

Safety of toys —

Part 5: Chemical toys (sets) other than experimental sets

ICS 71.040.99; 97.200.50

National foreword

This British Standard is the UK implementation of EN 71-5:1993+A2:2009. It supersedes BS EN 71-5:1993+A1:2006, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee CW/15, General and interpretations.

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

Attention of users is drawn to the Toys (Safety) Regulations 1995.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

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English version

Safety of toys Part 5: Chemical toys (sets) other than experimental sets

Sécurité des jouets
Partie 5: Jeux chimiques (coffrets) autres que
les coffrets d'expériences chimiques

Sicherheit von Spielzeug
Teil 5: Chemisches Spielzeug (Sets)
ausgenommen Experimentierkästen

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Standard was drawn up by the Technical Committee CEN/TC 52/WG 5 “Safety of toys — Chemical toys”, the secretariat of which is held by DS.

This standard was submitted for the second Formal Vote, and the result was positive.

This European Standard has been prepared under a mandate given to CEN by the Commission of the European Communities and the European Free Trade Association, and supports essential requirements of EC Directive(s).

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 1993, and conflicting national standards shall be withdrawn at the latest by November 1993.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Foreword to amendment A1

This European Standard (EN 71-5:1993/A1:2006) has been prepared by Technical Committee CEN/TC 52 “Safety of toys”, the secretariat of which is held by DS.

This Amendment to the European Standard EN 71-5:1993 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2006, and conflicting national standards shall be withdrawn at the latest by July 2006.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this European Standard.

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Foreword to amendment A2

This document (EN 71-5:1993/A2:2009) has been prepared by Technical Committee CEN/TC 52 “Safety of toys”, the secretariat of which is held by DS.

This Amendment to the European Standard EN 71-5:1993 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2010, and conflicting national standards shall be withdrawn at the latest by January 2010.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

This European Standard for safety of toys consists of the following Parts:

- Part 1: *Mechanical and physical properties*;
- Part 2: *Flammability*;
- Part 3: *Migration of certain elements*;
- Part 4: *Experimental sets for chemistry and related activities*;
- Part 5: *Chemical toys (sets) other than experimental sets*;
- [A1]** — Part 6: *Graphical symbol for age warning labelling*;
- Part 7: *Finger paints — Requirements and test methods*;
- Part 8: *Swings, slides and similar activity toys for indoor and outdoor family domestic use*;
- Part 9: *Organic chemical compounds — Requirements*;
- Part 10: *Organic chemical compounds — Sample preparation and extraction*;
- Part 11: *Organic chemical compounds — Methods of analysis*. **[A1]**

This standard is Part 5 of the European Standard for safety of toys, EN 71.

This Part should be read in conjunction with Parts 1, 2 and 3, particularly the introduction and clause 1 of Part 1.

It is intended to reduce the risks which may present health hazards to a child when the chemical toys are used as intended or in a foreseeable way, bearing in mind the normal behaviour of children.

When using these chemical toys, potential risks should be kept to a minimum by inclusion of appropriate information to give special attention to possible hazards, risks and other problems.

This Part of EN 71 specifies requirements for chemical toys (sets) other than experimental sets. Differing legal requirements, e.g. for classification of dangerous substances, risk/safety phrases, labelling and limits for substances, exist in EFTA countries.

[A1] Under a mandate given to CEN by the European Commission, test methods were developed to determine the migration and emission of the following substances or compounds, respectively:

- elements in ceramic and vitreous enamelling materials;
- plasticizers in oven hardening poly (vinyl chloride) (PVC) modelling clay sets;
- toluene, xylene and benzene in oven hardening plasticized PVC modelling clay sets and plastic moulding sets;
- styrene in plastic moulding sets;

- substances in photographic processing sets;
- organic solvents in adhesives, lacquers, paints etc. and
- modifiers, film builders and plasticizers in paints and lacquers.

Five lead laboratories worked out the relevant test methods. In a second step the developed test procedures were validated by the lead and peer review laboratories using specially manufactured or specially selected samples (see Annex D). All test methods have been supervised by CEN/TC 52/WG 5 which also developed EN 71-4.

Text deleted [A1]

[A2] After implementing the test methods some modifications to the standard are being brought forward:

- limits for toluene, xylenes and benzene in oven-hardening plasticized PVC modelling clay sets and plastic moulding sets;
- exclusion of teratogenic substances;
- updating the references to EU directives with subsequent modifications in the requirements. **[A2]**

Requirements and test methods for modifiers, resins and fillers are in preparation and will be added to this standard at the earliest opportunity.

1 Scope

[A1] This part of EN 71 specifies requirements and test methods for the substances and materials used in chemical toys (sets) other than experimental sets. **[A1]**

[A2] These substances and materials are:

- those classified as dangerous by the Directives on dangerous substances [1] and dangerous preparations [2];
- substances and preparations which in excessive amounts may harm the health of the children using them and which are not classified by the above mentioned Directives;
- any other chemical substance or preparation delivered with the toy.

NOTE The terms “substance” and “preparation” as used in directives 67/548/EEC [1] and 1999/45/EC [2] are also used in the “REACH Regulation” Regulation (EC) No. 1907/2006 [3]. This latter regulation requires that account be taken of the emerging international standards in the regulation of chemicals such as the Globally Harmonised System (GHS) of classification and labelling of chemicals. The EU has now proposed a timetable for the introduction of GHS and it is expected that the above two mentioned directives will be repealed on 1 June 2015.

In the GHS regulation the term ‘mixtures’ rather than ‘preparation’ is used. Preparations and mixtures should be considered synonymous; both are mixtures or solutions of substances that do not react with each other. **[A2]**

Additionally, requirements are specified for markings, warning, safety rules, contents list, instructions for use and first aid information.

This Part of EN 71 applies to:

- plaster of Paris (gypsum) moulding sets;
- ceramic and vitreous enamelling materials supplied in miniature workshop sets;
- oven hardening plasticized PVC modelling clay sets;
- plastic moulding sets;
- embedding sets;
- photographic developing sets;
- adhesives, paints, lacquers, varnishes, thinners and cleaning agents (solvents) supplied or recommended in model sets.

2 Normative references

A1 The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. **A1**

EN 71-1, *Safety of toys — Part 1: Mechanical and physical properties*.

EN 71-2, *Safety of toys — Part 2: Flammability*.

A2 EN 71-3:1994, *Safety of toys — Part 3: Migration of certain elements* **A2**

A1 EN 14517:2004, *Liquid petroleum products — Determination of hydrocarbon types and oxygenates in petrol — Multidimensional gas chromatography method*.

EN ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods (ISO 3696:1987)*.

Text deleted **A1**

A2 Text deleted **A2**

3 Definitions

For the purposes of this Part of EN 71 the following definitions apply:

3.1

plaster of Paris (gypsum) moulding set

a toy containing moulds into which a mixture of water and gypsum (predominantly calcium sulfate hemihydrate $\text{CaSO}_4 \cdot 0,5 \text{H}_2\text{O}$) is poured and allowed to harden, e.g. for preparing figures and plates

3.2

ceramic and vitreous enamelling materials supplied in miniature workshop set

a toy containing ceramic glazes and vitreous enamels (transparent, opaque or coloured) which after addition of water are painted on ceramic and metallic bodies to obtain smooth coatings, whereafter it is dried and fired at temperatures above 700 °C

3.3

oven hardening plasticized PVC-modelling clay set

a toy to be used for creating all kinds of figures, brooches, fashion jewellery, etc. prepared by hardening in the oven at temperatures between 100 °C and 130 °C

3.4

plastic moulding set

a toy to be used in substitution of ceramic materials to create decorative articles or models by fusion of a polymer by heating in an oven up to a maximum of 180 °C

3.5

embedding set

a toy to be used to preserve certain products in a transparent material

3.6

photographic developing set

a toy containing chemicals (developer, stop bath and fixing bath) to process black-and-white photographic film and prints and designed to teach the basic principles of photography

3.7 adhesives, paints, lacquers, varnishes, thinners and cleaning agents supplied or recommended in model sets

Products used to assemble and coat models, e.g. motorcars, aeroplanes, houses, ships.

3.7.1

adhesive

a non-metallic substance capable of joining materials by surface bonding (adhesion) and the bond possessing adequate internal strength (cohesion)

3.7.2

water-based paint

a pigmented material which when applied in a liquid form to a surface, forms after a time a dry adherent film

3.7.3**paint and lacquers containing solvents**

coatings based on binders, solvents, dyes and pigments (colouring agents), fillers and modifiers

3.7.4**varnishes**

low viscosity lacquers

3.7.5**thinners and cleaning agents (solvents)**

products which are intended to obtain the required viscosity of paints and lacquers and to clean tools and brushes

4 Plaster of Paris (gypsum) moulding sets

NOTE Basically plaster of Paris (gypsum) is not a harmful material, but if the powder is inhaled or swallowed, it may form hard clots in the lungs or in the stomach.

4.1 Marking

The outer packaging shall in addition to the marking required in **10.1** bear the following:

CAUTION! For children over 5 years of age only.
For use under adult supervision.
Read the instructions before use,
follow them and keep them
for reference.

4.2 Safety rules

The instructions for use shall in addition to the rules required in **11.4** contain the following safety rules:

Do not place the material in the mouth.

Do not inhale dust or powder.

Do not apply to the body.

5 Ceramic and vitreous enamelling materials supplied in miniature workshop sets**5.1 Chemical preparations**

These ceramic glazes and vitreous enamels are mixed preparations of silicate glazes incorporating metal oxides and other compounds, given in Table 1. The maximum mass of each preparation in a set shall not exceed 50 g.

NOTE A ceramic glaze is a vitrified inorganic silicate material. A ceramic frit is a vitrified inorganic silicate material incorporating a pigment.

5.2 Marking

The outer packaging shall in addition to the marking required in **10.1** bear the following warnings:

WARNING! For children over 5 years of age only.
For use under adult supervision.

CAUTION! Read the instructions before use,
follow them and keep them for
reference.

5.3 Safety rules

The instructions for use shall in addition to the rules required in **11.4** contain the following safety rules:

Do not inhale powder.

Do not place the powder in the mouth.

Do not apply to articles intended to come into contact with food and drink.

Table 1 — Chemical preparations

Chemical substance/preparation	CAS number	EINECS number
Calcium silicate hydrate (clay)	1344-96-3	—
Kaolin (china clay)	1332-58-7	—
Sparingly soluble silicate glazes, e.g. enamel and ceramic frits	65997-18-4	266-047-6
Only the following pigments shall be used in these glazes:		
Copper oxide 0,25 %	1317-38-0	215-269-1
Diiron trioxide 5 %	1309-37-1	215-168-2
Ferro-zirconium-silicate 5 %	68412-79-3	270-210-7
Tin dioxide 10 %	18282-10-5	242-159-0
Vanadium-zirconium-silicate 5 %	68186-95-8	269-057-9
(x) Aluminium(y)cobalt(z)oxide 3 %	1333-88-6	—
Zirconium orthosilicate 15 %	10101-52-7	—
Zirconium-praseodymium silicate 5 %	68187-15-5	269-075-7

Table 2a — Plasticizers in oven-hardening plasticized PVC modelling clay sets

Chemical substance	CAS-Number
Adipic acid polyesters	—
Alkylsulfonic acid esters (C ₁₂ to C ₂₀) of phenol	—
Di-isononyl cyclohexane-1,2-dicarboxylate (DINCH)	166412-78-8
Phthalic acid esters with straight-chain aliphatic (C ₆ upwards except C ₈) alcohols and mixtures of these esters	—
Tributyl acetylcitrate	77-90-7
Tris(2-ethylhexyl) acetylcitrate	144-15-0

Keep the set away from food and drink.
The firing process is not part of the function of the toy therefore keep children away during the firing process and do not inhale gases emitted.

6 Oven hardening plasticized PVC-modelling clay sets

6.1 Chemical substances

These modelling clay sets shall consist of PVC (Polyvinylchloride), plasticizers, fillers (e.g. China clay, aluminium hydroxide) and colourants. Only plasticizers given in Table 2 shall be used.
The maximum content of plasticizers in the preparation shall not exceed 30 %.

A2 The vinylchloride monomer content shall be below 1 mg/kg (See [4]).

During heating of these materials at the maximum permitted temperature and duration, the limits given in Table 2.b shall not be exceeded for the emission of the listed toxic substances when tested according to 12.4.

Table 2b — Limits for the emission of substances from oven-hardening plasticized PVC modelling clay sets and plastic moulding sets during heating

Substance	Limit (mg/kg)
Benzene	5
Toluene	15
Xylenes	25

6.2 Marking

The outer packaging shall in addition to the marking required in 10.1 bear the following warnings:
WARNING! For children over 8 years of age only.
For use under adult supervision.
CAUTION! Read the instructions before use, follow them and keep them for reference.

6.3 Safety rules

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rules:
Do not place the material in the mouth.
Do not exceed a temperature of 130 °C or harmful gases may be produced.
Do not exceed a hardening time of 30 min.
The hardening process is not part of the function of the toy and should be carried out by the supervising adult.

Use a domestic oven thermometer, e.g. bimetal, to measure the temperature.

Do not use a glass thermometer.

Do not use a microwave oven.

7 Plastic moulding sets

7.1 Polystyrene granules

7.1.1 Chemical substances

These sets shall contain uncoloured and coloured polystyrene granules in accordance with Table 3.

Table 3 — Polystyrene

Chemical substance	CAS number	EINECS number
Polystyrene with monomer content of styrene # 500 mg/kg	9003-53-6	—

7.1.2 Marking

The outer packaging shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 10 years of age only.

For use under adult supervision.

CAUTION! Read the instructions before use, follow them and keep them for reference.

7.1.3 Safety rules

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rules:

Do not exceed a temperature of 180 °C.

The melting process is not part of the function of the toy and should be carried out by the supervising adult.

Use a domestic oven thermometer, e.g. bimetal, to measure the temperature.

Do not swallow material.

Do not heat the material and cook food at the same time in a domestic oven.

Do not use a glass thermometer.

Do not exceed the maximum recommended processing period.

Do not use a microwave oven.

7.2 Embedding sets

⚠ Substances classified as dangerous substances (see [1]) shall not be used in embedding sets. ⚠

NOTE Substances such as gelatine or agar-agar could be utilized with suitable preservation.

⚠ Only preservatives permitted in foodstuffs (see [5]) and/or cosmetics, except those preservatives which are only allowed in cosmetic products that are rinsed-off after use, (see [6]) shall be used. ⚠

7.2.1 Packaging

⚠ The name(s) of any preservative(s) used shall be indicated on the outer packaging. ⚠

7.2.2 Marking

The packaging shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 5 years of age only.

CAUTION! Read the instructions before use, follow them and keep them for reference.

7.2.3 Safety rules

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rule:

Do not place the preserved material in the mouth.

8 Photographic processing sets

8.1 Chemical substances and preparations

Only substances and preparations given in Table 4 shall be supplied in black-and-white photographic sets up to the amounts stated. These amounts are based on the set being used to make up four separate batches of 0,5l each of the photographic solutions.

8.2 Packaging

The chemicals may be packed as mixed preparations for the developer and the fixing bath in order to avoid spilling.

The sets shall contain eye-protectors, gloves and tweezers.

Table 4 — Maximum amounts of chemical substances

Substance	Max. amount per set	Classification according to [1]	CAS number
7 % (V/V) Acetic acid	100 ml	Xi	64-19-7
Ammonium thiosulfate	4 x 75 g	–	7783-18-8
Ascorbic acid	4 x 10 g	–	50-81-7
Citric acid ^a	5 g	Xi	77-92-9
Disodium disulfite	4 x 10 g	Xn, Xi	7681-57-4
N-(4-Hydroxyphenyl) aminoacetic acid	4 x 5 g	–	2298-36-4
N-Methyl-p-amino-phenol and its salts	4 x 5 g	Xn, N	55-55-0
1-Phenylpyrazolidin-3-one	4 x 1 g	Xn, N	92-43-3
Potassium bromide ^a	4 x 0,5 g	Xi	7758-02-3
Sodium carbonate	4 x 20 g	Xi	497-19-8
Sodium sulfite	4 x 20 g	–	7757-83-7
Sodium thiosulfate	4 x 75 g	–	7772-98-7

NOTE The maximum amounts specified refer to anhydrous chemicals. Equivalent amounts of the hydrated chemicals or their salts (where applicable), which have different CAS numbers, may replace the anhydrous substances.

^a The classifications of the relevant substances correspond to manufacturer's self-classifications.

A2

8.3 Marking

8.3.1 Marking of the outer packaging

The outer packaging shall in addition to the marking required in 10.1.1 bear the following warnings:

WARNING! For children over 12 years of age only.

For use under adult supervision.

CAUTION! This set contains hazardous chemicals.
Read the instructions before use, follow them exactly. Keep for future reference.

8.3.2 Marking of the individual packaging

Each container shall be marked according to clause 10.2.

8.4 Safety rules

When experimenting with these sets, care should be taken and the instructions followed strictly. The safety information of the containers should be observed.

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rules:

Always wear eye protection.

Always wear protective gloves and use tweezers.

Do not place photographic solutions in the mouth.

Do not mix chemicals where food or drink is handled.

Do not allow chemicals to come into contact with the skin and the eyes.

Do not swallow chemicals.

Do not inhale dust.

9 Adhesives, paints, lacquers, varnishes, thinners and cleaning agents (solvents) supplied or recommended in model sets

9.1 General

Adhesives, paints, lacquers, varnishes, thinners and cleaning agents (solvents) supplied in model sets shall comply with the requirements in clause 9. The instructions included in the set shall mention only adhesives, paints, lacquers, varnishes, thinners and cleaning agents (solvents) that comply with the requirements in clause 9.

9.2 Adhesives

9.2.1 Water-based adhesives

A2 Only preservatives permitted in foodstuffs (see [5]) and/or cosmetics, except those preservatives which are only allowed in cosmetic products that are rinsed-off after use, (see [6]) shall be used. **A2**

Only preservatives permitted in foodstuffs and cosmetics as defined in Directives 64/54/EEC⁽¹²⁾ (with subsequent amendments and adaptations) and 76/768/EEC⁽¹²⁾ (with subsequent amendments and adaptations) shall be used except those for short-term use. The name of the preservative used shall be labelled according to the Directive 76/768/EEC⁽¹²⁾.

A2 The basic materials shall be appropriate for food contact (see [7]). The migration solvent shall be water, grade 3 (see EN ISO 3696). **A2**

Table 5 — Basic materials for water-based adhesives and water-based paints and lacquers

Chemical substance	CAS number	EINECS number
Acrylic polymers	—	—
Hydrophilic polyurethane containing neither free isocyanate-groups nor aromatic amino-compounds	—	—
Polymers and copolymers with monomers as permitted for materials intended to come into contact with foodstuffs	—	—
Poly(vinyl acetate)	9003-20-7	—
Poly(vinyl alcohol)	9002-89-5	209-183-3

The basic materials shall comply with the Directive 90/128/EEC¹³⁾, Annex II (with subsequent amendments and adaptations).

The migration solvent shall be water grade 3 (see ISO 3696). The contact time shall be 1 h at 40 °C.

9.2.1.1 Liquid adhesives for paper and wood

Special materials for adhesives for paper and wood shall be in accordance with Table 6.

Table 6 — Special materials for adhesives for paper and wood and water-based paints and lacquers

Chemical substance	CAS number	EINECS number
Cellulose ethers (e.g. carboxymethylcellulose, methylcellulose)	9004-67-5	—
Dextrin	9004-53-9	232-675-4
Gum arabic	9000-01-5	232-519-5
Starch or modified starch	9005-25-8	232-679-6

Special additives for adhesives for paper and wood shall be in accordance with Table 7.

Table 7 — Special additives for liquid adhesives for paper and wood

Chemical substance	CAS number	EINECS number
Butyl glycolate < 3 %	7397-62-8	230-991-7
Caprolactam < 5 %	105-60-2	203-313-2
Glycerol	56-81-5	200-289-5
Polyacrylamide	9003-05-8	—
Polyacrylic acid	9003-01-4	—
Polyethylene glycol	25322-68-3	—
Polymethacrylic acid	25087-27-7	—
Polypropylene glycol	25322-69-4	—
Sodium salts of fatty acids (C ₁₄ upwards)	—	—
Sorbitol	50-70-4	200-061-5
2-(2-butoxyethoxy)ethyl acetate < 3 %	124-17-4	204-685-9
Xylitol	87-99-0	201-788-0

A2 The polymers given in Table 7 shall be appropriate for food contact (see [7]).

The migration solvent shall be water, grade 3 (see EN ISO 3696). **A2**

Liquid adhesives for paper and wood shall not contain more than 10 % of butyl glycolate, caprolactam and 2-(2-butoxyethoxy) ethyl acetate in total.

9.2.1.1.1 Packaging

Containers for water-based adhesives in a set shall not contain more than 100 ml. **A2** The name(s) of any preservative(s) used shall be indicated on the outer packaging. **A2**

9.2.1.1.2 Marking

The adhesive container shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 3 years of age only.
For use under adult supervision.

9.2.1.2 Adhesive sticks for paper

Special materials for adhesive sticks for paper shall be in accordance with Table 6, Table 7 and Table 8.

Table 8 — Special material for adhesive sticks for paper

Chemical substance	CAS number	EINECS number
Poly(vinyl pyrrolidone)	9003-39-8	—

A2 The special materials shall be appropriate for food contact (see [7]). The migration solvent shall be water grade 3 (see EN ISO 3696). **A2**

9.2.1.2.1 Packaging

The mass of the adhesive stick in a set shall not exceed 50 g.

9.2.1.2.2 Marking

The packaging, if any, or the adhesive stick container shall in addition to the marking in 10.1 bear the following warnings:

WARNING! For children over 3 years of age only
For use under adult supervision.

9.2.2 Solvent-based adhesives

Solvent-based adhesives consist of substances from Table 5 to Table 12 and may additionally contain fillers, modifiers and plasticizers.

A2 Plasticizers shall be appropriate for food contact (see [7]) or be in accordance with Table 12b.

NOTE The use of DEHP, DBP and BBP is prohibited for all toys (see [8]). **A2**

The content of plasticizer in these adhesives shall not exceed 8 %. The content of modifiers shall not exceed 3 %.

A2 For solvent-based adhesives containing petroleum fractions the *n*-hexane content shall not exceed 0,5 %. **A2**

9.2.2.1 Multi-purpose adhesives

Basic materials for multi-purpose adhesives shall be in accordance with Table 9.

Table 9 — Basic materials for multi-purpose adhesives

Chemical substance	CAS number	EINECS number
Acrylic polymers	9003-01-4	—
Cellulose nitrate	9004-70-0	—
Poly(vinyl acetate)	9003-20-7	—
Vinyl acetate copolymers	—	—

9.2.2.2 Contact adhesives

Basic materials for contact adhesives shall be in accordance with Table 10.

Table 10 — Basic materials for contact adhesives

Chemical substance	CAS number	EINECS number
Polymers and copolymers with monomers as permitted for materials intended to come into contact with foodstuffs	—	—
Poly(chlorobutadiene)	9010-98-4	—
Polyurethane	73561-64-5	—

9.2.2.3 Special adhesives

Basic materials for special adhesives shall be in accordance with Table 11.

A2 The basic materials shall be appropriate for food contact (see [7]). The migration solvent shall be water, grade 3 (see EN ISO 3696). **A2**

Table 11 — Basic materials for special adhesives

Chemical substance	CAS number	EINECS number
Acrylic polymers	—	—
Polymers and copolymers with monomers as permitted for materials intended to come into contact with foodstuffs	—	—
Polystyrene	9003-53-6	—
Poly(vinylchloride) copolymers	—	—

A2 Table 12a — Solvents in solvent-based adhesives A2

Chemical substance/preparation	CAS number	EINECS number
Acetone	67-64-1	200-662-2
Cyclohexane	110-82-7	203-806-2
Diethyl ketone	96-22-0	202-490-3
Ethyl acetate	141-78-6	205-500-4
Ethyl alcohol	64-17-5	200-578-6
Isopropyl acetate	108-21-4	203-561-1
Isopropyl alcohol	67-63-0	200-661-7
Methyl acetate	79-20-9	201-185-2
Methylethylketone	78-93-3	201-159-0
Methyl isopropylketone	563-80-4	209-264-3
<i>n</i> -butyl acetate	123-86-4	204-658-1
<i>n</i> -propyl acetate	109-60-4	203-686-1
1-methoxy-2-propanol	107-98-2	203-539-1
1,1-dimethoxyethane	534-15-6	208-589-8
A2 Petroleum fraction (60 to 140) °C A2	64742-89-8	265-192-2
A2 Petroleum fraction (135 to 210) °C A2	64742-88-7	265-191-7

The maximum content of 1-methoxy-2-propanol shall be 20 %.

Table 12b — Plasticizers in solvent-based adhesives and solvent-based paints, lacquers, thinners and cleaning solvents

Plasticizer	CAS number
Di-isononyl phthalate (DINP)	28553-12-0 and 68515-48-0
Di-isodecyl phthalate (DIDP)	26761-40-0 and 68515-49-1
Tributyl acetylacrylate	77-90-7
Tris(2-ethylhexyl) acetylacrylate	144-15-0
Alkylsulfonic acid esters (C12 to C20) of phenol	91082-17-6
Adipic acid polyesters	various
Di-isononyl cyclohexane-1,2-dicarboxylate (DINCH)	166412-78-8

2,2-Bis(4-hydroxyphenyl)propane diglycidyl ether (BADGE), bis(hydroxyphenyl)methane diglycidyl ether (BFDGE) and Novolac glycidyl ethers (NOGE) together with their derivatives shall not be used as modifiers for adhesives.

NOTE Key
BADGE – 2,2-bis(4-hydroxyphenyl)propane diglycidyl ether, Bisphenol-A diglycidyl ether [1675-54-3];
BFDGE – bis(hydroxyphenyl)methane diglycidyl ether, Bisphenol-F diglycidyl ether [39817-09-9];
NOGE – Novolac glycidyl ethers [28064-14-4] and [9003-36-5]. 

9.2.2.4 Packaging

The content of the container in a set shall not exceed 15 g.

9.2.2.5 Marking

The outer packaging of the set shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 8 years of age only.
For use under adult supervision.

CAUTION! Read the instructions before use,
follow them and keep them for
reference.

The individual container shall be marked according to 10.2.

9.2.2.6 Safety rules

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rules:

Keep away from ignition sources.

Do not allow adhesive to come into contact with the skin, the eyes and the mouth.

Do not swallow material.

Do not inhale fumes.

9.3 Water-based paints and lacquers

Water-based paints and lacquers shall consist of water, colouring agents, fillers, preservatives, modifiers, basic materials given in Table 5, special materials given in Table 6 and organic solvents and film forming agents given in Table 13.

The content of organic solvents and film forming agents shall not exceed 10 %.  Only preservatives permitted in foodstuffs (see [5]) and/or cosmetics, except those preservatives which are only allowed in cosmetic products that are rinsed-off after use, (see [6]) shall be used. 

Table 13 — Organic solvents and film forming agents

Chemical substance/preparation	CAS number	EINECS number
Di (2-methyl-propyl) ester of aliphatic dicarbonacids (C ₂₀ to C ₃₃) (maximum 2 % as film forming agents)	—	—
Ethanol	64-17-5	200-578-6
Mixture of aliphatic esters and alcohols (C ₁₂ to C ₁₄) (maximum 2 % as film forming agents)	—	—
1-methoxy-2-propanol	107-98-2	203-539-1
1, 2-propandiol (propyleneglycol)	57-55-6	200-338-0
2-methyl-2, 4-pentanediol (hexyleneglycol)	107-41-5	203-489-0
2-propanol	67-63-0	200-661-7
 Text deleted 		

The migration of elements from the applied material shall comply with the limits given in Table 1 of EN 71-3.

9.3.1 Packaging

The content of the container in a set shall not exceed 100 ml. ^{A2} The name(s) of any preservative(s) used shall be indicated on the outer packaging. ^{A2}

9.3.2 Marking

The packaging or the container shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 8 years of age only.
For use under adult supervision.

CAUTION! Read the instructions before use, follow them and keep them for reference.

9.3.3 Safety rules

The instructions for use shall in addition to the rules required in 11.4 contain the following safety rules:

Do not allow material to come into contact with the eyes.

Do not place material in the mouth.

Do not inhale vapours.

9.4 Solvent-based paints, lacquers, thinners and cleaning solvents

Solvent-based paints and lacquers shall contain colourants, fillers, modifiers, basic materials given in Table 14 and solvents given in Table 13 and Table 15. The content of modifiers shall not exceed 3 %.

For solvent-based paints and lacquers prepared with nitrocellulose the content of plasticizer shall not exceed 5 %.

^{A2} Plasticizers shall be appropriate for food contact (see [7]) or be in accordance with Table 12b.

NOTE The use of DEHP, DBP and BBP is prohibited for all toys (see [8]). ^{A2}

NOTE Further reference to plasticizers and modifiers is made in Synoptic Document V, list 1, which may be obtained from the EEC.

Thinners and cleaning solvents shall contain only substances and preparations given in Table 13 and Table 15 except film forming agents. Paints and lacquers shall not contain more than 2 % of isobutanol or *n*-butanol and not more than 20 % 1-methoxy-propanol-2. Isobutanol, *n*-butanol and 1-methoxy-propanol-2 shall not be used in thinners and cleaning agents.

^{A2} For solvent-based paints, lacquers, thinners and cleaning solvents containing petroleum fractions the *n*-hexane content shall not exceed 0,5%. *n*-Hexane shall only occur in these solvents as a contaminant of petroleum fractions. ^{A2}

Pressurized containers (aerosols) shall not be used for paints, lacquers, thinners or cleaning solvents.

The migration of elements from the applied material shall comply with the limits given in Table 1 of ^{A2} EN 71-3:1994 ^{A2}.

Table 14 — Basic materials

Chemical substance	CAS number	EINECS number
Acrylic polymers	—	—
Alkyd polymers	—	—
Nitrocellulose	9004-70-0	—

Table 15 — Solvents

Chemical substance/preparation	CAS number	EINECS number
Glyceroltriacetate	102-76-1	203-051-9
Isobutanol	78-83-1	201-148-0
Methylethylketone (butan-2-one)	78-93-3	201-159-0
1-methoxy-2-propanol (PM)	107-98-2	203-539-1
(1-methoxy-2-propyl)-acetate (MPA)	108-65-6	203-603-9
<i>n</i> -butanol	71-36-3	200-751-6
3-methoxy- <i>n</i> -butyl-acetate	4435-53-4	224-644-9
^{A2} Petroleum fraction (60 to 140 °C)	64742-89-8	
Petroleum fraction (135 to 210 °C)	64742-88-7 ^{A2}	

9.4.1 Packaging

The maximum content of the container in a set shall not exceed:

- 15 ml for preparations with a flash point of up to 55 °C.
- 50 ml for preparations with a flash point of above 55 °C.

^{E2} **NOTE** For information regarding packaging and labelling, including child-resistant fastenings, see [2] and [9]. ^{A2}

9.4.2 Marking

The outer packaging shall in addition to the marking required in 10.1 bear the following warnings:

WARNING! For children over 8 years of age only.
For use under adult supervision.

CAUTION! Read the instructions before use,
follow them and keep them for
reference.

9.4.3 Safety rules

The instructions for use shall in addition to the rules
required in 11.4 contain the following safety rules:

Keep away from ignition sources.

Do not allow product to come into contact with the
skin and the eyes.

Do not place material in the mouth.

Do not inhale vapours.

10 Marking

Markings shall be visible, easily legible, indelible
and in the national language(s) of the country of
sale.

Letters of a minimum height of 7 mm shall be used
for the terms “WARNING!” and “CAUTION!”.

If the container is too small to carry all the
information necessary an additional instruction
leaflet shall be supplied with the package.

A2 The outer packaging shall indicate any
dangerous substances (see [1]) or dangerous
preparations (see [2]) that are recommended but
not included in the toy. **A2**

Detailed safety information shall be given in the
instructions for use.

10.1 Marking of the outer packaging

10.1.1 Manufacturer's identification

The outer packaging shall bear the name and/or
trade name and/or mark and the address of the
manufacturer or his authorized representative or
the importer.

The name and address may be abbreviated provided
that the abbreviation enables the manufacturer, his
authorized representative or the importer to be
identified.

10.1.2 Warning and caution phrases

The outer packaging shall bear the relevant
warning and caution phrases given in clauses 4 to 9.

10.2 Marking of individual containers and packagings

A2 Individual containers and packagings shall
be marked with the following information:

- a) If the substance/preparation is classified as
dangerous (see [1] and [2]), the name of the
chemical substance or preparation as given in
the relevant table(s) and clause(s).

- b) Where relevant, the required danger symbol
and the required risk/safety phrases (see [1]). **A2**

11 Instructions for use

11.1 General

The instructions for use shall be given in the
national language(s) of the country of sale.

The marking of the outer packaging according
to 10.1 shall be repeated on the cover of the
instructions for use.

Some of the instructions and information phrases
are not applicable to the requirements given in
clauses 4 to 9. In these cases exceptions are
documented and/or modified phrases are given.

11.2 Contents list

The contents lists shall contain the following
information:

- a) Where relevant, the chemical(s) supplied.

A2b) Where relevant, the risk/safety phrases
(see [1] and [2]) appropriate to each particular
substance and preparation.

- c) Where relevant and if the substances/
preparations are dangerous (see [1] and [2]), an
empty space shall be provided in which the
telephone number of the local poison centre
(central office for first aid information) or
hospital, if possible, shall be entered in case of
intake by accident of dangerous substances. **A2**

- d) General first aid information as follows:

In case of skin contact and burns: Wash affected
area with plenty of water for at least 15 minutes
and seek medical advice.

Phrase is not applicable for clauses: 4, 5, 6, 7.2.

Modified version for clause 8:

In case of skin contact: Wash affected area with
plenty of water for at least 15 minutes.

Modified version for 9.2.1, 9.2.2, 9.3, 9.4:

In case of skin contact: Wash affected area with
plenty of water.

In case of eye contact: Wash out eye with plenty
of water, holding eye open. Seek immediate
medical advice.

Phrase is not applicable for clauses: 6, 7.1, 7.2.

If swallowed: Wash out mouth with water, drink
some fresh water. DO NOT INDUCE
VOMITING. Seek immediate medical advice.

Phrase is not applicable for
clauses: 5, 6, 7.1, 9.2.1, 9.2.2, 9.3.

In case of inhalation: Remove person to fresh air.

Phrase is not applicable for clauses: 4, 5, 7.2, 9.2.1.1, 9.2.1.2.

Modified version for clause 6:

In case of accidental overheating and inhalation of poisonous gases:

Remove person to fresh air and seek immediate medical advice.

In case of doubt seek medical advice without delay. Take the chemical and/or product together with the container with you.

In case of injury always seek medical advice.

NOTE First aid information may also be found in the instructions for carrying out the activity.

e) Specific first aid information when appropriate.

11.3 Advice for adult supervision

Where appropriate, the advice for adults shall contain the following information:

- a) This chemical toy is for use only for children over the age of years (as appropriate).
- b) Read and follow these instructions, the safety rules and the first aid information and keep them for reference.
- c) Incorrect use of chemicals can cause injury and damage to health. Only carry out those activities which are listed in the instructions.
- d) Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which activities are suitable and safe for them. The instructions should enable supervisors to assess any activity to establish its suitability for a particular child.
- e) The supervising adult should discuss the warnings, safety information and the possible hazards with the child or children before commencing the activities. Particular attention should be paid to the safe handling of alkalies, acids and flammable liquids.
- f) The area surrounding the activity should be kept clear of any obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.
- g) The working area should be cleaned immediately after carrying out the activity.

11.4 Safety rules

The following safety rules shall be given:

- Keep younger children under the specified age limit and animals away from the activity area.
- Store chemical toys out of reach of young children.
- Wash hands after carrying out activities.

— Clean all equipment after use.

— Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.

— Do not eat, drink or smoke in the activity area.

and where appropriate:

Special safety rules given in clauses 4 to 9.

11.5 Instructions for carrying out the activities

Detailed information on how to perform each activity shall be given.

NOTE 1 The activities, where relevant, should be evaluated by the manufacturer.

NOTE 2 Any known hazards arising from the use of the toy should be detailed.

11.6 Spills and disposal of chemicals

Where relevant, information on the handling of spills and on the disposal of used chemicals shall be given.

The instructions for disposal shall take account of national regulations for the disposal of such chemicals.

12 Test methods

12.1 General

All chemicals used for analysis shall be of analytical grade (pro analysis) or, if unavailable, the best technical grade. Water shall be of grade 3 according to EN ISO 3696 or of a comparable quality, and demonstrably free from analytes of interest.

The precision of volumetric glassware should be grade A.

12.2 Determination of elements in ceramic and vitreous enamelling materials

12.2.1 Principle

The ceramic or enamel sample is submitted to a melting digestion using dilithium tetraborate. After the dissociation the fused product is extracted by means of diluted hydrochloric acid. The individual metals are determined by atomic emission spectrophotometry.

A1

A1 12.2.2 Standards and reagents

12.2.2.1 Standards

NOTE These elemental standard solutions are commercially available.

Table 16 — Standards

Chemical	Concentration mg/l
Copper	1 000
Iron	1 000
Praseodymium	1 000
Cobalt	1 000
Zirconium	1 000
Vanadium	1 000
Tin	1 000

12.2.2.2 Reagents

Table 17 — Reagents

Chemical	Concentration
Di-lithium tetraborate ($\text{Li}_2\text{B}_4\text{O}_7$)	
Hydrochloric acid	$\rho(\text{HCl}) = 1,12 \text{ g/ml}$

12.2.3 Apparatus

NOTE As there is no standardized equipment on the market only general detailed user's instructions could be provided.

12.2.3.1 Platinum crucible

12.2.3.2 Muffle furnace, or relevant equipment, temperature range: up to $(1\,000 \pm 50)^\circ\text{C}$

12.2.3.3 Analytical balance, precision 0,1 mg

12.2.3.4 Glassware (beaker, funnel, volumetric flask and pipettes)

Before use all glass equipment shall be cleaned using 10 % hydrochloric acid (per volume).

12.2.3.5 Atomic emission spectrometer

12.2.4 Preparation of standard solutions

12.2.4.1 Multi-element standard solution I

$c(\text{Cu}, \text{Fe}, \text{Pr}, \text{Co}, \text{Zr}, \text{V}, \text{Sn}) = 10 \text{ mg/l}$

Pipette $(1,0 \pm 0,01) \text{ ml}$ of each of the 1 000 mg/l standards (12.2.2.1) into a 100-ml volumetric flask. Add 10 ml of hydrochloric acid (12.2.2.2), mix and make up to the mark with water.

NOTE The multi-element standard solution I may be stored for a month in a refrigerator at $(4 \pm 2)^\circ\text{C}$.

12.2.4.2 Multi-element standard solution II

$c(\text{Cu}, \text{Fe}, \text{Pr}, \text{Co}, \text{Zr}, \text{V}, \text{Sn}) = 5,0 \text{ mg/l}$

Pipette $(50 \pm 0,05) \text{ ml}$ of the multi-element standard solution I into a 100-ml volumetric flask. Add 10 ml of hydrochloric acid, mix and make up to the mark with water.

This solution shall be freshly prepared.

12.2.4.3 Multi-element standard solution III

$c(\text{Cu}, \text{Fe}, \text{Pr}, \text{Co}, \text{Zr}, \text{V}, \text{Sn}) = 1,0 \text{ mg/l}$

Pipette $(10 \pm 0,02) \text{ ml}$ of the multi-element standard solution I into a 100-ml volumetric flask. Add 10 ml of hydrochloric acid, mix and make up to the mark with water.

This solution shall be freshly prepared.

12.2.5 Blank solution

Add 10 ml hydrochloric acid to 90 ml water in a polyethylene- or polytetrafluorethene (PTFE)-flask.

12.2.6 Sampling

Obtain three test portions from each colour of the material and treat them separately.

NOTE Homogenisation of the test portions is not necessary because the materials have been melted and are very finely ground.

12.2.7 Sample preparation

Weigh $(0,1 \pm 0,05) \text{ g}$ to the nearest 0,001 g of each test portion in a platinum crucible. Add 1 g of dilithium tetraborate to the crucible and mix carefully. Heat the crucible in a muffle furnace to $(1\,000 \pm 50)^\circ\text{C}$ for 120 min.

After cooling to approximately 500°C remove the crucible from the muffle furnace and transfer it into a glass of water. Add 20 ml of hydrochloric acid. Heat the solution to boiling point and let it boil until complete dissolution of the sample occurs. Transfer the solution into a 250-ml volumetric flask and filled up to the mark. If silicon dioxide is precipitated, remove it by filtration.

12.2.8 Procedure

Determine the elemental concentrations using the wavelengths according to Table 18. In case of spectral interference choose an alternative appropriate wavelength.

Table 18 — Wavelengths

Element	Wavelength nm
Copper (Cu)	324,752
Iron (Fe)	259,942
Praseodymium (Pr)	422,285
Cobalt (Co)	228,616
Zirconium (Zr)	339,198
Vanadium (V)	292,399
Tin (Sn)	189,932

After the verification of the calibration function the samples are measured.

Determine the blank solutions before analysing the solutions.

Ⓐ Recalibrate the analytical instruments frequently. To avoid memory effects perform also checks with the blank solution.

12.2.9 Evaluation of results

12.2.9.1 General

The mean value of three test portions shall be given. The metal contents are calculated according to Equation (1):

$$M_m = \frac{(c_{\text{sample}} - c_{\text{blank}}) \times V \times f}{W \times 10\,000} \quad (1)$$

where

- M_m is the content of the metal in the sample, in mass-%;
- c_{sample} is the concentration of the metal in the analytical solution, in mg/l;
- c_{blank} is the concentration of the metal in the blank value solution, in mg/l;
- V is the volume of the sample solution, in ml;
- f is the dilution factor;
- W is the weighed portion of the sample, in g.

The calculated contents of elements are compared with the maximum permitted element concentrations in the compounds given in Table C.1. If these concentrations are not exceeded, the requirements of EN 71-5 are fulfilled.

If the concentrations are exceeded, the concentration of compounds have to be calculated according to Equation (2) and 12.2.9.2:

$$M_m = \frac{(c_{\text{sample}} - c_{\text{blank}}) \times V \times f \times f_m}{W \times 10\,000} \quad (2)$$

where

- M_m is the content of the metal in the sample, in mass-%;
- c_{sample} is the concentration of the metal in the analytical solution, in mg/l;
- c_{blank} is the concentration of the metal in the blank value solution, in mg/l;
- V is the volume of the sample solution, in ml;
- f is the dilution factor;
- W is the weighed portion of the sample, in g;
- f_m is the calculation factor of metal to metal oxide.

For the conversion factor f as to the individual metals see Table 19.

Table 19 — Conversion factors

Compound	Element	Conversion factor
Copper oxide (CuO)	Cu	1,251 8
Di-iron trioxide (Fe ₂ O ₃)	Fe	1,429 7
Dipraseodymium trioxide (Pr ₂ O ₃)	Pr	1,170 3
Cobalt oxide (CoO)	Co	1,271 5
Zirconium dioxide (ZrO ₂)	Zr	1,350 8
Divanadium pentoxide (V ₂ O ₅)	V	1,785 2
Tin dioxide (SnO ₂)	Sn	1,269 6

12.2.9.2 Calculation of the pigment contents in the enamel samples

12.2.9.2.1 Calculation of the concentration of copper oxide (CuO) and tin dioxide (SnO₂)

The concentration of copper oxide and tin dioxide shall be calculated according to Equation (2).

12.2.9.2.2 Calculation of the concentration of aluminium cobalt oxide (CoO.Al₂O₃)

The concentration of aluminium cobalt oxide shall be calculated by multiplying the amount of CoO calculated according to Equation (2) by the factor 2,360 7.

$$\text{CoO} \times 2,360\,7 = \text{CoO} \cdot \text{Al}_2\text{O}_3 \quad (3)$$

12.2.9.2.3 Calculation of the concentration of praseodymium zirconium silicate (Pr₂O₃ + ZrSiO₄)

The concentration of praseodymium zirconium silicate shall be calculated by multiplying the amount of Pr₂O₃ calculated according to Equation (2) by the factor 1,555 8.

$$\text{Pr}_2\text{O}_3 \times 1,555\,8 = \text{Pr}_2\text{O}_3 + \text{ZrSiO}_4 \quad (4)$$

12.2.9.2.4 Calculation of the concentration of vanadium zirconium silicate (V₂O₄ + ZrSiO₄)

The amount of vanadium zirconium silicate shall be calculated by multiplying the amount of V₂O₅ calculated according to Equation (2) by the factor 1,919 8.

$$\text{V}_2\text{O}_5 \times 1,9198 = \text{V}_2\text{O}_4 + \text{ZrSiO}_4 \quad (5)$$

12.2.9.2.5 Calculation of the concentration of di-iron oxide (Fe₂O₃), iron zirconium silicate (Fe₂O₃ + ZrSiO₄) and zirconium ortho silicate (ZrSiO₄)

Calculate the Fe₂O₃ total, V₂O₅ total, Pr₂O₃ total and ZrO₂ total concentration according to Equation (2).

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A1 If Pr_2O_3 is present, then the concentration of $(\text{Pr}_2\text{O}_3 + \text{ZrSiO}_4)$ shall be calculated according to Equation (4).

The amount of ZrO_2 (a) shall be calculated by multiplying the concentration of $(\text{Pr}_2\text{O}_3 + \text{ZrSiO}_4)$ by the factor 0,240 1.

$$(\text{Pr}_2\text{O}_3 + \text{ZrSiO}_4) \times 0,240\ 1 = \text{ZrO}_2\ (a) \quad (6)$$

If V_2O_5 is present, the concentration of $(\text{V}_2\text{O}_4 + \text{ZrSiO}_4)$ shall be calculated according to Equation (5).

The amount of ZrO_2 (b) shall be calculated by multiplying the concentration of $(\text{V}_2\text{O}_4 + \text{ZrSiO}_4)$ by the factor 0,352 9.

$$(\text{V}_2\text{O}_4 + \text{ZrSiO}_4) \times 0,352\ 9 = \text{ZrO}_2\ (b) \quad (7)$$

The ZrO_2 (a) and ZrO_2 (b) amounts shall be added and subtracted from $\text{ZrO}_2\ \text{total}$.

$$\text{ZrO}_2\ \text{total} - (\text{ZrO}_2\ (a) + \text{ZrO}_2\ (b)) = \text{ZrO}_2\ (c) \quad (8)$$

The concentration of iron zirconium silicate $(\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4)$ shall be calculated from the amount of Fe_2O_3 calculated according to Equation (2).

The amount of Fe_2O_3 shall be multiplied by the factor 2,147 8.

$$\text{Fe}_2\text{O}_3 \times 2,147\ 8 = \text{Fe}_2\text{O}_3 + \text{ZrSiO}_4 \quad (9)$$

The amount of ZrO_2 (d) shall be calculated by multiplying the concentration of $(\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4)$ by the factor 0,359 3.

$$(\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4) \times 0,359\ 3 = \text{ZrO}_2\ (d) \quad (10)$$

If $\text{ZrO}_2\ (c) > \text{ZrO}_2\ (d)$ the difference $\text{ZrO}_2\ (c) - \text{ZrO}_2\ (d)$ is used to calculate $\text{ZrO}_2\ (e)$.

$$\text{ZrO}_2\ (c) - \text{ZrO}_2\ (d) = \text{ZrO}_2\ (e) \quad (11)$$

The amount of $\text{ZrSiO}_4\ \text{pure}$ is calculated by multiplying the $\text{ZrO}_2\ (e)$ concentration by the factor 1,487 6.

$$\text{ZrO}_2\ (e) \times 1,487\ 6 = \text{ZrSiO}_4\ \text{pure} \quad (12)$$

If $\text{ZrO}_2\ (c) < \text{ZrO}_2\ (d)$ the concentration of $(\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4)$ is calculated by multiplying the $\text{ZrO}_2\ (c)$ concentration by the factor 2,783 6.

$$\text{ZrO}_2\ (c) \times 2,783\ 6 = \text{Fe}_2\text{O}_3 + \text{ZrSiO}_4 \quad (13)$$

The amount of Fe_2O_3 (a) is calculated by multiplying the concentration of $(\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4)$ by the factor 0,465 6.

$$\text{Fe}_2\text{O}_3 + \text{ZrSiO}_4 \times 0,465\ 6 = \text{Fe}_2\text{O}_3\ (a) \quad (14)$$

The concentration of the pure di-iron oxide $(\text{Fe}_2\text{O}_3\ \text{pure})$ is the difference between $(\text{Fe}_2\text{O}_3)\ \text{total}$ and $\text{Fe}_2\text{O}_3\ (a)$.

$$\text{Fe}_2\text{O}_3\ \text{total} - \text{Fe}_2\text{O}_3\ (a) = \text{Fe}_2\text{O}_3\ \text{pure} \quad (15)$$

12.2.10 Test report

The analytical report shall contain as a minimum the following information:

- a) type and identification of the product and/or material tested;
- b) a reference to this European Standard;
- c) the results of the tests expressed as x % (m/m) pigment content rounded to 0,01 % (m/m), but not more than three significant digits;
- d) any deviation from the test procedure specified;
- e) date of test.

12.3 Determination of plasticizers in oven hardening polyvinyl chloride (PVC) modelling clay sets

12.3.1 Principle

The plasticizer content is determined by solvent extraction to quantitatively extract the plasticizer from a known weight of PVC material using a soxhlet extractor. Hexane is used to extract phthalic acid esters, citric acid esters and alkylsulfonic acid esters. Methanol is used to extract adipic acid polyesters. Indicative plasticizer content can be determined by evaporating off the solvent and weighing the solvent residue and identifying the plasticizer by Attenuated Total Reflectance-Fourier Transform-Infra Red (ATR-FT-IR) Spectrometry.

Determination of plasticizer(s) content is by Gas Chromatography-Mass Spectrometry (GC-MS) for phthalic acid esters, alkylsulfonic acid phenyl ester and citric acid esters. Adipic acid esters are quantified gravimetrically.

This method is also partly used for the determination of plasticizers in solvent-based adhesives and solvent-based paints and lacquers (see 12.8.4).

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A1 12.3.2 Standards and reagents

12.3.2.1 Standards

NOTE The given substances (except citrates) are examples for the requirements in Table 17.

Table 20 — Phthalic acid esters

Chemical	CAS No.
<i>bis(2-ethylhexyl) phthalate (DEHP)</i>	117-81-7
<i>di-isononyl phthalate (DINP)</i>	28553-12-0
<i>di-isodecyl phthalate (DIDP)</i>	26761-40-0
<i>benzyl butyl phthalate (BBP)</i>	85-68-7
<i>di-n-butyl phthalate (DBP)</i>	84-74-2
di-n-hexyl phthalate (DNHP)	84-75-3
di-n-heptyl phthalate (DNHpP)	3648-21-3
di-n-octyl phthalate (DNOP)	117-84-0
di-n-nonyl phthalate (DNP)	84-76-4
di-n-decyl phthalate (DDP)	84-77-5
NOTE 1 The chemicals DEHP, DINP, DIDP, BBP and DBP can be used for analytical purposes for modelling clays. They are not permitted for the use in PVC modelling clays. However, they are examples for plasticizers according to the requirements in 9.2.2 and 9.4.	
NOTE 2 The technical grade of the substances DINP and DIDP is typically a mixture of isomers and homologues.	

Table 21 — Adipic acid polyesters

Chemical	Trade names	CAS No.
Hexanedioic acid, polymer with propane-1,2-diol, acetate	Palamoll ^{a)} 632 & 636	55799-38-7
Hexanedioic acid, polymer with butane-1,3-diol and butane-1,4-diol, acetate	Palamoll ^{a)} 646	150923-12-9
Hexanedioic acid, polymer with 2,2-dimethylpropane-1,3-diol and propane-1,2-diol, isononyl ester	Palamoll ^{a)} 652	208945-13-5
Hexanedioic acid, polymer with butane-1,4-diol and 2,2-dimethylpropane-1,3-diol, isononyl ester	Palamoll ^{a)} 654 & 656	208945-12-4
Hexanedioic acid, polymer with 2,2-dimethylpropane-1,3-diol and 3-hydroxy-2,2dimethylpropanoic acid, isononyl ester	Palamoll ^{a)} 858	208945-11-3
No chemical inventory name available	Paraplex ^{b)} G-40	39363-92-3
^{a)} Polymeric plasticizer derived from adipic acid and polyhydric alcohols.		
^{b)} Polyester adipate.		
NOTE Trade names for adipic acid polyesters are examples for those types of plasticizers.		

Table 22 — Citric acid esters

Chemical	CAS No.
Tributyl acetylcitrate	77-89-4
Tris(2-ethylhexyl) acetylcitrate	144-15-0

Table 23 — Alkylsulfonic acid esters

Chemical	CAS No.
Alkylsulfonic phenyl ester	91082-17-6

12.3.2.2 Reagents

Table 24 — Solvents

Chemical	CAS No.
Hexane, analytical grade	110-54-3
Methanol, analytical grade	67-56-1

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