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Indoor air —

Part 32: Investigation of buildings for the occurrence of pollutants

Air intérieur —

Partie 32: Investigation sur la présence de polluants dans les bâtiments

Reference number
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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 146, *Air quality*, Subcommittee SC 6, *Indoor air*.

ISO 16000 consists of the following parts, under the general title *Indoor air*:

— *Part 1: General aspects of sampling strategy*

— *Part 2: Sampling strategy for formaldehyde*

— *Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method*

— *Part 4: Determination of formaldehyde — Diffusive sampling method*

— *Part 5: Sampling strategy for volatile organic compounds (VOCs)*

— *Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas-chromatography using MS or MS-FID*

— *Part 7: Sampling strategy for determination of airborne asbestos fibre concentrations*

— *Part 8: Determination of local mean ages of air in buildings for characterizing ventilation conditions*

— *Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

— *Part 10: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test cell method*

— *Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

— *Part 12: Sampling strategy for polychlorinated biphenyls (PCBs), polychlorinated dibenzo*-p-*dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polycyclic aromatic hydrocarbons (PAHs)*

— *Part 13: Determination of total (gas and particle-phase) polychlorinated dioxin-like biphenyls (PCBs) and polychlorinated dibenzo-*p*-dioxins/dibenzofurans (PCDDs/PCDFs) — Collection on sorbent-backed filters*

— *Part 14: Determination of total (gas and particle-phase) polychlorinated dioxin-like biphenyls (PCBs) and polychlorinated dibenzo-*p*-dioxins/dibenzofurans (PCDDs/PCDFs) — Extraction, clean-up and analysis by high-resolution gas chromatography and mass spectrometry*

— *Part 15: Sampling strategy for nitrogen dioxide (NO_2)*

— *Part 16: Detection and enumeration of moulds — Sampling by filtration*

— *Part 17: Detection and enumeration of moulds — Culture based method*

— *Part 18: Detection and enumeration of moulds — Sampling by impaction*

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— *Part 20: Detection and enumeration of moulds — Determination of total spore count*

— *Part 21: Detection and enumeration of moulds — Sampling from materials*

— *Part 23: Performance test for evaluating the reduction of formaldehyde concentrations by sorptive building materials*

— *Part 24: Performance test for evaluating the reduction of volatile organic compound (except formaldehyde) concentrations by sorptive building materials*

— *Part 25: Determination of the emission of semi-volatile organic compounds by building products — Micro-chamber method*

— *Part 26: Sampling strategy for carbon dioxide (CO_2)*

— *Part 27: Determination of settled fibrous dust on surfaces by SEM (scanning electron microscopy) (direct method)*

— *Part 28: Determination of odour emissions from building products using test chambers*

— *Part 29: Test methods for VOC detectors*

— *Part 30: Sensory testing of indoor air*

— *Part 31: Measurement of flame retardants and plasticizers based on organophosphorus compounds — Phosphoric acid ester*

— *Part 32: Investigation of buildings for the occurrence of pollutants*

Introduction

Investigations on the occurrence of pollutants in buildings and their technical installations make it possible to determine the level of pollution (e.g. polychlorinated biphenyls, asbestos) at the time of the investigation (actual condition) and to assess its impact.

During the investigation it should be considered that structural changes (e.g. thicker building envelope), hygiene conditions (e.g. ventilation, air flows) and other factors may affect the actual condition as surveyed and should therefore be indicated if necessary.

In specific circumstances it may be expedient to assess the indoor air quality in order to undertake an investigation on pollutants.

Treatment of contaminated construction products resulting from the demolition, partial dismantling and remediation of buildings is not covered by this part of ISO 16000.

The legal regulations in the different countries have to be taken into account.

This part of ISO 16000 is based on Reference [1].

Indoor air —

Part 32: Investigation of buildings for the occurrence of pollutants

1 Scope

This part of ISO 16000 specifies the requirements for investigating buildings and other structures and their technical installations for the occurrence of pollutants, as a basis for subsequent sampling of suspect areas and determination of the type and quantity of pollutants, which are described in other parts of ISO 16000.

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.

ISO 16000-1, *Indoor air — Part 1: General aspects of sampling strategy*

3 Terms and definitions

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

3.1
construction product
building product
material, material preparation or combination of materials which form(s) a permanent part of a building

Note 1 to entry: Construction product is the official term for building material in the European legislation which is cited in this part of ISO 16000.

3.2
structural element
building element or component of a building element

EXAMPLE Wall, floor, roof or part thereof.

3.3
component of structural element
one of several components or layers of a structural element comprising one construction product with uniform characteristics

EXAMPLE Bricks as components or plasterwork as a layer on a wall.

3.4
building
part of the collective outcome of a construction and civil engineering work that, when taken as a whole, fulfils an economic and technical function

3.5
site visit
visual site investigation of the spatial entity on which the pollution investigation concept is based

3.6
sampling
collecting of samples from construction elements or from other media (e.g. air, water) in and around the building in order to conduct appropriate analyses to give an indication of the extent of contamination in the building under investigation

3.7
pollutant
substance which either alone or in combination with other substances or through its products of degradation or emissions can have a harmful effect on human health or the environment or can lead to a reduction in the value or restriction in the use of the building

3.8
pollution investigation
investigation of the condition of the building with regard to the extent of contamination

3.9
remediation
removal, immobilisation and control measures of pollutants and other hazards to achieve the specified remediation target

3.10
volatile organic compound
VOC
organic compound whose boiling point is in the range from (50 °C to 100 °C) to (240 °C to 260 °C)

Note 1 to entry: This classification has been defined by the World Health Organization (see Reference [2]).

Note 2 to entry: Boiling points of some compounds are difficult or impossible to determine because they decompose before they boil at atmospheric pressure. Vapour pressure is another criterion for classification of compound volatility that may be used for classification of organic chemicals (see Reference [3]).

Note 3 to entry: Due to practical reasons to be taken into account for test chambers, the definition given in ISO 16000-9 differs from that defined in this part of ISO 16000.

3.11
semi-volatile organic compound
SVOC
organic compound whose boiling point is in the range from (240 °C to 260 °C) to (380 °C to 400 °C)

Note 1 to entry: This classification has been defined by the World Health Organization (see Reference [2]).

Note 2 to entry: Boiling points of some compounds are difficult or impossible to determine because they decompose before they boil at atmospheric pressure. Vapour pressure is another criterion for classification of compound volatility that may be used for classification of organic chemicals (see Reference [3]).

4 Type, origin and causes of pollutants in buildings

Pollutants include hazardous materials and preparations which are listed in different national laws or European laws in the different fields, e.g. Construction Product Regulation[4] and REACH[5]. Other factors (e.g. anthropogenic emissions or electromagnetic fields, which are not dealt with in this part of ISO 16000) which may have an adverse effect on human health and well-being should also be considered. Pollutants may be of very diverse origin.

The following causes of pollution have been identified.

a) Primary sources of pollutants in the construction products themselves: asbestos, man-made mineral fibres, heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), halogenated organic compounds, volatile organic substances (VOCs) biocide active agents from wood preservatives, odour emissions from construction products and radioactive construction products.

b) During interaction of several primary sources new pollutions not originally existing in the construction products can be generated by chemical reactions between single construction products (secondary emission of a primary source), e.g. odour emissions from multi-layered sandwich structure of a flooring.

c) Such secondary emissions can be generated by chemical reaction in air (e.g. by reaction of VOC with ozone).

d) Secondary sources of pollutants generated by the transfer of pollutants to other structural elements or building areas: e.g. asbestos dust, PCBs, PAHs, contaminations due to the use of solvents and operation, e.g. from building preservation (such as cleaning, disinfection or pest control), production processes (e.g. tetrachloroethylene used for dry cleaning, toluene used in printing works), microbial contamination in consequence of water damages.

e) The influence of pollution from geogenic (e.g. radon) or anthropogenic sources (e.g. particles and dust, pet or vermin allergens, soot).

f) Electromagnetic fields, sound, vibrations; not dealt with in this part of ISO 16000.

g) Biological hazards (potential sensitizing, toxic or infectious effects of mould, microbial volatile organic compounds (MVOC), bacteria, pigeon droppings, mess and rests of rodents and, vermin.

h) Transient pollution and emissions caused by use: anthropogenic carbon dioxide, bodily exhalations, humidity, odours.

i) Pollutants that enter the building by infiltration and ventilation provision.

j) Structural-physical weaknesses as origin of humidity penetration and mould.

Annex A lists examples of pollutants contained in specific structural elements whereas in Annex B important examples of VOCs and their possible sources (see Table B.1) and vice versa building related VOC sources and their VOC emissions (see Table B.2) are given.

5 Method of undertaking an investigation of pollutants in buildings

5.1 General

Investigations and assessments are performed by specialists and inspection bodies that have the relevant expertise in the following fields:

a) building and associated installations or equipment;

b) materials science and material testing;

c) pollutants in buildings and their technical installations originating from used construction materials, use or maintenance;

d) laws, regulations and technical rules;

e) health protection, environment protection and occupational safety, if necessary.

Prior to initiating an investigation of pollutants in buildings, a pollution investigation concept shall be submitted which outlines the procedure.

The pollution investigation concept shall be described in the pollution investigation report, based on:

— the aim of the pollution investigation and

— the motive for the pollution investigation.

5.1.1 Aim of the investigation of pollutants in buildings

The pollution investigation will focus on:

a) a specific pollutant;

b) a specific group of pollutants; or

c) an indeterminate range of pollutants.

It shall also be established whether the spatial entity on which the pollution investigation is based involves:

— a part of a building;

— an entire building;

— several building units;

— exterior as well as interior of a building.

5.1.2 Motive for the investigation of pollutants in buildings

An investigation of buildings for contamination may be motivated by the following factors:

a) inventory control;

b) complaints;

c) purchase or sales examination (due diligence);

d) preparation for remediation, conversion or demolition;

e) as a basis for facility management and maintenance (facility management tool).

5.2 Phases of the pollution investigation

An investigation of buildings for contamination generally takes place in several, systematically coordinated phases which focus on the following key areas:

a) research into the circumstances relating to site, building and use;

b) evaluation and recording of complaints;

c) site visit;

d) set-up of a sampling plan;

e) sampling and analysis;

f) evaluation and assessment.

This represents the ideal sequence of events. In practice, individual phases may be omitted (e.g. research phase in the absence of any documents or information), reduced in scope (e.g. site visit if access is restricted) or repeated in the light of new information (e.g. unexpected results of sampling and analysis call for further investigation of the building's history, or additional visits). This shall be recorded in the investigation report.

The omission or reduction in the scope of research may result in extra time spent on site visits; however, no amount of research can compensate for the omission or curtailment of the site visit.

It may be sensible to undertake the sampling and analysis phase gradually by conducting preliminary qualitative and/or semi quantitative investigations (e.g. screening with dust samples, composite

samples, cumulative parameters, indoor air measurements) which consolidate information about the possible range of pollutants.

5.2.1 Research into the circumstances relating to site, building and use

The research phase involves gathering and recording all documentation and/or information relating to the building under investigation, its location and its former use.

This documentation and/or information may offer firm evidence or indications of the presence of certain pollutants, or even grounds for ruling out their existence, and serves as a useful tool for the subsequent investigative phases.

5.2.1.1 Researching the site

Site-related factors may affect the building due to interactions between the building and its location. These may be of geogenic nature (e.g. radon), they may be attributable to earlier environmental contamination on the site (e.g. brownfield sites, land contaminated by war) or caused by current emissions (e.g. traffic, industry). They may also be affected by climatic and/or other natural factors.

The following data sources may be used for investigating the site:

a) registers of contaminated land and areas of potential pollution;

b) underground radon levels;

c) aerial photographs;

d) archive material derived from various sources;

e) environmental studies;

f) interviews with eyewitnesses (familiar with the site or facility).

5.2.1.2 Researching the building

Research into the building, as the focal point of the pollution investigation, should provide all requisite qualitative and quantitative information regarding:

a) the recorded building stock;

b) the relevant construction products used;

c) heating and sewage systems and, where applicable, ventilation and hydraulic systems;

d) any maintenance, renovation and conversion work that has been carried out;

e) events involving accidents, fire, war damage, water damages.

The following data sources may be used for this purpose:

— company archives (building documentation, building plans, technical specifications),

— government archives,

— official certificates and relating correspondence,

— historical tender documents or construction product specifications,

— enquiry of users in the past (maintenance man, users of the building in the past).

5.2.1.3 Researching the use

Pollutant contamination in a building may be attributable to the specific way in which the building has been used. Consequently, adverse effects on the health of users may already have been observed. Research in this field should provide all the necessary findings regarding:

a) current and former use;

b) current and former materials used (e.g. hazardous substances and materials);

c) areas suspected of contamination based on use;

d) current or former incidences of disease or symptoms of illness amongst building users.

The following data sources may be used for this purpose:

— company archives,

— official certificates, commercial conveyancing and associated correspondence,

— medical reports and opinions (e.g. company doctor, school doctor, health and safety inspectorate),

— interviews with eyewitnesses (familiar with the site or facility).

5.2.2 Site visit

The site visit shall cover all areas of the spatial entity. Any individual areas which cannot be accessed shall be clearly indicated in the pollution investigation report and the reason for their exclusion shall be given.

Before visiting the site, a site visit concept shall be drawn up to define the objective of the visit. The objective is generally to check and verify the findings from the previous research phase and to collect and document new information and findings in both qualitative and quantitative terms using the specifications.

To achieve this objective, all necessary resources relating to the organisational, scheduling and technical aspects of the investigation shall be obtained and carefully coordinated. It may therefore be necessary to conduct the site visit in several consecutive stages.

5.2.3 Sampling

Before starting sampling, the sampling strategy shall be taken into account according to assumed pollution. For this purpose, the general sampling strategy (specified in ISO 16000-1) as well as the compound-specific sampling strategies shall be employed. Samples include solid, liquid or gaseous substances and biological substances.

Standardized sampling methods in compliance with relevant standards should be used. Any sampling technique which deviates from standardized methods shall be documented.

In the absence of a standardized sampling method, the sample material — depending on type — shall be representative of its intended function (motive of sampling) (e.g. ISO 22262-1 and ISO 22262-2 for sampling of asbestos). In addition, it is important to ensure that the packaging used does not contaminate the sample, thereby compromising the subsequent laboratory analyses. The same applies to the handling and storage of samples.

Each sample shall be packed and clearly, unmistakably and permanently labelled.

The selected sampling strategy (e.g. sample types, number, frequency, spatial and temporal distribution of sampling points, selection of sampling methods) shall be explained in the investigation report.

An example of a sampling plan is provided in Annex C, while Annex D contains an example of a sampling record.

The requirements of all relevant national health and safety regulations shall be followed.

Sampling should be focused on those compounds for which limit or guide values exist, e.g. from the World Health Organization (WHO Guideline values).

5.2.4 Analysis

The samples are tested for the presence of the pollutant they are suspected of containing; cross-sectional analyses (screening) may also be conducted.

Standardized analytical methods in compliance with relevant standards should be used. Any analytical method deviating from standardized methods shall be documented.

The chosen analytical methods shall be explained in the investigation report. In the absence of a standardized method of analysis, the laboratory's internal test specifications shall be cited, or the individual analytical methods described.

If highly reliable information is available on the composition of certain construction products to be sampled and analysed (such as safety data sheets), sampling and analysis may be unnecessary. In that case, straight documentation of such data shall be provided for the report.

The requirements of all relevant national health and safety regulations shall be followed.

5.2.5 Evaluation of the results of the investigation and assessments

If the results of the building pollution investigation are to be evaluated, the purpose of the evaluation shall be considered.

Evaluation is not included in this part of ISO 16000 (it is described in Reference [7]).

With regard to the basis for evaluation and the evaluation method, reference shall be made to the relevant, currently valid regulations (e.g. acts, ordinances).

6 Investigation report and documentation

The entire process of investigating buildings for contamination shall be fully described and documented. All qualitative and quantitative information shall be included in the investigation report and attached appendices.

6.1 The investigation report shall contain statements about the following points as a minimum requirement:

a) summary;

b) object and aim of the investigation;

c) presentation of the investigation concept;

d) name, location and size of the building/area of investigation;

e) date and time of investigation and people involved;

f) investigative method or procedure;

g) results of the history research for location, building und usage;

h) results of the site visit taking into account the initial situation of the historical research (documentation shall cover and describe not only all of those structural elements, where pollutants have been detected, but also all the ones without any findings of pollutants, even if suspicious or not),

i) sampling procedure and analysis results.

6.2 Appendices to the investigation report should include the following elements:

a) photographs and plans relating to the site visit;

b) sampling record, including all sampling-related photographs and planning documents;

c) site plan with sampling positions, statements regarding the spatial distribution of the pollutants with clear description of the building or plant area and the building parts;

d) photographic documentation of all suspect areas and sampling locations;

e) test reports from the analyses carried out (current and historical analyses, depending on the findings of the research phase);

f) a body of documents, depending on the findings of the research phase (e.g. building specifications, material specifications, data sheets for individual structural element, official documents, settlement statements).

If any individual aspects referred to above are not covered by the investigation report, or are not included in the appendices to the investigation report, the reasons shall be given.

Annex A
(informative)

Example of an investigation of pollutants in buildings

Building components and materials are listed below together with associated potential pollutants, (the list is based on Reference [6]).

a) Floor slabs and foundations:

— base/drainage layer beneath the floor made from foreign material, e.g. slag, heavy metals, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH),

— base/drainage layer beneath the floor slab sprayed with bitumen (to prevent rising damp) (TPH, PAHs),

— barrier layers/insulation in/on the floor slab, e.g. heat-sealed sheeting (PAHs), non-woven fabrics [synthetic mineral fibres (SMF)], bitumen cork or ground cork (PAHs), oil paper (PAHs), foils,

— use-related contamination, e.g. TPH, very volatile halogenated hydrocarbons, aromatic hydrocarbons, heavy metals,

— jointing compounds in buildings/movement joints, [polychlorinated biphenyls (PCBs), PAHs],

— defects in water tightness of building elements,

— paintwork/floor structures (VOCs, SVOCs).

b) Walls in contact with the ground:

— black paint or coatings on external wall areas in contact with the ground (PAHs),

— external insulation of walls in contact with the ground, possibly glued (PAHs),

— areas where the black paint or primer has penetrated the rendering or brickwork (PAHs),

— barriers to control rising damp in the transition between the floor slab and the ascending brickwork, occasionally the second course slightly above the floor slab (PAHs),

— moulds due to sticky walls or surfaces.

c) External walls/facades:

— rendering (heavy metals),

— wall claddings (wood preservative/PCP, asbestos cement, SMF insulation),

— joint sealants in prefabricated concrete parts or expansion joints in the building (PCBs, PAHs),

— stud walls (SMF insulation, formaldehyde, chlorinated naphthalene, chlorinated anisole),

— insulation material in construction joints (SMF, bitumen cork/PAHs, asbestos),

— insulation between double-skinned wall constructions, e.g. in cold stores (SMF, bitumen cork/PAHs).

d) Interior building:

— wall paints (heavy metals, PCB, VOC, SVOC, glycol ethers),

— use-related contamination [e.g. pesticides, fungicides, siloxanes (roll-on)],

— wall coverings and adhesives (VOCs, plasticisers, PAHs, asbestos),

— stud walls (SMF insulation, formaldehyde, chlorinated naphthalene, chlorinated anisole),

— wall material (radon, formaldehyde, wood preservative/PCP/lindane),

— lightweight construction boards and fire protection boards (asbestos, formaldehyde),

— insulation in wet rooms and cold stores (SMF, bitumen cork/PAHs, heat-sealed sheeting/PAHs),

— plugging compounds for wall penetrations (asbestos, SMF),

— timber ceiling cladding and/or suspended ceilings (PAHs, wood preservative),

— insulation in suspended ceilings (SMF),

— pentachlorophenol- (PCP) treated wood [possibility of tetrachloroanisole (TCA) formation by degradation of PCP],

— painted metal surfaces (siloxanes),

— wooden furniture (terpenes),

— organic cleaning materials (terpenes).

e) Ceilings:

— floor structure on the top side,

— fill made from slag or contaminated sand (heavy metals, PAHs, radon),

— use-related contamination (particularly in floor drains/gullies),

— fire protection cladding on intermediate floors, beams, stanchions etc. (asbestos),

— insulation in beamed ceilings (SMF),

— fibreboard ceiling linings (SMF, asbestos, PCBs),

— insulation in wet rooms and cold stores (SMF, bitumen cork/PAHs, heat-sealed sheeting/PAHs),

— plugging compounds in ceiling penetrations (asbestos, SMF),

— plaster and paint (heavy metals, PCBs, asbestos).

f) Floor construction:

— mineral tiles: black adhesives (PAHs, asbestos),

— elastic jointing compounds in construction joints and edge terminations (PCBs),

— PVC floor coverings (asbestos, phthalates),

— wooden parquet flooring (wood preservative/PCP/lindane) and adhesives (PAHs), wood preservative/PCP/lindane, knot varnishes (formaldehyde), polyurethane (phenol, isocyanate), water based varnish (glycol ether), wax and oils for surface treatment (terpenes),

— black floor adhesive (PAHs, asbestos),

— wood block flooring with grain running perpendicular to floor/“Holzstöckelpflaster” (PAHs),

— grouts and mastics (PCBs, asbestos),

— mastic asphalt (PAHs),

— asphalt floor slabs (PAHs),
— floor screed (asbestos, PAHs),
— fill made from slag or contaminated sand (heavy metals, PAHs, radon),
— footfall sound insulation (SMF, bitumen cork/PAHs),
— partition layer (SMF, oil paper/PAHs),
— barrier layer (PAHs),
— insulation in wet rooms and cold stores (SMF, bitumen cork/PAHs, heat-sealed sheeting/PAHs),
— concrete paint (PCBs, heavy metals),
— special floors containing woodchips and some adhesive agents (phenols),
— adhesive gents (phenols),
— linoleum (long chain aldehydes and *n*-hexanol),
— floor coverings made from natural fibres (e.g. wool or sisal or jute may emit pyrethroids).

g) Windows, doors, stairs:

— connection joints (PAHs, PCBs),
— insulation around the edges of windows or in roller shutter boxes (asbestos, SMF, bitumen cork),
— mould growth on window or door architrave and reveal,
— window sills (asbestos cement),
— fire doors (asbestos),
— painted metal parts (heavy metals, PCBs).

h) Roof:

— roof trusses and other roof timbers (PAHs, wood preservative/PCP/lindane, DDT),
— defects in water tightness (mould, microbial growth),
— pigeon droppings,
— house longhorn beetle and other timber pests,
— insulation (SMF, bitumen cork/PAHs),
— roofing felt (PAHs), often several generations in multiple layers, often with primer coat,
— flat roof fill and other levelling materials made from slag (heavy metals, PAHs),
— lead flashings,
— asbestos cement roof boards.

i) Chimney:

— combustion residues (PAHs, heavy metals, dioxins, furans),
— firebricks (heavy metals),
— fire dampers, sweeping hatches (asbestos),

— insulation between exterior shell and masonry (SMF, asbestos).

j) Building services:

— air conditioning and ventilation systems (dust, SMF, asbestos, allergens, microorganisms),

— power cables made from lead or with lead sheath,

— sheathed power cables (PAHs),

— oil-filled mains cabling (PCBs),

— capacitors in fluorescent tubes (PCBs),

— lighting appliances [energy saving lamps (mercury)],

— transformers (PCBs),

— hydraulic equipment (PCBs),

— switches (mercury),

— water pipes (lead, bio films and microorganisms),

— sewage pipes with bitumen tape around the joints (PAHs),

— asbestos cement pipes and shafts,

— oil separators,

— use-related contamination in the sewage system and surrounding area (leaks),

— flange gaskets on lines of heating systems and ventilation and air conditioning systems (asbestos),

— oil storage area, oil tank, filling point (TPH) VOC, SVOC,

— electric storage heaters (asbestos, chromate, PCBs),

— pipe insulation (SMF, asbestos, PAHs),

— lift brake linings (asbestos),

— dry cleaner in the neighbourhood (perchloroethylene),

— latex paint.

k) External hard surface areas:

— tarmac surfaces (PAHs),

— construction joints in concrete slabs (PAHs),

— joint compound in cobbled areas (PAHs),

— use-related contamination.

Annex B
(informative)

VOCs and possible sources and building related VOC sources

Table B.1 — Examples for VOC and their possible sources

Group of substances	Individual substances	Sources (examples)
Aliphatics	hexane, heptane, octane, decane, undecane, dodecane, tridecane, tetradecane, methylpentane, methylcyclopentane	fuels (gasoline/diesel), light fuel oil, synthetic lacquers, solvents, cleaning materials, natural resin lacquers
Alcohols	ethanol, 2-propanol, 1-butanol, 2-ethyl-1-hexanol	cleaning materials, cosmetics, room sprays, alkaline hydrolysis of plasticisers
	chlorinated anisole	wood preservatives
Aromatics	benzene, toluene, xylene, ethylbenzene,styrene, *n*-propylbenzene, trimethylbenzene, ethyltoluene,	open fires, tobacco smoke, vehicle emissions, gasoline, coating material, wood preservatives, cleaning materials, adhesives, solvents
	naphthalene	mothballs
Aldehydes	formaldehyde,	particle board,
	butanal	vulcanisations, synthetic lacquers, plasticisers
	benzaldehyde	odorant, perfume
	C_5 to C_{11} aldehydes	flooring materials
Halogenated hydrocarbons	dichlorobenzene, perchloroethylene, trichloroethylene,	spot removers, paint strippers, furniture polish, shoe polish, dry cleaners (freshly cleaned clothing), deodorants
	1,1,1-trichloroethane	
Esters	ethyl acetate *n*-butyl acetate	coating materials, furniture polish, adhesives, spot removers, nail polish removers, synthetic lacquers, solvents, cleaning materials
	phthalates (DMP, DEP DBP etc.)	plasticisers
Glycol and glycol ethers and glycol esters	butoxyethanol, methoxy-propanol, butoxyethoxyethanol	dispersion paint, dispersion adhesives, water-based paint
Ketones	2-butanone, methylisobutylketone, acetophenone, cyclohexanone	adhesives, synthetic lacquers, solvents, cleaning materials, synthetics
Siloxanes	octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane	furniture varnish, roll-ons
Terpenes	α-pinene, β-pinene, limonene,	turpentine oil (paints, floor care products, wood preservatives, furniture polish, shoe polish, natural resin lacquer), softwood (massive wood furniture), scented oils, waxes, ointments, liniments
	3-carene	

Table B.2 — Examples for building-related VOC sources

Source	Typical VOCs
Adhesives	alkanes (C_9 – C_{11}), toluene, styrene
Flooring:	
- Carpets	C_3 –C_6-alkylaromatics, styrene, 4-phenylcyclohexene, vinylcyclohexane, 2-ethylhexane, siloxane, amines
- Cork	1,2-propylene glycol
- Linoleum	C_5 –C_{11}-aldehydes, aliphatic acids, benzaldehyde
- Parquet floor	C_5 –C_6-aldehydes, terpenes
- PVC	alkanes, aromatics, 2-ethyl-1-hexanol, glycol, esters
- Rubber	acetophenone, alkylaromatics, styrene, benzothiazol
- Construction boards	alkanes, aldehydes, butanol, formaldehyde, ketones
Coatings:	
- lacquers	alkanes, aromatics, aldehydes
- paints	alkanes, glycols, glycol esters, glycol ether
Sealants	esters, glycols, ketones, PCBs, siloxanes
Insulating materials	aldehydes, aromatics, ketones
Vapour barriers	naphthalene
Wall papers	hexanol, terpenes
Textiles	acetone, ethylacetate, siloxane, thiophene, dimethylsulfides

Annex C
(informative)

Sampling plan for pollution investigation

NOTE ISO grants the user of this part of ISO 16000 the right to reproduce or otherwise use the sampling protocol on this page solely for the purpose of implementing this part of ISO 16000.

Project:					
Name:					
Address:					
Date:					
Technical specification; room schedule:					
Building area	Remarks about suspected contamination	Construction material	Type and number of samples	Sampling technique	Pollutant analysis

Annex D
(informative)

Sampling record for investigation of pollutants in buildings

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Objectives	Type	Details	Description
1	Project	Name	
		Place/address	
2	Client	Company	
		Street	
		Telephone	
		Name of contact	
		Postcode, town	
3	Sampling person	Company	
		Street	
		Telephone	
		Name of contact	
		Postcode, town	
		Sampler	
		Date	
		Place	
		Signature	
4	Date and time of sampling		
5	Persons present		
6	Signatures of attendees		
7	Laboratory, test centre	Company	
		Street	
		Telephone	
		Name of contact	
		Postcode, town	
8	Submission to the test centre/laboratory	Date	
9	Sample designation		
10	Sampling point coordinates	Building	

		Technical description; area according to room schedule	
		Designation on site plan	
		Photographic documentation	
		Easting/northing	
11	Structural element		
12	Construction product		
13	Material description	Colour	
		Consistency	
		Homogeneity	
		Age	
		Visual appearance	
		Odour	
		Suspected contaminant(s)	
14	Estimation of total volume of construction product sampled		
15	Sampling	Number	
	Individual sample	Type sampling	
	Area sampling	Composite sample	
16	Sampling method	Remarks	
	Core drilling	Sectioning	
	Removal of sample material with hammer and crowbar	Indoor air measurement	
	Chipping	Swipe sample	
	Scraping	Adhesive-film test	
	Removal	Petri dish	
17	Sampling material	Remarks	
	Dust, core particulate	Tubules	
	Chips, strata	Filter	
	Core sample	On-culture medium	
	Fibres		
18	Specimen vessel		
19	Sample volume		
20	Sample transport and storage		
Miscellaneous remarks			

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