AS/NZS 4020:2005

Australian/New Zealand Standard™

Testing of products for use in contact with drinking water

Accessed by UNIVERSITY OF SOUTH AUSTRALIA on 16 Mar 2007

STANDARDS Australia

STANDARDS NEW ZEALAND Paerewa Aotearoa

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The following are represented on Committee CH-034:

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Australian Chamber of Commerce and Industry
Australian Electrical and Electronic Manufacturers Association
Australian Industry Group
Australian Paint Manufacturers' Federation
Australian Society for Microbiology Incorporated
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Australian/New Zealand Standard™

Testing of products for use in contact with drinking water

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CH-034, Materials in Contact with Drinking Water, to supersede AS/NZS 4020:2002, *Testing of products for use in contact with drinking water*.

In preparing this Standard, consideration has been given to comparable overseas Standards, to minimize duplication of effort and to maintain commonality, wherever reasonable, with those Standards. Particular consideration has been given to the various parts of BS 6920, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water.* Several of the test procedures and criteria given in BS 6920 have been adopted or modified for Australian and New Zealand requirements.

This Standard departs from BS 6920 as follows:

(a) This Standard provides a method of testing for the leaching of compounds that may produce a mutagenic effect.

(b) The requirement for products to be tested at surface area-to-volume ratios that are not less than those in the intended end-use exposure (with the exception of the test for growth of aquatic micro-organisms). Where there is a difference between test and end-use exposures, provision is made for a scaling factor to be applied to the test result.

(c) The inclusion of testing for metals extracted from metal products that are often components of products in contact with drinking water.

Significant changes from the previous edition include the following:

(i) Inclusion of a colorimetric method for determination of cytotoxic activity.

(ii) Inclusion of an appendix on the structure of test reports.

(iii) Revision of the appendix on product submission information.

(iv) Altered requirements for testing non-metallic products for leaching of metals.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendices to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is for information and guidance only.

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CONTENTS

Page

FOREWORD 4
1 SCOPE 5
2 REFERENCED DOCUMENTS 5
3 DEFINITIONS 6
4 TEST SAMPLES 8
5 SCALING FACTORS 9
6 TEST REQUIREMENTS 11
7 HOT WATER TESTS 14

APPENDICES
A SAMPLE PREPARATION 15
B SCALING FACTORS—DERIVATION AND APPLICATION 21
C TEST METHOD—TASTE OF WATER EXTRACT 26
D TEST METHOD—APPEARANCE OF WATER EXTRACT 32
E TEST METHOD—GROWTH OF AQUATIC MICRO-ORGANISMS 35
F TEST METHOD—CYTOTOXIC ACTIVITY OF WATER EXTRACT 42
G TEST METHOD—MUTAGENIC ACTIVITY OF WATER EXTRACT 51
H TEST METHOD—EXTRACTION OF METALS 55
I TEST METHOD—EXTRACTION PROCEDURES FOR END-OF-LINE FITTINGS 59
J HIGH TEMPERATURE TESTS 64
K TEST METHOD—SAMPLE EXTRACTION PROCEDURE FOR USE WITH WATER-HEATING SYSTEMS 66
L PRODUCT SUBMISSION INFORMATION 71
M SIMULATED SAMPLES 74
N TEST REPORT 76

Accessed by UNIVERSITY OF SOUTH AUSTRALIA on 16 Mar 2007

FOREWORD

Guidelines for drinking water quality in Australia have been prepared conjointly by the National Health and Medical Research Council (NHMRC) and the Australian Water Resources Council (AWRC), which combined in 1993 with the Agricultural Council and the Soil Conservation Council to form the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). In New Zealand, drinking water quality is subject to the Drinking Water Standards for New Zealand prepared by the Ministry of Health. The *Australian Drinking Water Guidelines* (ADWG) and *Drinking Water Standards for New Zealand* (DWSNZ) cover a range of physical, chemical, microbiological and radiological characteristics relevant to the health and aesthetic concerns of consumers, and recommend values for those characteristics.

One of the important factors influencing the quality of water supplied to consumers is the effect of the various materials that come into contact with the water as it passes through the system. The potential effect becomes more critical as the size of the system decreases from water supply to reticulation to plumbing systems, and the residence time in contact with these systems increases. This Standard provides a means to test such materials in order that the achievement of the appropriate national recommended water quality values is not jeopardized. The Standard prescribes methods of testing and compliance limits for the effects of a product on the taste and appearance of water, the ability of a product to support the growth of aquatic micro-organisms and the quantity of toxic metals and non-metallic substances leached from the product when exposed to the test water. In addition, the Standard prescribes extraction procedures for products in contact with hot water and in end-of-line situations. The hot water tests apply where water has the potential for human consumption, food preparation, utensil washing and oral hygiene.

Not all of the physical and chemical characteristics listed in the NHMRC/ARMCANZ guidelines and the DWSNZ are specifically referred to in this Standard. For those characteristics not listed, it is envisaged that the methods of testing given in this Standard and the recommended values given by NHMRC/ARMCANZ or the DWSNZ will be sufficient and readily adapted by the responsible authority.

The dominant principle of this Standard is to allow water quality requirements, as adopted by the particular authority responsible for water supply quality, to be met at consumers' taps. Besides the effects of materials, this quality will depend on other factors, including commissioning and operational procedures such as flushing of mains, which are the responsibility of the local water agency.

This Standard is published for use by manufacturers, water agencies and regulators in Australia and New Zealand to allow the selection of materials exposed to drinking water, and as a basis for identifying the performance that can be expected by purchasers of products used in water supply systems.

It is intended that appropriate Australian and New Zealand Standards and other specifications will refer to this Standard if they specify requirements for the effects of a particular product on the quality of drinking water.

The Standard applies only to water quality at customer taps with respect to general health requirements for the consumer. It is not intended as either a long-term indication of the corrosion resistance of the material itself or any short-term effects due to highly localized and unpredictable conditions of water chemistry.

It is the understanding of the Committee that prepared this Standard that, in line with the intention of the ADWG and the DWSNZ, the only products that are required to satisfy the provisions of this Standard are products in contact with drinking water.

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Australian/New Zealand Standard
Testing of products for use in contact with drinking water

1 SCOPE

This Standard specifies requirements for the suitability of products for use in contact with drinking water, with regard to their effect on the quality of water. These products include all items such as pipes, fittings, components, and materials used in coating, protection, lining, jointing, sealing and lubrication applications in the water supply and plumbing industry. The Standard requires that products intended for use in contact with drinking water be tested by exposure to extractant waters. Where appropriate, a scaling factor is applied to such tests to compensate for differences between laboratory and field conditions.

NOTE: This Standard may be used to test the suitability of products intended for use in contact with types of water other than drinking water.

This Standard does not take into account possible changes in materials, methods of manufacture or installation, nor is any consideration given to the frequency of testing of products. These should be covered by relevant product Standards. As a guide, re-verification testing of products to this Standard is generally desirable after a period of five years. This is consistent with the requirements of overseas bodies such as the Drinking Water Inspectorate in the United Kingdom.

Chemicals and media used directly for treating raw water to provide a suitable drinking water supply (e.g. lime, coagulants, activated carbon, ion-exchange resins) are not covered by this Standard.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1012	Methods of testing concrete
1012.8.1	Part 8.1: Method of making and curing concrete—Compression and indirect tensile test specimens
1012.8.2	Part 8.2: Method of making and curing concrete—Flexure test specimens
2567	Laminar flow cytotoxic drug safety cabinets
4276	Water microbiology
4276.2	Part 2: Culture media, diluents and reagents
5601	Gas installations (AG 601)
AS/NZS	
1477	PVC pipes and fittings for pressure applications
2031	Selection of containers and preservation of water samples for microbiological analysis
2243	Safety in laboratories
2243.3	Part 3: Microbiological aspects and containment facilities
3350	Safety of household and similar electrical appliances
3350.2.21	Part 2.21: Particular requirements—Storage water heaters
3500	Plumbing and drainage
3500.4	Part 4: Heated water services

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ISO

2230	Rubber products—Guidelines for storage
3696	Water for analytical laboratory use—Specification and test methods
5725	Accuracy (trueness and precision) of measurement methods and results
5725-2	Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method
5814	Water quality—Determination of dissolved oxygen—Electrochemical probe method
7027	Water quality—Determination of turbidity
7393	Water quality—Determination of free chlorine and total chlorine
7393-2	Part 2: Colorimetric method using *N*,*N*-diethyl-1, 4-phenylenediamine, for routine control purposes
7887YYYY	Water quality—Examination and determination of colour

BS

748	Specification for haemacytometer and particle counting chambers
5586	Sensory analysis apparatus
5586-1	Part 1: Specification for wine-tasting glass
6068	Water quality
6068-2	Part 2: Physical, chemical and biochemical methods

NHMRC/ARMCANZ

Australian Drinking Water Guidelines. NHMRC/ARMCANZ. AGPS, Canberra, 1996

Manual of analytical quality control for the water industry. Water Research Centre. Technical report NS30, 1989

New Zealand Ministry of Health

Drinking Water Standards for New Zealand (DWSNZ). 2005. New Zealand Ministry of Health, Wellington, 2005

APHA, AWWA and WPCF

Standard methods for the examination of water and waste water. 20th edition, American Public Health Association, American Water Works Association, Water Environment Federation.

HMSO

Methods for the examination of waters and associated materials. The microbiology of water, Part 1—Drinking water. Report on public health and medical subjects No. 71. HMSO, London, 1994

OECD

Guideline for testing of chemicals, 471: Genetic toxicology: *Salmonella typhimurium,* reverse mutation assay. OECD, Paris 1983

Guideline for testing of chemicals, 472: Genetic toxicology: *Escherichia coli*, reverse mutation assay. OECD, Paris, 1983

3 DEFINITIONS

For the purposes of this Standard, the definitions below apply.

3.1 Anaerobic adhesive

An adhesive that cures spontaneously in the absence of oxygen, curing being inhibited by the presence of oxygen and catalysed by metal ions.

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3.2 Colour (true colour)

The colour produced by a solution containing 1 mg of platinum per litre (in the form of hydrogen hexachloroplatinate(IV) in the presence of 2 mg of cobalt(II) chloride hexahydrate per litre).

NOTE: The unit of colour is the Hazen Unit (HU).

3.3 Composite product

A product in which more than one type of material is in contact with drinking water, e.g. a product having both metal and plastic exposed surfaces.

NOTE: Where the composite product is wholly metallic, it is tested as such.

3.4 Cytotoxic

Poisonous (toxic) to cells under the conditions of test.

3.5 Drinking water

Water that has the potential for human consumption, food preparation, utensil washing and oral hygiene. For the purpose of this Standard—

(a) tap water and drinking water are synonymous;

(b) cold water has a temperature less than 40°C; and

(c) hot water has a temperature in the range 40°C to 80°C inclusive, except where varied in accordance with Clause 3.9.

3.6 End-of-line fitting

Any product, or part of a product, installed within 250 mL draw-off of a drinking water delivery point.

NOTE: Products typically include taps, tap components, fittings, flexible tubes, drink dispensers, boiling water dispensers, drinking fountains, water treatment appliances, hose-connection vacuum breakers, ball valves and flow-control valves.

3.7 Extract (leachate)

The solution formed when the product has been in contact with the test water.

3.8 Extractant water

See 'test water'.

3.9 Maximum holding water temperature

The temperature, nominated by the manufacturer, at which the product is held in contact with water for an extended period, e.g. several hours. During this time, there is a no-flow condition through the product.

3.10 Mutagenic

Causes genetic changes to bacteria under the conditions of test.

3.11 Organoleptic

Pertaining to a method of systematically assessing the effects of a substance on the human senses, particularly taste or smell.

3.12 Product

A manufactured item that comes into contact with drinking water, including a component part of a manufactured item.

3.13 Sample

A product, or part of a product, submitted for testing for suitability for use in contact with drinking water.

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3.14 Scaling factor

The ratio of the *end-use* surface area-to-volume ratio to the *test* surface area-to-volume ratio.

3.15 Taste panellist

An individual who has volunteered and who has been trained to participate in the assessment of water samples for taste.

3.16 Test water

Water in contact with normally in-service wetted surface areas and used as the medium to obtain extracts from samples of the product under test.

3.17 Threshold dilution

The highest dilution level of the sample at which a taste is detectable.

3.18 Turbidity

Reduction of transparency of a liquid caused by the presence of undissolved matter.

NOTE: The unit of turbidity is the Nephelometric Turbidity Unit (NTU).

3.19 Water fitting

Anything fitted or fixed in connection with the supply, measurement, control, distribution and utilization of water.

4 TEST SAMPLES

4.1 Selection and preparation of samples

The sampling of product and preparation of samples for testing shall be carried out in accordance with Appendix A. Sufficient samples of the product shall be provided to conduct all of the tests required.

Products may be tested as a complete assembly or the separate components or sub-assemblies may be tested individually. For test results from components or sub-assemblies to be acceptable, the sum of the tested exposures shall be equal to or greater than the actual exposures of the complete assembly, except for the growth of micro-organisms test, where the tested exposure shall be in the range of 1000 mm^2/L to 15 000 mm^2/L.

NOTE: Care should be taken in considering the approval of materials that are not in final product form. The performance of materials is affected by the processing conditions, which may influence results of the tests described in this Standard. Any changes in the material formulation, the process of manufacture, the method of application, or the surface area-to-volume ratio in end use could affect the suitability of the product for use in contact with drinking water and re-testing may be required.

4.2 Range of product sizes

Where a manufacturer produces a complete range of product sizes of the same material composition, tests on the greatest surface area-to-volume ratio product shall qualify the remainder of the range, provided that the same manufacturing conditions and processes are used for the complete range of products.

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4.3 Product exposure

Wherever possible, samples of the product shall be tested by in-the-product exposure (see Paragraph A4.1), so that only the surface that is normally wetted in end use is exposed to the test water.

Where in-the-product exposure is not possible, or where unfabricated material is being tested, the product surface or a representative sample of the material surface shall be tested by immersion exposure (see Paragraph A4.2). The ratio of exposed surface area to extractant water volume for immersion exposure testing shall be equal to (within 5%) or greater than the surface area-to-volume ratio in the intended end use, and shall not be less than 1000 mm^2/L.

Where testing for the growth of micro-organisms, the ratio shall be in the range 1000 mm^2/L to 15 000 mm^2/L. Where the end-use exposure is greater than 15 000 mm^2/L, the test result shall be based on a testing exposure of 15 000 mm^2/L and no scaling factor shall be applied to this result. Where a product has multiple non-metallic components, the non-metallic wetted components shall be tested at the end-use exposure, with the exception that end-of-line fittings shall be tested at an exposure for each component in contact with 250 mL of water. The MDOD result shall be the average of results for individual components.

5 SCALING FACTORS

5.1 General

Scaling factors are normally specified in the relevant product Standard. The discussion below applies to situations in which this is not the case.

Flexible hoses are tested as end-of-line fittings unless otherwise specified in the relevant product Standard.

A scaling factor is generally not applicable to in-the-product testing (e.g. the testing of pipe). In this method of exposure, the ratio of the exposed surface area to the extractant water volume will in most cases be equal to the surface area-to-volume ratio in end use (i.e. a scaling factor of 1).

An exception applies in certain cases of in-the-product testing, where in end use the internal surface of the product is effectively in contact with a substantially larger volume of water than in the test. Examples of such products are valves and fittings connected into water supply pipelines. A further exception applies in the testing of end-of-line-fittings such as taps and their components, where in the end-use situation the extract contained in the fitting is effectively diluted before consumption. Similarly, the use of a composite extract in the metals extraction test for end-of-line fittings has the effect of providing an inbuilt scaling factor.

In immersion exposure testing, the selected surface-area-to-volume ratio in the test can be greater than in the intended end use. Where this is the case, a scaling factor having a value of less than 1 may be applied in the evaluation of the test result. For end-of-line fittings requiring the total immersion procedure, the fitting is tested in 250 mL of test water. In addition, the testing exposure shall be not less than 1000 mm^2/L.

Scaling factors cannot be applied to qualify products for end-use surface area-to-volume ratios higher than the test ratio, i.e. the scaling factor cannot be greater than 1. Scaling factors can be used only to qualify products for use at surface area-to-volume ratios lower than the test ratio.

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5.2 Determination of scaling factors

Where a scaling factor is applied in either immersion exposure testing or in-the-product testing, the value of this scaling factor will have been agreed between the manufacturer and the testing laboratory. Where product certification is required, the agreed scaling factor needs to be acceptable to the certifying body. The scaling factor specified shall be in the range 0.01 to 1.0 and shall apply to all tests. The test report shall include the value and method of derivation of the scaling factor.

NOTE: Examples of the method of scaling factor calculation in some typical product applications are given in Appendix B. In the case of domestic plumbing fittings, a scaling factor based on the layout in Figure B1 will apply, unless the manufacturer presents another valid approach.

5.3 Application of scaling factors (see Paragraph B3 Example 1)

The scaling factor shall be applied by sample size selection (to produce the surface area-to-volume ratio applicable to the end-use situation) and/or by the application of the scaling factor to each test. Where used for a test, the scaling factor shall be applied as follows:

(a) *Taste*

The extract is diluted with fresh extractant water in proportion to the scaling factor.

(b) *Appearance*

The extract is diluted in proportion to the scaling factor or, alternatively, the concentration of each colour and/or turbidity value in the extract is multiplied by the scaling factor.

(c) *Growth of micro-organisms*

The mean dissolved oxygen difference is multiplied by the scaling factor.

(d) *Cytotoxic and mutagenic activity*

The extract is diluted with fresh extractant water in proportion to the scaling factor.

(e) *Extraction of metals*

The extract is diluted with fresh extractant water in proportion to the scaling factor or, alternatively, the concentration of each metal in the extract is multiplied by the scaling factor.

5.4 Restrictions on the use of scaling factors

The uncertainty of measurement in laboratory testing will increase as the amount of dilution of the extract increases. As a practical limit, the maximum allowable dilution of the extract prior to assessment for taste, appearance, cytotoxic and mutagenic activity, and extraction of metals (Appendices C, D, F, G and H) shall not exceed 1 part extract to 99 parts fresh extractant water.

Similarly, a scaling factor applied to the test result in the appearance test (see Clause 5.3(b)) or the extraction of metals test (see Clause 5.3(e)) shall not have a value of less than 0.01.

In the growth of micro-organisms test (see Clause 5.3(c)), the scaling factor applied to the test result shall not have a value of less than 0.33.

NOTE: Where a scaling factor of less than 0.33 is required for the growth of micro-organisms test, adjustment of the surface area-to-volume ratio is necessary prior to testing.

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6 TEST REQUIREMENTS

6.1 General

Products for use in contact with drinking water shall be subjected to tests for taste, appearance, growth of aquatic micro-organisms, cytotoxicity, mutagenicity and extraction of metals, dependent on whether the type of product is in-line, end-of-line or hot water system, in accordance with Table 1 and the methods given in Appendices C to K, as appropriate. The results of these tests shall comply with the criteria set out below.

Testing shall be undertaken unless specifically excluded by the relevant product standard.

NOTE: As experience in the use of this Standard increases, a list of products exempt from testing may be developed.

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TABLE 1

SELECTION OF TESTS

Test	In-line products		Water-heating systems	End-of-line products	
	Wholly metallic (see Note 1)	Composite and non-metallic	Appendix K	Wholly metallic (see Note 1)	Composite and non-metallic
Taste (Appendix C)	Cold or hot Appendix J	Cold or hot Appendix J	N/A	Cold or hot Appendix I	Cold or hot Appendix I
Appearance (Appendix D)	Cold or hot Appendix J	Cold or hot Appendix J	Hot	Cold or hot Appendix I	Cold or hot Appendix I
Microbial (Appendix E) See Note 2	N/A	Cold	Cold If applicable (see Note 2)	N/A	Cold
Cytotoxicity (Appendix F)	Cold or hot Appendix J	Cold or hot Appendix J	Hot	Cold or hot Appendix I	Cold or hot Appendix I
Mutagenicity (Appendix G)	N/A	Cold or hot Appendix J	Hot	N/A	Cold or hot Appendix I
Metals (Appendix H)	Cold or hot Appendices H & J	Cold or hot Appendices H & J	Hot	Cold or hot Appendices H & I	Cold or hot Appendices H & I

NOTES:

1 'Metallic pipes and fittings' are defined as those products that contain only wetted metallic components as part of the complete assembly.

2 The microbial test is undertaken for products that contain non-metallic wetted components. Testing of the products is usually conducted at 30°C and covers products that operate at less than 40°C (see Appendix E).

3 N/A: Test is not required.

6.2 Taste of water extract

When the product is tested in accordance with Appendix C, if a reportable taste is detected by any member of the taste panel in the first dilution of the first and/or seventh chlorinated or unchlorinated extract, the product shall be deemed unsuitable for contact with drinking water unless two further samples are examined and each panellist reports no taste in the first dilution of the final (i.e. seventh) chlorinated or unchlorinated extract from these samples.

6.3 Appearance of water extract

When the product is tested in accordance with Appendix D, the increase in true colour and turbidity of the water in the first extract shall be less than five Hazen Units (HU) and 0.5 Nephelometric Turbidity Units (NTU) respectively. If a single sample does not comply with this requirement after a seventh extract, the product shall be deemed unsuitable for contact with drinking water unless three further samples are examined and the mean colour and turbidity of their final (i.e. seventh) extracts are not increased by more than 5 HU or 0.5 NTU respectively.

6.4 Growth of aquatic micro-organisms

When the product is tested in accordance with Appendix E, the mean dissolved oxygen difference (*MDOD*) shall be less than or equal to 2.4 mg/L.

If a single sample of a product gives an *MDOD* in the range 1.7 mg/L to 2.9 mg/L inclusive, two further samples of the product shall be examined. If the arithmetic mean of the three *MDOD* values is greater than 2.4 mg/L, the product shall be deemed unsuitable for contact with drinking water.

6.5 Cytotoxic activity of water extract

When the product is tested in accordance with Appendix F, the extract shall not cause a cytotoxic response.

If a single sample gives a cytotoxic response, two further samples of the product shall be examined using fresh reagents.

6.6 Mutagenic activity of water extract

The product shall be tested in accordance with Appendix G and the test result shall be reported.

If a single sample gives a statistically significant result, two further samples shall be extracted using fresh reagents and the reversion test repeated with the same strain of bacterium. A positive result shall be confirmed by testing for mutagenicity of the extract using the alternative micro-organism test system.

NOTE: The reliability of the test for mutagenic activity is currently under investigation. Whereas there is still a requirement to report the result of this test, that test result should not at this time form the basis for overall failure of the sample.

6.7 Extraction of metals

6.7.1 *Products in general*

When the product is tested in accordance with Appendices H to J, the amounts of the specified metals in the first and/or final extracts shall not exceed the limits given in Table 2.

NOTE: The limits give in Table 2 are subject to adjustment from time to time. The latest available concentrations should be obtained from the *Australian Drinking Water Guidelines* (ADWG) and the *Drinking Water Standards for New Zealand* (DWSNZ).

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If the limit for any metal is exceeded in the final (seventh) extract from any of the duplicate samples, the product shall be deemed unsuitable for contact with drinking water unless a further three samples are examined and the mean of the specified metals in their final seventh extracts does not exceed the limits specified in Table 2.

Where the product tested is applied to a metal fitting, the assessment shall be made on the differences in concentrations of the specified metals between the final extracts and the metal-fitting blank test.

Where a cementitious product has been tested, the assessment shall be made on the differences in concentrations of the specified metals between the final extracts and the reagent blank test.

6.7.2 *End-of-line fittings*

A procedure for testing end-of-line fittings for extraction of metals is given in Appendix I.

If either of the duplicate samples exceeds the concentration limits specified in Table 2, a further three fresh samples of the product shall be examined. The product shall be deemed to pass the test if the mean of the specified metals for all samples does not exceed the limits given in Table 2.

7 HOT WATER TESTS

Where products are designed for use in hot water installations and the water in contact with the product surfaces meets the definition given in Clause 3.5, products shall be tested in accordance with Appendix J or K. The manufacturer of the product is responsible for nominating the maximum holding temperature of the water contained in the product, within the range 40°C to 100°C inclusive. For end-of-line fittings used in cold and hot water applications, a maximum temperature shall be used for test extractions in accordance with Appendix I.

Products that pass the tests required in Appendix I, J or K meet the requirements for hot water exposure up to the temperature used in testing. Products that pass these tests shall also be deemed to comply with the cold water requirements for all tests undertaken as part of the hot water testing program.

TABLE 2

MAXIMUM ALLOWABLE CONCENTRATIONS OF METALS*

Metal	Maximum allowable concentration, mg/L
Antimony (Sb)	0.003
Arsenic (As)	0.007
Barium (Ba)	0.7
Cadmium (Cd)	0.002
Chromium (Cr)	0.05
Copper (Cu)	2
Lead (Pb)	0.01
Mercury (Hg)	0.001
Molybdenum (Mo)	0.05
Nickel (Ni)	0.02
Selenium (Se)	0.01
Silver (Ag)	0.1

* These levels are taken from the *Australian Drinking Water Guidelines* (1996 as amended).

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APPENDIX A

SAMPLE PREPARATION

(Normative)

A1 SCOPE

This Appendix specifies the preparation of samples of products, for testing their suitability for use in contact with drinking water. It is applicable to both metallic and non-metallic products.

A2 APPARATUS

A2.1 Sample storage bags

Of a food-grade material such as polyethylene, for storing samples in the laboratory.

A fresh bag shall be used for each product type or sets of products made from an identical material. Unsealed bags shall be used for elastomeric compounds. If manufacturers supplying samples provide alternative written instructions to which the products are subject in practice, the samples shall be stored as advised.

A2.2 Glass plates

Of sand-blasted glass, having dimensions suitable for the tests specified in Paragraphs A7.3, A7.4, A7.5, A7.6 and A7.8. Plates shall be prepared as follows:

(a) Clean the plates in an aqueous solution of biodegradable laboratory detergent.

(b) Rinse thoroughly in tap water and then once in distilled water complying with Grade 3 of ISO 3696.

(c) Drain and dry.

A2.3 Test containers

For immersion exposure testing. The containers shall be made of clear borosilicate glass for all tests with the exception of the growth of micro-organisms test (see E7.1). The containers shall be of an appropriate size to accommodate the sample while maintaining the required surface area-to-volume ratio. The containers shall be provided with a method of sealing during test extractions, using materials that are known to have no significant effect on the test results. Polyethylene film, aluminium foil and borosilicate glass covers have been found to be suitable sealing materials.

NOTE: Aluminium foil should not be used for sealing test containers in the metals extraction test.

A2.4 Temperature-measuring device

A2.5 Relative humidity-measuring device

A2.6 Glass-encapsulated weights

For weighing down the products, if necessary.

A3 SAMPLES

A3.1 Nature of samples

The samples used for testing shall, wherever possible, be manufactured products or components of water fittings drawn from production batches. The products shall be tested in the condition in which they are intended to be used in service. Wherever possible, samples of the actual product (e.g. pipe, fitting, appliance) shall be tested by filling with extractant water so that only the surface normally wetted in use is exposed to the extractant.

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If it is not possible to test a finished product, or where unfabricated material is being tested, a representative sample of the material shall be tested by immersion exposure.

Where the surface area-to-volume ratio adopted for testing is greater than the end-use ratio, a scaling factor may be applied (see Clause 5). Successful evaluation of the product having the highest surface area-to-volume ratio shall qualify all lower surface area-to-volume ratios in the product range. For example, for polyvinyl chloride pipe manufactured to AS/NZS 1477, the smallest PN 12 pipe is DN 20 having an internal surface area of 169 000 mm^2 per litre of contents. Successful evaluation of DN 20 pipe shall qualify all of the PN 12 or lower-pressure class pipes manufactured to AS/NZS 1477.

Where a manufacturer does not produce a complete range of product sizes, testing of the highest surface area-to-volume ratio product will apply to the remainder of the range having lower surface area-to-volume ratios.

Where the material being tested is not in final product form, a statement to that affect shall be included in the test report.

NOTES:

1 A format for presenting data to the testing laboratory is given in Appendix L.

2 Care should be taken in considering the approval of materials that are not in final product form. The performance of materials is affected by the processing conditions, which may influence results of the tests described in this Standard.

An option that may be considered in some circumstances is the use of simulated samples, but the decision to use this approach is made in the relevant product Standard.

NOTE: A description of the use of simulated samples, if allowed, is given in Appendix M.

A4 PRODUCT EXPOSURE

A4.1 In-the-product exposure

In-the-product exposure shall be used, wherever possible, for the extraction tests. Samples are completely filled with extractant water so that the surface area-to-volume ratio is equal to the actual ratio in end use.

In certain cases, the product in end use will effectively be in contact with a larger volume of water than in the test. In such cases, a scaling factor (see Clause 5) may be applied in the evaluation of the test result.

The extractant water volume will vary according to the size of the product; therefore it is necessary to ensure that a sufficient volume of extractant (typically about 250 mL) can be obtained for each test. For products having a small volume, it may be necessary to use more than one sample for each test to obtain the required volume of extractant water.

Because of the need for a tightly sealed test container, in-the-product exposure cannot be applied to the growth of micro-organisms test specified in Appendix E. The growth of micro-organisms test shall be carried out by immersion exposure (see Paragraph A4.2). Products may need to be sectioned to obtain the required sample size for this immersion exposure.

A4.2 Immersion exposure

Immersion exposure shall be used for samples that cannot be evaluated by in-the-product exposure. In using immersion exposure, steps shall be taken to prevent contact between the extractant and product surfaces that, under end-use conditions, do not come in contact with drinking water. The sample is immersed in extractant water contained in a clear borosilicate glass test container (A2.3).

During the extraction, samples shall always be completely submerged in the extractant water. If the density of the sample is less than that of water, the sample is kept submerged by using glass-encapsulated weights.

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The surface area-to-volume ratio selected for immersion exposure testing shall be equal to the nominal end-use ratio, or alternatively, the sample shall be tested at a surface-area-to-volume ratio that is greater than the end-use ratio, and a scaling factor (see Clause 5) used in the evaluation of the test result. An exception applies to the growth of micro-organisms test, where the surface area-to-volume ratio shall be in the range 1000 mm^2/L to 15 000 mm^2/L.

The actual surface area-to-volume ratio used in each immersion exposure test shall be within 5% of the exposure ratio intended for the test. When calculating the surface area-to-volume ratio, no adjustments shall be made to take account of variations due to surface texture.

The minimum surface area-to-volume ratio used for all immersion exposure testing shall be 1000 mm^2/L.

A5 SAMPLE TRANSPORT AND STORAGE

During the period between packaging and receipt by the laboratory, and during storage in the laboratory, the samples shall be protected from contamination by dirt, oil, grease, excessive heat, sunlight and volatile chemicals. Samples shall be stored in accordance with Paragraph A2.1.

CAUTION: DO NOT USE ADHESIVE TAPE OR LABELS, INK OR PENCIL ON TEST SAMPLES

A6 SAMPLE WASHING

On the day that testing is to start, samples of the products to be tested shall be rinsed dynamically in flowing distilled water, or as required by the test method, to remove dirt, dust or other foreign material.

A7 SPECIAL PRODUCTS

A7.1 General

The products in Paragraphs A7.2 to A7.8 require special treatment. All of these products shall be tested by immersion exposure (see Paragraph A4.2) in a clear borosilicate glass test container (A2.3).

A7.2 Elastomeric products

Elastomeric products shall be stored in accordance with ISO 2230, except that storage envelopes or pockets shall not be sealed, dusting powder shall not be used and cleaning shall not be carried out unless any of these procedures form part of the usual production procedures.

Suppliers of products shall arrange for storage of the products for at least four weeks before testing.

NOTE: If samples of elastomeric products are tested within four weeks of manufacture, the results obtained with this method may not be representative of the material as it is used in practice.

A7.3 Greases

The product shall be evenly applied to the surface of a glass plate (A2.2) to produce a test panel having the required surface area-to-volume ratio.

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A7.4 Coatings

The product shall be evenly applied to the surface of a glass plate (A2.2) to produce a test panel having the required surface-area-to-volume ratio. Alternatively, the product shall be applied to a panel of a corrosion-resistant material, e.g. stainless steel. The coating shall be applied at the specified film thickness and cured in accordance with the manufacturer's instructions.

NOTE: When preparing the test panels, account should be taken of the curing conditions (time, temperature, and relative humidity) that are applicable to the practical use of the product.

For multiple-layer coating systems, a separate test shall be undertaken for each coating layer. When testing the final coat, the surface area-to-volume ratio in the test shall not be less than the final coat exposure ratio in end use. When testing a layer under the final coat, the minimum required exposure ratio is less than that required for the final coat. The minimum surface area-to-volume ratio for testing each layer shall be determined by use of the multipliers given in Table A1.

TABLE A1

MULTIPLE-LAYER COATING SYSTEM TEST PANEL PREPARATION

Number of layers in system	Layer	Surface area to volume ratio multiplier
Two coat	Final coat First coat	1 1/3
Three coat	Final coat Second coat First coat	1 1/3 1/6
Four coat	Final coat Third coat Second coat First coat	1 1/3 1/6 1/12

Each layer in a multiple-layer coating system shall be tested either separately or in one combined test.

For example, testing of a three-layer system that has a surface area-to-volume ratio of 15 000 mm^2/L in the end use would be carried out using three separate tests, with a minimum exposure ratio of 15 000 mm^2/L for the final coat, 5000 mm^2/L for the second coat, and 2500 mm^2/L for the first coat. Alternatively, a single test including all three layers would be carried out, with a total minimum exposure ratio of 22 500 mm^2/L (final coat at 15 000 mm^2/L, second coat at 5000 mm^2/L, and first coat at 2500 mm^2/L).

Layers that are 1 mm or more from the water contact surface of the coating are not normally expected to contribute to leaching, and are not required to be tested.

NOTE: Testing of all the layers together has the potential advantage of reducing the total amount of testing required. However, if a failure occurs during testing, it would be necessary to retest the layers individually to identify the cause of the failure.

A7.5 Sealing compounds

The product shall be evenly applied to the surface of a glass plate (A2.2) to produce a test panel having the required surface area-to-volume ratio. Alternatively, the test panel shall be produced as a cast sheet (2 mm to 5 mm thick) between food-grade polyethylene film. Immediately following preparation, the panel shall be cured in accordance with the manufacturer's instructions.

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During the cure period the test panel shall be suspended, e.g. by a wire or a nylon monofilament, to prevent contact with other surfaces. Where cast sheet is used as the test panel, the polyethylene film shall be removed when the sheet is sufficiently cured to be self supporting, and the sheet then suspended for the remainder of the cure period.

A7.6 Jointing compounds

The product shall be evenly applied to the surface of a glass plate (A2.2) to produce a test panel having the required surface area-to-volume ratio. The panel shall be tested immediately (without curing).

A7.7 Solder fluxes

The product shall be evenly applied to the surface of a copper sheet to produce a test panel having the required surface area-to-volume ratio. The copper sheet is then placed in a muffle furnace at a temperature of 300°C, and allowed to heat until the flux flows (approximately 30 s to 1 min). The panel shall be tested after cooling.

A7.8 Anaerobic adhesives

The product shall be evenly applied to the surface of a glass plate (A2.2) to produce a test panel having the required surface area-to-volume ratio, then cured in accordance with the manufacturer's instructions in an anaerobic chamber.

A8 CEMENTITIOUS PRODUCTS

Cementitious products are those that have been manufactured from or are coated with cementitious materials. The samples used for testing shall be manufactured products (see Paragraph A3), or test blocks that are representative of the manufactured products. Samples of cementitious products shall be given a standard moist-curing treatment of 28 d at (23 ±2)°C as specified in AS 1012.8.1 or 1012.8.2, or in accordance with the manufacturer's instructions.

NOTE: When preparing the test samples, account should be taken of the curing conditions (time, temperature, and relative humidity) that are applicable to the practical use of the product.

The cured samples shall be pre-conditioned by sequential soaking in water that has an aggressivity index (*AI*) of 12.0 or greater, to remove readily soluble alkali constituents.

The aggressivity index is given by the following equation:

$$AI = pH + \log_{10}(AH) \qquad \ldots (A1)$$

where

A is the total alkalinity expressed as mg/L of $CaCO_3$

H is the calcium hardness expressed as mg/L of $CaCO_3$

Pre-conditioning water shall be obtained from a tap connected directly to a service pipe at mains pressure. If the tap water has an *AI* of less than 12.0, it shall be treated as follows:

(a) Add calcium carbonate.

(b) Dissolve the calcium carbonate by stirring and passing carbon dioxide through the water until it is clear.

(c) Pass filtered air through the water until the pH rises to an equilibrium level.

(d) Measure the *AI*. If not 12.0 or greater, repeat the process.

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After curing, the sample shall be rinsed with pre-conditioning water for 10 min. Samples that are to be tested by in-the-product exposure are filled with pre-conditioning water. Samples to be tested by immersion exposure are pre-conditioned in a clean and dust-free container of 1 L capacity. Soak the samples for 24 h and measure the pH of the water in accordance with *Standard methods for the examination of water and waste water*. Discard the water and replace with fresh pre-conditioning water. Continue this process of sequential soaking until the pH of the water is less than 9.0 on two successive occasions. If a pH level of less than 9.0 is not achieved after 10 sequential soakings, discontinue the test.

Test the samples after pre-conditioning. The test water used for all of the tests shall have the same aggressivity index as the pre-conditioning water. The level of copper in the test water shall be determined, to ensure that it is in accordance with Table E2.

Samples of cementitious products should be maintained in a moist condition between the stages of curing, pre-conditioning, and testing.

A9 METAL ALLOYS

Where metal alloys are used, laboratories shall test any part that comprises 30% or greater of the wetted area, for all relevant elements listed in Table 2. These metals shall be recorded on the test report.

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APPENDIX B

SCALING FACTORS DERIVATION AND APPLICATION

(Informative)

B1 INTRODUCTION

A scaling factor has been defined in Clause 3.14 of this Standard and the circumstances in which scaling factors may be used in the evaluation of test results have been described in Clause 5.

B2 CALCULATION OF SCALING FACTORS

The scaling factor is calculated using the following equation:

$$SF \quad \frac{A_f}{V_f} \div \frac{A_t}{V_t} \quad \frac{A_f V_t}{A_t V_f} \qquad \ldots (B1)$$

where

SF = scaling factor

A_f = surface area of product exposed to water in the field, in square millimetres

V_f = volume of water to which the product is exposed in the field, in litres

A_t = surface area of the product exposed to water in the test, in square millimetres

V_t = volume of water to which the product is exposed in the test, in litres

NOTE: Scaling factors cannot be greater than 1.0. That is, the test surface area-to-volume ratio for the test product cannot be less than the end-use ratio. If the scaling factor were greater than 1.0, it could not be applied to the taste, appearance, cytotoxicity or mutagenicity tests.

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B3 EXAMPLES OF SCALING FACTOR CALCULATIONS

Example 1: Sealing gasket (immersion exposure)

The smallest ductile iron pipe in a manufacturer's product range is DN 100. The pipes have an effective length of 5.5 m and an internal diameter after cement mortar lining of 102 mm. The pipe joints are sealed with a rubber ring gasket and the estimated water contact area for each gasket is 6960 mm^2. The surface area-to-volume ratio used for the immersion exposure testing is the specified minimum of 1000 mm^2/L.

A_t 1000 mm^2 A_f 6960 mm^2

V_t 1.0 L V_f = 44.9 L

$\frac{A_t}{V_t}$ 1000 mm^2 / L $\frac{A_f}{V_f}$ = 155 mm^2/L

$$SF \quad \frac{A_f}{V_f} \div \frac{A_t}{V_t}$$

$$= \frac{155}{1000}$$

$$= 0.155$$

Example 2 Sluice valve (in-the-product exposure)

The smallest sluice valve in a manufacturer's range is size DN80. This valve represents the highest surface area-to-volume ratio in the product range. In service, the valves are installed in an AS/NZS 1477 DN80 PN 15 PVC pipeline having an internal diameter of 77.0 mm. There are 10 × 6 m lengths of pipe between valves. The valve has a volume of 1.6 L. In the pipeline, the valve is exposed to a further 280 L of water.

V_t 1.6 L V_f 1.6 + 280

281.6 L

$$SF \quad \frac{A_f V_t}{A_t V_f}$$

Because A_f A_t

$$SF \quad \frac{V_t}{V_f}$$

$$\frac{1.6}{281.6}$$

0.0057

The maximum scaling factor of 0.01 would be used rather than the calculated scaling factor.

NOTE: For growth of micro-organisms test (Appendix E), appropriately sized samples of the individual water contact components of the product are tested by immersion exposure. A scaling factor based on the water contact surface area under end-use conditions is then calculated for each component.

Example 3 Domestic plumbing systems

Domestic plumbing typically has a high proportion of fittings such as tees and elbows in the piping system. Because the pipes are small in diameter compared to reticulation pipe, the surface area-to-volume ratios of the fittings are correspondingly higher.

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An example of a cold water domestic plumbing layout is shown in Figure B1. In this example, the plumbing uses copper piping and brass fittings in the form of tees and elbows. The water in the fittings is assumed to be mixed with the water in the piping by turbulent flow when water is withdrawn from the system.

A scaling factor, which relates the surface area-to-volume ratio of the fitting being tested to the average surface area-to-volume ratio for all the fittings in the cold water system, can be determined.

The total wetted surface area for all of the fittings in the cold water system, calculated as shown in Table B1, is 16 130 mm^2. The total length of piping in the cold water system is approximately 40 m of DN20 pipe and 19.3 m of DN15 pipe. The volume of water contained in this piping and the associated fittings is calculated to be 10.87 L.

The average surface area-to-volume ratio for the fittings in service is therefore as follows:

$$\frac{A_f}{V_f} \quad \frac{16130}{10.87}$$

$$1484 \text{ mm}^2 / \text{L}$$

Provided that the fittings all have a similar composition and a similar method of manufacture, any fitting can be tested to qualify the range of fittings for use in domestic plumbing systems of the type shown in Figure B1.

In-the-product tests on DN20 elbows, for example, would be evaluated using the scaling factor derived below. The DN20 elbow has a surface area of 1100 mm^2 and a volume of 0.0042 L.

$$A_t \quad 1100 \text{ mm}^2 \qquad A_f \quad 16\,130 \text{ mm}^2$$

$$V_t \quad 0.0042 \text{ L} \qquad V_f \quad 10.87 \text{ L}$$

$$\frac{A_t}{V_t} \quad 261\,905 \text{ mm}^2 / \text{L} \qquad \frac{A_f}{V_f} \quad 1484 \text{ mm}^2 / \text{L}$$

$$SF \quad \frac{A_f}{V_f} \div \frac{A_t}{V_t}$$

$$\frac{1484}{261\,905}$$

$$0.0057$$

The maximum scaling factor of 0.01 would be used rather than the calculated scaling factor.

NOTE: The calculated scaling factor in both the sluice valve example and the plumbing fitting example is 0.0057. This would correspond to a laboratory dilution of 1 part extract to 175 parts extractant water, greater than the permitted level of extract dilution (see Clause 5.4). A pass result at the maximum allowable laboratory dilution would, however, qualify either product for use at the calculated scaling factor.

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TABLE B1

SURFACE AREAS OF FITTINGS

Fitting	Surface area mm^2	Number of fittings	Total surface area mm^2
DN20 × DN20 × DN15 tee	965	2	1 930
DN20 tee	1 190	4	4 760
DN20 elbow	1 100	2	2 200
DN20 × DN15 × DN15 tee	1 190	1	1 190
DN20 × DN15 elbow	850	3	2 550
DN15 elbow	500	7	3 500
Total		19	16 130

Example 4: Growth of micro-organisms test

Scaling factors of 0.01 to 1.0 can apply to the growth of micro-organisms test. However, where the scaling factor is in the range 0.01 to 0.33, scaling can be applied only by adjusting the area-to-volume ratio of the sample prior to testing. This is because the test method (Appendix E) does not allow scaling of the test result by values lower than 0.33 (as this invalidates the result).

By way of example, consider a fitting that has a surface area-to-volume ratio of 100 000 mm2/L, and the product standard specifies a scaling factor of 0.05. For some tests, the test result can be multiplied by 0.05. However, for the growth of micro-organisms test, this cannot be done. Instead, the sample size is selected to give a surface area-to-volume ratio of 5000 mm2/L. The requirement (in Appendix E) that a value lower than 0.33 cannot be used to scale the test result does not mean that the product cannot have a scaling factor less than 0.33. It does mean that the scaling factor needs to be achieved by adjustment of the surface area-to-volume ratio prior to commencement of the test.

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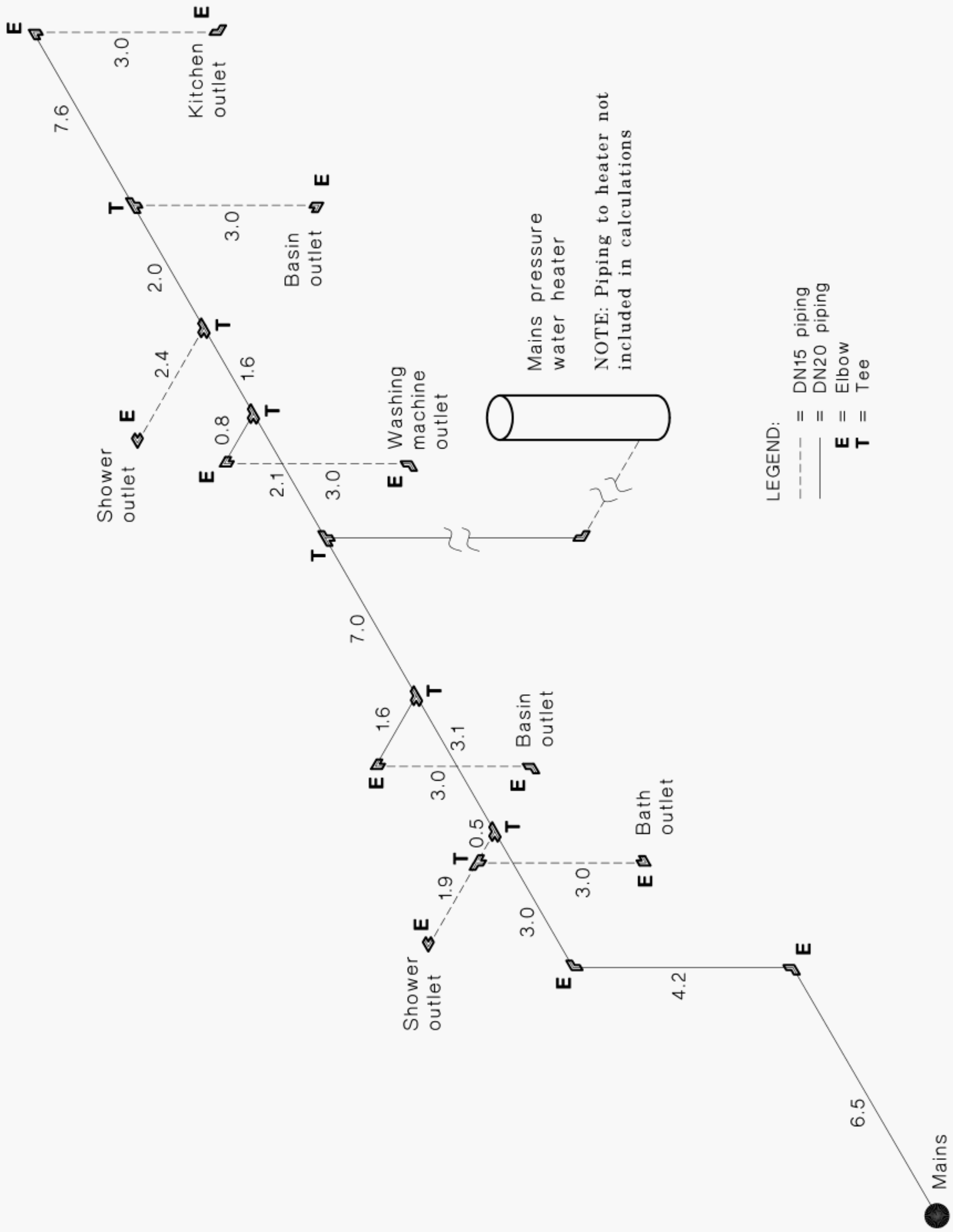

FIGURE B1 EXAMPLE OF A DOMESTIC MAINS PRESSURE COLD WATER PIPING LAYOUT

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APPENDIX C

TEST METHOD TASTE OF WATER EXTRACT

(Normative)

C1 SCOPE

This Appendix sets out a method for assessing the ability of a product to impart a discernible taste to drinking water. The method is applicable to all types of product used in contact with drinking water.

C2 INTRODUCTION

WARNING: CONDUCT THIS TEST WITH DUE REGARD TO THE POSSIBLE PRESENCE IN THE EXTRACTS OF SUBSTANCES THAT MAY BE HAZARDOUS TO THE HEALTH OF THE TASTE PANELLISTS. ONLY PRODUCTS FOUND TO BE SATISFACTORY IN THE MICROBIOLOGICAL GROWTH TEST (SEE APPENDIX E), THE ORGANIC SUBSTANCES TESTS (SEE APPENDICES F AND G) AND THE METALS EXTRACTION TESTS (SEE APPENDICES H AND I) MAY BE ASSESSED IN THIS TEST, UNLESS DETAILS OF THE CHEMICAL COMPOSITION AND PROCESS OF MANUFACTURE OF THE SAMPLES ARE KNOWN AND ANY POSSIBLE HAZARD CAN BE ASSESSED.

Some materials are capable of leaching into water compounds, giving rise to unacceptable tastes at very low concentrations.

All taste assessment procedures are subjective and fall into the following two basic types:

(a) Those that involve the tasting of a water sample and its qualitative classification on the basis of the intensity and nature of the taste.

(b) Those in which a semi-quantitative determination of taste intensity is made by a group of people who assess a series of dilutions of the sample.

The method described in this Appendix involves a combination of these procedures.

NOTE: Experience gained from the assessment of a wide variety of different materials indicates that odours are not encountered in the absence of a discernible taste. It is for this reason that this method is concerned with taste alone.

C3 PRINCIPLE

A sample of the product is exposed to chlorine-free test water for 24 h and the extract is then diluted and assessed by a taste panel. If any panellist reports a taste in the first dilution, the same samples are exposed to the test water for a further six sequential periods, including one 72 h period and concluding with a 24 h period, fresh chlorine-free test water being used for each period. The water from the seventh exposure period is diluted and then assessed by a taste panel. The test procedure is also carried out using chlorinated test water.

C4 TEST PREMISES

The assessment of taste shall be performed in a room that is free from obtrusive draughts and noise and has a general environment that allows the panellists to perform their task unobserved. No air fresheners or room deodorizers shall be used in the room, which shall be sited away from any activity that could generate interfering odours. The temperature of the room shall be (21 ±4)°C.

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C5 REAGENTS

C5.1 Test waters

C5.1.1 *General*

Test water shall be of drinking quality and shall have a hardness of 50 mg/L (as calcium carbonate), except for the testing of cementitious products (see Paragraph A8). The test water shall be prepared using distilled or deionized water (complying with Grade 3 of ISO 3696), as follows:

(a) To 20 mL of sodium bicarbonate ($NaHCO_3$) solution (0.04 M) add 12.5 mL of calcium chloride ($CaCl_2$) solution (0.04 M).

(b) Dilute the mixture to 1 L with distilled or deionized water.

C5.1.2 *Chlorine-free test water*

Accurately determine the free residual chlorine concentration in the test water (C5.1.1) in accordance with ISO 7393-2. As prepared, the test water will not contain any free residual chlorine. Add a sufficient quantity of a fresh solution of sodium thiosulfate to neutralize any measured free residual chlorine.

C5.1.3 *Chlorinated test water*

Accurately determine the free residual chlorine concentration in the test water (C5.1.1) and add a sufficient quantity of sodium hypochlorite solution (C5.2) to give a final free residual chlorine concentration of (1 ±0.1) mg/L.

NOTE: Chloraminated water has been tested and found to have no effect on results.

C5.2 Sodium hypochlorite solution

Dilute a quantity of commercial sodium hypochlorite solution with distilled water to give a final concentration of 1% by mass available chlorine.

C5.3 Distilled water, complying with Grade 3 of ISO 3696.

C6 APPARATUS

C6.1 Test containers

Made of clear borosilicate glass as specified in Appendix A (A2.3).

Containers shall be treated as follows:

(a) Clean with an aqueous solution of a biodegradable laboratory detergent.

(b) Rinse in distilled water (C5.3).

(c) Drain and dry in a hot air cabinet.

(d) Before use, rinse with chlorine-free test water (C5.1.2).

C6.2 Dilution beakers

Consisting of graduated borosilicate glass beakers cleaned as for the test containers (C6.1) and having a capacity of at least 250 mL.

They shall be reserved exclusively for taste assessment.

C6.3 Water bath and incubator

Capable of maintaining a temperature of 20 ±2°C.

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C6.4 Tasting glass

Consisting of a cup supported by a stem resting on a base, the opening of the cup being narrower than the convex part of the cup. The opening shall be (45 ±2) mm, the maximum internal diameter of the cup shall be (62 ±3) mm and the internal length of the cup shall be (100 ±2) mm. The physical characteristics of the cup shall comply with BS 5586-1. Before use, the glass shall be cleaned and dried in accordance with Paragraph A2 of BS 5586-1.

C6.5 Glass-encapsulated weights, for weighing down the products, if necessary.

C7 SELECTION OF TASTE PANELLISTS

C7.1 Taste panel requirements

It is essential that the sensitivities of each taste panellist to the categories of taste given in Paragraph C7.2.1 do not differ widely. To achieve this, each potential taste panellist shall participate in an initial sensitivity test (see Paragraph C7.2). At periodic intervals not exceeding 12 months, an audit of the sensitivity of each taste panellist shall be undertaken to ensure continued capability. The use of taste panels is covered by Mallevialle and Suffet* and by *Standard methods for the examination of water and waste water*.

Taste panellists shall abstain from drinking beverages other than water, eating and smoking for a minimum period of 60 min before performing a taste assessment. Individuals suffering from a respiratory ailment (colds or allergies) shall not participate in taste assessment until the symptoms subside. Perfumes or cosmetic preparations (including scented soap for hand washing) shall not be used on the day of taste assessment.

The taste panel shall be composed of a minimum of four tasters.

C7.2 Initial sensitivity test

C7.2.1 *Preparation of taste samples*

Four separate samples of water having halogenated phenol, lead pencil, plastics, and rubber tastes shall be prepared as follows:

(a) *Halogenated phenol* Dissolve 0.5 g of iodine crystals, 6.5 g of phenol crystals BP and 0.5 g of sodium salicylate in about 750 mL of distilled water. Slowly add 4 g of free chlorine, obtained from an aqueous sodium hypochlorite solution, over a period of 0.5 min with stirring. Make up to 1000 mL with distilled water and store in the absence of light. Before use, dilute this solution in the ratio of 1:1 000 000 with distilled water.

(b) *Lead pencil* Place two samples (total surface area 30 000 mm^2) of polyethylene containing 4,4'-thiobis(2-tert-butyl-5-methylphenol) as antioxidant in a clean test container (C6.1). Add sufficient chlorine-free test water (C5.1.2) to reach the 1000 mL calibration mark and seal the container with aluminium foil. Store for 18 h at 30 ±1°C.

(c) *Plastics* Prepare as in Item (b) using polycarbonate plastics in place of polyethylene.

(d) *Rubber* Prepare as in Item (b) using natural rubber in place of polyethylene.

If difficulty is encountered in obtaining suitable material samples for use in the preparation of these waters, samples that have exhibited these tastes in the laboratory during the previous 12 months may be used.

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* MALLEVIALLE, J. and SUFFET, J.H. (Eds). 'Identification and treatment of tastes and odors in drinking water'. American Waterworks Association Research Foundation/Lyonnaise des Eaux, Published by American Waterworks Association, Denver, USA, 1987, Appendices A and B pp 227-250.

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C7.2.2 *Threshold taste test*

A series of dilutions of the taste samples (C7.2.1) is prepared according to Paragraph C9.2 and presented to each taster. The dilution at which the taster first observes a taste is recorded.

C7.2.3 *Selection*

Panellists are selected from those who can detect the tastes at the highest dilution. If there is a sufficient number of tasters, those whose sensitivity differs by no more than a factor of four are chosen. If the number is limited, a factor of not more than eight is acceptable.

C7.3 Regular assessment

Prior to each day's tasting program, each panellist is presented with unidentified duplicate 200 mL samples of three waters, i.e. the test water (C5.1.1), glass distilled water (C5.3) and uncarbonated bottled drinking water. Panellists record whether they can distinguish any difference between the samples and which sample is preferred. Selected as panellists are those individuals who show a preference for the test water and who observe no difference between each pair of duplicate samples.

NOTES:

1 Panellists should be able to distinguish between the samples of glass distilled water and the other waters.

2 Any member of the taste panel who exhibits an erratic response to taste tests should be replaced by a taster who has been screened by the procedure in Paragraph C7.2.2.

C7.4 Personal logs

A written log shall be kept of the performance of all panellists in both the initial sensitivity tests and all subsequent audits. These records and the performance of the panellists using actual samples shall be reviewed annually for any signs of bias either for or against any particular taste or group of tastes.

C8 CROSS-CONTAMINATION OF SAMPLES

To prevent the risk of cross-contamination of samples through the release and subsequent absorption of volatile compounds, especially where a sample emits a discernible odour, samples of different products shall be physically isolated from each other during storage prior to testing (for example, in separate sealed containers).

C9 TEST PROCEDURE

C9.1 Extraction

C9.1.1 *General*

On the day that testing is to start, the sample or samples shall be rinsed in chlorine-free test water (C5.1.2) for 10 min, then the following procedure shall be conducted:

(a) *In-the-product exposure*

For products such as pipes, seal one end before filling. Fill each sample completely with chlorine-free test water (C5.1.2) and record the volume of water added. Seal the remaining end to prevent contamination. All seals shall be lined with PTFE or aluminium foil, or be made with other materials that have been shown to have no significant effect on the test results. With each batch of samples, include a test blank to measure contributions to the test results from sources other than the sample. Maintain the samples (in the absence of light) at (20 ±2)°C for (24 ±2) h in an incubator (C6.3). At the completion of the 24 h incubation period, retain a sample of the extract for testing as in Paragraphs C9.2 and C9.3.

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(b) *Immersion exposure*

Place each sample into a separate clean test container (C6.1). In addition, with each batch of samples, include one container without test sample as the test blank. Add to each container a measured volume of chlorine-free test water (C5.1.2) to obtain the correct surface area-to-volume ratio and seal the container. Maintain the containers (in the absence of light) at (20 ±2)°C for (24 ±2) h in an incubator (C6.3). If the density of the sample is less than that of water, ensure that the sample is kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights. At the completion of the 24 h incubation period, retain a sample of the extract for testing as in Paragraphs C9.2 and C9.3.

If no reportable taste is detected in the first 24 h extract, no further extractions are carried out. If a taste is detected, further extractions are carried out (see C9.1.2).

C9.1.2 *Further extractions*

Repeat the procedure used in the first extraction for a further six sequential periods, including one 72 h period and concluding with a 24 h period, fresh test water being used for each period. Retain the extract from the final extraction.

Dilute the first and/or seventh extract in accordance with the scaling factor (see Clause 5).

C9.2 Taste test dilutions

A series of three 1 + 1 dilutions of each diluted first or seventh extract of the sample and the blank shall be prepared using fresh chlorine-free test water (C5.1.2) as follows:

(a) Place 100 mL of the diluted extract (C9.1.2) into a clean 250 mL dilution beaker (C6.2), add 100 mL of fresh chlorine-free test water (C5.1.2) and mix thoroughly. (This constitutes the first dilution.)

(b) Transfer 100 mL of this dilution to an additional clean 250 mL dilution beaker and add 100 mL of fresh chlorine-free test water. (This constitutes the second dilution.)

(c) Repeat this procedure one more time to obtain the third dilution.

C9.3 Tasting procedure

C9.3.1 *Temperature of test solution*

The temperature of all the dilutions shall be adjusted to (20 ±2)°C by placing the beakers containing the dilutions (C9.2) in a water bath (C6.3).

C9.3.2 *Assessment of extract(s) and their dilutions by the panel*

Assessment shall be made by the panel as follows:

(a) Remove the third dilution of the blank test from the water bath (C6.3) and pour off 30 ±5 mL of the water into a clean tasting glass (C6.4) for each of the panellists. Instruct them to take into the mouth whatever volume of water is comfortable and to hold it in the mouth for several seconds before discharging it without swallowing. If no taste is detected, instruct the panel to assess in turn the second and first dilutions of the blank (C9.2) in the same manner. If a taste is detected in any of these dilutions, then start the complete test again (i.e. from Paragraph C9.1.1) using a fresh sample, fresh test water and fresh test containers.

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(b) Repeat this tasting procedure for the three dilutions of the first and/or seventh extract of the sample. If no taste is detected in the first dilution, record the result and discontinue the test. If a taste is detected in any of the three dilutions, record the threshold dilution and a description of the taste.

WARNING: DO NOT SWALLOW ANY TASTE EXTRACT UNDER ANY CIRCUMSTANCES

C9.3.3 *Repeat testing*

If any taste panellist reports a taste in the first dilution of the seventh extract, the complete test (i.e. from Paragraph C9.1.1) shall be repeated using two further samples of the product.

C9.4 Extraction procedure using chlorinated water

C9.4.1 *General*

For each sample, the extraction procedure specified in Paragraph C9.1 shall be repeated using a fresh sample and chlorinated test water (C5.1.3).

C9.4.2 *Preparation of dilutions from chlorinated water extracts*

After the extraction period (see Paragraph C9.1), the level of free residual chlorine in the water shall be determined. This chlorine shall be neutralized by the procedure described in Paragraph C5.1.2.

Dilutions shall be prepared according to the procedure in Paragraph C9.2 using chlorine-free water (C5.1.2).

C9.4.3 *Tasting procedure*

The testing procedure shall be carried out in accordance with Paragraph C9.3.

C10 EXPRESSION OF RESULTS

C10.1 Validation

If a taste is detected in the first dilution of the blank by any panellist, it can be considered that contamination has occurred and that the test is invalid. A fresh sample of the test product shall then be assessed, according to the procedure in Paragraph C9.1, after ensuring that the possible contamination has been eliminated.

C10.2 Expression of results

The results obtained by the panel are expressed in terms of the taste description and the threshold dilution number.

NOTE: A list of tastes commonly encountered is given in Paragraph C12.

In repeat testing, if a reportable taste is detected by any member of the taste panel in the first dilution of the final (seventh) chlorinated extracts, the product shall be deemed unsuitable for contact with drinking water.

C11 TEST REPORT

The requirements for the test report are given in Appendix N.

C12 LIST OF TASTES

A list of tastes commonly encountered is given below.

Bitter	Earthy	Mouldy	Plastic
Chemical	Iodine	Musty	Resinous
Chlorinous	Medicinal	Paint	Rubber
Dry aftertaste	Metallic	Phenolic	Woody

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APPENDIX D

TEST METHOD APPEARANCE OF WATER EXTRACT

(Normative)

D1 SCOPE

This Appendix sets out a method for assessing the ability of a product to impart a noticeable colour or turbidity to drinking water. The method is applicable to all types of product used in contact with drinking water.

D2 PRINCIPLE

A sample of the product is exposed to test water for 24 h and the colour and turbidity of the extract are then measured. If any noticeable colour (>5 HU) or turbidity (>0.5 NTU) is observed in the extract, a seventh test extract is analysed by exposing the same samples to a further six sequential periods, including a 72 h period and concluding with a 24 h period, fresh test water being used for each period. If a noticeable colour or turbidity is still evident in the final seventh extract, the final seventh extracts of three further samples are measured.

D3 REAGENTS

D3.1 Test water

Prepared as described in Paragraph C5.1.1 except that the following shall also apply:

(a) The colour of the water shall be less than 5 HU when determined in accordance with ISO 7887.

(b) The turbidity of the water shall be less than 1 NTU when determined in accordance with ISO 7027.

D3.2 Colour matching solutions

Prepared according to the procedure given in ISO 7887.

D3.3 Formazine solutions

Prepared according to the procedure given in ISO 7027.

D4 APPARATUS

D4.1 Laboratory ware

Thoroughly cleaned by using an aqueous solution of biodegradable laboratory detergent followed by thorough rinsing with test water (D3.1).

D4.2 Test containers

Made of clear borosilicate glass as specified in Appendix A (A2.3).

D4.3 Colour measurement apparatus

As specified in ISO 7887.

D4.4 Incubator

Capable of maintaining a temperature of (20 ±2)°C.

D4.5 Turbidity measurement apparatus

Consisting of a nephelometer with measuring cells of glass and with a tungsten lamp, operated at between 85% and 100% of its rated voltage, as the light source.

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The total distance travelled by the incident plus scattered light within the water sample shall not exceed 100 mm. The angle of light received by the detector of the nephelometer shall not exceed 30° and it shall be centred at right angles to the incident light path.

D4.6 Glass-encapsulated weights

For weighing down the products, if necessary.

D5 SAMPLES

Samples shall be prepared in accordance with Appendix A. Samples containing cementitious materials shall be pre-conditioned in accordance with the method in Paragraph A8.

D6 TEST PROCEDURE

D6.1 General

On the day that testing is to start, the sample or samples shall be rinsed in test water (D3.1) for 10 min, then the following procedure shall be carried out:

(a) *In-the-product exposure*

For products such as pipes, seal one end before filling. Fill each sample completely with test water (D3.1) and record the volume of water added. Seal the remaining end to prevent contamination. All seals shall be lined with PTFE or aluminium foil, or be made with other materials that have been shown to have no significant effect on the test results. With each batch of samples, include a test blank to measure contributions to the test results from sources other than the sample. Maintain the samples (in the absence of light) at (20 ±2)°C for (24 ±2) h or seven extract periods (D6.2) in an incubator (D4.4).

(b) *Immersion exposure*

Place each sample into a separate clean test container (D4.2). In addition, with each batch of samples, include one container without sample as the test blank. Add to each container a measured volume of test water (D3.1) to obtain the correct surface area-to-volume ratio and seal the container. Maintain the containers (in the absence of light) at (20 ±2)°C for (24 ±2) h or seven extract periods (D6.2) in an incubator (D4.4). If the density of the sample is less than that of water, ensure that the sample is kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights.

(c) *Dilution*

In either Case (a) or Case (b), remove a portion of the extract from each sample or container and dilute in a glass container in accordance with the scaling factor (see Clause 5) and measure its colour and turbidity as described in Paragraph D7.

D6.2 Further extracts

If the first and final seventh extracts (D6.1) show either an increase in true colour of greater than 5 HU or an increase in its turbidity of greater than 0.5 NTU, when compared with the blank, the procedure described in Paragraph D6.1 shall be repeated using three further samples of the product. After the first extraction drain the test water, including the blank, replace with fresh test water, and repeat the extraction for a further six sequential periods, including one 72 h period and concluding with a 24 h period.

Measure the colour and turbidity of portions of water withdrawn from the seventh extract.

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D7 MEASUREMENT OF COLOUR AND TURBIDITY

The colour of each extract shall be measured using the method described in ISO 7887. The turbidity of each extract shall be measured using the method described in ISO 7027. The results shall be reported in accordance with Paragraph D9.

NOTE: Colour is measured after samples are filtered to remove the interference caused by turbidity. The colour is determined by measurement at 456 nm in a spectrophotometer that has been calibrated with a standard of 50 HU.

If an increase in turbidity occurs between the first extract (D6.1) and the seventh extracts (D6.2), a microscopic examination shall be carried out on the surfaces of the samples. If microbial growth is demonstrated, the test shall be repeated using fresh samples, sterile containers and sterile test water. The samples shall be pre-washed in sterile test water before starting the test.

D8 CALCULATIONS

The value obtained for the blank shall be subtracted from each value obtained from a test sample. If three samples of the same product have been re-tested, the value obtained for the blank shall be subtracted from the arithmetic mean of the values obtained. The resultant values shall be expressed for colour as described in ISO 7887 and for turbidity as described in ISO 7027.

D9 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX E

TEST METHOD GROWTH OF AQUATIC MICRO-ORGANISMS

(Normative)

E1 SCOPE

This Appendix sets out a biological assay designed to assess the ability of a product to promote the multiplication of aerobic aquatic micro-organisms in drinking water. The method is applicable to all types of product used in contact with drinking water. It is not applicable where drinking water is subjected to heating to 40°C and above before consumption.

E2 INTRODUCTION

WARNING: THE TEST DESCRIBED IN THIS APPENDIX SHOULD BE CARRIED OUT ONLY IN LABORATORIES HAVING SUITABLE FACILITIES AND BY SUITABLY QUALIFIED PERSONS HAVING AN APPROPRIATE LEVEL OF MICROBIOLOGICAL EXPERTISE. STANDARD MICROBIOLOGICAL PROCEDURES SHOULD BE FOLLOWED THROUGHOUT.

Materials containing organic substances (as ingredients, contaminants or process by-products) that are capable of being utilized by micro-organisms can give rise to a noticeable deterioration in the quality of the water with which they are in contact. This deterioration may manifest itself as a change in the organoleptic, physical or microbiological characteristics of water. Microbial growth may occur in the water or at the material-water interface. The phenomenon is distinct from that of microbial attachment, which can occur on the surface of any type of material. If utilizable substances leach out of the material into the water, the growth will be self-limiting and decline in proportion to the rate of leaching. Growths on such materials have been found to persist for periods from 18 months to three years. Where the utilizable substance is bound within or to the material, growths can persist indefinitely.

Materials capable of supporting microbial growth do not give rise to an observable deterioration in water quality in every situation. This is due to the influence of various environmental factors, particularly temperature and the presence of residual chlorine. However, in plumbing systems the water temperature is rarely low enough to inhibit microbial growth, and the low level of residual chlorine present in public water supplies will not exert any appreciable bacteriocidal or bacteriostatic action once the water is within the customer's piping.

Drinking water has been treated to ensure the absence of pathogens that give rise to enteric disease, but it is not sterile. The numbers and types of harmless micro-organisms present in drinking water vary considerably, and the natural flora comprise many strains that are adapted to living in a relatively hostile environment. Such organisms differ in their physiological capacity from strains of the same organism found in other environments or grown in the laboratory. Tests using natural strains of aquatic organisms have given responses that correlate well with the occurrence of problems in practice, whereas the responses of laboratory cultures have not given reliable predictions of the performance of a material in practice.

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There is no technique, based on growing micro-organisms on or in culture media, that enumerates all the aquatic micro-organisms present in a sample of water. Thus the overall number of micro-organisms can be assessed only by an indirect measurement of their activity. The method of assessing microbial activity in the test system described in this Appendix is the measurement of dissolved oxygen uptake. The organisms that give rise to appreciable microbial growth respire aerobically and exert an influence on the levels of oxygen dissolved in the water in the test systems.

E3 PRINCIPLE

Tap water in contact with a sample of the product is inoculated with a mixture of naturally occurring aquatic micro-organisms. The overall growth of micro-organisms is determined indirectly by the measurement of dissolved oxygen depletion in the test system and a control.

E4 TEST PREMISES

The tests shall be carried out in premises as free as practicable from the presence of any volatile organic chemicals in the atmosphere, as such chemicals can dissolve in exposed water surfaces in sufficient quantities to produce abundant microbial slimes that will mask similar growths due to the test sample.

NOTE: The volatile chemical most frequently responsible for such slimes is ethanol, but many other volatiles used in or near the test premises may produce this effect.

E5 SAFETY

As well as regulatory and general considerations of safety, particular care is needed in microbiological laboratories because the organisms present may be pathogenic. Media not being used specifically for tests for pathogens may enable pathogens to grow until present in large numbers; hence care is needed in the handling and disposal of all media after incubation. It is essential for any written safety guide to be supplemented by thorough training and supervision.

NOTE: The test presented in this Appendix falls within the scope of AS/NZS 2243.3. Generally, Risk Group 2 facilities are required.

E6 REAGENTS

E6.1 General

Only reagents of recognized analytical grade and water complying with Grade 3 of ISO 3696 shall be used, except where specified otherwise.

E6.2 Inoculum water

Consisting of a fresh sample taken from a surface water that complies with Table E1.

TABLE E1

QUALITY CRITERIA FOR INOCULUM WATER

Parameter	Units	Minimum value	Maximum value
pH		5.5	9.0
Total coliforms	per 100 mL	10	
Pseudomonas aeruginosa	per 100 mL	1	50
Copper	mg/L		0.05

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A method of assessing whether the inoculum water complies with Table E1 is as follows:

(a) Determine the conformity of the inoculum water with the criteria in Table E1 on the basis of analysis of samples of the surface water.

(b) Perform analyses of the water in accordance with the appropriate sections of BS 6068, AS 4276.2 or, if none exists, with *Standard methods for the examination of water and waste water*.

NOTE: Much of this water quality information can be obtained from the local regional water agency.

Use the inoculum water within 6 h of collection as required by AS/NZS 2031. If suspended solids are present, filter through suitable paper before use. If necessary, the criteria in Table E1 can be met by dilution with test water (E6.3).

E6.3 Test water

E6.3.1 *General*

Test water shall be obtained from a tap connected directly to a service pipe at mains pressure, except for the testing of cementitious products (see Paragraph A8). Before collection of the water, flush the tap until the temperature of the flowing water does not vary by more than 1°C over a period of 1 min and does not exceed 25°C.

NOTE: For measurements of water temperature, an instrument that shows values to the first decimal place should be used.

The test water shall exhibit the characteristics specified in Table E2 so that it can be added directly to the test container.

The conformity of the test water with the specified criteria shall be determined on the basis of analysis of samples of water drawn from a tap in the laboratory building after flushing. Analyses of the water shall be performed in accordance with the appropriate sections of BS 6068, AS 4276.2 or *Standard methods for the examination of water and waste water* (APHA, AWWA and WPCF; see Clause 2). Measure the pH of the water in accordance with *Standard methods for the examination of water and waste water*.

The water shall be used either directly from the tap or stored for up to 1 h prior to use. If storage is necessary, the storage vessel shall be made from borosilicate glass or polyethylene, cleaned using the procedure described in Paragraph E7.1.2, except that the final rinse water shall be at a temperature greater than 70°C, and be in contact with the inner surface of the storage vessel for a minimum of 10 min.

If the water is deficient in respect to total oxidized nitrogen or phosphate or has an excess of residual chlorine, then the procedures described in Paragraphs E6.3.2 and E6.3.3, respectively, shall be carried out to alter these characteristics.

E6.3.2 *Deficiency of total oxidized nitrogen or phosphate*

To rectify a deficiency of total oxidized nitrogen or phosphate, a sufficient quantity of a 10 g/L solution of potassium nitrate or a 2 g/L solution of potassium dihydrogen orthophosphate, or both, shall be added from a graduated pipette to achieve the minimum concentrations in the test water specified in Table E2.

E6.3.3 *Excess of free residual chlorine*

To rectify an excess of free residual chlorine, a sufficient quantity of a fresh solution of sodium thiosulfate to neutralize the measured free residual chlorine to less than 0.05 mg/L as free chlorine in the test water (see Paragraph C5.1.2) shall be added.

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TABLE E2

QUALITY CRITERIA FOR TEST WATER

Parameter	Units	Minimum	Maximum
Total coliforms	per 100 mL		<1
Pseudomonas aeruginosa	per 100 mL		<1
Bacterial colony count after incubation at:			
37°C for 48 h	per mL		50
22°C for 72 h	per mL		500
Phosphate	mg/L (as phosphate ion)	2.0	6.69
Total oxidized nitrogen	mg/L (as N)	5.0	11.0
Free residual chlorine	mg/L (as Cl_2)		0.05
Total residual chlorine	mg/L (as Cl_2)		0.2
pH		6.5	8.5
Copper	mg/L		0.05
Silver	mg/L		0.01
Dissolved oxygen	mg/L	6.5	

NOTE: For the testing of cementitious materials, the aggressivity index of the test water may need to be adjusted (see Paragraph A8).

E7 APPARATUS

E7.1 Test containers

E7.1.1 *General*

Test containers shall be cleaned, airtight, glass preserving jars fitted with glass lids and seals manufactured from medical grade silicone rubber. The containers shall be of a suitable size to accommodate the sample while maintaining the required surface area-to-volume ratio. The headspace during the test shall not exceed 25% of the total container capacity.

E7.1.2 *Cleaning of test containers*

The containers, lids and seals shall be cleaned with an aqueous solution of a suitable biodegradable, laboratory detergent. The containers, lids and seals shall be rinsed in tap water and then once in distilled water complying with Grade 3 of ISO 3696, drained and air dried. The lids and seals shall be attached to the containers, which shall be stored in a sealed state until required for use.

E7.2 Dissolved oxygen meter

For use with an electrochemical probe for the determination of dissolved oxygen.

The electrochemical probe shall be automatically temperature compensated for the solubility of oxygen in the water. The meter and probe shall be maintained in accordance with the manufacturer's instructions. The procedures described in ISO 5814 for the measurement of dissolved oxygen shall be followed.

E7.3 Incubator/chamber

Consisting of a conventional microbiological incubator calibrated to maintain (30 ±1)°C with fan-assisted circulation of the internal air.

E7.4 Glass-encapsulated weights.

For weighing down the products, if necessary.

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E8 SAMPLES

E8.1 General requirements

The samples shall be prepared in accordance with Appendix A. The maximum surface area-to-volume ratio used for testing shall be 15 000 mm^2/L, and the minimum surface-area-to volume ratio shall be 1000 mm^2/L (see Paragraph A4.2).

E8.2 Reference materials

Two reference materials shall be prepared for use with each batch of samples. These shall be a positive reference of paraffin wax (microscopy grade) containing between 20 and 25 carbon atoms per molecule (melting point 52°C to 54°C), and a negative reference of borosilicate glass. The reference material dimensions shall be such that each reference material provides a surface area-to-volume ratio of (15 000 ±500) mm^2/L when immersed in the test water.

NOTE: The positive and negative references are used to validate the results of the *MDOD* test (see Paragraph E10.2).

E9 TEST PROCEDURES

E9.1 Preparation of the test system

E9.1.1 *General*

On the day that testing is to start, rinse the samples (E8.1) in the test water (E6.3) for 10 min.

NOTE: To help ensure that optimum precision and accuracy of results are obtained in any biological test, the tests should be in regular use within the test laboratory. In addition, it is recommended that products are not tested individually.

Each sample and reference material (E8.2) shall be placed in separate test containers (E7.1). In addition, with each batch of samples one empty container, which constitutes the control, shall be included. The inoculum water (E6.2) shall be added to each container in the ratio of 10 mL of inoculum water per 100 mL of test water. The total volume of the mixture shall be appropriate to the sample under test.

If the density of the sample is less than that of water, the sample shall be kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights cleaned in accordance with Paragraph E7.1.2. Each container shall be sealed with the lid.

E9.1.2 *Cementitious samples and samples containing bacteriostatic or bacteriocidal compounds*

If a cementitious sample is included in the batch, an additional container for a cementitious reference test shall be included. Into this container a paraffin wax reference material (E8.2) and the second cementitious sample (see Paragraph A8) shall be placed, followed by the inoculum water and test water as in Paragraph E9.1.1.

If there is reason to believe that a product contains a water-soluble bacteriocidal or bacteriostatic compound, an additional reference container shall be set up for a bacteriocidal/bacteriostatic reference test using the sample plus the paraffin wax reference material (E8.2).

E9.1.3 *Samples applied to metal fittings: jointing compounds, solder fluxes and anaerobic adhesives*

If a sample applied to a metal fitting is included in the batch, an additional container for a metal fitting reference test shall be included in the test. Into this container an identical metal fitting, but without the test sample shall be placed. The inoculum water and test water shall be added as in Paragraph E9.1.1.

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E9.2 Incubation

Each sealed container shall be incubated (in the absence of light) at (30 ±1)°C for the periods of time given in Paragraph E9.3.

E9.3 Assessment of microbial growth

Twice a week, the water shall be decanted from each container, which shall then be refilled with fresh test water (E6.3) to obtain the correct surface area-to-volume ratio, resealed and the incubation continued. The interval between each water change shall be either three or four days.

At the time of the first water change during the fourth week of the test, 10 mL of the water from each test container and any sample/reference material present in the container shall be transferred aseptically (using a sterile pipette) into a fresh container of the same specification as the original container. Each of these new containers shall be filled with fresh test water (E6.3) to the calibration mark. All the containers shall be sealed and re-incubated. The water in the containers shall continue to be changed, using the procedure followed during the first three weeks of the test.

At the time of the first water change after the four-day interval, and immediately before the water is changed, during the fifth, sixth and seventh weeks of the test, the dissolved oxygen concentration in the water shall be measured in accordance with ISO 5814. Test measurements shall be taken in the following sequence:

(a) The control (E9.1.1).

(b) The negative reference (E8.2).

(c) Test waters that remain clear.

(d) Test waters with visible turbidity (including the positive reference (E8.2)).

(e) The positive reference (E8.2).

The instrument probe shall be rinsed with distilled water complying with Grade 3 of ISO 3696 between readings for each separate container. The values obtained shall be recorded in accordance with BS EN 25814 in milligrams per litre to one decimal place.

E9.4 Measurement of dissolved oxygen for lubricants and lubricated materials

E9.4.1 *Introduction*

If the electrochemical dissolved oxygen probe is introduced into the water through an oily film, the characteristics of its membrane are sometimes irreversibly altered. For products that give rise to an oily film on the surface of the test water, the dissolved oxygen concentration shall be measured by the method described in Paragraph E9.4.2.

E9.4.2 *Measurement*

With minimal disturbance, 300 mL of the water from the control and from the reference test containers (see Paragraphs E8.2, E9.1.2 and E9.1.3) shall be decanted into separate clean 500 mL beakers. The dissolved oxygen concentrations of these waters shall be measured. 300 mL of the water from beneath the oily film of the test sample container shall be removed carefully. To separate the test water from the oily film, a clean 400 mL beaker modified to allow the test water to be drained out of the beaker from below the surface by a bottom-exit tube shall be used. This shall be transferred to a clean 500 mL beaker and it shall be ensured by visual inspection that there is no oily film present on the surface of this water. The dissolved oxygen concentration in this water shall be measured as before.

NOTE: Commercially available fat-separating gravy jugs have been found to fulfil these requirements satisfactorily. The soak water (with oil film) should be carefully transferred into the jug with minimal disturbance of the water surface. The oil-free water should be carefully drained into a clean 500 mL beaker.

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E10 EXPRESSION OF RESULTS

E10.1 Calculation of results

The arithmetic mean of the three dissolved oxygen values obtained from each test sample container, each of the reference tests and the control shall be calculated. The mean for each test container shall be subtracted from the mean of the control.

For a sample applied to a metal fitting, the mean shall be subtracted from the mean of the metal fitting reference test (see Paragraph E9.1.3).

The resultant value for each test or reference test shall be expressed as the mean dissolved oxygen difference in milligrams per litre to one decimal place. If the *MDOD* from the test sample container lies within the range 1.7 mg/L to 2.9 mg/L inclusive, two further samples shall be tested.

E10.2 Validation of results

Glass reference materials shall have an *MDOD* value of (0.3 ±0.3) mg/L. Paraffin wax reference materials shall have an *MDOD* value of (7.0 ±1.5) mg/L.

The control shall have a dissolved oxygen (mean value) of (8.0 ±1.5) mg/L.

If any reference material or the control gives results that do not comply with the values given above, the test shall be repeated using fresh reagents and samples.

NOTE: The quality characteristics of the test and inoculum waters should be carefully assessed when an 'out-of-range' result occurs.

If the results for the cementitious or bacteriocidal/bacteriostatic reference test (see Paragraph E9.1.2) fail to exhibit a *MDOD* that is within ±0.5 mg/L of the *MDOD* obtained for the positive reference test (with paraffin wax) when tests have been done in the same batch, the material shall be reported as having a bacteriostatic or bacteriocidal effect and carry out no further tests on this product.

E10.3 Precision

When two or more identical samples of a product are examined by one analyst using the same apparatus within a short time interval, it has been found that repeatability r of the arithmetic mean is 15%. On this basis, the repeatability will be exceeded on average not more than once in 20 cases in the normal and correct operation of this method.

When two or more identical samples of a product are examined by two operators working in different laboratories, the reproducibility R of the arithmetic mean is 28%. The reproducibility will be exceeded on average not more than once in 20 cases in the normal and correct operation of this method.

NOTE: r and R have been calculated following the general principles and definitions given in ISO 5725-2 using 90 results obtained from the testing of one homogeneous reference material in three laboratories during 1985.

E11 APPLICATION OF SCALING FACTOR

The MDOD result may be multiplied by the scaling factor, provided that the scaling factor has a value not less than 0.33.

E12 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX F

TEST METHOD CYTOTOXIC ACTIVITY OF WATER EXTRACT

(Normative)

F1 SCOPE

This Appendix sets out qualitative and quantitative methods for cytotoxicity testing of all products used in contact with drinking water.

F2 PRINCIPLE

F2.1 General

A sample of the product is exposed to test water for 24 h. The exposures are repeated using fresh water for one further 48-hour period, followed by one 72-hour period.

An aliquot from each product extract is used in the preparation of a nutrient medium for the growth of mammalian cells.

Blank extracts, negative and positive controls are assessed in parallel with the sample extracts. Assessment of cytotoxicity is achieved by comparing identical time points of the product extracts with their relative blanks. Alternatively, evidence of a cytotoxic response is determined when the morphology of the cell line is affected by the sample extracts.

F2.2 Qualitative determination of cytotoxicity by microscopy

The morphology of cells grown in the presence of the product extracts is observed and compared to those of the blank extracts.

F2.3 Quantitative determination of cytotoxicity by endpoint assay

Cytotoxicity can be determined quantitatively by measuring cell viability via an endpoint assay. The use of 1-(4,5-dimethylthiazol-2-yl)-3,5-diphenylformazan (MTT) is one such example. In the presence of active cellular mitochondrial reductases, MTT is reduced from the soluble yellow tetrazolium salt into insoluble purple formazan crystals. Dissolving the cells and crystals in dimethyl sulfoxide (DMSO) creates a homogeneous solution, the absorbance of which is measured at 570 nm (reference at 630 nm). Absorbance is directly proportional to cell viability. The cytotoxicity of the extracts is quantified using a cytotoxicity standard curve and quality control standards. These are included to ensure correct performance of the assay.

F3 TEST PREMISES

Both procedures shall be carried out only by persons having experience in tissue culture and microscopic examination of cell morphology.

NOTES:

1 The test should be carried out in a suitable biohazard cabinet.

2 The nutrient media used in this test are capable of supporting microbial growth and the cell line is capable of being infected by human viruses.

WARNING: AS WELL AS OBSERVING SAFE WORKING PRACTICES, PARTICULAR CARE IS NECESSARY IN HANDLING CONTINUOUS CELL LINES BECAUSE THEY MAY BECOME INFECTED WITH PATHOGENIC VIRUSES AND BACTERIA DURING THE COURSE OF THEIR MANIPULATION.

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F4 REAGENTS

F4.1 Test water

Prepared as described in Paragraph C5.1.1, but using distilled or reverse-osmosis water rather than deionized water.

The test water shall be free from substances that are toxic to, or inhibit the growth of, the cell line.

NOTE: The suitability of the test water is verified by growing at least three successive generations of the cell line in a nutrient medium made with the test water and the morphology of the cells compared with that of cells from the same generation grown in the same medium made with distilled water.

F4.2 Distilled water (for the preparation of media)

Glass distilled water, or water produced by reverse osmosis and complying with Grade 3 of ISO 3696.

NOTE: Deionized water is not suitable.

F4.3 Media

F4.3.1 *General*

Where commercially available, only analytical grade reagents shall be used.

NOTE: Commercially available sterile media constituents may be used.

F4.3.2 *Growth medium*

Sterile high-purity water (e.g. Milli Q)	190 mL
10 × medium 199 (with Earle's salts, without sodium bicarbonate)	20 mL
Newborn-calf serum (*Mycoplasma* negative)	14 mL
Filter sterile gentamycin (50 IU/mL)	200 µL
Filter sterile L-glutamine (200 mmol)	680 µL
Sterile sodium bicarbonate buffer solution containing 0.01% (*w*/*V*) Phenol red	10 mL

Prepare growth medium aseptically and store in the dark for no more than 2 weeks at 4 ±1°C.

F4.3.3 *Concentrated growth medium*

10 × medium 199 (with Earle's salts, without sodium bicarbonate)	5 mL
Newborn-calf serum (*Mycoplasma* negative)	7 mL
Filter sterile gentamycin (50 IU/mL)	100 µL
Filter sterile L-glutamine (200 mmol)	340 µL
Sterile sodium bicarbonate buffer solution in 0.01% (*w*/*V*) phenol red	5 mL

Prepare concentrated growth medium aseptically and store in the dark for no more than 2 weeks at 4 ±1°C.

F4.3.4 *Phenol red solution (0.2% w/V)*

Phenol red	20 mg
High purity water (e.g. Mill Q)	100 mL

Dissolve the phenol red in the water and adjust the pH to 7.4 ±0.05.

Dispense into 25 mL glass bottles. Fill to the rim and close lid tightly.

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Autoclave at 121°C for 15 min.

Discard any bottles that are a bright magenta colour.

Store for no more than 6 months in the dark at 4 ±1°C.

F4.3.5 *Sodium bicarbonate buffer solution containing 0.01% (w/V) phenol red*

Sodium bicarbonate	8.8 g
Phenol red solution (0.2% *w/V*)	10 mL
High purity water (e.g. Milli Q)	up to 200 mL

Add sodium bicarbonate to phenol red and make up to 200 mL with high purity water. Stir till dissolved.

Dispense into 25 mL glass bottles and fill to the rim.

Close lids tightly.

Autoclave at 115°C for 20 min.

Discard any bottles that are a bright magenta colour.

Store for no more than 6 months in the dark at 4 ±1°C.

F4.3.6 *Cell culture phosphate-buffered saline solution (CC-PBS)*

High purity water (e.g. Milli Q)	up to 1 L
Sodium chloride	0.8 g
Dipotassium hydrogen orthophosphate	1.21 g
Potassium dihydrogen orthophosphte	0.34 g

Dissolve salts in 900 mL of water and adjust the pH to 7.4 ±0.05.

Make up to 1 L final volume with high purity water.

Dispense into 200 mL aliquots and autoclave at 121°C for 15 mins.

Store for no more than 6 months at room temperature.

F4.3.7 *Standard toxicant for qualitative method-zinc sulfate solution (4 mM)*

Zinc sulfate ($ZnSO_4.7H_2O$)	13.1 mg
High purity water (e.g. Milli Q)	50 mL

Dissolve the zinc sulfate in the water.

Autoclave at 121°C for 15 mins.

Store for no more than 1 year at room temperature.

F4.3.8 *Standard toxicant for quantitative method-nickel nitrate solution (10 mM)*

Nickel nitrate ($Ni(NO_3)_2.6\ H_2O$	154.5 mg
High purity water (e.g. Milli Q)	50 mL

Dissolve the nickel nitrate in water and adjust pH to 7.0 ±0.05.

Autoclave at 121°C for 15 min.

Store for no more than 1 year at room temperature.

F4.4 Cell line

Use the established VERO cell line of African green monkey kidney cells (ATCC Number CCL 81). Verify that the cell line is healthy upon receipt (see Paragraph F7.2).

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F5 APPARATUS

F5.1 Tissue-culture ware

Prepared as follows:

(a) Clean all glassware used for this test using an aqueous solution of a proprietary detergent specifically designed for use in tissue culture techniques.

(b) Rinse thoroughly after cleaning, and give two final rinses in distilled water.

(c) Sterilize glassware at a temperature of 121°C and at a gauge pressure of 103 kPa for 15 min.

Alternatively, use pre-sterilized plastics containers supplied specifically for tissue culture work.

F5.2 Haemocytometer counting chamber

Complying with BS 748.

F5.3 Test containers

Made of clear borosilicate glass as specified in Appendix A (Paragraph A2.3).

Clean the containers using an aqueous solution of biodegradable laboratory detergent. Rinse the containers in test water and then once in distilled water. Drain and dry in a hot air cabinet. Before use, rinse in the test water.

F5.4 Incubators

Capable of maintaining temperatures of (20 ±2)°C and a carbon dioxide incubator capable of maintaining a temperature of (37 ±1)°C and (5 ±2)% CO_2.

F5.5 Freezer

Capable of maintaining a temperature of (20 ±2)°C.

F5.6 Glass-encapsulated weights

For weighing down the products, if necessary.

F5.7 Plate reader

Having 570 nm and 630 nm excitation filters (for MTT assay).

F6 TEST SAMPLES

The samples shall be prepared in accordance with Appendix A.

F7 TEST PROCEDURE

F7.1 Introduction

The procedure shall be divided into the following stages:

(a) The cell line shall be established and maintained on a continuous basis in the test laboratory.

(b) Samples shall be submitted to an extraction procedure and the leachate collected and used to prepare batches of nutrient media.

(c) This stage is divided into either of the following:

(i) Qualitative method

The effect of these media on the morphology of the cells shall be observed.

A positive control (zinc sulfate at a final concentration of 0.4 mmol) shall be included in the test.

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A negative control of high-purity water (e.g. Milli Q) shall be included.

(ii) Quantitative method, e.g. MTT endpoint assay

Cytotoxicity assessment of product extract by the determination of cell viability via an endpoint assay. A negative control of high-purity water (e.g. Milli Q) shall be included. A positive control of nickel nitrate at 1 mmol, 0.3 mmol, 0.1 mmol and 0.01 mmol final concentrations is suggested. This allows for the determination of the cell response from about 100% to 10% cell death.

F7.2 Growth and maintenance of the cell line

The cell line shall be grown in gamma sterilized tissue culture flasks with vented lids using the growth medium. A suitable method for maintaining the cell line is as follows:

The cell line shall be grown in gamma sterilized tissue culture flasks with vented lids using the growth medium. A suitable method for maintaining the cell line is as follows: (*Carry out in a Class II Biohazard hood using stringent aseptic technique.*)

(a) Once the cells have been resuscitated, successfully established and reached confluence, remove medium under vacuum using a sterile pasteur pipette.

(b) Rinse cells with 10 mL of pre-warmed (37°C) cell culture PBS(CC-PBS).

(c) Remove CC-PBS under vacuum and for a 25 cm^2 cell culture flask add 700 µL of 0.25% trypsin-EDTA and coat the monolayer.

(d) Incubate the flask at 37 ±1˚C (monolayer side down) for approximately 5 minutes or until the cells detach from the flask.

(e) Resuspend cells in 15 mL of medium and add to a 75 cm^2 flask. The cells have been split in a ratio of 1:3. Incubate for 2 days at 37 ±1˚C and 5 ±2% CO_2.

(f) For cell culture maintenance, carry out either 1:2 or 1:3 split of cells 3 times a week into the 75 cm^2 flasks, with the total volume of 15 mL.

(g) Each time a sub-culture is due, examine the cells microscopically for any signs of unusual growth, turbidity or excessive granular inclusions. If there are any signs of the above, discard the cells and resuscitate a new vial.

NOTE: Other cell culture methods are acceptable, provided that the cell line remains healthy.

F7.3 Preparation and enumeration of the cell suspension

For the qualitative microscopic assay and the quantitative endpoint assay, a cell suspension of between $10^5$and 10^6 cells/mL is required. Prepare the cell suspension as follows:

(a) Remove the medium from the 75 cm^2 flasks aseptically by vacuum aspiration using a sterile pasteur pipette.

(b) Rinse the flasks with 10 mL of pre-warmed (37 ±1˚C) CC-PBS, then remove the CC-PBS under vacuum as described in Step (a).

(c) Add 1 mL of 0.25% trypsin-EDTA coating the monolayer and incubate the flasks (monolayer side down) at 37 ±1˚C, 5 ±2% CO_2 for 5 minutes or until cells detach.

(d) Resuspend cells in a volume of medium (allow 1 mL of cell suspension per time point for each product). Take 200 µL of cell suspension and add to 250 µL of 0.4% *w/V* trypan blue and 150 µL of CC-PBS. Vortex and load onto the two chambers of the haemocytometer.

(e) Determine concentration of cell suspension as follows:

(average cell number × 3 (dilution factor) × 10^4 = cells/mL).

(f) Adjust cell density to 10^5 to 10^6 cells/mL with growth medium.

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F7.4 Extraction procedure

The extraction procedure shall be in accordance with Case (a) in-the-product exposure of Case (b) for immersion exposure.

(a) *In-the-product exposure*

For products such as pipes, seal one end before filling. Fill each sample completely with chlorine-free test water (F4.1) and record the volume of water added. Seal the remaining end to prevent contamination. All seals shall be lined with PTFE or aluminium foil or made with other materials that have shown to have no significant effect on the test results. With each batch of samples, include a test blank to measure contributions to the test results from sources other than the sample. Maintain the sample extracts and blank extract (in the absence of light) at (20 ±2)˚C for (24 ±1) h in an incubator (F5.4). Treat sample extract and test blank in accordance with the sample preparation requirements of the method of analysis (see Paragraph F7.5.1); alternately, remove a measured portion (approximately 25 mL) of the sample extracts and blank extract and store at (20 ±2)˚C until required for analysis (see paragraph F7.5.2). Empty the containers and refill with fresh test water. Incubate the sample extract and blank extract at (20 ±2)˚C for (48 ±2) h. Withdraw measured portions of each extract for analysis. Empty the containers and refill with fresh test water. Incubate the sample extracts and blank extract at (20 ±2)˚C for (72 ±3) h.

(b) *Immersion exposure*

Place each sample (F6) in a separate clean container (F5.3). Include with each batch of samples an empty container as the blank. Add to each container a measured volume of test water (F4.1) to obtain the correct surface area-to-volume ratio and seal the container. Incubate the containers at (20 ±2)°C for (24 ±1) h. If the density of the sample is less than that of water, ensure that the sample is kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights. Withdraw measured portions of each extract and treat in accordance with the sample preparation requirements of the method of analysis (see Paragraph F7.5). Empty the containers and refill with fresh test water. Incubate the containers at (20 ±2)°C for (48 ±2) h. Withdraw measured portions of each extract for analysis. Empty the containers and refill with fresh test water. Incubate at (20 ±2)°C for (72 ±3) h.

(c) *Dilution*

In either Case (a) or Case (b), dilute the extract in accordance with the scaling factor (see Clause 5) and carry out the growth procedure described in Paragraph F7.5.

F7.5 Growth procedure

F7.5.1 *Qualitative method*

The growth procedure shall be as follows:

(a) Before testing, thaw the samples and add 2.7 mL of each extract into a sterile 5 mL capped tube.

(b) For the negative control, add 2.7 mL of sterile high-purity water (e.g. Milli Q) into a sterile 5 mL capped tube.

(c) For the positive control, add 2.3 mL of sterile high-purity water and 400 µL of zinc sulfate (4 mmol).

(d) Into all the vials add 300 µL of concentrated growth medium and pre-warm the vials to 37 ±1˚C.

(e) After harvesting, counting and adjusting the concentration of cells, add 1 mL of the cell suspension to each vial.

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(f) Resuspend well and transfer 3 × 1 mL aliquots from each vial into 3 × wells of a 48-well plate (therefore each time point from the sample(s) and blank(s) is analysed in triplicate, as well as the negative and positive controls).

NOTE: Each 48-well plate should have negative and positive controls.

(g) Incubate the plates at 37 ±1˚C, and 5 ±2% CO_2 for 24 ±2 h.

F7.5.2 *Quantitative method, e.g. MTT endpoint assay*

The growth procedure shall be as follows:

(a) In a sterile 96-well plate, aliquot 6 × 202.5 µL of the sample(s) and blank(s).

(b) For the negative control, aliquot 6 × 202.5 µL of sterile Milli Q water.

(c) For the plate blank control, aliquot 6 × 300 µL of sterile CC-PBS.

(d) For the positive controls, aliquot 3 × 202.5 µL of the following nickel nitrate solutions (made in sterile high-purity water from the 10 mmol stock nickel nitrate solution): 1.48 mmol, 0.44 mmol, 0.15 mmol, 0.0015 mmol; this gives final nickel nitrate concentrations of 1 mmol, 0.3 mmol, 0.1 mmol and 0.01 mmol respectively.

(e) Into all wells, except those of the plate blank, add 22.5 µL of concentrated growth medium. *See Table F1 for an example of the 96-well plate format.*

(f) Pre-warm the plate(s) by incubating at 37 ±1˚C, 5 ±2% CO_2 for approximately 20 min.

(g) After harvesting cells, generate a cell suspension between 10^5 and 10^6 cells/mL.

(h) Add 75 µL of the cells to each well, except those of the plate blank.

(i) Incubate for 24 ±2 h at 37 ±1˚C and 5 ±2 % CO_2.

NOTE: For any remaining wells that do not contain sample(s) or blanks, add 300 µL of CC-PBS. This ensures that humidity is equally maintained in all wells.

TABLE F1

96-WELL PLATE FORMAT

	1	2	3	4	5	6	7	8	9	10	11	12
A	Cells only						Plate blank					
B	Blank 24 h	Blank 48 h	Blank 72 h	Sample 1 24 h	Sample 1 48 h	Sample 1 72 h	Sample 2 24 h	Sample 2 48 h	Sample 2 72 h	Sample 3 24 h	Sample 3 48 h	Sample 3 72 h
C												
D												
E												
F												
G												
H	1 mmol Nickel			0.3 mmol Nickel			0.1 mmol Nickel			0.01 mmol Nickel		

F7.6 Qualitative microscopic examination

After incubation, the condition of the cells in each container from Paragraph F7.5 shall be microscopically examined.

NOTE: The use of a low-powered optical microscope that gives a magnification of ×40 is recommended.

The presence or absence of a confluent cell layer, and the presence of any irregularly shaped cell or cells showing signs of rounding off (Paragraph F7.2), shall be recorded. If confluent growth is not observed, the appearance of any cells floating in the growth medium shall be recorded.

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F7.7 Quantitation of cell death via an endpoint assay (e.g. MTT assay)

MTT, a yellow, soluble, tetrazolium-based salt is reduced to insoluble purple formazan crystals in the presence of active cellular mitochondrial reductases. Dissolving in DMSO and reading the absorbance at 570 nm, with a reference absorbance at 630 nm, provides the data to calculate cell death.

The procedure shall be as follows:

(a) After incubation of the plates at 37 ±1˚C, 5 ±2% CO_2 for 24 ±2 h, remove medium using a multi-channel pipette.

(b) For each 96-well plate, weigh 5 mg of MTT and dissolve in 1 mL of CC-PBS.

(c) To the stock MTT (5 mg/mL) add 6 mL of pre-warmed growth medium and aliquot 60 µL of the 1:6 diluted MTT solution into all wells.

(d) Incubate for 30 ±5 minutes at 37 ±1˚C and 5 ±2% CO_2.

(e) Remove the MTT solution using a multi-channel pipette.

(f) Add 100 µL of 100% DMSO to each well.

(g) Cover the plate with alfoil and shake on a plate shaker at 200 r/min for 20 minutes before reading the plate at 570 nm for the MTT and 630 nm for the reference.

F7.8 Expression of results

F7.8.1 *Qualitative method*

F7.8.1.1 *Validation of the qualitative microscopic examination*

For the test results to be valid, the negative control and the blank extracts shall exhibit confluent growth, not exhibit significant 'rounding off' or irregularly shaped cells. The positive control shall exhibit approximately 90% to 100% cell death as evidenced by rounding up of cells. Results of samples are regarded invalid if the controls do not exhibit the appropriate response. Therefore the assay is repeated with the same extracts but using fresh growth and concentrated growth medium and zinc sulfate solution.

F7.8.1.2 *Interpretation of the qualitative microscopic examination*

If the product extracts affect the morphology of the cell line in any way different to that of the corresponding blank sample, then two or more samples shall be examined using fresh reagents.

If subsequent extracts of the two new samples affect the morphology of the cell line in any way different to that of the corresponding blank, this shall be interpreted as a cytotoxic response.

If the cell line grown in the presence of the sample extracts form a confluent monolayer and the degree of rounding or irregular shaped cells is no greater than the corresponding blank, this shall be interpreted as a non-cytotoxic response.

F7.8.2 *Qualitative method, e.g. MTT endpoint assay*

F7.8.2.1 *Generation of a standard concentration response curve of the cells to nickel nitrate*

Upon establishment of the cell line, a standard nickel concentration response curve shall be completed. The nickel concentrations shall cover a full range for a sigmoidal response. One third serial dilutions ranging from 1 mmol to 0.0001 mmol provide equally-spaced points on a sigmoidal curve.

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F7.8.2.2 *Validation of the quantitative endpoint*

After calculating the percentage cell death due to the nickel nitrate as compared to the cells grown in high-purity water (negative control), convert the % cell death to % MTT. This normalizes the data so results from different days can be compared. The results are expressed as a proportion between the maximum effect (plate blank) and the minimum effect (negative control).

The nickel nitrate standards (1 mmol, 0.3 mmol, 0.1 mmol and 0.01 mmol final concentrations) are used as weekly quality control standards for every plate run. If the standards do not produce %MTT within ±2 standard deviations of the derived validated standard curve, then the assay is to be repeated with fresh nickel nitrate solutions, growth and concentrated growth media. If, upon repeat, the cells are not responding as required, a new cell line is to be resuscitated and a new standard curve generated.

F7.8.2.3 *Calculation of the % cell death from the quantitative method, e.g. MTT endpoint assay*

The cell death is calculated as follows:

(a) Subtract the reference absorbance readings (630 nm) from the MTT absorbance readings (570 nm) of identical wells (e.g. $B6_{570nm} - B6_{630nm}$)

(b) Determine the average absorbance of the plate blank and subtract this value from each of the absorbance readings from Step (a).

(c) Determine the percentage cell death of the sample extract from the relative blanks.

For example, if:

$A_{550nm\text{-}630nm}$ Blank 24 h = 0.96

$A_{550nm\text{-}630nm}$ Sample 24 h = 0.39

then

$$\text{\% cell death} = \frac{A_{550nm\ 630nm}\ \text{Blank at 24 h} \quad A_{550nm\ 630nm}\ \text{Sample at 24 h}}{A_{550nm\ 630nm}\ \text{Blank at 24 h}} \times 100$$

$$= (0.96 \quad 0.39)/0.96 \times 100$$

$$= 59$$

F7.8.2.4 *Interpretation of the quantitative method, e.g. MTT endpoint assay*

If the percentage cell death is below 30%, the sample is non-cytotoxic.

If the percentage cell death is between 31% and 49%, the sample is borderline cytotoxic.

If the percentage cell death is greater than 50%, the sample is cytotoxic.

In the instance of a borderline or cytotoxic result, the assay shall be repeated with fresh samples and reagents as specified in the procedure of Paragraph F7.4 to F7.6.

NOTE: These values need to be validated by each laboratory.

F8 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX G

TEST METHOD MUTAGENIC ACTIVITY OF WATER EXTRACT

(Normative)

G1 SCOPE

This Appendix sets out a method for bacterial mutagenicity testing of leachates from all products used in contact with drinking water.

G2 PRINCIPLE

The Ames test is a reverse mutation assay using *Salmonella typhimurium.* An alternative system uses *Escherichia coli*. The assay uses a pre-incubation plate incorporation method. A reverse-mutation assay detects mutation in a gene of an amino acid-requiring bacterial strain, the result of which is to produce an amino acid-independent strain. This assay is based on OECD Guidelines 471 and 472 and the Ames test as reviewed by Maron and Ames (1983).*

The *Salmonella typhimurium* histidine (His) reversion system is a microbial assay, which measures His to His^+ reversion induced by chemicals that cause base changes or frameshift mutations in the genome of this organism.

The *Escherichia coli* tryptophan (Trp) reversion system is a microbial assay, which measures Trp to Trp^+ reversion induced by chemicals that cause mutations in the genome of this organism.

The assay used incorporates a pre-incubation step in which the bacteria are exposed to the test substance with a metabolic activation system prior to addition of top agar and overlaying onto a defined minimal medium agar plate. The assay also uses a direct addition to the top agar overlay where no metabolic activation is attempted. After a suitable period of incubation, revertant colonies are counted and compared with the number of spontaneous revertants in a blank extract control culture. For the purposes of this Standard, separate tests with one of the two systems are used to determine the absence of substances that give rise to a mutagenic response. If a mutagenic response is detected in one system of reverse-mutation assay, confirmation in the other system is required (i.e. if an extract is mutagenic using the *Salmonella typhimurium* system, mutagenicity is confirmed using a suitable *Escherichia coli* system and vice versa).

G3 TEST PREMISES

Cultures and media shall be manipulated in a laboratory having a biologically clean atmosphere that is dust free, and the test shall be carried out in an environment that avoids contamination of the bacteria culture. The testing should be carried out in a suitable biohazard cabinet conforming with AS 2567 where appropriate.

G4 REAGENTS

G4.1 Test water

Prepared as described in Paragraph C5.1.1 except for the testing of cementitious products (see Paragraph A8).

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* MARON, D.M. and AMES, B.N. 'Revised methods for the *Salmonella* mutagenicity test'. *Mutation Research*, 1983, Vol 113, pp. 173 to 215.

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The test water shall be free from substances that are toxic to, or inhibit the growth of, bacteria or may eliminate mutagens.

G4.2 Distilled water (for preparation of media)

Glass distilled water, or water produced by reverse osmosis and complying with Grade 3 of ISO 3696.

NOTE: Deionized water is not suitable.

G4.3 Control mutagens

Suitable control mutagens appropriate for the bacterial strains.

G4.4 Medium

An appropriate, selective medium with an adequate overlay agar.

Petri dishes (approximately 90 mm in diameter) should contain from 25 mL to 30 mL of medium.

G4.5 Bacteria

G4.5.1 *General*

Fresh cultures of the selected strains of each bacterium shall be grown up to the late exponential or early stationary phase of growth (approximately 10^8 to 10^9 cells per mL). The recommended incubation temperature is (37 ±1)°C.

Recognized methods of stock culture preparation and storage should be used. The amino acid requirement for growth should be demonstrated for each strain, and the other phenotypic characteristics should be checked using such methods as sensitivity to crystal violet or Mitomycin C and resistance to ampicillin. The strains should also yield spontaneous revertants within the frequency ranges expected.

G4.5.2 *Salmonella typhimurium*

At least three strains TA 98, TA 100 and TA 102 shall be used. In addition, strains TA 1535, TA 1537, TA 1538 and TA 97 may be used if considered more appropriate.

G4.5.3 *Escherichia coli*

Three strains shall be used. WP2, WP2 uvrA, and WP2 uvrA (pKM 101) can be used.

G4.5.4 *Metabolic activation*

Bacteria should be exposed to the test substance in both the presence and the absence of an appropriate metabolic activation system. The most commonly used system is a cofactor-supplemented post-mitochondrial fraction prepared from the livers of rodents treated with enzyme-inducing agents (Mammalian liver S9).

G5 APPARATUS

G5.1 Bacteria-culture ware

Prepared as follows:

(a) Clean all glassware used for this test using an aqueous solution of a proprietary detergent specifically designed for use in tissue culture techniques.

NOTE: The performance of the detergent should yield results consistent with acid washing. For new glassware, acid washing is preferable.

(b) Rinse thoroughly after cleaning, and give two final rinses in distilled water.

(c) Sterilize glassware at a temperature of 121°C and at a gauge pressure of 103 kPa for 15 min.

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Alternatively, use pre-sterilized plastic containers supplied specifically for bacterial culture work.

G5.2 Test containers

Made of clear borosilicate glass as specified in Appendix A (Paragraph A2.3).

Clean the containers using an aqueous solution of biodegradable laboratory detergent. Rinse the containers in test water and then once in distilled water. Drain and dry the beakers in a hot air cabinet. Before use, rinse in the test water.

G5.3 Incubators

Capable of maintaining a temperature of (20 ±2)°C and (37 ±1)°C.

G5.4 Glass-encapsulated weights

For weighing down the products, if necessary.

G6 TEST SAMPLES

The samples shall comply with all the pertinent requirements given in Appendix A.

G7 TEST PROCEDURE

G7.1 Introduction

Mutagenicity is evidenced by an increase in the number of bacterial revertants so that the differences between the mean number of revertants in the tests, compared with the controls, exceeds two standard deviations (for triplicate analyses).

G7.2 Extraction procedure

To obtain the first extract, on the same day as testing is to start, the sample or samples shall be rinsed in test water (G4.1) for 10 min, then the following procedure shall be conducted:

(a) *In-the-product exposure*

For products such as pipes, seal one end before filling. Fill each sample completely with test water (G4.1) and record the volume of water added. Seal the remaining end to prevent contamination. All seals shall be lined with PTFE or aluminium foil, or be made with other materials that have been shown to have no effect on the test results. With each batch of samples, include a test blank to measure contributions to the test results from sources other than the sample. Maintain the samples (in the absence of light) at (20 ±2)°C for (24 ±2) h in an incubator (G5.3).

(b) *Immersion* exposure

After washing (see Paragraph A6), place each sample in a separate clean container (G5.2). Add to each container a measured volume of test water (G4.1) to obtain the correct surface area-to-volume ratio and seal the container. In addition, with each batch of samples, include one container, which contains only a glass slide, as the test blank. If the density of the sample is less than that of water, ensure that the sample is kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights. Seal each container with a fresh piece of aluminium foil. Store each container at a temperature of (20 ±2)°C for (24 ±2) h. After (24 ±2) h, retain a sample for testing in accordance with Paragraph G7.3.1.

Remove the sample and transfer the extract to a polyethylene bottle.

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(c) *Dilution*

In either Case (a) or Case (b), dilute the extract in accordance with the scaling factor (see Clause 5) and carry out the test procedure as described in Paragraph G7.3. If the diluted extract does not affect the number of revertants in any way, then the first extract is the last extract and testing is complete.

G7.3 Modified Ames test

Analyses shall be performed in triplicate, using aseptic techniques and, where appropriate, sterilized materials.

For the pre-incubation method with metabolic activation, 0.1 mL of extract, 0.5 mL of metabolic activation mixture containing an adequate amount of post-mitochondrial fraction and 0.1 mL of fresh bacterial culture shall be incubated at (37 ±1)°C for (25 ±5) min and then 2.0 mL of overlay agar shall be added. For tests without metabolic activation, 0.5 mL of distilled water shall be added to the extract and fresh bacterial culture. This mixture shall be pre-incubated as above, or added immediately to the overlay agar. The contents of each tube shall be mixed and poured over the surface of a selective agar plate. Overlay agar is allowed to solidify. All plates in a given test should be incubated for the same time period. This incubation period may be from 48 h to 72 h at (37 ±1)°C. At the end of the incubation period, the number of revertant colonies on each plate shall be counted.

G7.4 Controls

Analyses of suitable positive and negative controls shall be performed with the test extracts.

G7.5 Interpretation of results

Data should be presented as the number of revertant colonies per plate and as the mean number of revertants for triplicate analyses for each treatment of the extract and blank.

If the sample extract gives a statistically significant result as defined in Paragraph G7.1, two further samples shall be extracted using fresh reagents and the reversion test shall be repeated with the same strain of bacterium.

If the extract from either of the other two samples gives a statistically significant result as defined in Paragraph G7.1, this shall be interpreted as a mutagenic response regardless of which bacterial strain has produced revertants.

If these tests are negative, this shall be interpreted as a non-mutagenic response. A statistically positive result from any strain of test bacterium constitutes a test failure. A positive result shall be confirmed by testing for mutagenicity of the extract using the alternative micro-organism test system.

NOTE: A mutagenic response does not necessarily mean that the test material is harmful to humans, but indicates that there are substances leached into the water from the product that require further investigation (such as an investigation of the dose/response relation for the extract from the product) before the product may be approved for use in contact with drinking water.

If an extract produces no statistically significant increase in the mean number of revertants compared with the control, then this shall be interpreted this as a non-mutagenic response.

G8 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX H

TEST METHOD EXTRACTION OF METALS

(Normative)

H1 SCOPE

This Appendix sets out a method for assessing the leachability of metals from products used in contact with drinking water.

H2 LIMIT OF DETECTION AND SENSITIVITY

The limits of detection and sensitivity vary with the metal determined and are specified in the appropriate method of determination (see Paragraph H7.2).

NOTE: In view of the type of product tested and the amounts of additives present, a limiting level of solubility in the extract water is unlikely to be attained.

H3 PRINCIPLE

Duplicate samples of the product are exposed to test water for 24 h and the metal concentration measured for the two test extracts. If any of the metals exceeds the specified concentration limits, seventh extracts are prepared by exposing both samples to a further six sequential periods, including one 72 h period, and concluding with a 24 h period, fresh test water being used for each period. If the limit for any metal is exceeded in the seventh extract from either of the duplicate samples, the seventh extracts of three further samples are examined for the specified metal.

H4 REAGENTS

H4.1 Test water

Prepared as described in Paragraph C5.1.1, except for the testing of cementitious products (see Paragraph A8).

H4.2 Nitric acid, ρ20 1.42 g/mL

Analytical reagent grade, suitable for use in atomic absorption spectrophotometry.

H4.3 Nitric acid, 10% by volume

Prepared by diluting 100 mL of nitric acid (H4.2) to 1 L with distilled or deionized water.

H5 APPARATUS

H5.1 Cleaning

Soak new glass and polyethylene ware for two days in nitric acid solution (H4.3) and subsequently rinse thoroughly with test water (H4.1).

NOTE: Cleanliness is essential in the determination of trace metals.

H5.2 Test containers

Made of clear borosilicate glass as specified in Appendix A (A2.3).

Before use, wash the containers using biodegradable laboratory detergent, rinse with nitric acid solution (H4.3) and finally with test water (H4.1).

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H5.3 Bottles

Made of polyethylene, large enough to hold the extract prepared as described in either Paragraph H7.1.1 or Paragraph H7.1.3 as appropriate. Prewash the bottles by the procedure described in Paragraph H5.2.

H5.4 Incubator

Capable of maintaining a temperature of (20 ±2)°C.

H5.5 Glass-encapsulated weights

For weighing down the products, if necessary.

H6 TEST SAMPLES

H6.1 General requirements

The samples shall be prepared in accordance with Appendix A. Where metal alloys are used, laboratories shall test any part that comprises 30% or greater of the wetted area, for all relevant elements listed in Table 2. These metals shall be recorded on the test report.

H6.2 Number of tests

Prepare duplicate samples (see Paragraph H6.1) of each product being tested and carry out the extraction procedure given in Paragraph H7.1.1 on each sample. If either sample exceeds the specified concentration limits (see Table 2), repeat the extractions using a further three fresh samples, and carry out the extraction procedure given in Paragraph H7.1.2.

H7 TEST PROCEDURE

H7.1 Extraction

H7.1.1 *General*

On the day that testing is to start, the sample shall be rinsed in flowing tap water for 30 min to remove loose particulate matter and dust and finally rinsed three times with fresh portions of the test water (H4.1). The following procedure shall then be carried out:

(a) *In-the-product exposure*

For products such as pipes, seal one end before filling. Fill each sample completely with test water (H4.1) and record the volume of water added. Seal the remaining end to prevent contamination. All seals shall be lined with glass or PTFE or be made with other materials that have been shown to have no significant effect on the test results. With each batch of samples, include a test blank to measure contributions to the test results from sources other than the sample. Maintain the samples (in the absence of light) at (20 ±2)°C for (24 ±2) h in an incubator (H5.4).

Remove the extract and transfer by filtration into a polyethylene bottle (H5.3) using a metal-free filter of pore size 0.45 μm. Add 0.5 mL of nitric acid (H4.2) for every 100 mL of extract to prevent metals being adsorbed into the bottle wall. Retain and determine the metals content as described in Paragraph H7.2.

(b) *Immersion exposure*

Place each sample in a separate clean container (H5.2). Add to each container a measured volume of test water (H4.1) to obtain the correct surface area-to-volume ratio and seal the container. In addition, with each batch of samples, include one empty container as a test blank. If the density of the sample is less than that of water, ensure the sample is kept totally submerged in the test water for the duration of the test by using glass-encapsulated weights. Seal each container with the glass cover. Maintain each container at (20 ±2)°C for (24 ±2) h.

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Remove the sample and transfer all but 50 mL of the extract by filtration into a polyethylene bottle (H5.3) using a metal-free filter of pore size 0.45 μm. Transfer 50 mL of test water from the blank container to the test container, add 0.5 mL of nitric acid (H4.2) for every 100 mL of total extract. Rinse the test container and filter the acidified extract through a second filter. Add the filtrate to the polyethylene bottle. Retain and determine the metals as described in Paragraph H7.2.

If, after the application of the scaling factor (see Clause 5), the results from this first extract do not exceed the specified concentration limits (see Table 2), no further extractions are necessary. If the results exceed the specified limit, further extractions are carried out (see Paragraph H7.1.2), and the metals content is determined on the seventh extract.

Alternatively, the test procedure can proceed directly to the seventh extract. There is no requirement to carry out a metals determination on the first extract.

H7.1.2 *Repeat extractions*

The procedure used in the first extraction shall be repeated for six sequential periods, including one 72 h period and concluding with a 24 h period, fresh test water being used for each period.

The first or seventh extract shall be collected in a polyethylene bottle (H5.3) in the manner described in Paragraph H7.1.1. The seventh extract shall be retained and the metals content shall be determined as described in Paragraph H7.2.

H7.1.3 *Blank tests*

The blank test shall be carried out to provide information on the effect of the container or possible ingress of contaminants from external sources. If any of the blank results are greater than the respective detection limits for the metals being determined, steps shall be taken to eliminate the source of contamination and the whole test of the product shall be repeated.

Where testing a cementitious product, an acidified sample of the test water shall be retained in a polyethylene bottle (H5.3) as a reagent blank test. Comparison of the analysis of this sample with the analysis of the extraction blank test will show whether contamination has occurred during the test procedure.

If a sample applied to a metal fitting is being tested, an identical cleaned metal fitting shall be tested but without the product under test, as a metal fitting blank test. All the procedures given in Paragraphs H7.1.1 to H7.1.2 and also a reagent blank test shall be carried out on this metal fitting.

H7.2 Determination of extracted metals

In the final extracts the metals listed in Table 2 (see Paragraph H7.1.1 or H7.1.3 as appropriate) shall be determined.

Analysis of reference test solutions containing the metals to be determined provides a check on the total error. Analysis of such solutions shall be carried out at the same time as that for the final extracts and the blank (see Paragraph H7.1.3), and a quality assurance scheme shall be maintained.

The analytical method shall be chosen so that the total error of an analytical result does not exceed either 10% of the relevant value given in Table 2 or 20% of the result, whichever is the greater. The requirements for the random and systematic errors are that neither shall exceed one half of the tolerable total error as defined in this Paragraph.

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NOTES:

1 For an introduction to the concepts of random, systematic and total error in water analysis, the following publications may be consulted:

(a) HMSO. General principles of sampling and accuracy of results 1980 in the series *Methods for the examination of water and associated materials.*

(b) WATER RESEARCH CENTRE. *Manual of analytical quality control for the water industry.* Technical Report NS30, 1989.

For the determination of metals, where possible use a method given in BS 6068-2 that meets these criteria. For determinations of those metals not covered in BS 6068-2, use a method meeting these criteria from the following publications:

(i) *Standard methods for the examination of water and waste water.*

(ii) HMSO. *Methods for the examination of water and associated materials.*

2 In determining the extracted metals content, dilutions of the extract may be made to bring the metal concentrations within the range of the particular analytical technique. Any dilution should be taken into account when calculating the original concentration of the metal in the extract.

H8 EXPRESSION OF RESULTS

The concentration of each metal determined in the final extracts shall be recorded in milligrams per litre, applying a correction factor for the volume of acid added to the final extracts (see Paragraph H7.1.1 or H7.1.3 as appropriate).

The concentration shall be expressed as a final result by applying the scaling factor according to the procedure described in Clause 5.

The concentration of each metal determined in the test blank shall be recorded.

Where metals are not detected in either the sample extract or the test blank, the results shall be recorded as being less than the limit of detection for the analytical method used.

Where a sample applied to a metal fitting has been tested, the corresponding value determined for the metal fitting blank test (see Paragraph H7.1.3) shall be subtracted from each concentration of each metal determined in the final extract. Both sets of values and the differences shall be recorded.

Where a cementitious product has been tested, the corresponding value determined for the reagent blank (see Paragraph H7.1.3) shall be subtracted from each concentration of each metal determined in the final extract. Both sets of values and differences shall be recorded.

H9 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX I

TEST METHOD EXTRACTION PROCEDURES FOR END-OF-LINE FITTINGS

(Normative)

I1 SCOPE

This Appendix sets out the method for obtaining extracts from end-of-line fittings. Where the fitting is in contact with cold and hot water, the method takes into account hot and cold cycles and the transient nature of water temperature. It also uses a scaling factor of less than 1, as the extract contained in the fitting is in practice dispersed into a larger total volume of water when the water is consumed.

The test for growth of aquatic micro-organisms is undertaken using the extraction procedures described in Appendix E.

For methods of analysis of the extracts, refer to the appropriate appendices.

I2 PRINCIPLE

In-the-product exposure is used wherever possible for the test extractions (A4.1), so that the sample of the fitting is completely filled with the test water (extractant water) to cover the surface area-to-volume ratio in end use. For Appendices C, D, F and G, at the completion of the appropriate contact period, which may include an initial maximum temperature exposure (for fittings used for the distribution of water that is ≥40°C), the volume held in the test fitting is collected, and made up to a final volume of 250 mL prior to analysis.

Immersion exposure (A4.2) is used for fittings such as tap components that cannot be evaluated by in-the-product exposure and can be installed within 250 mL draw-off of a drinking water delivery point. In such cases, the test fitting is totally immersed in 250 mL of extractant water at not less than 1000 mm^2/L test water.

Immersion exposure applies also for extraction of metals (see Appendix H) in cases where fittings and components cannot be tested for metals using the test rig (I3.1).

The test rig is used to test for extraction of metals (see Appendix H) in end-of-line fittings.

The test rig comprises a suitable water storage container and heater (hot tests) connected via a pipe to an isolation valve, which is then connected via a pipe to the test fitting. The extractant water is brought into contact with the fitting materials up to the closing mechanism or, if this does not exist, the outlet end of the fitting, for an extended contact period. This period simulates overnight contact of water with an end-of-line fitting in a domestic situation. After the contact period, aliquots of water are drawn from the fitting over a 3.5 h period and the aliquots combined and tested as a composite test extract for the relevant metals (see Table 2).

I3 APPARATUS

I3.1 Test rig (for test procedure I6.3)

The test rig is constructed of materials shown not to leach materials into the water. The test rig comprises a water storage vessel suitable for containing at least 15 L of extractant water and a connecting valve and pipe. For testing end-of-line fittings for the hot water tests, a suitable method of heating the test water shall be used. A commercial urn, shown not to influence any results, can be used for this purpose.

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The storage container is connected via a DN 25 diameter fitting to an isolating valve adjacent to the container and then via a DN 25 diameter PE, PP or PB pipe to a threaded junction for the test fitting. The volume contained in the pipe between the isolating valve and the entry to the fitting shall be (350 ±10) mL.

I3.2 Measuring vessels

Beakers or cylinders capable of holding 250 mL and up to 2 L of extractant water.

Before use, all glassware shall be rinsed with nitric acid solution (H4.3) and finally with test water (H4.1).

I4 REAGENTS (for test procedure I6.3)

I4.1 Test water

Prepared as in Paragraph C5.1.1.

I4.2 Methanol

Laboratory grade, for cleaning of the test fittings prior to conducting the test procedure.

I5 TEST FITTINGS (for test procedure I6.3)

The test fittings shall comply with all the pertinent requirements given in Appendix A. Where metal alloys are used, laboratories shall test any part that comprises 30% or greater of the wetted area, for all elements listed in Table 2. These metals shall be recorded on the test report.

I6 TEST PROCEDURE

I6.1 Test procedure for extracts for Appendices C and D

The test procedure is conducted at (20 ±2)°C for cold water tests, or at the hot and cold cycles for fittings used for the distribution of water that is ≥40°C. For fittings in use with cold and hot domestic installations, (55 ±2)°C is the recommended maximum temperature for conducting hot water tests, or as otherwise nominated by the manufacturer.

The test procedure shall be as follows:

(a) On the day that testing is to commence, rinse the test sample in chlorine-free test water (C5.1.2) for Appendix C, and test water (C5.1.1) for Appendix D for a period of 10 min before carrying out the following procedure.

(b) For in-the-product exposure, proceed as follows:

(i) Fill the test sample with either chlorine-free test water (C5.1.2) for chlorine-free test extracts, or chlorinated test water (C5.1.3) for chlorinated test extracts for Appendix C; and test water (D3.1) for Appendix D, making sure that the wetted surface areas are exposed to the test water. Include a test blank using a test container (A2.3) with test water to measure contributions to the test results from sources other than the sample.

(ii) The test fitting sample and the test blank for cold water tests are held at (20 ±2)°C for (24 ±1) h. The test fitting sample and the test blank for hot water tests are incubated initially at a maximum temperature of (55 ±2)°C for a period of (2 ±0.25) h, followed by an incubation at (20 ±2)°C for a further period of (22 ±0.75) h. At the completion of (24 ±1) h, collect the test sample extract and dilute with test water to provide a final volume of (250 ±10) mL. The final diluted sample extract and the test blank are both tested according to the relevant procedure outlined in C9.2, C9.4 for Appendix C, and D7 for Appendix D.

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(c) For immersion exposure, proceed as follows:

(i) The test fitting sample is totally submerged in (250 ±10) mL extractant water (equivalent to a minimum exposure of 1000 mm^2/L) contained in a clear borosilicate glass container (A2.3).

(ii) Follow Step (b) (ii) but no dilution of the final test extract is required unless the fitting is tested at a much higher exposure than in end use.

(d) If the first 24 h test extract used in Steps (b) and (c) fails to meet the test requirements of the appropriate Appendix, repeat the procedure used in the first extraction for a further six sequential periods, including one (72 ±3) h period and concluding with a (24 ±1) h period, using fresh water for each extraction period. Retain only the extract from the final extraction and test according to the relevant procedure outlined in C9.2, C9.4 for Appendix C, and D7 for Appendix D. Also, include a test blank and for each 24 h period in the hot water tests, ensure an initial 2 h test extraction at 55°C, followed by a final 22 h at 20°C as outlined in Step (b). For the 72 h period, an initial (6 ±0.75) h incubation at (55 ±2)°C, followed by a final (66 ±2.25) h incubation at (20 ±2)°C shall be employed.

NOTE: The procedure for testing to Appendix C is conducted upon satisfactory results of Appendices D, E, F, G and H being achieved.

I6.2 Test procedure for extracts for Appendix F and G

The test procedure is conducted at (20 ±2)°C for cold water tests, or at the hot and cold cycles for fittings used for the distribution of water that is ≥40°C. For fittings in use with cold and hot domestic installations, (55 ±2)°C is the recommended maximum temperature for conducting hot water tests, or as otherwise nominated by the manufacturer.

The test procedure shall be as follows:

(a) On the day that testing is to commence, rinse the test sample in the test water (C5.1.1) for a period of 10 min before carrying out the following procedure.

(b) For in-the-product exposure, proceed as follows:

(i) Fill the test sample with test water (F4.1) for Appendix F, and test water (G4.1) for Appendix G, making sure that the wetted surface areas are exposed to the test water. Include a test blank using a test container (A2.3) with test water to measure contributions to the test results from sources other than the sample.

(ii) The test fitting sample and the test blank for cold water tests are held at (20 ±2)°C for (24 ±1) h. The test fitting sample and the test blank for hot water tests are incubated initially at a maximum temperature of (55 ±2)°C for a period of (2 ±0.25) h, followed by an incubation at (20 ±2)°C for a further period of (22 ±0.75) h. At the completion of (24 ±1) h, collect the test sample extract and dilute with test water to provide a final volume of (250 ±10) mL. The final diluted sample extract and the test blank are both tested according to the relevant procedure outlined in F7.5 for Appendix F, and G7.3 for Appendix G.

(c) For immersion exposure, proceed as follows:

(i) The test fitting sample is totally submerged in (250 ±10) mL extractant water (equivalent to a minimum exposure of 1000 mm^2/L) contained in a clear borosilicate glass container (A2.3).

(ii) Follow Step (b) but no dilution of the final test extract is required unless tested at a much higher exposure than in end use.

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(d) For Appendix F, continue as follows:

(i) Refill the test fitting sample and the test blank container (A2.3) with fresh test water. For total immersion exposure, refill the test containers with fresh test water as outlined in Step (c). The test fitting sample and the test blank for cold water tests are held at (20 ±2)°C for (48 ±2) h. The test fitting sample and the test blank for hot water tests are incubated initially at a maximum temperature of (55 ±2)°C for a period of (4 ±0.50) h, followed by an incubation at (20 ±2)°C for a further period of 44 ±1.50 h. At the completion of 48 ±2 h, collect the test sample extract and dilute with test water to provide a final volume of (250 ±10) mL. The final diluted sample extract and the test blank are both tested according to F7.5.

(ii) Refill the test fitting sample and the test blank container with fresh test water. For total immersion exposure, refill the test containers with fresh test water as outlined in Step (c). The test fitting sample and the test blank for cold water tests are held at (20 ±2)°C for a further (72 ±3) h. The test fitting sample and the test blank for hot water tests are incubated initially at a temperature of (55 ±2)°C for a period of (6 ±0.75) h, followed by an incubation at (20 ±2)°C for a further period of (66 ±2.25) h. At the completion of (72 ±3) h, collect the test sample extract and dilute with test water to provide a final volume of (250 ±10) mL. The final diluted sample extract and the test blank are then tested according to F7.5.

I6.3 Test procedure for extracts for Appendix H

The test procedure uses the test rig (I3.1) and is conducted at (20 ±2)°C for cold water tests and for hot water tests at (55 ±2)°C or at a temperature otherwise nominated by the manufacturer.

The test procedure shall be as follows:

(a) Prepare duplicate samples (I5.1) and clean each test fitting sample with methanol (I4.2) for 30 s, then connect the test sample to the test rig as described in I3.1.

NOTE: The test rig may accommodate more than one test fitting per storage container.

The test fitting is to be orientated to the position that it would occupy in an actual installation.

The storage container isolating valve shall remain closed until testing is to commence.

(b) Fill the storage tank with 13 ±1 L of extractant water for each test fitting, establish the test temperature, and open the isolating valve.

Flush (2 ±0.1) L of extractant water through the test fitting to waste. Close the test fitting. After (72 ±3) h, open the fitting and flush (5 ±0.1) L through the fitting to waste. Close the fitting. After (48 ±1) h, open the fitting and flush a further (5 ±0.1) L through the fitting to waste. Close the fitting and close the isolating valve. Discard any water that remains in the storage tank.

(c) Refill the storage tank with (13 ±1) L of extractant water for each test fitting and open the isolating valve.

(d) Flush (1 ±0.1) L of extractant water through the test fitting. Close the test fitting so that it retains the same volume of water as it would in normal installation and commence the contact time.

(e) After (16 ±0.5) h contact, open the test fitting valve and collect (250 ±10) mL of extractant water as the first sample extract.

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(f) Flush (2 ±0.1) L of extractant water through the test fitting. Close the fitting and discard the (2 ±0.1) L of extractant water.

(g) After a further (30 ±5) min contact time, collect another (250 ±10) mL of sample extract from the test fitting. After collection of the second sample extract, flush (1 ±0.1) L of extractant water through the test fitting, close the fitting and discard the (1 ±0.1) L of extractant water.

(h) Repeat Step (g) six times. This will result in the production of a total of seven (250 ±10) mL samples (including the extract from Step (g).

(i) Mix the sample of (250 ±10) mL of extract from Step (e) with the seven (250 ±10) mL extracts from Steps (g) and (h) to produce a composite extract.

(j) Include a test blank in the test procedure, to cover test water in the test rig (I3.1) to measure contributions to the test results from sources other than the sample (H7.1.3).

(k) Analyse the composite extract for the metals listed in Table 2 and evaluate with the results of the test blank. If either sample exceeds the specified concentration limits in Table 2, repeat the test extractions using a further three fresh samples.

I7 EXPRESSION OF RESULTS

The result of each test on a sample shall be expressed in accordance with the appropriate appendix.

I8 TEST REPORT

The requirements of the test report are given in Appendix N.

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APPENDIX J

HIGH TEMPERATURE TESTS

(Normative)

J1 SCOPE

Products used in contact with hot water can leach water-soluble compounds not detectable in significant quantities when extracted and tested under conditions specified elsewhere in this Standard for cold water applications. Such products, if found to be satisfactory by the other tests described in this Standard, can be tested by the method described in this Appendix if they are intended for use in hot water installations and the water in contact with the product will pass to a draw-off point from which the water is intended for drinking purposes.

This Appendix describes the extraction procedure to be used in assessing the ability of a product to impart a discernible taste or any noticeable colour or turbidity to hot water intended for drinking. It is also applicable in assessing the leaching of metals from products in hot water and the extraction from such products of substances that may be of concern to public health. It is not applicable to the test for growth of aquatic micro-organisms (see Appendix E), except where the product is to be used for cold and hot water applications. In such cases, the test for growth of aquatic micro-organisms is undertaken at 30°C for cold and hot water tests, using the extraction procedures in Appendix E. Products used exclusively with water not intended for drinking purposes, e.g. in industrial or steam services, are not included.

J2 PRINCIPLE

The product is immersed in, or exposed to, test water in accordance with Paragraph C9.1, C9.4, D6, E9, F7.4, G7.2 or H7.1, as appropriate. For total immersion, the product and test water are held in a suitable container, as in Paragraph A2.3, at the maximum holding water temperature. Extraction is allowed to proceed for the time given in the relevant test. The extract is then cooled to the test temperature and tested in accordance with this Standard.

J3 APPARATUS

J3.1 Water bath or incubator

Capable of maintaining a test container at the extraction temperature to within 2°C.

J4 SAMPLES

Samples shall comply with all the requirements of Appendix A.

J5 TEST PROCEDURE

J5.1 Extraction temperature

During the extraction procedures (see Paragraph J5.2), the sample shall be exposed to the test water within 2°C of the maximum holding water temperature for which the product is intended to be used within the range 40°C to 80°C inclusive, or as specified in Clause 3.9.

NOTE: The test temperature chosen should not be in conflict with that given in the particular product Standard.

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J5.2 Extraction procedure

Each extraction procedure shall be carried out in accordance with that given in Appendices C to K as appropriate, in a water bath or incubator (J3.1) maintained at the required temperature.

J5.3 Testing

For total immersion, before carrying out the tests given in Appendices C to K as appropriate, each container plus test water and sample or reference container shall be allowed to cool to the temperature required for the intended test. The extracts from each sample shall then be tested according to the relevant Appendix.

J6 EXPRESSION OF RESULTS

The results of each test on a sample shall be expressed in accordance with the appropriate Appendix.

J7 TEST REPORT

The requirements of the test report are given in Appendix N.

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APPENDIX K

TEST METHOD SAMPLE EXTRACTION PROCEDURE FOR USE WITH WATER-HEATING SYSTEMS

(Normative)

K1 SCOPE

This Appendix specifies the method to be used to prepare sample extracts from water-heating units for testing their suitability for use in contact with drinking water.

The term water heater relates to a broad range of appliances having cold water inlets, various energy sources, hot water outlets and various heating cycles. This Appendix covers all types of water heating devices such as the following:

(a) Instantaneous water heaters.

(b) Storage water heaters.

(c) Units incorporating heat exchangers (coil heaters).

(d) Free-vent or push-through water heaters.

It may be applicable to test for the growth of aquatic micro-organisms (see Appendix E) where the holding temperature is less than 40°C. This may include devices such as instantaneous water heaters and warm water systems.

K2 PRINCIPLE

The method outlined in this Appendix aims to replicate the normal operational cycle of water heaters by preparing sample extracts from functional test units. The test procedure requires connecting the test unit to pipes and fittings that comply with this Standard and operating the test unit to simulate the in-contact use in the installed situation. The test units are operated as specified by the manufacturer to supply water at their normal operating temperature and, where applicable, held at maximum holding temperature. The sample extractions are cooled to the test temperature and are tested in accordance with this Standard. Blank sample extracts are taken from the inlet line and are assessed with the sample extractions.

K3 REAGENTS

K3.1 Test water

The test water shall be from a service main that meets the requirement of the *Australian Drinking Water Guidelines* (1996).

K4 TEST PROCEDURE

K4.1 Installation

The test unit shall be installed to a serviced mains water system using pipes and fittings that comply with this Standard or materials shown not to influence any results. The installation shall be in accordance with the manufacturer's installation instructions, AS 5601(AG 601), AS/NZS 3500.4, AS/NZS 3350.2.21 and all local building, water and gas-fitting regulations (if applicable). The following criteria also apply:

(a) The unit shall be installed by a suitably qualified person holding the relevant licence(s).

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(b) The unit shall be fitted with the minimum number of devices and/or valves that are supplied or nominated by the manufacturer to ensure safety during the test procedure.

(c) The serviced pipe shall contain a separate complying with this Standard valve prior to the inlet of the test unit for collecting blank extracts.

K4.2 Test method

K4.2.1 *Test unit preparation*

K4.2.1.1 *General*

On the day of testing, the test unit shall be operated in accordance with the manufacturer's instructions, and set at its maximum thermostat setting.

K4.2.1.2 *Instantaneous water heaters*

The procedure shall be as follows:

(a) Open the inlet and outlet valves.

(b) Operate with hot water for a period of 30 min.

NOTE: A valve or switch causes the activation of gas or electricity for heating the water.

K4.2.1.3 *Storage (including solar) water heaters*

The procedure shall be as follows:

(a) Open the inlet valve to the test unit, fill the test unit with water to the maximum volume capacity and allow to heat.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) Operate for a period of 30 min.

K4.2.1.4 *Water heaters incorporating a heat exchanger*

The procedure shall be as follows:

(a) Open the inlet valve to the test unit, fill the test unit to the maximum volume capacity and allow to heat.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) Operate for a period of 30 min.

K4.2.1.5 *Free-vented/push-through water heaters*

The procedure shall be as follows:

(a) Open the inlet and outlet valves. Fill the test unit until water flows from the outlet. Close the inlet valve and allow to heat.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) Operate for a period of 30 min.

(d) At the completion of the preparation period, shut down the test unit. Make the test unit inoperable.

K4.2.2 *Sample extraction procedure (after preparation of unit)*

K4.2.2.1 *Instantaneous water heaters*

The procedure shall be as follows:

(a) Close only the outlet valve, allowing the heated test water to remain in the test unit.

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(b) At the completion of (24 ±2) h, disconnect the inlet and outlet and drain all water contained in the unit. Retain a sample extract for testing in accordance with Paragraphs D7, F7.5, G7.3 and H7.2. Retain a blank extract sample for assessment to the appropriate clause.

(c) For testing in accordance with Appendices D and H:

(i) Repeat Steps (a) and (b) for two further sequential (24 ±2) h periods. Discard the sample extracts.

(ii) Repeat Steps (a) and (b) for a further (72 ±3) h period. Discard the sample extract.

(iii) Repeat Steps (a) and (b) for three further sequential (24 ±2) h periods. Discard all sample extracts except the final extract and a blank.

(iv) If the 24 h sample extract used in Step (b) fails to meet the requirements of the appropriate appendix, submit the final extracts and blanks from Step (iii) for testing.

(d) For testing to Appendix F:

(i) Following the 24 h period detailed in Step (b), repeat Steps (a) and (b) for a 48 ±2) h period. Retain a sample extract and a blank.

(ii) Repeat Steps (a) and (b) for a further (72 ±3) h period. Retain a sample extract and a blank.

(iii) Submit the sample extracts and blanks for testing in accordance with Paragraph F7.5.

K4.2.2.2 *Storage water heaters (including Solar)*

The procedure shall be as follows:

(a) Empty the test unit and refill with test water.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) At the completion of (24 ±2) h, open the outlet valve and retain a sample extract for testing in accordance with Paragraphs D7, F7.5, G7.3 and H7.2. Retain a blank extract sample for assessment to the appropriate clause.

(d) For testing in accordance with Appendices D and H:

(i) Repeat Steps (a), (b) and (c) for two further sequential (24 ±2) h periods. Discard the sample extracts.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Discard the sample extract.

(iii) Repeat Steps (a), (b) and (c) for three further sequential (24 ±2) h periods. Discard all sample extracts except the final extract and a blank.

(iv) If the 24 h sample extract used in Step (c) fails to meet the requirements of the appropriate appendix, use a further six sequential periods, including one 72 h period and concluding with a 24 h period, and submit the final extracts and blanks from Step (iii) for testing.

(e) For testing to Appendix F:

(i) Following the 24 h period detailed in Step (c), repeat Steps (a), (b) and (c) for a 48 ±2 h period. Retain a sample extract and a blank.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Retain a sample extract and a blank.

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(iii) Submit the sample extracts and blanks for testing in accordance with Paragraph F7.5.

K4.2.2.3 *Water heaters incorporating a heat exchanger*

The procedure shall be as follows:

(a) Empty the heat exchanger and refill with test water.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) At the completion of (24 ±2) h, open the valve and retain a sample extract for testing in accordance with Paragraphs D7, F7.5, G7.3 and H7.2. Retain a blank extract sample for assessment to the appropriate clause.

(d) For testing in accordance with Appendices D and H:

(i) Repeat Steps (a), (b) and (c) for two further sequential (24 ±2) h periods. Discard the sample extracts.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Discard the sample extract.

(iii) Repeat Steps (a), (b) and (c) for three further sequential (24 ±2) h periods. Discard all sample extracts except the final extract and a blank.

(iv) If the 24 h sample extract used in Step (c) fails to meet the requirements of the appropriate appendix, use a further six sequential periods, including one 72 h period and concluding with a 24 h period, and submit the final extracts and blanks from Step (iii) for testing.

(e) For testing to Appendix F:

(i) Following the 24 h period detailed in Step (c), repeat Steps (a), (b) and (c) for a (48 ±2) h period. Retain a sample extract and a blank.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Retain a sample extract and a blank.

(iii) Submit the sample extracts and blanks for testing in accordance with Paragraph F7.5.

K4.2.2.4 *Free-vented/push-through water heaters*

The procedure shall be as follows:

(a) Open the inlet valve. When the capacity volume of the unit has flowed through the outlet, close the inlet valve.

(b) Allow to heat until thermostat has switched off and the maximum temperature has been achieved.

(c) At the completion of (24 ±2) h, open the inlet valve and retain a sample extract for testing in accordance with Paragraphs D7, F7.5, G7.3 and H7.2. Retain a blank extract sample for assessment to the appropriate clause.

(d) For testing in accordance with Appendices D and H:

(i) Repeat Steps (a), (b) and (c) for two further sequential (24 ±2) h periods. Discard the sample extracts.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Discard the sample extract.

(iii) Repeat Steps (a), (b) and (c) for three further sequential (24 ±2) h periods. Discard all sample extracts except the final extract and a blank.

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(iv) If the 24 h sample extract used in Step (c) fails to meet the requirements of the appropriate appendix, submit the final extracts and blanks from Step (iii) for testing.

(e) For testing to Appendix F:

(i) Following the 24 h period detailed in Step (c), repeat Steps (a), (b) and (c) for a (48 ±2) h period. Retain a sample extract and a blank.

(ii) Repeat Steps (a), (b) and (c) for a further (72 ±3) h period. Retain a sample extract and a blank.

(iii) Submit the sample extracts and blanks for testing in accordance with Paragraph F7.5.

K5 EXPRESSION OF RESULTS

The results of each test on a sample shall be expressed in accordance with the appropriate appendix.

K6 TEST REPORT

The requirements for the test report are given in Appendix N.

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APPENDIX L

PRODUCT SUBMISSION INFORMATION

(Informative)

L1 GENERAL

Persons requiring products to be tested to this Standard should submit the information listed in this Appendix to the testing laboratory.

L2 GENERAL INFORMATION

The following general information should be included:

(a) Product designation (model number/name, size, general description).

(b) Product range (sizes/models if applicable).

(c) Product type, e.g. coating, lining, pipes and fittings (metal/plastic) etc.

(d) General composition of product, namely wetted component(s) if metallic, non-metallic or both. Identify any metal alloy that comprises 30% or greater of the total wetted area and list the specific components made of alloy(s).

(e) Details of submitting organization.

(f) General use of product, e.g. in-line/end-of-line.

(g) Sampling details and sampling organization, if applicable.

(h) Product manufacturer and place of manufacture.

(i) End-use exposure, total wetted surface area-to-volume ratio in mm^2/L.

(j) Temperature range.

(k) Maximum holding or maximum temperature (°C), if hot water testing is applicable (40°C or greater).

(l) Material detail of each wetted component (see Paragraph L6) or attach a detailed bill of materials plus supporting drawings.

(m) Product certification requirements, including certifying body and contact details.

(n) Any previous testing?

L3 APPLIED MATERIALS

The following information should be included:

(a) For applied materials, e.g. coatings, specify names of products and provide application details, including—

  (i) mix ratios (by mass or volume);

  (ii) applied film thickness (minimum and maximum as appropriate);

  (iii) minimum curing temperature, minimum curing period and relative humidity limitations;

  (iv) technical and material safety data sheets, and other health and safety information.

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(b) For coatings containing multiple-layers, e.g. primers and undercoats, identify and provide for testing all items that are less than 1 mm from the water contact surface of the coating.

L4 SIMULATED SAMPLES

Provide dimensional criteria (dimensioned drawing(s)) of the component and finished product, including calculations (total wetted surface area (mm^2); total wetted volume (mL) and surface area-to-volume ratio and reference to the relevant product Standard), as follows:

(a) Specify manufacturing processes used.

(b) Provide details of specific processes critical to passing the test requirements.

(c) Specify commercial grade (material designation).

(d) Measurement and recording of specific element(s) of the material where the maximum level is critical to the test requirements.

L5 SCALING FACTORS

The following information should be included:

(a) For product range, what are the sizes of product for which qualification is sought?

(b) Which product size has the greatest surface area-to-volume ratio of wetted parts? What is this ratio? (Show calculations).

(c) For in-line products, what scaling factor can be applied to the product where used as a system component? (Show calculations).

(d) What is the maximum exposure of the product in terms of wetted surface area (mm^2) per litre of water? (Show calculations).

L6 OTHER INFORMATION

The following information should be included:

(a) For cementitious products, does the product contain any organic additives, modifiers? (Provide details).

(b) For all products and materials, does the product or material contain a known biocide? (Provide details).

L7 IDENTIFICATION

Figure L1 provides an example of a form for listing identification information as described in this Appendix.

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Fu dent f cat on of each product and deta s of the r ntended use w ass st n the assessment of the r su tab ty for the use n contact w th potab e water. P ease g ve a re evant deta s n the tab e of a wetted components and mater a s, as we as deta s of the products ntended for use n contact w th dr nk ng water. Use separate sheets f necessary and nc ude d agrams, b of mater a s, etc.

N.B. For coat ng, p ease g ve deta s of a re evant pr mers and undercoats.

A. Material of each component		B. Component(s) which are manufactured from each wetted material		C. Fittings/assembled product in which component(s) will be used	
Name & code	**Supplier/manufacturer**	**Name & code**	**Supplier/manufacturer**	**Name & code**	**Manufacturer**

FIGURE L1 EXAMPLE OF PRODUCTS, COMPONENTS AND MATERIALS FORM

APPENDIX M

SIMULATED SAMPLES

(Informative)

M1 SCOPE

This Appendix sets out means by which simulated samples may be used, if allowed by the relevant product Standard.

M2 GENERAL

Components made from a single material may be pre-qualified by a simulated sample that has been tested and shown to meet the requirements of this Standard. The simulated sample is manufactured using the same manufacturing processes and having an envelope of characteristics (e.g. dimensions, surface finish, material composition) within which the components lie. For example, plastic pipe samples would not be represented by compression-moulded samples.

M3 TYPICAL EXAMPLES OF SIMULATED SAMPLES

The process of pre-qualification may be applicable to the following types of materials:

(a) Metals and metallic alloys.

(b) Plastic materials.

M4 SPECIAL ISSUES

For assessment purposes, it is critical that the documentation surrounding the simulated sample is comprehensive so that a clear relationship exists between the simulated sample and the component under consideration.

A clear description of the simulated sample should include the following:

(a) General description including a specific sample number.

(b) Material designation, such as—

(i) manufacturer, commercial grade of material and reference to the relevant standard; and

(ii) where the maximum level of a specific element(s) of the material is critical to the test requirements, a measurement and recording of these elements and their maximum level. The acceptable variation in concentration of specific elements/ingredients in the sample from that allowed in a supplied component should be specified in the product Standard. For example, if the composition of the simulated sample is 71.8%A, 25.0%B, 3.0%C and 0.2%D, the product Standard might accept compositions of: ≤ 75.4%A, ≤ 26.25%B, ≤ 3.15%C, ≤ 0.3%D (and no other ingredients) in a component. This example is based on all of the ingredients of the component being not more than $1/20^{th}$ of the value or 0.1% (whichever is the higher) more than the amounts that were in the simulated sample.

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(c) The processing used to manufacture the simulated sample should be the same as that used to manufacture the components and should be defined as follows:

(i) The manufacturing processes used to make the simulated sample.

(ii) Details of specific processes that are deemed to be critical to passing the test requirements and meeting the component standard.

NOTE: Materials and processes used for simulated samples and components should be defined in the product Standard, in a manner that facilitates the ongoing monitoring of the suitability of the component to comply with this Standard.

(d) Dimensional criteria, i.e. a dimensioned drawing of the simulated sample including calculations under test conditions of —

(i) total wetted surface area, in square millimetres;

(ii) total wetted volume, in cubic centimetres or millilitres; and

(iii) surface area-to-volume ratio.

(e) Testing of the sample as in-line product or end-of-line product.

(f) The scaling factor.

(g) A copy of the test report for the simulated sample to this Standard, showing that the sample passed all appropriate test requirements.

NOTE: Appendix L should also be taken into consideration.

M5 COMPONENT DOCUMENTATION

The following documentation should be included if not required by the product Standard:

(a) Identification/name of the component.

(b) Title of the applicable Standard.

(c) Evidence that the component complies with the Standard.

(d) Evidence that the material matches that of the simulated sample.

(e) The processes used to manufacture the component.

(f) Dimensional criteria, i.e. dimensioned drawing(s) of the component and finished product, including calculations for the component of the following criteria where the component is installed in the finished product:

(i) Total wetted surface area, in square millimetres.

(ii) Total wetted volume, in cubic centimetres or millilitres.

(iii) Surface area-to-volume ratio.

These dimensions will not be calculated or verified by the testing laboratory.

M6 ACCEPTANCE

A certifying body could be used in verification that the requirements for simulated samples, as specified in the product Standard, are met.

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APPENDIX N

TEST REPORT

(Normative)

N1 GENERAL

The test report shall include the particulars shown in Paragraphs N2 and N3, plus the additional details shown in Paragraph N4 that are specific to the given test.

N2 TEST REPORT INFORMATION

The test report shall include the following:

(a) The name and address of the laboratory undertaking the testing, the date of the report and a unique laboratory report number.

(b) The product designation (model number/name, product type, size, general description).

(c) The manufacturer, the submitting organization and the organization responsible for preparing the samples.

(d) The origin of and the method for selecting the test sample.

(e) A full description of the sample, including the wetted surface area or dimensions and general composition of the product including component parts (see Figure L1).

(f) Where the samples are articles, e.g. components of water fittings/products, the trade names and reference numbers of the components and the water fitting/product, together with the name of the relevant manufacturer.

(g) The proposed use of the product.

(h) Whether the testing was undertaken under cold or hot water conditions and if hot identify the temperature in degrees Celsius.

(i) For a coating, in addition to the information in Items (a) to (h), the report shall contain—

  (i) the names of primers and undercoats used, together with the film thickness of each coating applied; and

  (ii) a full description of the preparation and application of the product, including method of application to the test plates, nature of the test plates and full curing conditions.

(j) For a cementitious product, in addition to the information in Items (a) to (i), the report shall contain—

  (i) the name of the additive or coating under test, together with the film thickness of each coating applied;

  (ii) the composition or trade name of the mortar/cement materials;

  (iii) the aggressivity index of the pre-conditioning/test water; and

  (iv) the number of pre-conditioning 24 h soaks required to reach a pH of less than 9.0.

(k) The surface area-to-volume ratio used in the test.

(l) The value and method of derivation of any scaling factor.

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(m) Where the samples tested are unfabricated material (i.e. not in final product form), a statement to this effect.

N3 GENERAL INFORMATION

The following general information shall be included in the test report:

(a) A reference to the method, e.g. AS/NZS 4020, Appendix C.

(b) The temperature at which the sample and the test water were maintained throughout the extraction period.

(c) A statement to indicate whether the test sample passed the particular test.

(d) The following note: 'The results stated in this report relate to the sample or samples of the product submitted for testing. Any changes in the material formulation, the process of manufacture, the method of application, or the surface area-to-volume ratio in the end use, could affect the suitability of the product for use in contact with drinking water, and re-testing may be required.'

N4 SPECIFIC INFORMATION

N4.1 Appendix C (taste)

Where applicable, the following shall be included in the test report:

(a) Whether there was a taste in the first dilution of the first and/or seventh unchlorinated and chlorinated extracts as assessed by the panel.

(b) The results in terms of the threshold dilution number of the assessment by the panel of the final unchlorinated and chlorinated extracts from the sample.

(c) A statement giving the number of samples of the product tested and a description of any tastes encountered.

N4.2 Appendix D (appearance)

Where applicable, the following shall be included in the test report:

(a) The results from the final extracts (first 24 h or seventh) expressed in accordance with Paragraph D8

(b) A statement giving the number of samples of the product tested.

N4.3 Appendix E (growth of aquatic micro-organisms)

Where applicable, the following shall be included in the test report:

(a) The mean dissolved oxygen difference (MDOD) of the test and reference materials, in milligrams per litre.

(b) The mean dissolved oxygen concentration of the control, in milligrams per litre.

(c) A statement giving the number of samples of the product tested.

N4.4 Appendix F (cytotoxic activity)

Where applicable, the following shall be included in the test report:

(a) A description of the morphology of the cells in contact with the test extract and a statement as to whether the findings indicate a cytotoxic or non-cytotoxic response; and in addition a description of the morphology of the cells in the positive control indicating a positive cytotoxic response.

(b) A statement giving the number of samples of the product tested.

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N4.5 Appendix G (mutagenic activity)

Where applicable, the following shall be included in the test report:

(a) For a mutagenic response, the following information:

(i) Bacterial strains used.

(ii) Individual plate counts.

(iii) A description of any increase in the number and mean of revertants formed after contact with the test extract.

(iv) A statement as to whether the findings indicate a mutagenic response.

(b) A statement giving the number of samples of the product tested.

N4.6 Appendix H (extraction of metals)

Where applicable, the following shall be included in the test report:

(a) The method of analysis for each metal and the source of the method.

(b) The limit of detection for each of the methods of analysis used.

(c) The concentration of each metal determined in the final extracts (first 24 h or seventh), together with the concentration of each metal determined in the test blank and, where appropriate, in the metal fitting blank or reagent blank. Where three samples have been re-tested, subtract the value obtained for the blank from the arithmetic mean of the values obtained.

(d) A statement giving the number of samples of the product tested and the number of extractions carried out on each sample.

(e) The metallurgical analysis of any metal alloy that comprised 30% or greater of the wetted area.

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