

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 —

Part 2: Methods of test —

Section 2.6: The extraction of metals

ICS 13.060.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee EH/6, *Effects of materials on water quality*, upon which the following bodies were represented:

- Automatic Vending Association of Britain
- British Cement Association
- BCF — British Coatings Federation Ltd
- British Malleable Tube Fittings Association
- British Plastics Federation
- British Plumbing Fittings Manufacturers' Association
- British Precast Concrete Federation Ltd
- British Rubber Manufacturers' Association Ltd
- British Water
- DEFRA — Water and Land Directorate
- Galvanizers Association
- Laboratory of the Government Chemist
- Pipeline Industries Guild
- UK Steel Association
- Water Regulations Advisory Scheme
- Water Research Centre plc

This British Standard, having been prepared under the direction of the Health and Environment Sector Committee, was published under the authority of the Standards Committee and came into effect on 15 May 2000

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Published by BSI Standards Limited 2014

The following BSI references relate to the work on this standard:
Committee reference EH/6
Drafts for comment 99/560131 DC, 13/30287801 DC

ISBN 978 0 580 83882 8

Amendments/corrigenda issued since publication

Amd. No.	Date	Comments
14722	21 January 2004	Revision of 7.5 and 10.1
A2	30 June 2014	See Foreword, Introduction, Normative references, Clauses 5.3, 4, 7

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Foreword

Publishing information

This subsection of BS 6920 is published by BSI Standards Limited, under licence from The British Standards Institution and came into effect on 15 May 2000. It was prepared by Technical Committee EH/6, *Effects of materials on water quality*.

Supersession

BS 6920-2.6:2000+A2:2014 supersedes BS 6920-2.6:2000, Incorporating Amendment No. 1, which is withdrawn.

Relationship with other publications

BS 6920 is published in several parts, namely *Part 1: Specification*, *Part 2: Methods of test*, *Part 3: High temperature tests* and *Part 4: Method for the GCMS identification of water leachable organic substances*.

Part 2 is further subdivided into a number of sections and subsections as follows.

Section 2.1: Samples for testing;

Section 2.2: Odour and flavour of water;

Subsection 2.2.1: General method of test;

Subsection 2.2.2: Method of testing odours and flavours imparted to water by multi-layered hoses and pipes;

Subsection 2.2.3: Method of testing odours and flavours imparted to water by hoses for conveying water for food and drink preparation;

Section 2.3: Appearance of water;

Section 2.4: Growth of aquatic microorganisms test;

Section 2.5: The extraction of substances that may be of concern to public health;

Section 2.6: The extraction of metals.

Information about this document

This edition introduces technical changes but it does not reflect a full review or revision of the standard.

The start and finish of text introduced or altered by Amendment No. 2 is indicated in the text by tags **A2** **A2**. Minor editorial changes are not tagged.

Hazard warnings

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 7 and a back cover.

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Introduction

In the development of this test, much consideration was given to the composition of the water used to extract the metals. The composition and character of water intended for human consumption varies widely from region to region and there can be considerable changes according to season. No evidence was found to show that any particular water was more effective than distilled or deionized water in the leaching of metals from organic materials. It was therefore decided that distilled or deionized water was the most convenient for the wide range of products to be tested.

A2 Subsequent experience has shown that the selected test water (4.1) was too aggressive to use with cementitious materials and a suitable test water, based upon the outcome of European research into leaching tests on cementitious materials, is included in this standard (4.4). **A2**

1 Scope

This section of BS 6920 specifies the test procedure for assessing the leachability of metals from non-metallic products when used in contact with water intended for human consumption.

NOTE 1 In view of the type of product tested and the amounts of additives present, a limiting level of solubility in the extract water (saturation) is unlikely to be attained.

NOTE 2 The limit of detection and sensitivity of the method vary according to the particular metal being analysed (see Clause 8).

NOTE 3 **A2** Under the relevant National Regulations [4] to [10], the National Regulator may specify additional provisions in some cases and will assess the significance of the results obtained. **A2**

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of BS 6920. For dated references, subsequent amendments to or revisions of any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 6068-2, *Water quality — Part 2: Physical, chemical and biochemical methods*.

BS 6920-1:2014, *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 — Part 1: Specification*.

BS 6920-2.1:2014, *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 — Part 2: Methods of test — Section 2.1: Samples for testing*.

BS EN ISO 3696, *Water for analytical laboratory use — Specification and test methods*.

A2 BS EN ISO 10523, *Water quality — Determination of pH*. **A2**

3 Principle

Samples of a product are immersed in water for a period of 24 h; this constitutes the first extract. If necessary (see below) the same samples are immersed in test water for a further six sequential extraction periods, including one 72 h period and concluding with a 24 h period, using fresh test water for each period. Metals are determined on the first extract. If any concentrations found for any metals exceed the specified limits, further extracts are prepared and metals are determined on the seventh extracts also.

NOTE A flow diagram showing the sequence of the test procedures is given in Annex A.

4 Reagents

4.1 Test water, consisting of distilled or deionized water conforming to grade 3 of BS EN ISO 3696.

4.2 Nitric acid, concentrated (70 % by mass) analytical reagent grade, suitable for use in **A2** trace metals analysis **A2**.

4.3 Nitric acid, 10 % by volume, prepared by diluting **A2** 100 ± 1 ml **A2** of the nitric acid (4.2) to 1 l with test water (4.1).

CAUTION. Add the acid to the water carefully and with gentle stirring.

4.4 Cementitious material test water, prepared by dissolving (110 ± 1) mg anhydrous calcium chloride, (140 ± 1) mg sodium hydrogen carbonate and (48 ± 1) mg sodium silicate ($\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$) in 1 l demineralized water.

Determine the pH in accordance with BS EN ISO 10523 and adjust to 7.0 ± 0.1 by bubbling air and/or CO_2 through the solution.

NOTE The target total hardness is 100 mg/l as CaCO_3 , the target alkalinity is 122 mg/l as HCO_3^- and the silica concentration is 10 mg/l as SiO_2 .

5 Apparatus

5.1 General

New glass and polyethylene ware shall be soaked for 2 days in nitric acid (4.3) and subsequently thoroughly rinsed with test water (4.1).

NOTE Cleanliness is essential in the determination of trace metals.

5.2 Test containers, consisting of borosilicate glass beakers calibrated for a capacity in accordance with BS 6920-2.1:2014, 5.1.2 with borosilicate glass covers.

The containers shall be of a size that will allow the test sample to be placed in the container in such a way as to minimize contact between the surface of the sample and the sides and bottom of the container. Before use, wash the beakers using a biodegradable laboratory detergent, rinse with the nitric acid solution (4.3) and finally with test water (4.1).

5.3 Bottles, made of polyethylene (or other suitable material known not to affect adversely the analytical results), and of a size to hold the extract prepared as described in either 7.2 or 7.4 as appropriate.

For mercury analysis, bottles shall be made of glass, polyethylene or polyethylene terephthalate (PET) containing a suitable preservative to ensure there is no loss of mercury awaiting analysis.

NOTE 0.05% by mass potassium dichromate in 1% by volume nitric acid, or gold solutions acidified with nitric acid, depending upon the nature of the bottles, are suitable for preservation purposes.

The bottles shall be prewashed using the procedure described in 5.2.

6 Test samples

6.1 General requirements

The samples shall conform to all the pertinent requirements given in BS 6920-2.1.

6.2 Sample cleaning

On the same day as testing is to start, rinse the sample, contained in a suitably sized beaker, in flowing tap water for 30 min to remove loose particulate matter and dust. Finally, rinse three times with fresh portions of the test water (4.1).

6.3 Number of tests

Prepare duplicate samples (6.1) of each product being tested and carry out the extraction procedure given in Clause 7 on each sample. If either sample exceeds the concentration limits specified in BS 6920-1:2014, Clause 8 repeat the extractions using a further three untested fresh samples.

7 Test procedure

7.1 First extraction – non-cementitious materials

Immediately after cleaning (see 6.2), place each sample in a separate clean container (5.2). Add to the container a measured volume of test water (4.1) sufficient to reach the calibration mark given in BS 6920-2.1:2014, 5.1.2 and record the volume of water added. 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. Store each container at a temperature of $(23 \pm 2)^\circ\text{C}$ for (24 ± 1) h.

Remove the sample and transfer all but 50 ml of the extract into a sample bottle (5.3). To the remaining 50 ml of extract, add nitric acid (4.2) in the ratio of 5 ml of nitric acid to every 1 000 ml of total extract. Rinse the container with the acidified residual to remove any metals adsorbed onto the surface of the glass and finally add this rinse to the bulk of the extract in the sample bottle. Retain the acidified extract and determine the metals as described in Clause 8.

If the results from both of the extracts do not exceed the concentration limits specified in BS 6920-1:2014, Clause 8, then define these first extracts as the final extracts. In these circumstances, do not carry out further extractions. If the results for either of the extracts exceed the concentration limits specified in BS 6920-1:2014, Clause 8 carry out the further extractions (7.2).

7.2 Repeat extractions

Wash the container carefully to remove all traces of nitric acid and then rinse it in test water (4.1). Replace the sample.

Repeat the extraction procedure using the same volume of fresh test water in the same containers for a further six sequential periods, including one 72 h period and concluding with a 24 h period, discarding extracts and acidified washings each time.

If, for logistical reasons, a break in the extraction sequence is essential, store the test samples dry in clean food grade polyethylene bags until the sequence can be continued.

7.3 Final extract

Remove the sample and transfer all but 50 ml of the extract into a sample bottle (5.3). To the remaining 50 ml of extract, add nitric acid (4.2) in the ratio of 5 ml of nitric acid to every 1 000 ml of total extract. Rinse the container with the acidified residual to remove any metals adsorbed onto the surface of the glass and finally add this rinse to the bulk of the extract in the sample bottle. Retain the acidified final extract and determine the metals as described in Clause 8.

7.4 Blank tests

Carry out a blank extraction procedure (reagent blank) following the procedure described in 7.1 and 7.3 but omitting the sample.

Perform a reagent blank test to provide information on the effect of the container or possible ingress of contaminants from external sources.

If a sample applied to a metal fitting is being tested, then test an identical cleaned metal fitting but without the product under test, as a metal fitting blank test. Carry out on this metal fitting all the procedures given in 7.1, 7.2 and 7.3, and also carry out a reagent blank test.

If a cementitious additive is being tested, then test an identical block of the test mortar mix, cured and pre-conditioned in the same way but without the product under test, as a blank test. Carry out on this block all the procedures given in 7.1, 7.2 and 7.3, and also carry out a reagent blank test.

A2 7.5 Test procedure – cementitious materials

Prepare and analyse extracts from pre-conditioned samples (BS 6920-2.1:2014, 6.14.1.3 or 7.8.2.3) of the test material as set out in 7.1 to 7.3 above, together with the appropriate blank tests (7.4) using cementitious material test water (4.4). A2

7.6 Validation (reagent blank)

If the reported concentration for any metal in the reagent blank exceeds the appropriate reporting limit given in BS 6920-1:2014, Table 1 but is less than 25 % of the maximum allowable concentration (MAC) given in BS 6920-1:2014, Table 1 for the metal, carry out an investigation to determine the cause of the exceedance. Keep a record of these investigations. Include an examination of the concentrations for the blank to ensure that they are within the total error of the analytical method(s) and do not indicate any quality control difficulties. Evaluate the validity of test sample results as follows:

- a) where the results for the blank are less than the appropriate reporting limits given in BS 6920-1:2014, Table 1 then the results for the final test sample extracts are accepted as valid;
- b) where the results for the blank exceed the appropriate reporting limits given in BS 6920-1:2014, Table 1 and are greater than 25 % of the MAC, then the test results for the final sample extracts are invalid;
- c) where the results for the blank exceed the appropriate reporting limits given in BS 6920-1:2014, Table 1 but are less than 25 % of the MAC and the results for the final test sample extracts are less than 50 % of the MAC, then the test results are accepted as valid;
- d) where the results for the blank exceed the appropriate reporting limits given in BS 6920-1:2014, Table 1 but are less than 25 % of the MAC and the results for the final test sample extracts are greater than 50 % of the MAC, then the test results are invalid.

NOTE 1 Around the limit of detection small positive values can be obtained from statistical variation, minor sample contamination and actual concentration variations.

NOTE 2 It is very unusual to find a reported difference between two “identical” sample extracts. Due to the method of extract preparation, however, the results obtained from “identical” test samples can vary as a result of surface contamination of the test pieces, contamination in a test container, or sample collection bottle.

8 Determination of extracted metals

8.1 Analytical methods

Determine the presence of the metals listed in Table 1 of BS 6920-1:2014 in the final extracts (see 7.1 or 7.3 as appropriate).

Choose the analytical method such that the total error of an analytical result does not exceed either 10 % of the relevant value given in the table or 20 % of the result, whichever is the greater. Ensure that the requirements for the random and systematic errors are such that they each do not exceed one half of the tolerable total error as defined in this paragraph.

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

- a) General Principles of Sampling and Accuracy of Results *in the series* Methods for the Examination of Waters and Associated Materials [1].
- b) Water Research Centre. A Manual on Analytical Quality Control for the Water Industry [2].

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 Methods for the Examination of Waters and Associated Materials [3].

NOTE 2 In determining the extracted metals content, dilutions of the extract may be made in order 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.

8.2 Validation

Collect control data from reagent blanks, duplicates and “spikes” to provide information on background contamination, and on analytical precision and accuracy of the methods used during analysis of each batch of extracts. For “spikes” choose concentrations that are representative of the concentrations encountered in the test samples.

9 Expression of results

Record the concentration of each metal determined in all the extracts tested (in µg/l), applying a correction factor for the volume of acid added to the final extracts (see 7.1 or 7.3 as appropriate).

Record the concentration of each metal determined in the test blank.

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

When a sample has been tested applied to a metal fitting, subtract from each concentration of each metal determined in the final extract the corresponding value determined for the metal fitting blank test (see 7.4). Record both sets of values and the differences.

10 Test report

10.1 General

In the case where the concentration for any metal in the reagent blank exceeds the appropriate reporting limit given in BS 6920-1:2014, Table 1 but is less than 25 % of the MAC for the metal, the test report shall contain a statement concerning the investigation carried out and the conclusions drawn.

NOTE An example of this statement is “In the Extraction of Metals Test the concentration of xxxxxxx (insert the name of the element) found in the reagent blank exceeded the reporting limit of detection for this element. After investigation it was concluded, however, that the test was valid and that the results obtained for the product conform with the requirements for this test”.

The test report shall include the following particulars:

- a title (e.g. “Test Report”) and the date of issue of the report;
- a reference to this British Standard, i.e. BS 6920-2.6;
- name and address of laboratory, and location where the tests were carried out if different from the address of the laboratory;
- unique identification of the test report (such as serial number), and on each page an identification in order to ensure that the page is recognized as a part of the test report, and a clear identification of the end of the test report;
- name and address of the client placing the order;
- description and unambiguous identification of the item(s) tested; this shall meet the minimum requirements set out in BS 6920-2.1:2014, Clause 9;
- reference to any sampling or sample preparation procedures used by the laboratory, or other bodies and where appropriate, chain of custody details where these are relevant – in the case of site applied products include all the requirements in accordance with BS 6920-2.1:2014, 9.5;
- date of receipt of test item(s) and date(s) of performance of the tests undertaken;
- deviations from, additions to or exclusions from the test method;
- the method of analysis for each metal and the source of the method;
- the limit of detection for each of the methods ($\mu\text{g/l}$) of analysis used;
- the concentration of each metal ($\mu\text{g/l}$) determined in the first, and if appropriate, the seventh (final) extracts together with the concentration of each metal determined in the blank and the metal fitting blank, where appropriate;
- analytical control data for procedural blanks, duplicates and spiked samples, including statements of reproducibility and accuracy, if required;
- a statement of conformity/non-conformity with the test requirements of BS 6920-1:2014, Clause 8;
- the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report;
- a statement to the effect that the results relate only to the items tested, and that the test report shall not be reproduced except in full, without written approval of the laboratory.

When the test report contains results of tests performed by subcontractors, these results shall be clearly identified.

When reports are reissued to take into account errors/omissions, results of additional tests or for other reasons one of the following two approaches shall be adopted:

- a) issue an additional test report containing the additional information or corrections only and clearly marked “Supplement to Test Report, Reference.....”;
- b) issue a complete amended report (usually the preferred option) with a statement added below the original date of issue of the report stating “Reissued with correction/additional data/etc. (as appropriate):(date)”.

All previous results for the tested item(s) shall be included in any reissued reports containing the results of additional tests.

When it is necessary to issue a completely new test report, it shall be uniquely identified and a reference to the original that it replaces shall be included.

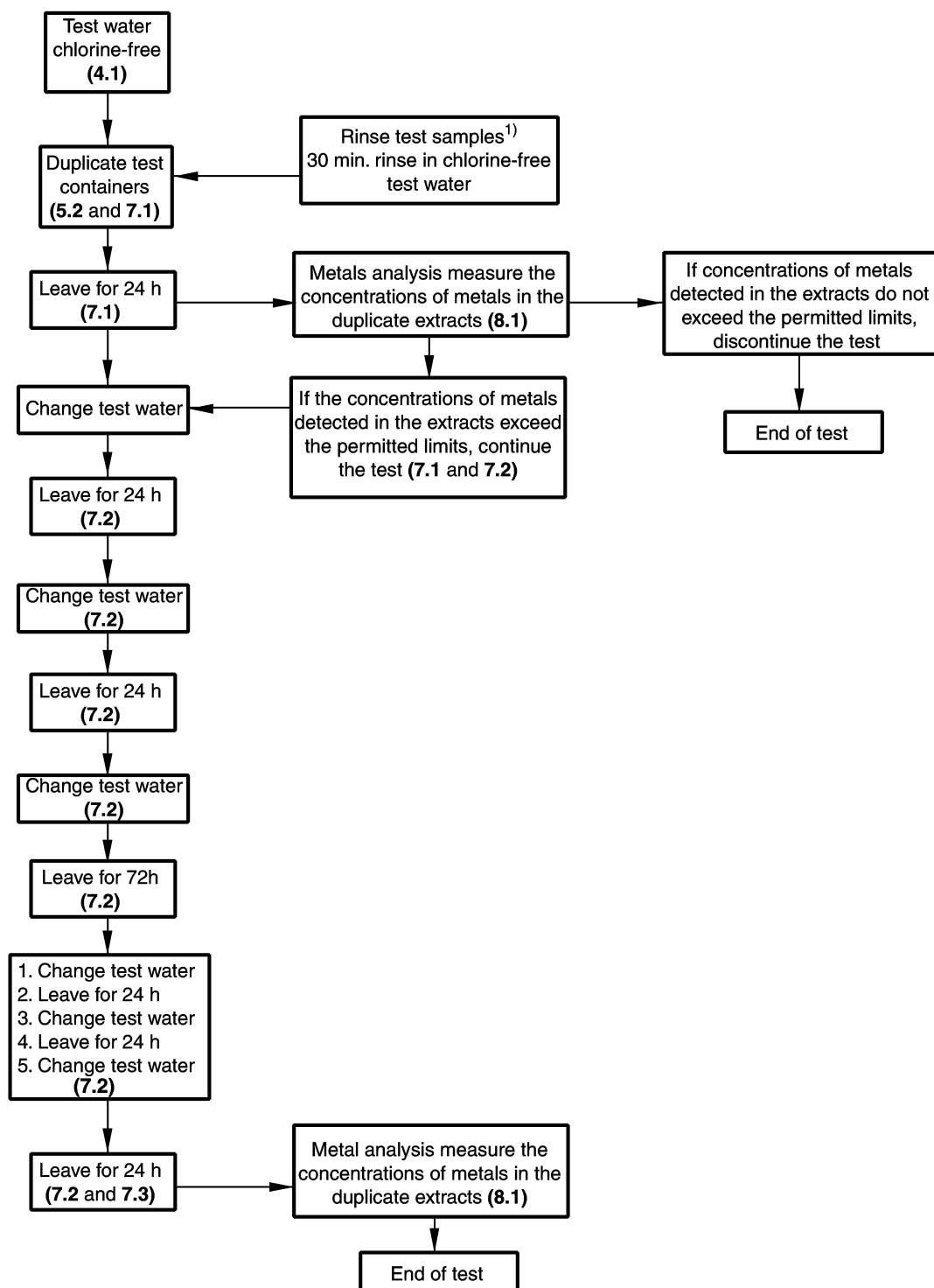
In reports based upon only some of the sections of BS 6920-2 the statement “NO OTHER TESTS WERE UNDERTAKEN ON THIS PRODUCT” shall be included.

10.2 Retesting using cold water test conditions/failure in BS 6920-3

If a product fails to conform to the high temperature tests and a cold water test is then undertaken and satisfactory results obtained, then both sets of results shall be included in the final report.

Annex A (informative)

Test sequence



¹⁾ The same test samples are used throughout the test — only the water is changed.

Figure A.1 — Test sequence

Bibliography

Other publications

- [1] GREAT BRITAIN. Standing Committee of Analysts, “General Principles of Sampling and Associated Materials (second edition) 1996”, — Methods for the Examination of Waters and Associated Materials, Environment Agency.
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- [10] NORTHERN IRELAND. The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009. Statutory Rules of Northern Ireland 2009, No. 255. London: The Stationery Office. [A2]

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