INTERNATIONAL STANDARD

ISO 8124-3

Third edition
2020-03

Safety of toys —

Part 3: Migration of certain elements

Sécurité des jouets —

Partie 3: Migration de certains éléments

Reference number
ISO 8124-3:2020(E)

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

Published in Switzerland

Contents

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 181, *Safety of toys*.

This third edition cancels and replaces the second edition (ISO 8124-3:2010), which has been technically revised. It also incorporates the Amendments ISO 8124-3:2010/Amd.1:2014 and ISO 8124-3:2010/Amd.2:2018. The main changes to the previous edition are as follows:

- two detailed dewaxing methods have been introduced to replace the original one;
- an ICP-OES method for determination of the elements is given in Annex C as informative content.

A list of all parts in the ISO 8124 series can be found on the ISO website.

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

Introduction

The requirements of this document are based on the bioavailability of certain elements resulting from the use of toys, which should not, as an objective, exceed the following levels per day:

- 0,2 µg for antimony;
- 0,1 µg for arsenic;
- 25,0 µg for barium;
- 0,6 µg for cadmium;
- 0,3 µg for chromium;
- 0,7 µg for lead;
- 0,5 µg for mercury;
- 5,0 µg for selenium.

For the interpretation of these values, it has been necessary to identify an upper limit for the ingestion of toy material. Very limited data have been available for identifying this upper limit. As a working hypothesis, a summed average daily intake of the various toy materials has been gauged at the currently accepted value of 8 mg/d, in the knowledge that in certain individual cases these values might be exceeded.

By combining the daily intake with the bioavailability values listed above, limits have been obtained for various toxic elements in micrograms per gram of toy material (milligrams per kilogram) and are detailed in Table 1. The values obtained have been adjusted to minimize children's exposure to toxic elements in toys and to ensure analytical feasibility, taking into account limits achievable under current manufacturing conditions (see Annex D).

Safety of toys —

Part 3: Migration of certain elements

WARNING — Persons applying this document should be familiar with laboratory practice for chemical analysis. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

IMPORTANT — It is essential that the laboratory ensures that personnel have the competence to perform laboratory activities for which they are responsible.

1 Scope

1.1 This document specifies maximum acceptable levels and methods of sampling, extraction and determination for the migration of the elements antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium from toy materials and from parts of toys.

1.2 Maximum acceptable levels are specified for the migration of the elements listed in 1.1 from the following toy materials:

- coatings of paints, varnishes, lacquers, printing inks, polymers and similar coatings (see 9.1);
- polymeric and similar material, including laminates, whether textile-reinforced or not, but excluding other textiles and non-woven textiles (see 9.2);
- paper and paperboard (see 9.3);
- natural, artificial or synthetic textiles (see 9.4);
- glass/ceramic/metallic materials, excepting lead solder when used for electrical connections (see 9.5);
- other materials, whether mass-coloured or not (e.g. wood, fibreboard, hardboard, bone and leather) (see 9.6);
- materials intended to leave a trace (e.g. the graphite materials in pencils and liquid ink in pens) (see 9.7);
- pliable modelling materials, including modelling clays and gels (see 9.8);
- paints to be used as such in the toy, including finger paints, varnishes, lacquers, glazing powders and similar material in solid or liquid form (see 9.9).

1.3 The requirements in this document apply to the following toys and toy components of toys and toy materials (see D.2.1):

- all intended food and oral contact toys, cosmetic toys and writing instruments categorized as toys, irrespective of any age grading or recommended age labelling;
- all toys intended for or suitable for children under 72 months of age;
- accessible coatings, irrespective of any age grading or recommended age labelling;

— accessible liquids, pastes and gels (e.g. liquid paints, modelling compounds), irrespective of any age grading or recommended age labelling.

1.4 Packaging materials are not included, unless they are intended to be kept, for example boxes and containers, or unless they form part of the toy or have intended play value (see D.2.2).

NOTE No requirements are given for toys and parts of toys which, due to their accessibility, function, mass, size or other characteristics, are obviously unlikely to be sucked, licked or swallowed, bearing in mind the normal and foreseeable behaviour of children (e.g. the coating on the crossbeam of a swing set, the tyres of a toy bicycle).

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 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 8124-1:2018, *Safety of toys — Part 1: Safety aspects related to mechanical and physical properties*

ISO 8124-6:2018, *Safety of toys — Part 6: Certain phthalate esters in toys and children's products*

3 Terms and definitions

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

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

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

3.1
base material
material upon which *coatings* (3.2) may be formed or deposited

3.2
coating
layers of material formed or deposited on the *base material* (3.1) of a toy, including paints, varnishes, lacquers, inks, polymers or other substances of a similar nature, whether they contain metallic particles or not, no matter how they have been applied to the toy, and which can be removed by *scraping* (3.7) with a sharp blade

3.3
method detection limit
MDL
three times the standard deviation of the result obtained in the method blank by the laboratory carrying out the analysis

3.4
mass-coloured material
material which has absorbed colouring matter without formation of a *coating* (3.2)

EXAMPLE Wood, fibreboard, hardboard, leather, bone and other porous substances.

3.5
paper

sheet formed by irregularly intervened cellulose fibres with a mass per unit area of 400 g/m^2 or less

Note 1 to entry: If paper with polymeric lamination, or other treatments which may be resistant to wetting, no longer presents the same properties as paper, then it is not treated as such.

[SOURCE: ISO 8124-1:2018, 3.46]

3.6
paperboard

sheet formed by irregularly intervened cellulose fibres with a mass per unit area over 400 g/m^2, excluding pressed wooden fibreboards such as medium density fibreboard (MDF), chipboard and materials with similar properties

Note 1 to entry: The term paperboard also includes materials commonly referred to as card or cardboard with a mass per unit area over 400 g/m^2.

Note 2 to entry: If paperboard with polymeric lamination, or other treatments which may be resistant to wetting, no longer present the same properties as paper, then they are not treated as such.

[SOURCE: ISO 8124-1:2018, 3.85]

3.7
scraping

mechanical process for removal of *coatings* (3.2) down to the *base material* (3.1)

3.8
toy material

accessible material present in a toy

3.9
method blank

aliquot of extraction solvent that is treated exactly as a sample including exposure to glassware, apparatus and conditions used for a particular test, but with no added sample

3.10
calibration blank

solution containing no analyte that is used to verify blank value

EXAMPLE 0,07 ± 0,005 mol/l hydrochloric acid solution (6.1).

3.11
instrument detection limit

IDL

three times the standard deviation of the result obtained by analysing calibration blank

3.12
calibration check solution

solution of known composition within the range of the calibration solutions, but prepared independently

4 Maximum acceptable levels

4.1 Specific requirements

See D.3.

Toys and parts of toys, as specified in Clause 1, are deemed to meet the requirements of this document when the adjusted value of migration of elements from them conform with the maximum limits given in Table 1 when tested in accordance with Clauses 8, 9 and 10.

4.2 Interpretation of results

See D.4.

Due to the precision of the methods specified in this document, an adjusted analytical result is required to take into consideration the results of interlaboratory trials. The analytical results obtained in accordance with Clauses 8, 9 and 10 shall be adjusted by subtracting the analytical correction in Table 2 to obtain an adjusted analytical result.

Materials are deemed to conform with the requirements of this document if the adjusted analytical result for the migrated element is less than or equal to the value given in Table 1.

Table 1 — Maximum acceptable element migration from toy materials

Values in milligrams per kilogram of toy material

Toy material	Element							
	Sb	As	Ba	Cd	Cr	Pb	Hg	Se
Any toy material given in Clause 1, except modelling clay and finger paint	60	25	1 000	75	60	90	60	500
Modelling clay	60	25	250	50	25	90	25	500
Finger paint	10	10	350	15	25	25	10	50

Table 2 — Analytical correction

Element	Sb	As	Ba	Cd	Cr	Pb	Hg	Se
Analytical correction (%)	60	60	30	30	30	30	50	60

EXAMPLE An analytical result for lead of 120 mg/kg was obtained. The necessary analytical correction taken from Table 2 is 30 %. Therefore, the adjusted analytical result is as shown in Formula (1).

$$120-\frac{120\times 30}{100}=120-36 \qquad (1)$$

= 84 mg/kg.

This is deemed to be conforming with the requirements of this document (maximum acceptable migration of lead as given in Table 1 is 90 mg/kg).

5 Principle

Soluble elements are extracted from toy materials under conditions that simulate the material remaining in contact with stomach acid for a period of time after swallowing. The concentrations of the soluble elements are then determined quantitatively by inductively coupled plasma optical emission spectrometry (ICP-OES) or other specified analytical methods with specified MDL.

6 Reagents

NOTE No recommendation is made for the reagents and materials necessary for carrying out elemental analyses within the MDL specified in 10.2.

During the analyses, use only reagents of recognized analytical grade.

6.1 **Hydrochloric acid solution**, $c(\text{HCl}) = (0{,}07 \pm 0{,}005)$ mol/l.

6.2 **Hydrochloric acid solution**, $c(\text{HCl}) = (0{,}14 \pm 0{,}010)$ mol/l.

6.3 Hydrochloric acid solution, $c(\mathrm{HCl})$ = approximately 1 mol/l.

6.4 Hydrochloric acid solution, $c(\mathrm{HCl})$ = approximately 2 mol/l.

6.5 Hydrochloric acid solution, $c(\mathrm{HCl})$ = approximately 6 mol/l.

6.6 General purpose reagent n-heptane, (C_7H_{16}), 99 %.

6.7 Water of at least grade 3 purity, in accordance with ISO 3696.

7 Apparatus

NOTE No recommendation is made for the apparatus necessary for carrying out elemental analyses within the MDL specified in 10.2.

See D.5.

Normal laboratory apparatus and the following:

7.1 Plain-weave wire-cloth stainless steel metal sieve, of nominal aperture 0,5 mm and tolerances as indicated in Annex A, Table A.1.

7.2 Means of measuring pH to proper accuracy without cross-contamination

The accuracy of pH measurement shall be cautiously considered to make sure the pH value of the mixture is in the range 1,0–1,5 (as specified in Clause 9). For example, when a pH measurement with an accuracy of ± 0,2 pH units is used, the range shall be changed to 1,2–1,3 after considering the uncertainty.

See D.5.1.

7.3 Membrane filter, of pore size 0,45 µm.

7.4 Centrifuge, capable of centrifuging at (5 000 ± 500) g[1].

See D.5.2.

7.5 Means of agitating the mixture, at a temperature of (37 ± 2) °C.

7.6 Series of containers, of gross volume between 1,6 × and 5,0 × that of the volume of hydrochloric acid extractant.

See D.5.3.

7.7 Soxhlet extractor, according to ISO 8124-6:2018, Figure C.1.

7.8 Solvent extractor, according to ISO 8124-6:2018, Figure C.2.

7.9 High retention filter paper, for example quantitative slow flow rate filter paper.

8 Selection of test portions

See D.6.

---

[1] 1 g = 9,806 65 m/s^2.

A laboratory sample for testing shall consist of a toy either in the form in which it is marketed or in the form in which it is intended to be marketed. Test portions shall be taken from the accessible parts (see ISO 8124-1) of a single toy sample. Identical materials in the toy may be combined and treated as a single test portion, but additional toy samples shall not be used. Test portions may be composed of more than one material or colour only if physical separation, such as dot printing, patterned textiles or mass limitation reasons, precludes the formation of discrete specimens.

NOTE The requirement does not preclude the taking of test portions from materials used to manufacture the toy, provided they are representative of the final toy.

Test portions of less than 10 mg of material shall not be tested.

9 Preparation and extraction of test portions

NOTE A guideline for the choice of procedure to be used for the various toy materials is provided in Annex B.

9.1 Coatings of paint, varnish, lacquer, printing ink, polymer and similar coatings

9.1.1 Test portion preparation

Remove the coating from the laboratory sample by scraping (see 3.7) at room temperature and comminute it at a temperature not exceeding ambient. Collect enough coating to obtain a test portion of preferably not less than 100 mg which will pass through a metal sieve of aperture 0,5 mm (7.1).

If only between 10 mg and 100 mg of comminuted uniform coating is available, extract this in accordance with 9.1.2 and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used. Report the mass of the test portion in accordance with Clause 11 e).

In the case of coatings that by their nature cannot be comminuted (e.g. elastic/plastic paint), remove a test portion of coating from the laboratory sample without comminuting.

9.1.2 Extraction procedure

Using a container of appropriate size (7.6), mix the test portion prepared in 9.1.1 with 50 × its mass of an aqueous HCl solution at (37 ± 2) °C of $c(\text{HCl})$ 0,07 mol/l (6.1). [Where the test portion has only a mass of between 10 mg and 100 mg, mix the test portion with 5,0 ml of this solution (6.1) at (37 ± 2) °C.]

Shake for 1 min. Check the acidity of the mixture (7.2). If the pH is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2 mol/l (6.4) until the pH of the mixture is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

Without delay, efficiently separate the solids from the solution, firstly by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 g (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by adding hydrochloric acid so that the concentration of the stored solution is approximately $c(\text{HCl}) = 1$ mol/l (6.3). Report such stabilization in accordance with Clause 11 e).

9.2 Polymeric and similar material, including laminates, whether textile-reinforced or not, but excluding other textiles

9.2.1 Test portion preparation

Obtain a test portion of preferably not less than 100 mg of the polymeric or similar material, while avoiding heating of the materials, according to the following procedure.

Cut out test portions from those areas having the thinnest material cross-section in order to ensure a surface area of the test pieces as large as possible in proportion to their mass. Each piece shall, in the uncompressed condition, have no dimension greater than 6 mm.

If the laboratory sample is not of a uniform material, obtain a test portion from each different material present in a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of uniform material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

9.2.2 Extraction procedure

Follow the extraction procedure in 9.1.2 using the test portions prepared in accordance with 9.2.1.

9.3 Paper and paperboard

9.3.1 Test portion preparation

See D.7.

Obtain a test portion of preferably not less than 100 mg of the paper or paperboard.

If the laboratory sample is not of a uniform material, where possible, obtain a test portion from each different material present in a mass of not less than 100 mg. Where there is only between 10 mg and 100 mg of uniform material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

If the paper or paperboard to be tested is coated with paint, varnish, lacquer, printing ink, adhesive or similar coating, test portions of the coating shall not be taken separately. In such cases, take test portions from the material so that they also include representative parts of the coated area and report this in accordance with Clause 11 e). Extract test portions obtained in accordance with 9.3.2.

9.3.2 Extraction procedure

Macerate the test portion prepared in 9.3.1 with 25 × its mass of water (6.7) at (37 ± 2) °C so that the resulting mixture is homogeneous. Quantitatively transfer the mixture to the appropriate-sized container (7.6). Add to the mixture a mass of aqueous solution of $c(\text{HCl}) = 0{,}14$ mol/l (6.2) at (37 ± 2) °C which has 25 × the mass of the test portion.

Shake for 1 min. Check the acidity of the mixture (7.2). If the pH is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2 mol/l (6.4) until the pH of the mixture is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

Without delay, efficiently separate the solids from the solution, firstly by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 g (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by adding hydrochloric acid so that the concentration of the stored solution is approximately c(HCl) = 1 mol/l. Report such stabilization in accordance with Clause 11 e).

9.4 Natural, artificial or synthetic textiles

9.4.1 Test portion preparation

See D.8.

Obtain a test portion of preferably not less than 100 mg by cutting the textile material into pieces that in the uncompressed condition have no dimension greater than 6 mm.

If the sample is not of a uniform material or colour, where possible, obtain a test portion from each different material or colour present in a mass greater than 100 mg. Materials or colours present in amounts between 10 mg and 100 mg shall form part of the test portion obtained from the main material.

Samples taken from patterned textiles shall be representative of the whole material.

9.4.2 Extraction procedure

Follow the extraction procedure in 9.1.2 using the test portions prepared in accordance with 9.4.1.

9.5 Glass/ceramic/metallic materials

9.5.1 Test portion preparation

See D.9.

Toys and toy components shall first be subjected to the small parts test in accordance with ISO 8124-1. If the toy or component fits entirely within the small parts cylinder and contains accessible glass, ceramic or metallic materials (excepting lead solder when used for electrical connections), then the toy or component shall be extracted in accordance with 9.5.2 after removal of any coating in accordance with 9.1.1.

NOTE Toys and toy components that have no accessible glass, ceramic or metallic materials do not require extraction in accordance with 9.5.2.

9.5.2 Extraction procedure

Place the weighed toy or toy component in a 50 ml glass cylinder with a nominal height of 60 mm and diameter of 40 mm.

NOTE This type of container will take all components/toys that fit inside the small parts cylinder defined in ISO 8124-1.

Add a sufficient measured volume of an aqueous solution of c(HCl) = 0,07 mol/l (6.1) at (37 ± 2) °C to just cover the toy or component. Cover the container, protect the contents from light and allow the contents to stand for 2 h at (37 ± 2) °C.

Without delay, efficiently separate the solids from the solution, firstly by decantation followed by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 g (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by adding hydrochloric acid so that the concentration of the stored solution is approximately c(HCl) = 1 mol/l (6.3). Report such stabilization in accordance with Clause 11 e).

9.6 Other materials, whether mass-coloured or not (e.g. wood, fibreboard, bone and leather)

9.6.1 Test portion preparation

See D.10.

Obtain a test portion of preferably not less than 100 mg of the material in accordance with 9.2.1, 9.3.1, 9.4.1 or 9.5.1, as appropriate.

If the laboratory sample is not of uniform material, a test portion shall be obtained from each different material present in a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of uniform material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

If the material to be tested is coated with paint, varnish, lacquer, printing ink or a similar coating, follow the procedure in 9.1.1.

9.6.2 Extraction procedures

Extract the materials in accordance with 9.1.2, 9.3.2 or 9.5.2, as appropriate. Report the method used in accordance with Clause 11 e).

9.7 Materials intended to leave a trace

9.7.1 Test portion preparation for materials in solid form

9.7.1.1 General

Obtain a test portion of preferably not less than 100 mg by cutting the material into pieces which in the uncompressed condition have no dimension greater than 6 mm.

A test portion shall be obtained from each different material intended to leave a trace present in the laboratory sample in a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

If the material contains any grease, oil, wax or similar material, these ingredients shall be removed before treatment of the test portion as described in 9.7.4. Two alternative dewaxing methods are described in 9.7.1.2 and 9.7.1.3 as Method A and Method B. Laboratories can select the most suitable dewaxing method at their discretion. Other methods may also be used but shall be validated to show that they are capable of completely removing non-polar ingredients from relevant toy materials.

9.7.1.2 Method A

Enclose the test portion in a high retention filter paper (7.9) and place into the thimble of a Soxhlet extractor (7.7). Add 50 ml of n-heptane (6.6) to the 100 ml boiling flask of the extractor and reflux for at least 30 min with no less than five reflux cycles. At the conclusion of the process, dry the folded filter paper containing the dewaxed test portion to ensure the removal of residual solvent. Take analytical measures to ensure that the removal of the ingredients referred to is quantitative. Report the solvent used in accordance with Clause 11 e).

The filter paper used shall be as small as possible without risking loss of the test portion during the dewaxing procedure.

NOTE The volume of n-heptane can be adjusted according to the Soxhlet extractor used.

9.7.1.3 Method B

Enclose the test portion in a high retention filter paper (7.9) and place into the thimble of a solvent extractor (7.8). Add 20 ml of n-heptane (6.6) to the receiver. After setting the temperature of the solvent extractor to approximately 140 °C, immerse the test portion with filter paper for 10 min as soon as the n-heptane is completely boiling and reflux for another 5 min. At the conclusion of the process, dry the folded filter paper containing the dewaxed test portion to ensure the removal of residual solvent. Take analytical measures to ensure that the removal of the ingredients referred to is quantitative. Report the solvent used in accordance with Clause 11 e).

The filter paper used shall be as small as possible without risking loss of the test portion during the dewaxing procedure.

NOTE The volume of n-heptane can be adjusted to ensure the immersion of the test portion. The temperature of solvent extractor can be adjusted to ensure the boiling of n-heptane.

9.7.2 Test portion preparation for materials in liquid form

Obtain a test portion of preferably not less than 100 mg of the material from the laboratory sample. The use of an appropriate solvent to facilitate the obtaining of a test portion is permitted.

A test portion shall be obtained from each different material intended to leave a trace present in the laboratory sample at a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used

If the material is intended to solidify in normal use and contains grease, oil, wax or similar material, allow the test portion to solidify under normal-use conditions and remove the grease, oil, wax or similar material using dewaxing methods as described in 9.7.1 before treatment of the test portion as described in 9.7.4.

9.7.3 Extraction procedure for samples not containing grease, oil, wax or similar material

Using a container of appropriate size (7.6), mix the test portion prepared in accordance with 9.7.1 or 9.7.2 with 50 × its mass of an aqueous HCl solution at (37 ± 2) °C of $c(\mathrm{HCl}) = 0{,}07$ mol/l (6.1). For a test portion of mass between 10 mg and 100 mg, mix the test portion with 5,0 ml of this solution at (37 ± 2) °C.

Shake for 1 min. Check the acidity of the mixture (7.2). If the test portion contains large quantities of alkaline materials, generally in the form of calcium carbonate, adjust the pH to between 1,0 and 1,5 using hydrochloric acid [$c(\mathrm{HCl})$ approximately 6 mol/l (6.5)] in order to avoid over-dilution. Report in accordance with Clause 11 e) the amount of hydrochloric acid used to adjust the pH in relation to the total amount of solution.

If only a small quantity of alkaline material is present and the pH of the mixture is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\mathrm{HCl})$ approximately 2 mol/l (6.4) until the pH is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C prior to elemental analysis.

9.7.4 Extraction procedure for samples containing grease, oil, wax or similar material

With the test portion as prepared in 9.7.1 or 9.7.2 remaining in the high retention filter paper (7.9), macerate the test portion with water (6.7) which has 25 × the mass of the original material, at (37 ± 2) °C, so that the resulting mixture is homogeneous. Quantitatively transfer the mixture to a container of appropriate size (7.6). Add to the mixture a mass of aqueous solution of $c(\mathrm{HCl}) = 0{,}14$ mol/l (6.2) at (37 ± 2) °C which has 25 × the mass of the original test portion.

In the case of a test portion of original mass between 10 mg and 100 mg, macerate the test portion with 2,5 ml of water (6.7). Quantitatively transfer the mixture to the appropriate-sized container (7.6). Add 2,5 ml aqueous solution of $c(\text{HCl}) = 0{,}14$ mol/l (6.2) at (37 ± 2) °C to the mixture.

Shake for 1 min. Check the acidity of the mixture (7.2). If the test portion contains large quantities of alkaline materials, generally in the form of calcium carbonate, adjust the pH to between 1,0 and 1,5 using hydrochloric acid of $c(\text{HCl})$ approximately 6 mol/l (6.5) in order to avoid over-dilution. Report in accordance with Clause 11 e) the amount of hydrochloric acid used to adjust the pH in relation to the total amount of solution.

If only a small quantity of alkaline material is present and the pH of the mixture is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2 mol/l (6.4) until the pH is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

NOTE The volume of HCl solution of either $c(\text{HCl}) = 0{,}07$ mol/l (see 9.7.3) or $c(\text{HCl}) = 0{,}14$ mol/l is calculated according to the mass of the test portion prior to dewaxing.

Without delay, efficiently separate the solids from the solution, firstly by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 *g* (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by the addition of hydrochloric acid so that the concentration of the stored solution is approximately $c(\text{HCl}) = 1$ mol/l. Report such stabilization in accordance with Clause 11 e).

9.8 Pliable modelling materials, including modelling clays and gels

9.8.1 Test portion preparation

Obtain a test portion of not less than 100 mg of the material from the laboratory sample; obtain a test portion from each different material in the laboratory sample.

If the material contains grease, oil, wax or similar material, remove these ingredients using dewaxing methods as described in 9.7.1 before treatment of the test portion as described in 9.8.3.

9.8.2 Extraction procedure for samples not containing grease, oil, wax or similar material

Using a container of appropriate size (7.6), mix the test portion prepared in accordance with 9.8.1, after breaking up of clay or doughy materials, if appropriate, with 50 × its mass of an aqueous solution at (37 ± 2) °C of $c(\text{HCl}) = 0{,}07$ mol/l (6.1).

Shake the mixture for 1 min. Check the acidity of the mixture. If the test portion contains large quantities of alkaline materials, generally in the form of calcium carbonate, adjust the pH to between 1,0 and 1,5 using hydrochloric acid of $c(\text{HCl})$ approximately 6 mol/l (6.5) in order to avoid over-dilution. Report in accordance with Clause 11 e) the amount of hydrochloric acid used in relation to the total amount of solution.

If only a small quantity of alkaline material is present and the pH of the mixture is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2,0 mol/l (6.4) until the pH is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

9.8.3 Extraction procedure for samples containing grease, oil, wax or similar material

With the test portion as prepared in 9.8.1 remaining in the high retention filter paper (7.9), macerate the test portion with water (6.7) which has 25 × the mass of the original material, at (37 ± 2) °C, so that the resulting mixture is homogeneous. Quantitatively transfer the mixture to a container of appropriate size (7.6). Add to the mixture a mass of aqueous solution of $c(\text{HCl})$ = 0,14 mol/l (6.2) at (37 ± 2) °C which has 25 × the mass of the original test portion.

Shake for 1 min. Check the acidity of the mixture (7.2). If the test portion contains large quantities of alkaline materials, generally in the form of calcium carbonate, adjust the pH to between 1,0 and 1,5 using an aqueous solution of $c(\text{HCl})$ approximately 6 mol/l (6.5) in order to avoid over-dilution. Report in accordance with Clause 11 e) the amount of hydrochloric acid used in relation to the total amount of solution.

If only a small quantity of alkaline material is present and the pH of the mixture is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2,0 mol/l (6.4) until the pH is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

NOTE The volume of the HCl solution of either $c(\text{HCl})$ = 0,07 mol/l (see 9.8.2) or $c(\text{HCl})$ = 0,14 mol/l is calculated according to the mass of the test portion prior to dewaxing.

Without delay, efficiently separate the solids from the solution, firstly by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 g (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by adding hydrochloric acid so that the concentration of the stored solution is approximately $c(\text{HCl})$ = 1 mol/l. Report such stabilization in accordance with Clause 11 e).

9.9 Paints, including finger paints, varnishes, lacquers, glazing powders and similar material in solid or liquid form

9.9.1 Test portion preparation for materials in solid form

Obtain a test portion of preferably not less than 100 mg of the material, if appropriate, by scraping off the material or by cutting into pieces that, in the uncompressed condition, have no dimension greater than 6 mm.

A test portion shall be obtained from each different material present in the laboratory sample at a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

If the material contains any grease, oil, wax or similar material, remove these ingredients using dewaxing methods as described in 9.7.1 before treatment of the test portion as described in 9.9.4.

If the test portion is removed by scraping, comminute it so that the material will pass through a metal sieve with an aperture of 0,5 mm (7.1).

9.9.2 Test portion preparation for materials in liquid form

Obtain a test portion of preferably not less than 100 mg of the material from the laboratory sample. The use of an appropriate solvent to facilitate the obtaining of a test portion is permitted.

A test portion shall be obtained from each different material present in the laboratory sample and forming a mass of 10 mg or more. Where there is only between 10 mg and 100 mg of material, report the mass of the test portion in accordance with Clause 11 e) and calculate the quantity of the appropriate elements as if a test portion of 100 mg had been used.

If the material is intended to solidify in normal use and contains grease, oil, wax or similar material, allow the test portion to solidify under normal-use conditions and remove the grease, oil, wax or similar material using dewaxing methods as described in 9.7.1 before treatment of the test portion as described in 9.9.4.

9.9.3 Extraction procedure for samples not containing grease, oil, wax or similar material

Follow the extraction procedure in 9.7.3 using the test portions prepared in accordance with 9.9.1 or 9.9.2.

9.9.4 Extraction procedure for samples containing grease, oil, wax or similar material

With the test portion as prepared in 9.9.1 or 9.9.2 remaining in the filter paper, macerate the test portion with water (6.7) which has 25 × the mass of the original material, at (37 ± 2) °C, so that the resulting mixture is homogeneous. Quantitatively transfer the mixture to a container of appropriate size (7.6). Add to the mixture a mass of aqueous solution of $c(\text{HCl}) = 0{,}14$ mol/l (6.2) at (37 ± 2) °C which has 25 × the mass of the original test portion.

Shake for 1 min. Check the acidity of the mixture. If the test portion contains large quantities of alkaline materials, generally in the form of calcium carbonate, adjust the pH to between 1,0 and 1,5 using an aqueous solution of $c(\text{HCl})$ approximately 6 mol/l (6.5) in order to avoid over-dilution. Report in accordance with Clause 11 e) the amount of hydrochloric acid used in relation to the total amount of solution.

If only a small quantity of alkaline material is present and the pH of the mixture is greater than 1,5, add dropwise, while shaking the mixture, an aqueous solution of $c(\text{HCl})$ approximately 2 mol/l (6.4) until the pH is between 1,0 and 1,5.

Protect the mixture from light. Agitate the mixture continuously at (37 ± 2) °C (7.5) for 1 h and then allow to stand for 1 h at (37 ± 2) °C.

NOTE The volume of the solution of either $c(\text{HCl}) = 0{,}07$ mol/l (see 9.7.3) or $c(\text{HCl}) = 0{,}14$ mol/l is calculated according to the mass of the test portion prior to dewaxing.

Without delay, efficiently separate the solids from the solution, firstly by filtration using a membrane filter (7.3) and, if necessary, by centrifuging at up to 5 000 *g* (7.4). Carry out the separation as rapidly as possible after completion of the standing time. If centrifuging is used, it shall take no longer than 10 min and shall be reported in accordance with Clause 11 e).

If the resulting solutions are to be stored for more than one working day prior to elemental analysis, stabilize them by adding hydrochloric acid so that the concentration of the stored solution is approximately $c(\text{HCl}) = 1$ mol/l. Report such stabilization in accordance with Clause 11 e).

10 Elemental analysis

10.1 Methods of analysis

The final extract is analysed for the presence of elements by ICP-OES, inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectrometry (AAS) or other suitable techniques. A method for analysis of elements using ICP-OES is given in Annex C for reference.

10.2 Method detection limit (MDL)

The MDL is deemed to be three times the standard deviation of the method blank value as measured by the laboratory carrying out the analysis of the toy materials.

For the quantitative analysis of the extracts of toys for the migrated elements listed in Clause 1, methods having an MDL of a maximum of 1/10 of the values to be determined (see 4.1 and Table 1) shall be considered adequate.

Methods with MDL other than that specified above may be used if the uncertainty of the measurement is considered when determining conformity or non-conformity to the specified limit. Laboratories using methods deviating from this requirement shall report the MDL under Clause 11 c).

10.3 Calculation of results

Calculate the migration of an element in the sample using Formula (2).

$$M = \frac{c \times V \times f}{m} \qquad (2)$$

where

M is the release of an element from the sample (mg/kg);

c is the concentration of the element in the extraction solution (mg/l);

V is the volume of simulant added (ml);

m is the mass of the test portion (g);

f is the dilution factor.

11 Test report

The test report shall contain at least the following information:

a) type and identity of the product and/or material tested;

b) a reference to this document; i.e. ISO 8124-3:2020;

c) the technique used for determining the quantity of each migrated element, and the MDL if different from the requirements in 10.2;

d) the adjusted results (see 4.2) of the quantitative elemental analysis, expressed as milligrams migrated element per kilogram of toy material, stating that the result is related to the element in the solution;

e) details of the procedure used (from Clause 9) to prepare the test portion (including, for example, if base material was incorporated, if centrifugation was required to separate the solids from the solution prior to analysis, if additional acid was required to lower the pH, if the ratio of solid to acid extractant exceeded 1:50 and the solvent used for removing any grease, oil, wax or similar ingredient in toy materials) and if the solution was adjusted to 1mol/l for overnight storage;

f) any departure, by agreement or otherwise, from the preparation and extraction procedures specified;

g) date of the test.

Annex A
(normative)

Sieve requirements

Table A.1 — Sieve dimensions and tolerances

Dimensions in millimetres

Nominal aperture size	Nominal wire diameter in test sieve	Tolerances		
		Maximum deviation for size of an individual aperture	Tolerance for average aperture	Intermediate deviation (no more than 6 % of the apertures shall exceed the nominal aperture size plus this number)
0,500	0,315	+0,090	±0,018	+0,054

Annex B
(informative)

Selection of procedure

Table B.1 is a guideline for the choice of procedure to be used for the various toy materials.

Table B.1 — Guidelines for choosing the procedure for preparation and extraction of test portions

Toy material	Relevant subclause
Paper or paperboard	9.3
Plastic-coated paper or paperboard	9.2
Removable coating	9.1 If accessible, test base material in accordance with 9.2, 9.4, 9.5 and 9.6
Non-textile polymer	9.2
Textile	9.4
Glass/ceramic/metallic	9.5
Other material	9.6
Material intended to leave a trace	9.7
Pliable modelling material or gel	9.8
Paint, varnish, lacquer, glazing powder or similar material in solid or liquid form	9.9

Annex C
(informative)

Methods for analysis of elements

C.1 Principle

This method quantifies antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium in the extraction solution. The basis of the method is the measurement of emission of light by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the lines are monitored by a detector. The concentration of the soluble elements and its dilutions are analysed directly by ICP-OES for identification and quantification.

C.2 Reagents

C.2.1 Water, free of substances causing interference with this method.

C.2.2 Hydrochloric acid solution, $c(\text{HCl}) = (0{,}07 \pm 0{,}005)$ mol/l.

C.2.3 Standard solution

Commercially available certified standard solution of individual element: antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium in 1 000 mg/l. Standard solutions prepared in sulfuric acid should not be used.

C.2.4 Stock solution

C.2.4.1 Stock solution of antimony, arsenic, barium, cadmium, chromium, lead and selenium

Prepare a multi-element stock solution of antimony, arsenic, barium, cadmium, chromium, lead and selenium by diluting the commercially available stock solutions of the individual elements (concentration = 1 000 mg/l) with hydrochloric acid solution (C.2.2) to a final volume of 50 ml according to the scheme in Table C.1 and transferring to a suitable storage bottle. This multi-element stock solution should be prepared every 6 months.

Table C.1 — Preparation scheme stock solution

Element	Volume stock ml	Final volume ml	Concentration mg/l
Antimony	0,5	50,0	10,0
Arsenic	0,5		10,0
Barium	0,5		10,0
Cadmium	0,5		10,0
Chromium	0,5		10,0
Lead	0,5		10,0
Selenium	0,5		10,0

C.2.4.2 Stock solution of mercury

Prepare a stock solution of mercury by quantitatively transferring 0,5 ml of commercially available individual standard solution of mercury into a 50 ml volumetric flask, followed by diluting to the mark with hydrochloric acid solution (see C.2.2) and transferring to a suitable storage bottle. The stock solution of mercury has a concentration of 10,0 mg/l and should be prepared every 6 months.

C.2.5 Working solutions (calibration standards)

C.2.5.1 Working solutions of antimony, arsenic, barium, cadmium, chromium, lead and selenium

Prepare working solutions of antimony, arsenic, barium, cadmium, chromium, lead and selenium by sequentially diluting multi-element stock solution (see C.2.4.1) with hydrochloric acid solution (see C.2.2) to a final volume of 50 ml, in order to obtain standards to be used for calibration according to the scheme in Table C.2. Transfer the working solutions to suitable storage bottles. The multi-element working solutions should be prepared every 3 months.

Table C.2 — Preparation scheme working solutions

Working solution	Volume stock ml	Volume total ml	Concentration of each element mg/l
Working solution *W*1	0,50	50,0	0,10
Working solution *W*2	1,00	50,0	0,20
Working solution *W*3	2,50	50,0	0,50
Working solution *W*4	5,00	50,0	1,00
Working solution *W*5	25,0	50,0	5,00

C.2.5.2 Working solutions of mercury

Prepare working solutions of mercury by quantitatively transferring 0,25 ml, 0,50 ml, 1,0 ml, 2,5 ml and 5,0 ml of mercury stock solution (see C.2.4.2) into a series of 50 ml volumetric flasks, followed by diluting to the mark with hydrochloric acid solution (see C.2.2) in order to obtain working solutions of mercury in 0,05 mg/l, 0,10 mg/l, 0,20 mg/l, 0,50 mg/l and 1,00 mg/l. Transfer the working solutions to suitable storage bottles. The working solutions of mercury should be prepared every 30 days.

C.3 Apparatus

C.3.1 Volumetric flasks, glass, 50 ml.

C.3.2 Variable pipettes with disposable tips, variable range.

C.3.3 Storage bottles, made of polypropylene, used for stock and working solutions. Bottles made of alternative plastic may be used provided that it is suitable for the intended use.

C.3.4 Inductively coupled plasma optical emission spectrometer (ICP-OES), computer controlled.

C.4 Analysis

C.4.1 General

The extraction solution can be analysed directly by ICP-OES to determine the content of antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium. The concentration of the elements should be within the range of the calibration curve and therefore dilutions of extraction solutions may be necessary. Analysis of a method blank should be carried out simultaneously.

C.4.2 Selection of wavelengths

Select one or more emission lines to commence the analysis. Take into consideration the wavelengths that are available on the instrument. The more sensitive lines will usually be the most favourable but avoid using wavelengths that have a direct spectral overlap or where there is a complex background shift caused by the occurrence of a number of intense, closely spaced nearby emission lines. It is recommended that more than one line is selected for each element. The recommended wavelengths for antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium, as well as the most important spectral interferences at the recommended wavelengths, are listed in Table C.3.

Table C.3 — Recommended wavelengths and important spectral interferences

Element	Recommended wavelength[a] nm	Interfering elements
Antimony	206,833	Co, Cr, Fe, Mg, Mn
	217,582	Pb, Fe
Arsenic	188,979	Al, Cr, Fe, Ti
	193,696	Al, Co, Fe
	197,198	Al, Co, Fe, Pb, Ti
Barium	230,425	—
	233,527	Fe, Sn
	455,403	—
	493,408	—
Cadmium	214,438	As, Cr, Fe, Sb
	226,502	As, Co, Fe, Ni
	228,802	As, Co
Chromium	205,560	Be, Fe, Ni, Ti
	267,716	Mn, P
	283,563	Cd, Fe
	284,324	Fe
Lead	220,353	Al, Co, Fe, Ti
	283,305	Cr, Fe
Mercury	184,950	Si
	194,168	—
	253,652	Co, Fe
Selenium	196,026	—
	203,984	Cr, Sb

[a] There might be slight variations in wavelength displayed in different instruments.

C.4.3 Instrument settings

Examples of ICP-OES instrument settings are given in Table C.4 and can be used on typical instruments. However, these settings could be different on different ICP-OES instruments. Optimization of instrument settings is highly recommended in order to achieve the requirements specified in Table C.5.

Table C.4 — ICP-OES parameters

Parameter	Setting/type
Observation orientation	Axial viewing
Nebuliser	Concentric
Spray chamber	Quartz cyclonic
Injector	2,0 mm i.d. quartz
Radio frequency (RF) power	1 300 W
Plasma argon flow	12 l/min
Nebuliser argon flow	0,65 l/min
Auxiliary argon flow	1,0 l/min
Sample uptake rate	1,5 ml/min
Stabilizing time	30 s
Total acquisition time	70 s

C.4.4 Calculation of results

C.4.4.1 Calibration curve

Prepare calibration curves of each element by plotting the concentration of the working solutions against the measuring signal intensity. For quantification, the calibration curve should have a correlation coefficient greater than or equal to 0,999.

C.4.4.2 Calculation of migration

See 10.3.

C.4.5 Quality control

C.4.5.1 Requirements for ICP-OES instruments

The performance of ICP-OES instruments should be checked periodically as follows:

a) Resolution: full width at half maximum of manganese at 257,610 nm should be less than 0,015 nm.

b) Short-term stability: 10 consecutive measurements of a standard solution containing antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium with concentration of (0,50 approximately 2,00) mg/l within the shortest possible time. The relative standard deviation (RSD) of measured concentration of barium, cadmium, chromium and lead should be less than 1,5 % and the RSD of measured concentration of antimony, arsenic, mercury and selenium should be less than 2,0 %.

c) Long-term stability: six measurements of standard solution containing antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium with concentration of (0,50~2,00) mg/l every 15 minutes. The RSD of measured concentration of barium, cadmium, chromium and lead should be less than 2,0 % and the RSD of measured concentration of antimony, arsenic, mercury and selenium should be less than 3,0 %.

d) Instrument detection limit (IDL): should not be higher than the maximum allowable IDL specified in Table C.5.

Table C.5 — Requirements for IDL

Element	Maximum allowable IDL mg/l
Antimony	0,05
Arsenic	0,05
Barium	0,005
Cadmium	0,005
Chromium	0,007
Lead	0,03
Mercury	0,03
Selenium	0,05

C.4.5.2 Method blank

A method blank should be prepared for each batch of samples by following the steps prescribed in Clause 9 without using a sample. The resulting extraction solution should be analysed at a frequency of at least 1 per 20 samples or a minimum of one per batch and the concentration of the elements should be lower than half of the reporting limit of the laboratory.

C.4.5.3 Calibration check solutions

A mid-point calibration check solution without extraction should be analysed at a frequency of at least 1 per 20 samples and at the end of the batch for the verification of the calibration standards. The measured concentration of each element should not deviate from the expected value by more than ± 10 % (or established control limit, whichever is lower).

C.4.5.4 Quality control solutions

Spike the method blank with known volume of stock solutions containing antimony, arsenic, barium, cadmium, chromium, lead, selenium and mercury. The stock solutions should be prepared from a source different from that used to prepare stock solutions in C.2.4. Analyse these quality control solutions at a frequency of at least 1 per 20 samples or a minimum of one per batch. The measured concentration of each element should not deviate from the true spiked value by more than ± 15 % (or established control limit, whichever is lower).

C.4.5.5 Certified reference materials

If available, certified reference materials (CRMs) for migration of certain elements should be analysed prior to use of the method to establish that the percentage recovery relative to the certified value is satisfactory. The CRMs used should be equivalent to toy materials in principle (e.g. toy material: polymer, CRMs: polymer).

C.4.6 Method performance

C.4.6.1 Method detection limit (MDL)

Typical MDLs for antimony, arsenic, barium, cadmium, chromium, lead, mercury and selenium are given in Table C.6.

Table C.6 — Typical MDLs in mg/kg toy material

Element	MDL mg/kg
Antimony	5

Table C.6 *(continued)*

Element	**MDL** mg/kg
Arsenic	2
Barium	2
Cadmium	2
Chromium	2
Lead	5
Mercury	2
Selenium	5

C.4.6.2 Repeatability and reproducibility

An inter-laboratory trial test was performed in 2018. The performance data are summarized in Table C.7.

Table C.7 — Summary of the results of the inter-laboratory trial test

Material category	**Element**	l	o %	M mg/kg	s_r mg/kg	CV_r %	r mg/kg	s_R mg/kg	CV_R %	R mg/kg
Green paint coating	Antimony	16	0,00	13,8	0,65	4,71	1,83	3,15	22,7	8,81
	Arsenic	16	0,00	19,2	0,86	4,46	2,40	2,42	12,6	6,79
	Barium	13	18,8	129	2,65	2,05	7,42	6,57	5,08	18,4
	Cadmium	14	12,5	42,4	0,79	1,88	2,23	2,95	6,96	8,26
	Chromium	16	0,00	7,77	0,29	3,71	0,81	0,88	11,3	2,46
	Lead	15	6,25	35,9	0,89	2,48	2,50	4,20	11,7	11,8
	Mercury	15	6,25	31,6	1,04	3,29	2,91	3,73	11,8	10,4
	Selenium	16	0,00	70,4	3,08	4,38	8,62	6,22	8,84	17,4
Brown plastic grain	Cadmium	16	0,00	6,07	0,24	3,94	0,67	0,54	8,86	1,50
	Chromium	16	0,00	48,9	3,59	7,34	10,1	6,48	13,2	18,1
	Lead	15	6,25	7,25	0,31	4,31	0,87	0,73	10,1	2,05
	Mercury	16	0,00	6,32	0,36	5,75	1,02	0,96	15,1	2,68
	Selenium	16	0,00	181	13,0	7,17	36,4	34,9	19,2	97,7
Blue crayon	Barium	15	0,00	59,0	4,19	7,10	11,7	8,68	14,7	24,3
	Cadmium	15	0,00	44,6	3,40	7,62	9,53	6,87	15,4	19,2
	Chromium	15	0,00	13,6	0,64	4,72	1,80	2,60	19,1	7,28
	Lead	15	0,00	94,3	4,57	4,84	12,8	12,4	13,1	34,6

Key

l number of laboratories after outlier rejection

o percentage of outliers

M mean value of the results

s_r standard deviation of repeatability

CV_r coefficient of variation of repeatability

r repeatability, $r = 2{,}8 \times S_r$

s_R standard deviation of reproducibility

CV_R coefficient of variation of reproducibility

R reproducibility, $R = 2{,}8 \times S_R$