test report

The test report shall refer to this document (EN 1276).

The test report shall state, at least, the following information:

a) identification of the testing laboratory;

b) identification of the client;

c) identification of the sample:

   1) name of the product;

   2) batch number and — if available — expiry date;

   3) manufacturer – if not known: supplier;

   4) date of receipt at the test laboratory;

   5) storage conditions;

   6) product diluent recommended by the manufacturer for use;

   7) active substance(s) and their concentration(s) (optional);

   8) appearance of the product;

d) test method and its validation:

   1) if the dilution-neutralization method is used, full details of the test for validation of the neutralizer shall be given;

   2) if the membrane filtration method is used, full details of the procedure which was carried out in order to justify the use of the membrane filtration method shall be given;

e) experimental conditions:

   1) date(s) of test (period of analysis);

   2) diluent used for product test solution (hard water or distilled water);

   3) product test concentrations (= *desired* test concentrations according to 5.4.2);

4) appearance product dilutions;

5) contact time(s);

6) test temperature(s);

7) interfering substance(s);

8) stability and appearance of the mixture during the procedure (note the formation of any precipitate or flocculant);

9) temperature of incubation;

10) neutralizer or rinsing liquid;

11) identification of the bacterial strains used;

f) test results:

1) controls and validation;

2) evaluation of bactericidal activity;

3) number of replicates per test organism;

g) special remarks;

h) conclusion;

i) locality, date and identified signature.

NOTE An example of a typical test report is given in Annex D.

Annex A
(informative)

Referenced strains in national collections

— *Pseudomonas aeruginosa*:	ATCC	15442
	CIP	103467
	DSM	939
	NCIMB	10421
— *Escherichia coli*:	ATCC	10536
	CIP	54127
	DSM	682
	NCTC	10418
	NCIMB	8879
— *Escherichia coli K12*	NCTC	10538
— *Staphylococcus aureus*:	ATCC	6538
	CIP	483
	DSM	799
	NCTC	10788
	NCIMB	9518
— *Enterococcus hirae*:	ATCC	10541
	CIP	5855
	DSM	3320
	NCIMB	8192
— *Salmonella* Typhimurium:	ATCC	13311
	CIP	5858
	DSM	5569
	NCTC	74
— *Lactobacillus brevis*:	CIP	103474
	DSM	6235
— *Enterobacter cloacae*:	CIP	104674
— *Enterococcus faecium*	DSM	6234
	ATCC	6057

Annex B
(informative)

Neutralizers and rinsing liquids

Important! Neutralizers of the residual antimicrobial activity of chemical disinfectants and antiseptics and rinsing liquids shall be validated according to the prescriptions of the standard.

Table B.1 — Examples of neutralizers of the residual antimicrobial activity of chemical disinfectants and antiseptics and of rinsing liquids

Antimicrobial agent	Chemical compounds able to neutralize residual antimicrobial activity	Examples of suitable neutralizers and of rinsing liquids (for membrane filtration methods) [a]
Quaternary ammonium compounds and fatty amines Amphoteric compounds	Lecithin, Saponin, Polysorbate 80, Sodium dodecyl sulphate, Ethylene oxide condensate of fatty alcohol (non-ionic surfactants) [b]	- Polysorbate 80, 30 g/l + saponin, 30 g/l + lecithin, 3 g/l. - Polysorbate 80, 30 g/l + sodium dodecyl sulphate, 4 g/l + lecithin, 3 g/l. - Ethylene oxide condensate of fatty alcohol, 3 g/l + lecithin, 20 g/l + polysorbate 80, 5 g/l. *Rinsing liquid: tryptone, 1 g/l + NaCl, 9 g/l; polysorbate 80, 5 g/l.*
Biguanides and similar compounds	Lecithin [c], Saponin, Polysorbate 80	- Polysorbate 80, 30 g/l + saponin, 30 g/l + lecithin, 3 g/l. *Rinsing liquid: tryptone, 1 g/l + NaCl, 9 g/l; polysorbate 80, 5 g/l.*
Oxidizing compounds (Chlorine, iodine, hydrogen peroxide, peracetic acid, hypochlorites, etc.)	Sodium thiosulphate [d] Catalase [for hydrogen peroxide or products releasing hydrogen peroxide]	- Sodium thiosulphate, 3 g/l to 20 g/l + polysorbate 80, 30 g/l + lecithin, 3 g/l. - Polysorbate 80, 50 g/l + catalase 0,25 g/l + lecithin 10 g/l. *Rinsing liquid: sodium thiosulphate, 3 g/l.*

Antimicrobial agent	Chemical compounds able to neutralize residual antimicrobial activity	Examples of suitable neutralizers and of rinsing liquids (for membrane filtration methods) [a]
Aldehydes	L – histidine Glycine	- Polysorbate 80, 30 g/l + lecithin, 3 g/l + L-histidine, 1 g/l (or + glycine, 1 g/l). - Polysorbate 80, 30 g/l + saponin, 30 g/l + L-histidine, 1 g/l (or + glycine, 1 g/l). *Rinsing liquid: polysorbate 80, 5 g/l + L-histidine, 0,5 g/l (or + glycine, 1 g/l).*
Phenolic and related compounds: orthophenylphenol, phenoxyethanol, triclosan, phenylethanol, etc. Anilides	Lecithin Polysorbate 80 Ethylene oxide condensate of fatty alcohol [b]	- Polysorbate 80, 30 g/l + lecithin, 3 g/l. - Ethylene oxide condensate of fatty alcohol, 7 g/l + lecithin, 20 g/l, + polysorbate 80, 4 g/l. *Rinsing liquid: tryptone, 1 g/l + NaCl, 9 g/l; polysorbate 80, 5 g/l.*
Alcohols	Lecithin, Saponin, Polysorbate 80 [e]	- Polysorbate 80, 30 g/l + saponin, 30 g/l + lecithin, 3 g/l. *Rinsing liquid: tryptone, 1 g/l + NaCl, 9 g/l; polysorbate 80, 5 g/l.*

[a] According to the pH of the tested product, the pH of the neutralizer or the rinsing liquid can be adjusted at a suitable value or prepared in phosphate buffer [ex: phosphate buffer 0,25 mol/l: potassium dihydrogen phosphate (KH_2PO_4) 34 g; distilled water (500 ml); adjusted to pH 7,2 ± 0,2 with sodium hydroxide (NaOH) 1 mol/l; distilled water up to 1 000 ml].

[b] The carbon chain-length varies from C_{12} to C_{18} carbon atoms.

[c] Egg and soya; egg is preferable.

[d] The toxic effect of sodium thiosulphate differs from one test organism to another.

[e] For the neutralization of short chain alcohols (less than C5), simple dilution can be appropriate. Care is to be taken if the alcohol-based -products contain additional antimicrobial agents.

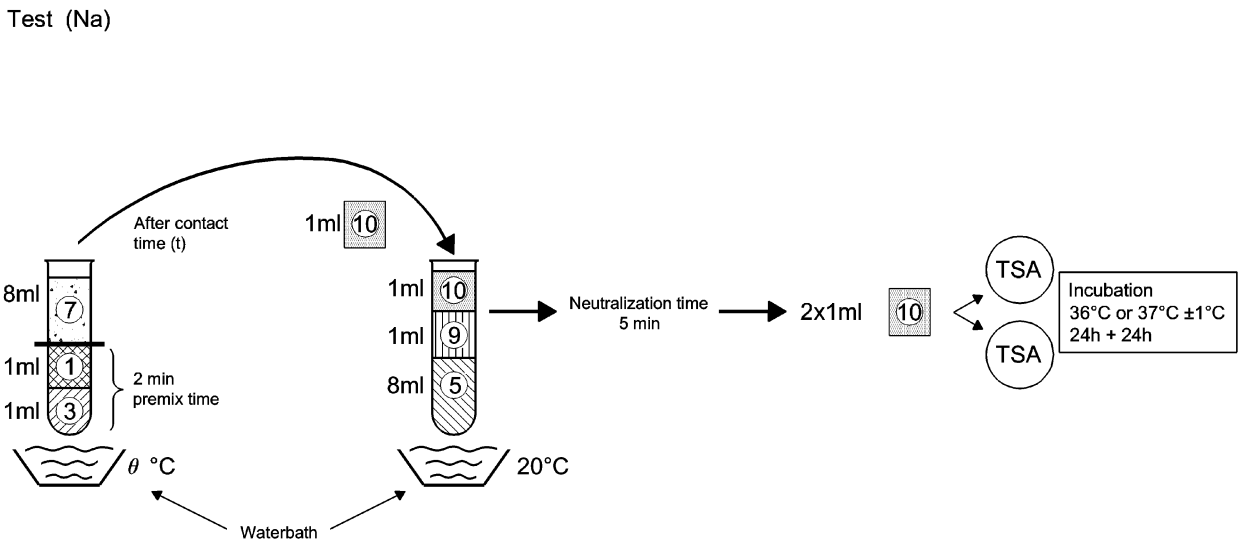
Other neutralizer mixtures can be required for products containing more than one antimicrobial agent.

The concentrations of the various neutralizing compounds or of the neutralizer as such cannot be adequate to neutralize high concentrations of the products.

Annex C
(informative)

Graphical representations of dilution neutralization method and membrane filtration method

C.1 Dilution-neutralization method

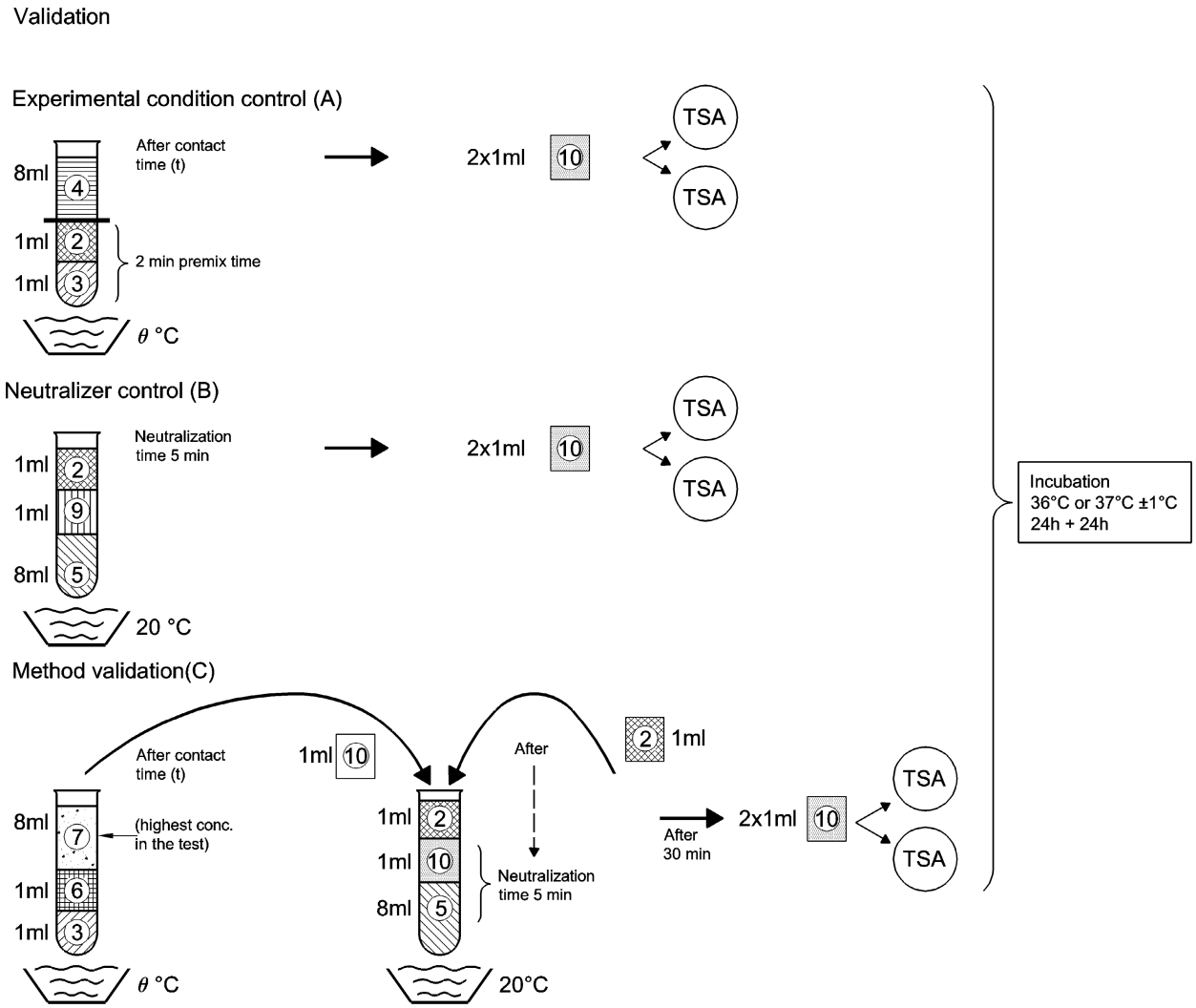


Key

1	Test Suspension (*N*)	3	Interfering substance	5	Neutralizer (20 °C)	7	Product test solution	9	Water
2	Validation Supension (*Nv*)	4	Hard water	6	Diluent	8	Rinsing liquid (20 °C)	10	Mixture

NOTE In case of contact times of 10 min or shorter, neutralization time is only (10 ±1) s.

Figure C.1 — Dilution neutralization method test



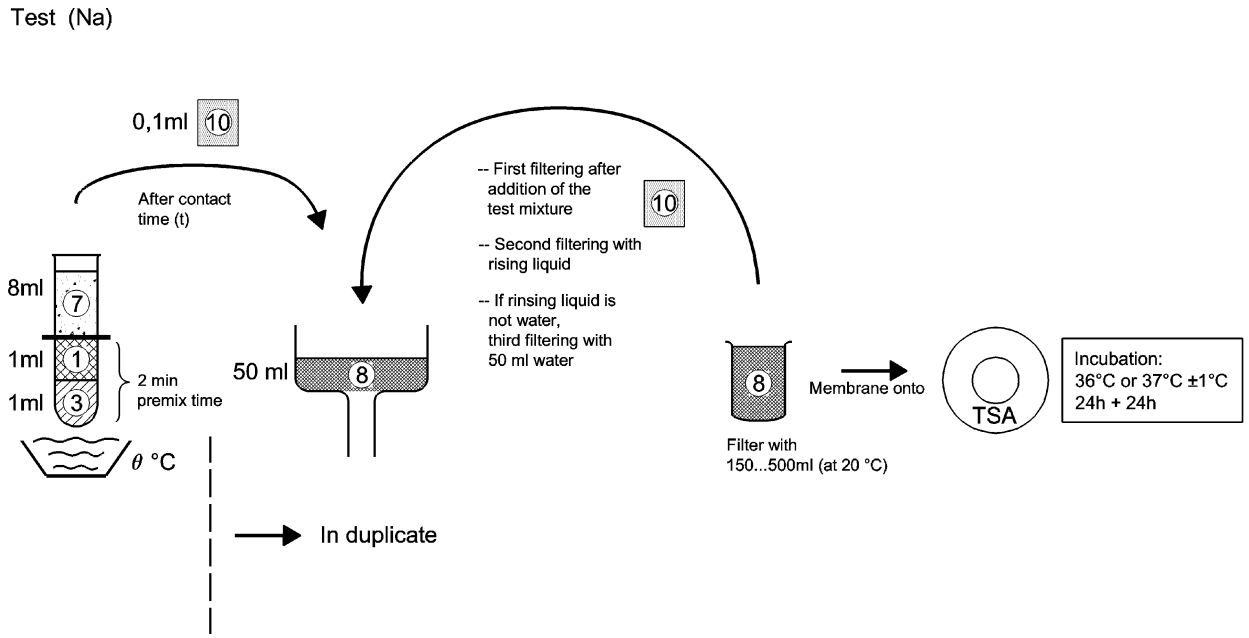
Key

1	Test Suspension (*N*)	3	Interfering substance	5	Neutralizer (20 °C)	7	Product test solution	9	Water
2	Validation Supension (*Nv*)	4	Hard water or distilled water	6	Diluent	8	Rinsing Liquid (20 °C)	10	Mixture

NOTE In case of contact times of 10 min or shorter, neutralization time is only 10 s ± 1 s.

Figure C.2 — Dilution neutralization method validation

C.2 Membrane filtration method

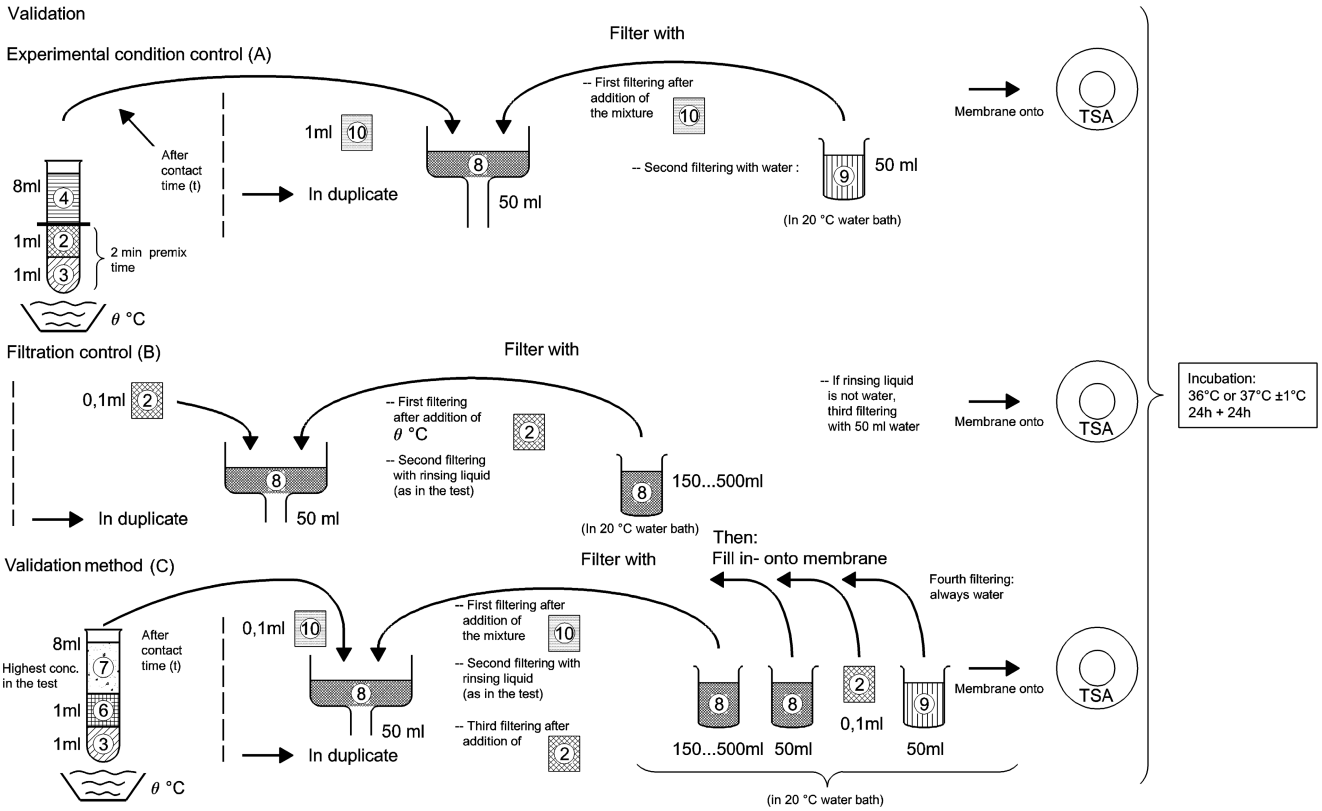


Key

1	Test Suspension (*N*)	3	Interfering substance	5	Neutralizer (20 °C)	7	Product test solution	9	Water
2	Validation Supension (*Nv*)	4	Hard water	6	Diluent	8	Rinsing liquid (20 °C)	10	Mixture

NOTE For handwash products, 0,1 ml of test mixture (Na) and pre-diluted in 9,9 ml of rinsing liquid (5.5.3.2).

Figure C.3 — Membrane filtration method test



Key

1	Test Suspension (*N*)	3	Interfering substance	5	Neutralizer (20 °C)	7	Product test solution
2	Validation Supension (*Nv*)	4	Hard water or distilled water	6	Diluent	8	Rinsing Liquid (20 °C)
9	Water	10	Mixture				

NOTE For handwash products, 0,1 ml of test mixture (Na) and pre-diluted in 9,9 ml of rinsing liquid (5.5.3.2).

Figure C.4 — Membrane filtration method validation

Annex D
(informative)

Example of a typical test report

NOTE 1 All names and examples in Annex D are fictitious apart from those used in this standard.

NOTE 2 Only the test results of one replicate for *Pseudomonas aeruginosa* are given as an example.

NOTE 3 Test reports for bactericidal activity are entitled "EN 1276, BACTERICIDAL ACTIVITY", and presented in the same format

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HHQ Laboratories

Antiseptville/Euroland

Tel. ++011.57 83 62–0

Fax ++011.57 83 62–19

e-mail:h.h.Q.lab@net.com

TEST REPORT

EN 1276, BACTERICIDAL ACTIVITY

Client: Mult Formulations Inc., Mannheim / Euroland

Disinfectant-sample

Name of the product: W **Batch number**: 26–01–48

Manufacturer or - if not known - **supplier**: Centipede Formulations Inc. (manufacturer)

Storage conditions (temp. and other): Room temperature, darkness

Appearance of the product: Liquid, clear, yellowish

Active substance(s) and their concentration(s): Not indicated

Product diluent recommended by the manufacturer for use: Potable water

Period of testing

Date of delivery of the product: 2006–05–01 **Dates of tests**: see "Test results" (attached)

Experimental conditions

Product diluent: hard water Concentrations of the product tested: see "Test results" (attached)

Test conditions:

test organisms: *Pseudomononas aeruginosa* ATCC 15442, *Escherichia coli* ATCC 10536, *Staphylococcus aureus* ATCC 6538, *Enterococcus hirae* ATCC 10541.

test temperature: 20 °C contact time: 5 min

interfering substance: 0,3 g/l bovine albumin = clean conditions

Incubation temperature: (36 ± 1)°C

Additional conditions:

1. test organism: *Pseudomononas aeruginosa* ATCC 15442

Test temperature: 40 °C contact time: 60 min

Interfering substance: 3,0 g/l bovine albumin = dirty conditions

Incubation temperature: 36 °C

Test results: see attached sheets.

2. test organism: *Salmonella Typhimurium* ATCC 13311

Test temperature: 4 °C contact time: 15 min

Interfering substance: 1,0 % reconstituted milk

Incubation temperature: 36 °C

Test results: see attached sheets

Special remarks regarding the results:

All controls and validation were within the basic limits.

At least one concentration of the product demonstrated an lg reduction of less than 5 lg.

No precipitate during the test procedure (test mixtures were homogeneous).

Conclusion:

For the product W (batch 26–01–48), the bactericidal concentration for general purposes determined according to the EN 1276 standard under clean conditions is:

1,0 % (v/v)

(the mean reduction of six replicates with the limiting test organism *Pseudomononas aeruginosa* was 1,2 x 10^5. *Staphylococcus aureus, Escherichia coli* and *Enterococcus hirae* were tested once and showed a 5 lg reduction or more at a lower concentration than *Pseudomononas aeruginosa).*

For the product *W* (batch 26–01–48), the bactericidal concentration for specific purposes determined according to the EN 1276 standard at 40 °C, with 60 min contact time under dirty conditions, using *Pseudomononas aeruginosa* ATCC 15442 as test organism is:

0,25 % (v/v).

For the product W (batch 26–01–48) the bactericidal concentration for specific purposes determined according to the EN 1276 standard at 4 °C, with 15 min contact time with milk as interfering substance, using *Salmonella Typhimurium* ATCC 13311 as test organism is:

0,25 % (v/v).

Antiseptville, 2001–11–11

Alexandra May, MD, PhD, Scientific Director

Test results (bactericidal suspension test)

EN....*1276*.....(Phase 2, step 1) Product-name: .....*W*..... Batch No.: .. *26-01-48*.....

Remarks:

Dilution neutralization method [*X*] Pour plate [ ] Spread plate [x] Number of plates .....2 / ml

Neutralizer:.....*Lecithin 3,0 g/l* in diluent.....

Membrane filtration method □ Rinsing liquid:.....

Test temperature: *20* °C interfering substance:....bovine albumin: 0,3 g/l ……..

Test organism: ....*Pseudomonas aeruginosa ATCC 15442*.....Incubation temperature: 36 °C

Internal lab. No:....*QS 68/00* .... | Date of test: *2006–06–06* | Responsible person: ...*Fang*..... Signature: Fang.

Validation and controls

Validation suspension (***Nv*₀**)			Experimental Conditions control (***A***)			Neutralizer or filtration control (***B***)			Method validation (***C***) Product conc.: *10 ml/l*		
*Vc*1	*86* *(40 + 46)*	$\bar{x}$ =	*Vc*1	*79* *(43 + 36)*	$\bar{x}$ =	*Vc*1	*86* *(42 + 44)*	$\bar{x}$ =	*Vc*1	*75* *(35 + 40)*	$\bar{x}$ =
*Vc*2	*92* *(47 + 45)*	89	*Vc*2	*84* *(39 + 45)*	*81,5*	*Vc*2	*91* *(43 + 48)*	*88,5*	*Vc*2	*87* *(41 + 46)*	*81*
30 ≤ $\bar{x}$ of Nv_0 ≤ 160 ? ☒ *yes* ☐ *no*			$\bar{x}$ of A is ≥ 0,5 x $\bar{x}$ of Nv_0 ? ☒ *yes* ☐ *no*			$\bar{x}$ of B is ≥ 0,5 x $\bar{x}$ of Nv_0 ? ☒ *yes* ☐ *no*			$\bar{x}$ of C is ≥ 0,5 x $\bar{x}$ of Nv_0 ? ☒ *yes* ☐ *no*		

Test suspension and Test

Test-suspension (*N* and N_0):	***N***	*Vc*1	*Vc*2	$\bar{x}$ wm = *193,64* x 10^6 ; lgN = 8,29
	10^{-6}	*168*	*213*	No = N/10 ; lg No = 7,29
	10^{-7}	*20*	*25*	7,17 ≤ lgN_0 ≤ 7,70? ☒ *yes* ☐ *no*

Conc. of the product %	*Vc*1	*Vc*2	***Na* =** $\bar{x}$ x10	**lg*Na***	**lg*R*** *(N_0 = 7,29)*	Contact-time (min)
0,50	*> 660*	*> 630*	*> 6 450*	*> 3,81*	*< 3,48*	*5 min*
0,75	*122*	*154*	*1 380*	*3,14*	*4,15*	*5 min*
1,00	*7*	*0*	*< 140*	*< 2,15*	*> 5,14*	*5 min*

Remarks:

Counting per plate for;

(*N*) 10^{-6}: 80 + 88; 105 + 108 (***Na***) 0,75 %: 66 + 56; 71 + 83
10^{-7}: 9 + 11; 15 + 10 1,00 % *Vc*1: 1 + 6

Explanations:

Vc = count per ml (one plate or more) $\bar{x}$ wm = weighted mean of $\bar{x}$

$\bar{x}$ = average of *Vc*1 and Vc2 (1. + 2. duplicate) *R* = reduction (lg $R = \lg N_0 - \lg Na$)

Annex E
(informative)

Precision of the test result

A collaborative study (ANDISTAND 1997 - 1999) was carried out to determine the precision of the test method within and between different laboratories. The study involved 16 laboratories from different European countries. Each laboratory replicated the test conditions three times.

The tests were performed using the dilution neutralization or membrane filtration methods with sodium dichloroisocyanurate, benzalkonium chloride and phenol on *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli* and *Enterococcus hirae* (as test organisms). The complete results and the statistical evaluation of this study is described in documents CEN/TC 216 HWG N 121 + N 121 Annexes + N 121 Corrigendum.

The agreement between laboratories, expressed in terms of bactericidal effect (reduction ≥ 5 log), is very good at low and high concentrations but less good at intermediate levels.

Uncountable data were replaced by theoretical fake values of reduction factor. When counts were below the lower counting limit (15 viable colonies), the reduction factor could vary between $3{,}33 \times 10^5$ (the maximum value when data were countable) and $5{,}00 \times 10^7$ (no surviving colonies), corresponding respectively to 5,52 and 7,70 log reduction. In order to simulate a possible variability, three theoretical reduction factors (one for each replicate) were chosen in this range: 5,50, 6,60 and 7,70 (in logarithmic terms).

When counts were above the upper counting limit (300 viable colonies), the reduction factor could vary between $1{,}00 \times 10^0$ (no reduction) and $5{,}00 \times 10^3$ (the minimum value when data were countable), giving the log reduction values of, respectively, 0,00 and 3,70. In this case, the three chosen fake theoretical reduction factors were 0,00; 1,80 and 3,60 (instead of 3,70 for calculation simplifying reason).

All these theoretical values were collected in the following table (Table E.1).

Table E.1 — Theoretical reduction factors used for bacteria (in logarithmic terms)

	... below the lower limit (15)	**... above the upper limit (150)**
All the 3 replicates are ...	5,50 – 6,60 – 7,70	0,00 – 1,80 – 3,60
Only 2 replicates are ...	5,50 – 7,70	0,00 – 3,60
Only 1 replicate is ...	6,60	1,80

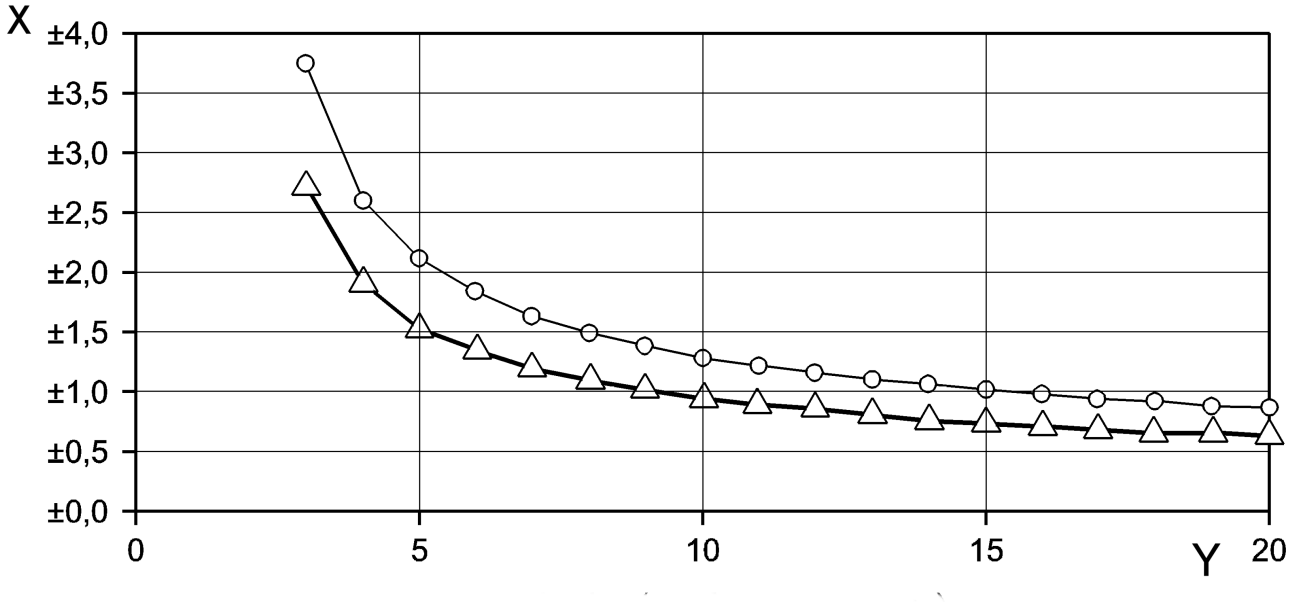
Variances analyses were performed on the reduction factors in order to point out the tested conditions with significant obtained results and to estimate the two types of variability: “within” and “between” laboratories.

The differences in reduction factors across the lab were essentially obtained with medium and high dilutions of the tested products. Some of those significant results were due to outliers, certain laboratories giving completely different reduction factor from most of the others. In other cases, it was more difficult to point out the outliers but the significant differences were the consequences of the important “within lab” variability.

In most of the cases, the “between” estimated standard deviation, which varied (in logarithmic terms) from 1,5 to 3,0, was higher than the “within” value, which oscillated between 1,0 and 2,0. Nevertheless, in some cases, this ratio was inverted (“between” dispersion lower than “within” one), due probably to

the techniques used for replacing uncountable data, which overestimated the "within" variability and reduced the "between" variation.

The "inside" variability was also used to estimate the precision of the obtained reduction factors. Two different hypotheses were taken into account: the first one, which could be qualified of "worst" case, used the maximum of the calculated "inside" variability (σ = 2,20) while the second o~e was based on an average "inside" dispersion (σ = 1,62). The estimated precision depended also on the sample size (number of replicates) and the confidence level (90 % probability of used in the calculation). With three replicates, the "worst" case lead to a reduction factor precision ± 3,71 while the "mean" case was about ± 2,73. So, if the precision target is ± 1 log reduction, 15 replicates were needed in the "worst" case and 9 in the "mean" one (Figure E.1 or Table E.2).



Key

X Precision (in log terms)
Y Sample size (number of replicates)
Worst case
Mean case

Figure E.1 — Precision of the reduction factor obtained with bacteria (in logarithmic terms)

Table E.2 — Precision of the reduction factors obtained for bacteria (in logarithmic terms)

Replicates	Standard Deviation (σ)								
	1,0	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**	**1,6**	**1,7**	**1,8**
2	***± 6,70***	***± 7,14***	***± 7,59***	***± 8,04***	***± 8,48***	***± 8,93***	***± 9,38***	***± 9,82***	***± 10,27***
3	***± 2,53***	***± 2,70***	***± 2,87***	***± 3,03***	***± 3,20***	***± 3,37***	***± 3,54***	***± 3,71***	***± 3,88***
4	***± 1,77***	***± 1,88***	***± 2,00***	***± 2,12***	***± 2,24***	***± 2,35***	***± 2,47***	***± 2,59***	***± 2,71***
5	***± 1,43***	***± 1,53***	***± 1,62***	***± 1,72***	***± 1,81***	***± 1,91***	***± 2,00***	***± 2,10***	***± 2,19***
6	***± 1,23***	***± 1,32***	***± 1,40***	***± 1,48***	***± 1,56***	***± 1,65***	***± 1,73***	***± 1,81***	***± 1,89***
7	***± 1,10***	***± 1,18***	***± 1,25***	***± 1,32***	***± 1,40***	***± 1,47***	***± 1,54***	***± 1,62***	***± 1,69***
8	***± 1,00***	***± 1,07***	***± 1,14***	***± 1,21***	***± 1,27***	***± 1,34***	***± 1,41***	***± 1,47***	***± 1,54***
9	±0,93	±0,99	***± 1,05***	***± 1,12***	***± 1,18***	***± 1,24***	***± 1,30***	***± 1,36***	***± 1,43***
10	±0,87	±0,93	±0,99	***± 1,04***	***± 1,10***	***± 1,16***	***± 1,22***	***± 1,28***	***± 1,33***
11	±0,82	±0,87	±0,93	±0,98	***± 1,04***	***± 1,09***	***± 1,15***	***± 1,20***	***± 1,26***
12	±0,78	±0,83	±0,88	±0,93	±0,99	***± 1,04***	***± 1,09***	***± 1,14***	***± 1,19***
13	±0,74	±0,79	±0,84	±0,89	±0,94	±0,99	***± 1,04***	***± 1,09***	***± 1,14***
14	±0,71	±0,76	±0,80	±0,85	±0,90	±0,95	±0,99	***± 1,04***	***± 1,09***
15	±0,68	±0,73	±0,77	±0,82	±0,86	±0,91	±0,96	*±1,00*	***± 1,05***
16	±0,66	±0,70	±0,75	±0,79	±0,83	±0,88	±0,92	±0,96	*±1,01*
17	±0,64	±0,68	±0,72	±0,76	±0,80	±0,85	±0,89	±0,93	±0,97
18	±0,62	±0,66	±0,70	±0,74	±0,78	±0,82	±0,86	±0,90	±0,94
19	±0,60	±0,64	±0,68	±0,72	±0,76	±0,80	±0,84	±0,88	±0,91
20	±0,58	±0,62	±0,66	±0,70	±0,73	±0,77	±0,81	±0,85	±0,89

NOTE It cannot be excluded that the precision can be better or worse when other test organism, products, and/or interfering substances are tested. However, it seems likely that the precision in these cases will be in the same range.

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK