IEC 62321-2

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INTERNATIONAL STANDARD

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Determination of certain substances in electrotechnical products – Part 2: Disassembly, disjointment and mechanical sample preparation

Détermination de certaines substances dans les produits électrotechniques – Partie 2: Démontage, désassemblage et préparation mécanique de l'échantillon

IEC 62321-2:2013

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DETERMINATION OF CERTAIN SUBSTANCES IN ELECTROTECHNICAL PRODUCTS –

Part 2: Disassembly, disjointment and mechanical sample preparation

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62321-2 has been prepared by IEC technical committee 111: Environmental standardization for electrical and electronic products and systems.

It has the status of a horizontal standard in accordance with IEC Guide 108.

The first edition of IEC 62321:2008 was a 'stand-alone' standard that included an introduction, an overview of test methods, a mechanical sample preparation as well as various test method clauses.

This first edition of IEC 62321-2 is a partial replacement of IEC 62321:2008, forming a structural revision and generally replacing Clause 5 and incorporating IEC/PAS 62596:2009 [1][1] which will be withdrawn upon publication of IEC 62321-2.

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1 Numbers in square brackets refer to the Bibliography.

Future parts in the IEC 62321 series will gradually replace the corresponding clauses in IEC 62321:2008. Until such time as all parts are published, however, IEC 62321:2008 remains valid for those clauses not yet re-published as a separate part.

The text of this standard is based on the following documents:

FDIS	Report on voting
111/301/FDIS	111/311/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62321 series can be found on the IEC website under the general title: *Determination of certain substances in electrotechnical products*

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The widespread use of electrotechnical products has drawn increased attention to their impact on the environment. In many countries this has resulted in the adaptation of regulations affecting wastes, substances and energy use of electrotechnical products.

The use of certain substances (e.g. lead (Pb), cadmium (Cd) and polybrominated diphenyl ethers (PBDEs)) in electrotechnical products, is a source of concern in current and proposed regional legislation.

The purpose of the IEC 62321 series is therefore to provide test methods that will allow the electrotechnical industry to determine the levels of certain substances of concern in electrotechnical products on a consistent global basis.

WARNING – Persons using this International Standard should be familiar with normal laboratory practice. This standard 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 and to ensure compliance with any national regulatory conditions.

DETERMINATION OF CERTAIN SUBSTANCES IN ELECTROTECHNICAL PRODUCTS –

Part 2: Disassembly, disjointment and mechanical sample preparation

1 Scope

This part of IEC 62321 provides strategies of sampling along with the mechanical preparation of samples from electrotechnical products, electronic assemblies and electronic components. These samples can be used for analytical testing to determine the levels of certain substances as described in the test methods in other parts of IEC 62321. Restrictions for substances will vary between geographic regions and from time to time. This Standard describes a generic process for obtaining and preparing samples prior to the determination of any substance which are under concern.

This standard does not provide:

– full guidance on each and every product that could be classified as electrotechnical equipment. Since there is a huge variety of electrotechnical components, with various structures and processes, along with the continuous innovations in the industry, it is unrealistic to attempt to provide procedures for the disjointment of every type of component;

– guidance regarding other routes to gather additional information on certain substances in a product, although the information collected has relevance to the sampling strategies in this standard;

– safe disassembly and mechanical disjointment instructions related to electrotechnical products (e.g. mercury-containing switches) and the recycling industry (e.g. how to handle CRTs or the safe removal of batteries). See IEC 62554 [2] for the disjointment and mechanial sample preparation of mercury-containing fluorescent lamps;

– the definition of a “unit” as the sample;

– sampling procedures for packaging and packaging materials;

– analytical procedures to measure the levels of certain substances. This is covered by other standards (for example other parts of IEC 62321), which are referred to as the "test standard" in this standard;

– guidelines for assessment of compliance.

NOTE Further guidance on assessment procedures is provided by IEC/TR 62476 [3].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62321-1, *Determination of certain substances in electrotechnical products – Part 1 Introduction and overview*

IEC 62321-3-1, *Determination of certain substances in electrotechnical products – Part 3-1: Screening – Lead, mercury, cadmium, total chromium and total bromine using X-ray fluorescence spectrometry*

IEC 62321-3-2, *Determination of certain substances in electrotechnical products – Part 3-2: Screening – Total bromine in polymers and electronics by combustion – Ion chromatography (C-IC)*

IEC 62321-4, *Determination of certain substances in electrotechnical products – Part 4: Determination of mercury in polymers, metals and electronics by CV-AAS, CV-AFS, ICP-OES and ICP-MS*

IEC 62321-5, *Determination of certain substances in electrotechnical products – Part 5: Determination of cadmium, lead and chromium in polymers and electronics and cadmium and lead in metals by AAS, AFS, ICP-OES, ICP-AES and ICP-MS* [2]

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the definitions given in IEC 62321-1, as well as the following, apply.

3.1.1
composite testing
testing two or more materials as a single sample that could be mechanically disjointed if necessary

3.1.2
certain substance
cadmium, lead, mercury, hexavalent chromium, polybrominated biphenyl, polybrominated diphenyl ether

NOTE IEC 62321-1 includes test methods for the evaluation of each of the substances identified in the definition above.

3.2 Abbreviations

AC	Alternating current
BGA	Ball grid array (electronic component)
CRT	Cathode ray tube (television)
DVD	Digital versatile disc
IC	Integrated circuit
JEDEC	Joint Electronic Devices Engineering Council
LCD	Liquid crystal display
MDL	Method detection limit
OEM	Original equipment manufacturer
PAS	Publicly Available Specification
PCB	Printed circuit board
PDA	Personal digital assistant
PWB	Printed wiring board
SIM	Subscriber identity module
SMD	Surface mounted device
TFT	Thin film transistor
TV	Television

USB Universal serial bus

4 Introduction to sampling

4.1 Introductory remark

Obtaining a sample (i.e. sampling) is the first step in analysing electrotechnical products for the presence of certain substances. The strategy and process of sampling are often as important as the analytical measurement itself. Hence an effective sampling strategy requires a clear understanding of the electrotechnical product, reasons for the analysis and the requirements that are to be met.

Sampling and testing for certain substances are performed for many reasons including:

– business-to-business for commercial release (e.g. contractual agreement between the OEM and component manufacturer);
– compliance with regulatory limits;
– forensic/impact assessment (why the product does not satisfy contractual or legal requirements, when did this happen, and how many products are affected?)

4.2 Requirements and concerns for substances of concern

While many governments, industry partners and other stakeholders have their own requirements, it is not the intention of this standard to discuss fully all of these differences. However, awareness of different limits for certain substances is an important step in preparing the sampling strategy. Subclause 4.2 highlights the main areas of concern regarding the requirements for certain substances.

– Certain substances: not all geographic regions or industrial partners restrict the same substances. For example, some regions have chosen to restrict the use of only a few specific PBDE compounds, while others have a broader restriction regarding this class of flame-retardants. When sampling a product, component etc. it is critical to keep in mind what are the applicable legal requirements.
– Allowable limits for certain substances: generally speaking, the allowable levels of most certain substances are below 1 000 mg/kg. Some geographic regions and industrial partners have limits below 1 000 mg/kg. For some product types, limits for certain substances are above 1 000 mg/kg, e.g. lead in copper and aluminum alloys.
– Application of the allowable level: the manner in which the allowable level of a certain substance is applied to an electrotechnical product determines the sampling strategy and how the test results are interpreted. Many geographic regions apply their allowable limits to "homogeneous materials". In this standard, an “homogeneous material” is as defined in IEC 62542 [4]. However, the interpretation of "homogeneous material" is not consistent across the different regions.
– Applicable exemptions: some types of electrotechnical products are exempt from certain substances requirements. These exemptions may be based on different rationales including the scope of the restrictions (e.g. for military purposes), the application of the material (e.g. high melting temperature solder), size of the sample, or the electrical properties of the product.

4.3 Complexity of electrotechnical products and related challenges

The complex characteristics of electrotechnical products are another important consideration when preparing a sampling strategy. These characteristics have a bearing on the practical execution of sampling and analysis. The following elements are identified as relevant to analysis and sampling:

a) Miniaturization: Miniaturization is one of the key trends in the electrotechnical industry. This implies that more functionality is provided within a smaller volume. More and more components and materials are used per cm^2 of printed wiring board (PWB) every year.

Taking samples for measurement from these small amounts of material is difficult. For example, the size of surface mounted devices (SMDs) is too small for regular tools to further disjoint or separate and the quantity of the remaining sample is often too small after disjointment to satisfy the requirements of adequate analysis.

b) Number of homogeneous materials: many components have complex structures and are constructed of multiple layers of different materials. In a typical case, one single component has more than 10 to 20 material layers, whereas many electrotechnical products or assemblies contain hundreds or thousands of components. This means one electrotechnical product can have more than 1 000 to more than 10 000 homogeneous materials. Often, homogeneous materials adhere too tightly together for a clean separation in a practical manner (see Figure 2). Experience has shown that the composition often changes due to molecular diffusion between materials (e.g. the composition of a plating is affected by a base material containing lead). Similarly, present-day electrotechnical products are made of many components and parts. A typical TV or laptop computer, for example, contains thousands of parts/components. Hence the design database for an OEM may include several tens of thousands of components. In Annex E this point is further illustrated in the disassembly of a mobile phone.

c) "Invisible" substances: another complicating factor in sampling and analysis is that generally certain substances are not visible. A component containing a certain substance may look and perform in an identical manner to one that does not. The presence or absence of certain substances can vary from lot to lot in the manufacturing process without any readily observable clues. While there are some visible indications (e.g. a yellow coating on steel products suggests the presence of hexavalent chromium) as to the presence of certain substances, visual detection is not practical.

d) Batch-to-batch variations: most product assembly manufacturers use commodity components from several suppliers simultaneously, e.g. cables, resistors and capacitors. Commodity components are mixed during production, because technically they are fully interchangeable as long as they fit the umbrella specification. However, in most cases they are not chemically identical. Furthermore, experience has shown that base materials can be changed by commodity manufacturers (e.g. in times of shortage) which leads to a change in the chemical composition as well. Notification of these changes does not always occur if the component still meets its technical specification.

e) Depth of the supply chain: producing electronic components/parts involves a complex supply chain. Relatively simple products, such as an external cable, can utilize supply chains at least seven tiers deep. The supply chain for a more complex component such as an LCD screen or IC, is considerably deeper.

These characteristics of the electrotechnical industry show that the management of certain substances, along with sampling and analysis, is not straightforward. The size and number of components, and complexity of the supply chain make it challenging to fully grasp the locations of certain substances in an electrotechnical product. The prospect of implementing homogeneous material level sampling and testing at the upper regions of the supply chain (towards finished products) is not practical for complex products.

NOTE Oxidation states of certain substances may not be stable over time. For example, the concentration of hexavalent chromium in corrosion protection layers can change significantly with time and storage conditions.

4.4 Strategies for sampling

While different sampling approaches may be utilized as appropriate for the broad range of electrotechnical products, it is possible to describe a generic procedure that will be applicable in the majority of cases. This is illustrated by the iterative loops of sampling, disassembly and disjointment shown in Figure 1.

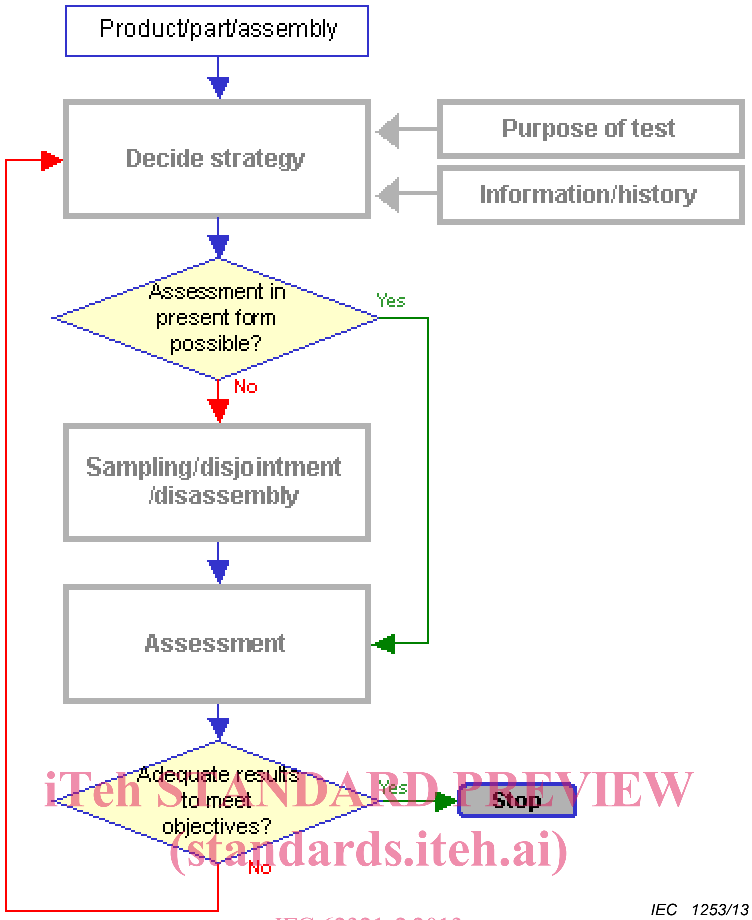

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Figure 1 – Generic iterative procedure for sampling

The process depicted in Figure 1 can have several iterative loops including:

- 1st iteration: partial disassembly (see 5.3);
- 2nd iteration: complete disassembly (see 5.4);
- 3rd iteration: partial disjointment (see 5.5);
- 4th – nth iteration: complete disjointment (see 5.6).

These iterative steps are described further in Clause 5.

Development of the sampling strategy for a particular electrotechnical product/part/ assembly begins with an information gathering stage. Some basic questions to be considered include:

– What is the complexity of the product/part/assembly and is it practical to consider sampling and testing at the homogeneous material level?
– Which substances are restricted?
– What are the allowable limits for these certain substances?
– Are there appropriate exemptions for the certain substance?
– Is a bill of materials available for the components/assemblies/materials in the product?
– Are specifications/drawings of the components available?
– What is the depth of the supply chain for the components and materials in this product?
– Are material declarations for this product available?
– Is there any previous experience evaluating this product or similar products that could be helpful?

– Is there any published probability of the presence matrices for the materials or parts used in this product?
– Was any screening (e.g. X-ray fluorescence) previously performed on this product or similar products that could be helpful?
– Is there any information regarding the manufacturing process of materials/components (metal making or IC production) used in this product or similar products that could be helpful?
– Are there any perceived process controls present at the component or material suppliers (e.g. level of trust in the manufacturer)?
– Is there any history of concern with the component or material supplier?

The answers to these questions and other characteristics will influence the sampling strategy. The organization's position in the supply chain will determine what extent of sampling is appropriate. Release for production of products/components etc. requires a more in-depth sampling strategy than an occasional verification check on specifications. In order to optimize costs and efficiency, the desired outcome of the testing needs to be understood. As previously stated, it is often impractical to sample and test all components/materials. An organization is left to determine the optimum balance of effort/costs against effectiveness of the sampling strategy. Some considerations to minimize sampling/testing efforts and costs are listed below:

– homogeneous materials with a low probability of containing certain substances (less likely to contain restricted substances hence pose a lower risk of non-confomity if not tested, see Annex B);
– applicable exemptions for certain substances (the presence of certain substances would not affect conformity);
– material declarations;
– historical test data (evidence for the probability of containing certain substances);
– composite sampling and testing (covers several materials in a single test, but other factors shall be considered, see 5.7.3 and Annex C);
– minimum sample size necessary to run analytical tests and the number of samples necessary to determine whether or not it's practical to test.

The sampling strategy will depend very much on the ultimate objective of analysis. One strategy (perhaps used by enforcement authorities) is an analysis to verify if the product contains at least one certain substance exceeding the allowable limit. This approach involves gradual, selective sampling, targeting deliberately those parts of the product that are either known, or are likely to contain certain substances. Each sampling phase could be followed by analysis. If the results show no certain substances above the allowable limit, a further stage of sampling and analysis could be performed. Once the test results exceed the allowable limit for at least one certain substance in any part, the product as a whole is deemed non-compliant and no further sampling and analysis are necessary. Annex B provides a list of components which currently have a probability of the presence of one or more of substances of concern.

Another strategy is to prove total compliance of the product, as far as possible down to the homogeneous material level. This approach would be typical for the product or component manufacturer. Samples would be prepared from each individual material or component. As the objective is to cover all components and materials in a product/assembly, other routes may be used to gather information on a product level. In the downstream supply chain process documentation and/or analysis reports may exist that would reduce the effort required in sampling and analysis.

Once the objective of the analysis has been defined, feasibility of the testing is performed (e.g. is the sample mass/size/volume sufficient?). Further sampling and disjointment may be necessary, where a choice can be made to either completely disjoint or only select materials with a high probability of containing certain substances. Table B.1 is used to assist in the identification of these components and materials.

If testing is appropriate, the relevant testing procedure shall be followed. Where certain substances are present in the product/part there may be an applicable exemption (some examples are given in Table B.1).

Following the flowchart in Figure 1 is an iterative process, retrieving samples at an ever deeper level. How far this process is pursued will depend on the objective of the sampling strategy. After the screening steps, further analytical testing is undertaken as necessary.

5 Sampling

5.1 Introductory remark

This standard only provides general sampling guidelines, which are intended to form the basis of the sampling strategy appropriate to the electrotechnical product.

Before sampling, the following questions need to be addressed:

a) Based on available knowledge of the product, can any sections/parts be identified that are likely to contain certain substances (see Annex B)?

b) Is it practical to analyse any of these sections/parts without disassembly?

c) Can the section/part selected be regarded as homogeneous material for the purpose of the analysis?

d) Is the section/part selected for analysis representative?

e) Does the sample selected fulfil the criteria of minimum mass, area, thickness or volume required by the chosen analytical methods?

The answers to these questions will determine the sampling strategy and the extent of disassembly and disjointment, if any, required to provide representative samples that are homogeneous and of sufficient quantity to permit a valid analysis.

Whenever possible, sampling shall be performed by stages of minimal disassembly and disjointment. Each stage is followed by an assessment of its effectiveness (see the flowchart in Figure 1), typically by screening analysis (see IEC 62321-3-1 and IEC 62321-3-2). Depending on the results of the assessment and objectives of the analysis, further disassembly, disjointment and sampling shall be performed, as required, especially for verification analysis of the product’s components and materials. This approach offers the least expensive, fastest and the most efficient means of analysis, especially when undertaken on the finished product.

The numerous types and diversity of electrotechnical products make it impractical to provide detailed sampling strategies for each one. Instead, procedures covering five increasingly destructive levels of sampling are described.

Annex A provides generic sampling flowcharts based on Figure 1 for certain characteristic electrotechnical products: DVD player, CRT tube, LCD TV set, PDA/phone and a desk fan, along with two components, a thick film resistor and SMD potentiometer.

Annex D lists some commonly used disassembly and disjointment tools.

When determining certain substances it is strongly recommended to ensure that the tools used are free from the substances of interest to avoid possible contamination.