



BSI Standards Publication

Copper concentrates — Determination of mercury content — Cold vapour atomic absorption spectrometric method

National foreword

This British Standard is the UK implementation of [ISO 13546:2021](#).

The UK participation in its preparation was entrusted to Technical Committee NFE/36, Copper lead and zinc ores and concentrates.

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

Contractual and legal considerations

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

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

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

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

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

ISBN 978 0 539 12846 8

ICS 73.060.99

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

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

Amendments/corrigenda issued since publication

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

**INTERNATIONAL
STANDARD**

**ISO
13546**

First edition
2021-07-29

**Copper concentrates —
Determination of mercury content
— Cold vapour atomic absorption
spectrometric method**

*Concentrés de cuivre — Dosage du mercure — Méthode par
spectrométrie d'absorption atomique de vapeur froide*



Reference number
ISO 13546:2021(E)



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	2
5 Reagents	2
6 Apparatus	3
7 Sampling and sampling preparation	4
7.1 Test sample.....	4
7.2 Test portion.....	4
8 Procedure	4
8.1 Number of determinations.....	4
8.2 Blank test.....	4
8.3 Dissolution of the test portion.....	5
8.4 Storage of digested solutions.....	5
8.5 Preparation of sample solutions.....	5
8.6 Preparation of test solutions.....	5
8.7 Preparation of calibration solutions.....	5
8.8 Preparation of mercury calibration graph.....	5
8.9 Determination of mercury content in test solutions.....	6
9 Expression of results	6
10 Procedure for obtaining the final result	6
11 Precision	6
11.1 Expression of precision.....	6
11.2 Procedure for obtaining the final result.....	7
11.3 Precision between laboratories.....	7
11.4 Check of trueness.....	8
11.4.1 General.....	8
11.4.2 Type of certified reference material or reference material.....	8
11.4.3 Reference material certified or characterized by an interlaboratory test programme.....	8
11.4.4 Reference material certified or characterized by one laboratory.....	8
12 Test report	9
Annex A (normative) Procedure for obtaining the final results	10
Bibliography	11

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 183, *Copper, lead, zinc and nickel ores and concentrates*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Copper concentrates — Determination of mercury content — Cold vapour atomic absorption spectrometric method

WARNING — The use of this document can involve hazardous materials, operations and equipment. It is the responsibility of the user of this document to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This document specifies an acid digestion and vapour generation atomic absorption spectrometric method for the determination of the mercury content in copper sulfide concentrates.

This document is applicable to mass fraction of mercury between 5 µg/g and 65 µg/g in copper sulfide concentrates.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[ISO 385](#), *Laboratory glassware — Burettes*

[ISO 648](#), *Laboratory glassware — Single-volume pipettes*

[ISO 1042](#), *Laboratory glassware — One-mark volumetric flasks*

[ISO 3696](#), *Water for analytical laboratory use — Specification and test methods*

[ISO 4787](#), *Laboratory glassware — Volumetric instruments — Methods for testing of capacity and for use*

[ISO 9599](#), *Copper, lead, zinc and nickel sulfide concentrates — Determination of hygroscopic moisture content of the analysis sample — Gravimetric method*

[ISO 12743:2018](#), *Copper, lead, zinc and nickel concentrates — Sampling procedures for determination of metal and moisture content*

[ISO Guide 35](#), *Reference materials — Guidance for characterization and assessment of homogeneity and stability*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Principle

The test portion is decomposed by treatment with hydrochloric and nitric acid at a temperature between 60 °C and 80 °C followed by the addition of potassium permanganate as oxidizing agent. Subsequently, the potassium permanganate is reduced by hydroxylamine hydrochloride. The mercury vapour is generated by vapour generation using tin (II) chloride as reduction agent. The equipment is set to measure the absorbance at 253,7 nm. The absorbances of the test and calibration solutions, including those of certified or other reference materials, are compared to determine the mercury content.

5 Reagents

During the analysis, use only reagents of recognized analytical grade and grade 2 water in accordance with [ISO 3696](#).

Reagents shall be selected or purified for the lowest possible blank value.

5.1 Tin (II) chloride dehydrate, ($\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$), containing < 5 mg/g mercury.

5.2 Potassium permanganate (KMnO_4).

5.3 Hydroxylamine hydrochloride ($\text{HONH}_2 \cdot \text{HCl}$).

5.4 Mercury (II) chloride (HgCl_2).

5.5 Nitric acid, $\rho = 1,42$ g/ml.

5.6 Hydrochloric acid, $\rho = 1,16$ g/ml to 1,19 g/ml.

5.7 Sulfuric acid, $\rho = 1,84$ g/ml.

5.8 Sulfuric acid solution, diluted 1 + 5.

5.9 Sulfuric acid solution, diluted 1 + 9.

5.10 Aqua regia. Mix 300 ml of hydrochloric acid ([5.6](#)) and 100 ml nitric acid ([5.5](#)). Prepare freshly for each batch of mercury determination.

5.11 Tin (II) chloride solution, 100 g/l. Add 10 g of tin (II) chloride ([5.1](#)) to 80 ml sulfuric acid solution ([5.9](#)). Heat and swirl to dissolve. Cool the solution and dilute with deionized water to 100 ml and mix thoroughly.

Continuously stir the solution with a magnetic stirrer for at least 2 h before use and maintain stirring during analysis. Prepare weekly.

Hydrochloric acid may be used instead of sulfuric acid.

Alternative procedure:

Tin (II) chloride solution, 100 g/l: add 10 g of tin (II) chloride ([5.1](#)) to 20 ml of deionized water. Add continuously 60 ml of sulfuric acid solution ([5.8](#)). Heat and swirl to dissolve. Cool, dilute to 100 ml with deionized water and mix thoroughly.

5.12 Potassium permanganate (KMnO_4) solution, 2 g/l. Add 0,2 g of potassium permanganate ([5.2](#)) to 100 ml of deionized water. Store in a glass bottle.

5.13 Hydroxylamine hydrochloride solution, 20 g/l. Add 2 g of hydroxylamine hydrochloride (5.3) to 100 ml of deionized water.

5.14 Mercury trapping solution. Add 10 g of potassium permanganate (5.2) to 100 ml of water and mix well. This reagent is used to oxidize mercury vapour to its Hg^{2+} state and trap it in solution.

5.15 Nitric acid solution, diluted (1+9).

5.16 Mercury standard solution A, 100 $\mu\text{g}/\text{ml}$. Weigh 0,1354 g of mercury (II) chloride (5.4) into a 250 ml beaker and dissolve in 100 ml of nitric acid (5.5). Quantitatively transfer to a 1-l volumetric flask with water. Mix and store in a labelled glass container.

Alternatively, use a suitable high-quality commercial standard solution.

5.17 Mercury standard solution B, 10 $\mu\text{g}/\text{ml}$. Pipette 10 ml of mercury standard solution A (5.16) into a 100-ml volumetric flask containing 10 ml nitric acid (5.5). Dilute to volume with water. Mix and store in a labelled volumetric flask.

Prepare the solution monthly.

5.18 Mercury standard solution C, 0,1 $\mu\text{g}/\text{ml}$. Pipette 10 ml of mercury standard solution B (5.17) into a 1-l volumetric flask containing 100 ml of nitric acid (5.5). Dilute to volume with water. Mix and store in a labelled volumetric flask.

The solution should be freshly prepared.

6 Apparatus

All laboratory glassware and equipment shall be free of mercury contamination. Use ordinary laboratory apparatus, including pipettes and volumetric flasks conforming with the specifications of [ISO 648](#) and [ISO 1042](#), respectively, and the following:

6.1 Analytical balance, sensitive to 0,1 mg.

6.2 Magnetic stirrers.

6.3 Laboratory glassware, of class A conforming with [ISO 385](#), [ISO 648](#), [ISO 1042](#) and used in accordance with [ISO 4787](#).

6.4 Atomic absorption spectrometer, equipped with a mercury hollow cathode lamp or electrodeless discharge lamp or a continuum radiation source.

WARNING — Follow the manufacturer's instructions to avoid possible explosion hazards when igniting and extinguishing the air-acetylene flame and possible burning from the hot electric furnace. Wear tinted safety glasses whenever the atomic absorption spectrometer is in operation. Good ventilation is necessary to prevent poisoning by mercury hydride.

The atomic absorption spectrometer used in this method shall meet the following criteria:

- a) Minimum sensitivity: the absorbance of the highest concentration calibration solution (see 8.7) is at least 0,5 $\mu\text{g}/\text{ml}$.
- b) Graph linearity: the slope of the calibration graph covering the top 20 % of the concentration range (expressed as a change in absorbance) is not less than 0,7 of the value of the slope for the bottom 20 % of the concentration range determined in the same way.

- c) Minimum stability: the standard deviation of the absorbance of the most concentrated calibration solution and that of the zero-calibration solution, each being calculated from a sufficient number of repetitive measurements, are less than 1,5 % and 0,5 %, respectively, of the mean value of the absorbance of the most concentrated solution.

The use of a strip-chart recorder, digital readout device or both is recommended to evaluate criteria a), b) and c) and for all subsequent measurements.

Parameters will vary with each instrument.

6.5 Stopwatch.

6.6 Hotplate.

7 Sampling and sampling preparation

7.1 Test sample

Prepare an air-equilibrated test sample and a hygroscopic moisture test sample in accordance with [ISO 9599](#).

Mercury can evaporate from samples at elevated temperatures, so a separate chemical analysis sample shall be prepared as described in [ISO 12743:2021](#), 16.2.

7.2 Test portion

Taking multiple increments, extract the test portion from the test sample as specified in [Table 1](#) and weigh to the nearest 0,1 mg. At the same time as the test portions are being weighed for analysis, weigh test portions for the determination of hygroscopic moisture in accordance with [ISO 9599](#).

Table 1 — Recommended test portion masses

Mercury content of sample µg/g	Mass of test portion g
< 50	1,0000
50 to 65	0,5000

8 Procedure

8.1 Number of determinations

Carry out the determinations at least in duplicate in accordance with [Annex A](#), independently, on each test sample.

NOTE The expression “independently” means that the second and any subsequent result is not affected by previous results. For this particular analytical method, this condition implies that the repetition of the procedure is carried out either by the same operator at a different time or by a different operator including, in either case, appropriate recalibration.

8.2 Blank test

Carry out a blank test in parallel with the analysis using the same quantities of all reagents but omitting the test portion. The purpose of the blank test in this method is to check the quality of reagents. If a significant value is obtained as a result of the blank test, check all reagents and repeat the analysis.

8.3 Dissolution of the test portion

Transfer the test portion (7.2) to a conical beaker. Wash down the walls of the conical beaker with 5 ml of deionized water so that none of the sample remains on the walls. Carefully add 25 ml of aqua regia (5.10) while swirling the solution. Leave for 30 min at room temperature. Then, using a hotplate to maintain the temperature between 60 °C and 80 °C, digest the sample for 1 h.

If the mercury content of the test portion is to be determined within 6 h then proceed to 8.5. Otherwise, store the samples using the procedure described in 8.4.

8.4 Storage of digested solutions

Dilute the cooled solution from 8.3 to approximately 60 ml and add 10 ml of potassium permanganate solution (5.12), then cover the beaker with a watch glass or other suitable cover to minimize contamination of the sample.

When the mercury content of the sample is going to be determined, reduce the potassium permanganate by adding dropwise hydroxylamine hydrochloride solution (5.13) until the pink colour disappears, while swirling the conical beaker slowly to ensure adequate mixing.

8.5 Preparation of sample solutions

Dilute the sample solution from either 8.3 or 8.4 to approximately 80 ml with deionized water. If necessary, allow the solution to cool to room temperature and then dilute to 100 ml.

8.6 Preparation of test solutions

Prepare test solutions for each determination at least in duplicate.

Pipette 1 ml to 5 ml of the sample solution prepared in 8.5, containing between 0,1 µg and 0,5 µg of mercury, into the reaction vessel used for mercury determination. Dilute this solution to 100 ml with nitric acid solution (5.15).

8.7 Preparation of calibration solutions

Prepare all calibration solutions at least in duplicate.

With the mercury standard solution C 0,1 µg/ml Hg (5.18) and using Table 2 as a guide, prepare a series of calibration standards using pipettes to transfer the appropriate volumes into separate reaction vessels and dilute to 100 ml with nitric acid solution (5.15).

Table 2 — Calibrating solutions

Volume of mercury standard solution ml	Mercury content µg
1	0,1
2	0,2
3	0,3
4	0,4
5	0,5

8.8 Preparation of mercury calibration graph

Set up the atomic absorption spectrometer (6.4) according to the guidelines set out in 6.4. Adjust the instrument read-out scale to zero. Using vapour generation equipment, reduce the mercury in the first duplicate of the calibration solutions prepared in 8.7 with 5 ml of tin (II) chloride solution (5.11). Record the absorbance of the generated vapour with the atomic absorption spectrometer (6.4). If necessary,

flush out any residual mercury vapour from the vapour generation apparatus and check for condensed water vapour on the absorption cell.

Calculate the average absorbance for each calibration solution. Plot a graph of the average absorbance versus micrograms of mercury and repeat any errant standards.

NOTE New instruments are usually equipped with software to calculate and draw the calibration curve.

8.9 Determination of mercury content in test solutions

Immediately after calibrating the atomic absorption spectrometer, determine the mercury content in the test solutions prepared in 8.6.

Adjust the instrument read-out scale to zero and using vapour generation equipment reduce the mercury in the first duplicate of the test solutions prepared in 8.6 with 5 ml of tin (II) chloride solution (5.11). Record the absorbance of the generated vapour with the atomic absorption spectrometer (6.4). If necessary, flush out any residual mercury vapour from the vapour generation apparatus and check for condensed water vapour on the absorption cell. Repeat this procedure for the second duplicate.

If the difference in absorbance between the two test solutions exceeds 5 % then re-prepare the test solution as per 8.6 and repeat the mercury determination.

9 Expression of results

From the graph determined in 8.8 establish the micrograms of mercury found (F_{Hg}) in the aliquot taken in 8.6 by calculating the mercury content of the sample according to Formula (1):

$$w_{\text{Hg}} = \left(\left((F_{\text{Hg}} - B) * 100 \right) / (V_{\text{a}} * m) \right) * K \quad (1)$$

where

w_{Hg} is the mercury content of the sample, in $\mu\text{g/g}$;

F_{Hg} is the mass of mercury found in test sample aliquot, in μg ;

m is the mass of the test portion, in g;

V_{a} is the volume of the test sample aliquot, in ml;

B is the mass of mercury found in the blank test, in μg , corrected as follows: $(F_{\text{Hg b}} * V_{\text{a}}) / V_{\text{a b}}$;

$F_{\text{Hg b}}$ is the mass of mercury found in blank test, in μg ;

$V_{\text{a b}}$ is the volume of blank test aliquot, in ml;

K is the hygroscopic moisture conversion factor determined as follows: $K = 100 / (100 - H)$;

H is the hygroscopic moisture content of the sample determined by ISO 9599.

10 Procedure for obtaining the final result

Process the duplicate results for each test portion of the sample according to Figure A.1 and repeat the determination for a sample as necessary.

11 Precision

11.1 Expression of precision

The precision of this analytical method is expressed by Formulae (2) and (3):

$$S_r = 0,059 4X + 0,074 4 \quad (2)$$

$$S_L = 0,150 0X + 0,099 4 \quad (3)$$

where

X is the concentration of mercury in the sample, in $\mu\text{g/g}$;

S_r is the within-laboratory standard deviation;

S_L is the between-laboratory standard deviation.

11.2 Procedure for obtaining the final result

Calculate the quantities in [Formulae \(4\) to \(6\)](#) from the duplicate results X_1 and X_2 (%) and process according to [Annex A](#).

Mean of duplicates:

$$X = (X_1 + X_2) \quad (4)$$

Within-laboratory standard deviation (repeatability):

$$S_r = 0,059 4X + 0,074 4 \quad (5)$$

Repeatability limit:

$$r = 2,8S_r \quad (6)$$

11.3 Precision between laboratories

The precision between laboratories is used to determine the agreement between the results reported by two (or more) laboratories. It is assumed that all laboratories followed the same procedure.

Calculate the quantities in [Formulae \(7\) to \(11\)](#).

Mean of final results:

$$\mu_{1,2} = \frac{\mu_1 + \mu_2}{2} \quad (7)$$

where

μ_1 is the final result, in $\mu\text{g/g}$, reported by laboratory 1;

μ_2 is the final result, in $\mu\text{g/g}$, reported by laboratory 2.

Between-laboratory standard deviation:

$$S_L = 0,150 0X + 0,099 4 \quad (8)$$

Within-laboratory standard deviation:

$$S_r = 0,059 4X + 0,074 4 \quad (9)$$

Permissible tolerance:

$$P = 2,8 \left[S_L^2 + (S_r^2 / 2) \right]^{1/2} \quad (10)$$

$$\text{Range } E = |\mu_1 - \mu_2| \quad (11)$$

where

- μ_1 is the final result, in $\mu\text{g/g}$, reported by laboratory 1;
- μ_2 is the final result, in $\mu\text{g/g}$, reported by laboratory 2.

If $E \leq P$, the final results are in agreement.

11.4 Check of trueness

11.4.1 General

The trueness of the analytical method can be checked by applying it to a certified reference material (CRM). When the precision has been confirmed, the final laboratory result can be compared with the certified value, A_c .

Two possibilities exist, as shown in [Formula \(12\)](#) and [Formula \(13\)](#):

$$|\mu_c - A_c| \leq C \quad (12)$$

where

- μ_c is the final result, expressed as $\mu\text{g/g}$ of mercury of the CRM;
- A_c is the certified value, expressed as $\mu\text{g/g}$ of mercury of the CRM;
- C is a quantity, expressed as $\mu\text{g/g}$ of mercury, depending on the type of CRM used, as defined in [11.4.2](#).

If this condition exists, the difference between the reported result and the certified value is statistically significant.

$$|\mu_c - A_c| > C \quad (13)$$

If this condition exists, the difference between the reported result and the certified value is statistically insignificant.

11.4.2 Type of certified reference material or reference material

The reference materials used for this purpose shall be prepared and certified in accordance with [ISO Guide 35](#).

11.4.3 Reference material certified or characterized by an interlaboratory test programme

The quantity C (see [11.4.1](#)), in $5 \mu\text{g/g}$, is given by [Formula \(14\)](#):

$$C = 2\sqrt{(S_L^2 + S_r^2 / n + S^2 \{A_c\})} \quad (14)$$

where

- $S^2\{A_c\}$ is the variance of the certified value;
- n is the number of replicate determinations.

11.4.4 Reference material certified or characterized by one laboratory

The quantity C (see [11.4.1](#)), in $5 \mu\text{g/g}$, is given by [Formula \(15\)](#):

$$C = 2\sqrt{(S_L^2 + S_r^2 / n)} \quad (15)$$

It is recommended that this type of CRM is avoided unless the particular CRM is known to have an unbiased certified value.

12 Test report

The test report shall contain the following information:

- a) sample identification;
- b) date of issue of the test report;
- c) a reference to this document, i.e. [ISO 13546:2021](#);
- d) the mercury content of the sample, in $\mu\text{g/g}$;
- e) any characteristics noticed during the determination and any operations not specified in this document which have possibly influenced the results, for either the test sample or the CRM.

Annex A (normative)

Procedure for obtaining the final results

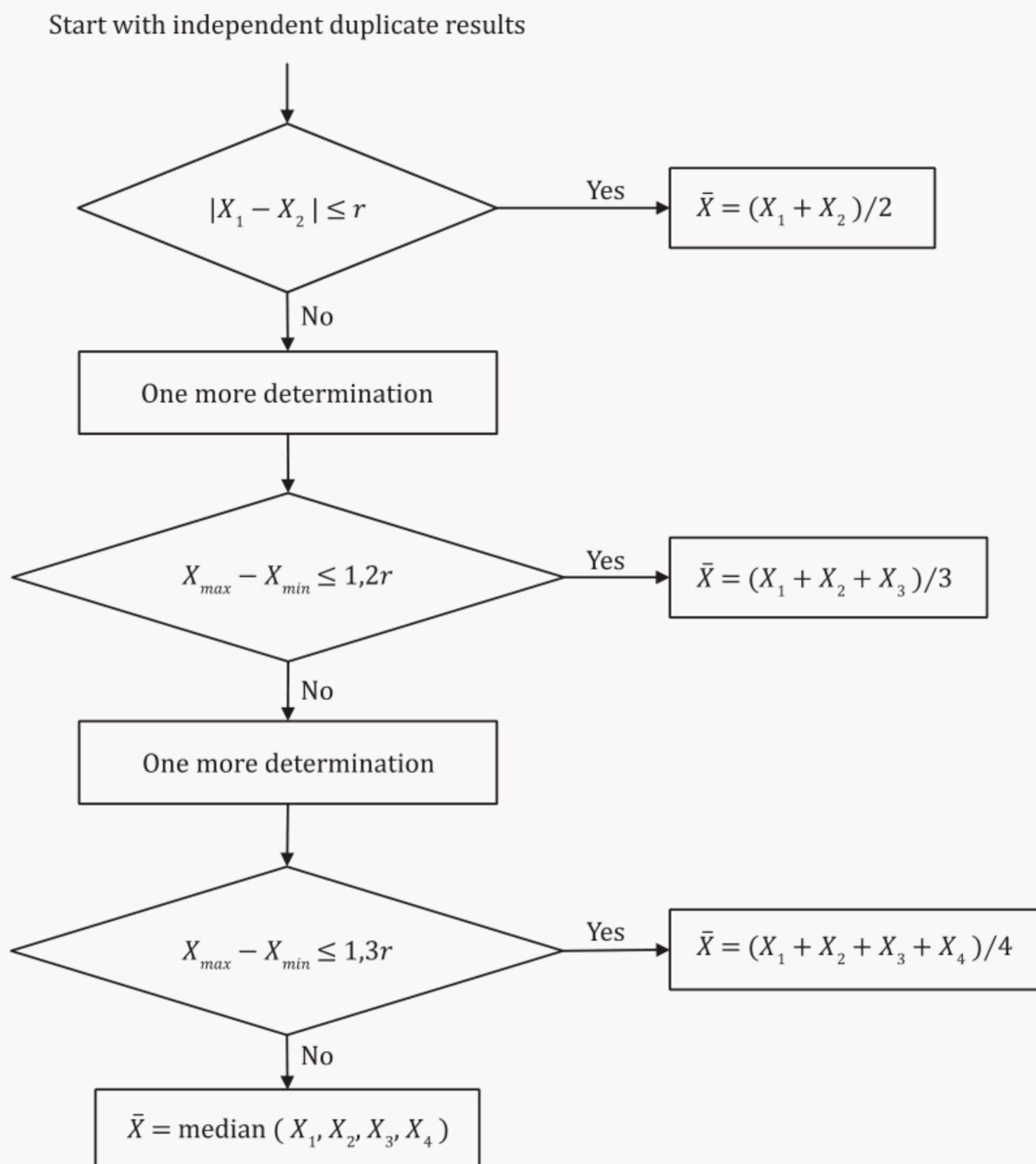


Figure A.1 — Flowsheet of the procedure for the acceptance of analytical values for the test sample

Bibliography

- [1] ISO 8466-2, *Water quality — Calibration and evaluation of analytical methods and estimation of performance characteristics — Part 2: Calibration strategy for non-linear second-order calibration functions*

British Standards Institution (BSI)

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

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

About us

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

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

Information on standards

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

Buying standards

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

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

Copyright in BSI publications

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

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

Storing and using standards

Standards purchased in soft copy format:

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

Standards purchased in hard copy format:

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

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

Reproducing extracts

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

Subscriptions

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

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

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

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

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

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

Revisions

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

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

Useful Contacts

Customer Services

Tel: +44 345 086 9001

Email: cservices@bsigroup.com

Subscriptions

Tel: +44 345 086 9001

Email: subscriptions@bsigroup.com

Knowledge Centre

Tel: +44 20 8996 7004

Email: knowledgecentre@bsigroup.com

Copyright & Licensing

Tel: +44 20 8996 7070

Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK