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Indoor air—General aspects of sampling strategy

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Land, Infrastructure and Transport through deliberations at the Japanese Industrial Standards Committee.

This Standard has been made based on **ISO/DIS 16000-1** : 2001, *Indoor air—Part 1 : General aspects of sampling strategy* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Indoor air—General aspects of sampling strategy

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO/DIS 16000-1** *Indoor air—Part 1: General aspects of sampling strategy* published in 2001 with some modifications of the technical contents.

The portions given sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex 1 (informative).

This Standard is intended as an aid to planning indoor air pollution measurements. Additional Standards describe the sampling strategy, including the conditions to be observed for the particular substances or groups of substances. The actual procedures dealing with indoor air measurements for the individual substances are also presented in other Standards.

Annex A table A.1 summarizes the most important types of indoor environment, and examples of the sources that may be encountered in them. The list is not, of course, fully comprehensive because of the large number of possibilities.

Annex B table B.1 shows the sources of indoor air pollutants and the most important substances emitted.

In contrast to table A.1, Annex C table C.1 lists substances frequently detected and their possible sources. In some cases, the sources of indoor pollution arise outside the building; for example, benzene from vehicle traffic and petrol and chlorinated hydrocarbons from nearby dry-cleaning establishments. Soil emissions may also be important if, for example, buildings have been erected on old landfills, industrial sites, or uranium-containing soils which emit radon.

Annex D contains a checklist relating to information to be recorded when indoor air measurements are carried out. This list is also intended to aid the analytical result.

The determination of indoor air pollutants proceeds, as a rule, by either of two approaches.

a) Sampling is carried out on-site using instruments that are as manageable and simple as possible, and subsequently analysis is carried out in the laboratory.

b) Sampling and analysis are performed on-site by direct-reading measuring systems.

Before a sampling strategy is devised, it is necessary to clarify for what purposes, when, where, how often and over what periods of time monitoring is to be performed. The answers to these questions depend, in particular, on a number of special characteristics of the indoor environments, on the objective of the measurement and, finally, on the environment to be measured. This Standard deals with the significance of these factors and offers suggestions on how to develop a suitable sampling strategy.

Attention should be given to the special role of the human sense of smell in identifying substances or classes of substances in indoor air. Here it is not so much the

sensitivity of the sense of smell, but the memory of smell and the experience of the specialist (chemist, perfume specialist) that is important. Sensoric adaptation affects the sensory information, particularly in the case of persistent indoor pollutants.

The interpretation of indoor air measurements is assisted by the use of guideline values for acceptable indoor air quality. To draw a conclusion about whether and to what extent the concentrations of a pollutant measured in a room exceed the normal level or the level acceptable from the standpoint of health, it is useful to rely on guideline values or published literature. The column "Remarks" of table C.1 (see Annex C) shows the Air Quality Guidelines of the World Health Organization [WHO] [1] and the Guideline values of indoor concentration of chemical substances such as formaldehyde and the Guideline values of the Law concerning the Securing of Hygienic Environment is Buildings of the Ministry of Health, Labour and Welfare [5]. It is emphasized, however, that these values are not legally binding. In the absence of published guideline values, the investigator may consult peer reviewed journal articles or other literature for guidance on typical values observed in buildings without reported complaints.

1 Scope This Standard is intended to aid the planning of indoor pollution monitoring. Careful planning of sampling has particular significance since the result of the measurement may have far-reaching consequences such as the need for remedial action or the success of such an action.

An inappropriate monitoring strategy can contribute to the great error caused by the error due to the monitoring procedure.

For this Standard the following definitions concerning the indoors such as buildings are used (in accordance with the professionals conference concerning environmental problems held in Europe.) [2].

Living rooms, bed rooms, workshop, hobby rooms, basements, kitchens or bathrooms in residential building; workshops in the buildings not applied to the inspection of health and safety concerning air pollutant (for example, offices, stores): public buildings (for example, hospitals, schools, kindergartens, sports rooms, libraries, restaurants, bar rooms, theaters, movie theaters and other buildings) and the inside of car of transport vehicles.

Remarks 1 Concerning air pollution, the working places such as offices, or stores are subject to the national supervision in some countries. The total area of at least 3 000 m^2 is regulated by the Law Concerning the Securing of Hygenic Environment in Building (the Building Hygiene Law) in Japan.

2 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO/DIS 16000-1:2001 *Indoor air—Part 1: General aspects of sampling strategy* (MOD)

2 Normative references The following standard contains provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year of coming into effect or publication is given to this referred standard, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative reference without the indication of the year of coming into effect or publication applies only to the most recent edition (including amendments).

JIS Q 17025:2005 *General requirements for the competence of testing and calibration laboratories*

Remarks : **ISO/IEC 17025**:2000 *General requirements for the competence of testing and calibration laboratories* is identical with the said standard.

3 Special characteristics of the indoor environment An indoor environment is rarely static, since the concentration of any substance may be constantly altered by the strength of the source, human activity, ventilation rate, external or internal climatic conditions, chemical reactions and possible sinks (e.g. sorption by surfaces and furnishings). Because of the proximity of source to receptor, human exposure in the indoor environment is of special concern. In addition, the composition of indoor air may vary within and between rooms, and be less homogeneous than the outdoor air surrounding the building.

Equation (1) describes a simplified relationship of some of the parameters that affect the concentration of a substance in indoor air.

$$dc_i / dt = Q/V + nc_a - Ac_i - nc_i \quad (1)$$

where, C_i : the mass concentration of substance in indoor air (mg/m^3)

Q : the strength of the source (mg/h)

V : the volume of the room (m^3)

n : the number of air changes (h^{-1})

C_a : the mass concentration of substance in outdoor-air (mg/m^3)

A : the elimination factor (h^{-1})

t : the time (h)

Remarks : The “strength (mg/h)” in different from the “emission speed ($mg/m^2 \cdot h$)”. Namely the “emission speed” means the emission amount per unit area and per unit time, and the value of that multiplied by emission area is the “strength”.

The left-hand side of the equation (1) represents the change in the concentration of the substance with time. The first two terms on the right-hand side describe the increase in the concentration due to emissions from a source and the penetration of outdoor air, while the last two terms represent the decrease in the concentration which may result from removal by ventilation or from elimination mechanisms, such as sorption of the compound by textiles in the room.

The most important term in equation (1) is the source strength. It is often observed to vary with time, but this is not taken into account by equation (1). If it is found that the variation is of particular significance, a more complex equation is needed. Depending on how the strength varies with time, a distinction can be made between a constant and a variable source strength, and both cases can be subdivided still further into regular and irregular emissions. The strength of continuous sources may also depend on room temperature, the relative humidity and the amount of movement of the air in the room, and may only change in the long term; i.e. over weeks and months. The emission rate of intermittent sources is generally only slightly affected by room-climate parameters and often varies within much shorter periods of time.

Particle board with aminoplastic bonding is an example of a source that continually emits pollutants into the air. Such a source emits formaldehyde over long periods of time in amounts that depend heavily on environmental factors such as temperature and relative humidity.

A gas cooker, which may be operated at varying conditions according to cooking requirements, is an example of an intermittent source having variable strength. However, a very regular emission pattern may be observed from day to day, since the preparation of meals is often subject to a regular schedule.

The occasional use of insecticide sprays represents a combination of an intermittent source and an irregular emission pattern.

4 Sampling objective Indoor air measurements are mainly undertaken for the following five reasons, of which the first may be unrelated to, or may evoke the other four **b**) to **e**).

a) complaints by users about poor air quality

b) the need to determine the exposure of occupants to certain substances

c) the need to measure whether specified limit or guideline values are being maintained

d) testing the effectiveness of remedial treatment

e) observed or suspected effects on the occupants' health

In the first case an extended search for the causes of the complaint may be necessary and there is a need to adapt the sampling strategy to the individual case. The other situations **b**) to **e**) are easier to address, because information is available about the substances to be determined before monitoring is started.

The nature of a substance, its concentration and its effect on humans can also have an influence of the boundary conditions for the monitoring. In assessing the health implications of irritants, short periods mean of the maximum allowable exposure is important. In the case of compounds that have potential long-term health effects (e.g. carcinogenic compounds), the fairly long periods mean exposure is important.

5 Sampling procedure The equipment is on the basis that it is suitable for the measurement task and does not have a substantial adverse effect of the normal use of the rooms in which it is used because of size, sampling rate and noise. This is

particularly important in residential monitoring. In this case, the instrument used should be relatively noise-free and its sampling rate should not interfere with the normal ventilation rate. In positioning the monitoring equipment, consideration should be given to the fact that the concentration of the indoor air may not be homogeneous.

Time resolution of the measurement is an important factor. Different techniques may give different time resolutions, which will affect the interpretation of the result observed.

The hourly sampling volume in the room shall be not more than 10 % of the ventilation rate. If the ventilation rate value is not available or cannot be measured, the hourly sampling volume should be not more than 10 % of the room volume.

For determination of average concentrations of a substance over fairly long time periods (e.g. 8 h), diffusive samplers, which do not have some of the disadvantages of active samplers, may be used. However, care should be taken to assure that diffusive samplers are used only in areas with adequate ventilation such that the specified face velocity is maintained. Suitable quality assurance procedures in accordance with **JIS Q 17025** shall be followed for both active and diffusive sampling.

Remarks 1 It is usual to refer to sampling times of up to 1 h as short-term sampling, and to times ranging from several hours to several days as long-term sampling.

2 Sampling procedures are described in other parts of **ISO 16000**.

6 Time of sampling It is essential to take into account the variation in the concentration of air pollutants with time when evaluating a measurement result. Pollutants such as cigarette smoke and chemical vapours (e.g. for cleaning) shall first be ventilated from indoor air, unless there is intention to take these pollutants into account for evaluation of the measurement results.

Important parameters to which attention shall be paid in choosing the sampling time are the ventilation, the usage of the sources, the occupants and their activities, the type of indoor environment (finishing and its condition), the temperature and the relative humidity.

Opening a window inevitably decreases the substance concentration in a room (provided the outdoor air is not more heavily polluted with the substance of concern), and it may also disturb a previously established equilibrium.

In the case of short-term sampling, it is impossible to obtain representative results if sampling is started immediately after ventilation. If the substance to be determined is emitted constantly and continuously, several hours shall be allowed for the establishment of equilibrium after ventilating by opening a window.

This effect is also important for long-term sampling. However, it is less important, especially if the sampling is carried out for a long time and under the actual living conditions.

For the reasons mentioned, it is important to plan the time of monitoring carefully, taking into account the start of sampling after the end of the last ventilation. If there are no serious objections, the procedure for short-term sampling shall include a waiting time of several hours after a change in ventilation before sampling is

begun. Indications of the interval of time to be chosen in individual cases are found in other parts of **ISO 16000** relating to the particular substance or group of substances.

If air pollutants are due to emissions from intermittent sources, the time of sampling depends on the sampling objectives. It may correspond to the peak exposure period or cover the average exposure over a longer period.

If the building or room is equipped with a 24-hour ventilating system, additional aspects shall be considered. For example, undesirable emissions may result from the system itself (e.g. from sealing materials, humidifier water, dust deposits), resulting in pollutants from one room being distributed throughout the entire building, especially if the system has a high recirculation rate. The outdoor air drawn in by the system may contain a high level of pollution due to nearby sources. If operation is intermittent or restricted, at least 3 h shall be allowed to elapse with the system performing normally before sampling is started.

7 Sampling frequency The duration of sampling is determined by:

– the nature of the substances under consideration

– the emission characteristics of the source

– the limits of quantification of the analytical method

In may cases, particularly if only a few measurements are made, it is necessary to make compromises that do not take into account all three aspects at the same time.

The sampling duration chosen is particularly important in relation to the potential health effects of the targeted substance. For substances causing acute health effects, short-term sampling should be used, whereas long-term sampling should be used for substances having chronic effects on health.

Long-term sampling methods do not detect short-term peaks in concentration. This may result in difficulties in interpretation of the measurement results, particularly if a substance also has a short-term effect on health.

In relation to the emission characteristics of the source, it is clear that emissions from a source that emits only for a short time can only reasonably be determined by a short-term measurement. Conversely, sources with long-term emissions are best dealt with by long-term measurements. However, it is quite possible that there are deviations from this general rule. For example, the short-term peak concentration of an insecticide due to aerosol spraying can only be determined with a short-term measurement, but long-term sampling may be quite appropriate after spraying if residual concentration levels in the room are of primary interest. In some cases, the emission characteristics of suspected sources are initially unknown. In such cases, a continuous recording of measured quantities [for example, total gaseous organic compounds using a flame ionization detector (FID) or photoionization detector (PID) for a limited time] may provide useful information for developing the sampling strategy.

The sampling duration shall also be appropriate for the limit of quantification of the chosen analytical method. That is the mass of the analyte collected during sampling shall make possible an unambiguous identification and a reliable quantitative determination. At the same time, it should be remembered that the amount of

analyte collected is not necessarily substantially increased by extending the sampling time over a longer period. When the intention is to determine the concentration of a compound originating from an intermittent source that is activated only on rare occasions and for short intervals, nearly as much substance may be collected in a 1 h sampling period as in 24 h. Furthermore, information may be lost if the choice of sampling time is unsuitable.

The sampling duration may be imposed on the analyst in some cases. Such is the case with tetrachloroethane, for which an upper limit value has been set to 0.1 mg/m^3 in Germany[3] as a 1-week average. The average time was set for rooms adjacent to dry-cleaning shops to cover the full weekly pattern of emission levels that vary between working days and weekends.

Due to cost considerations, the number of individual measurements carried out in a room is generally small. On the other hand there is a tendency to take the result of one (or only a few) measurement(s) as representative of the situation in the room under study. In this conflicting situation, it is essential to provide as much information as possible about those parameters that can have an influence on the result, in order to be able to judge whether the result reflects the average or an extreme condition.

Short-term sampling is often carried out under conditions that represent an extreme situation (e.g. low number of air changes, elevated temperature) in order to be able to estimate the maximum exposure. Long-term sampling is often used to determine the state of pollution under normal conditions of occupancy. The conditions of the use and all that at the time of sampling shall be precisely documented.

For a comprehensive assessment, both a short-term sample and a long-term sample shall be collected. The assessment shall also take into account the changes in concentration that may result from changes in the ventilation pattern and the conditions of use, including seasonal differences. This is especially important for some pollutants, e.g. formaldehyde and viable fungi.

In the case of formaldehyde, seasonal changes in concentration are particularly important since the emission of formaldehyde from wood-based materials bonded with urea/formaldehyde-containing resins is affected by temperature and relative humidity (see clause 3).

The final sampling design is necessarily dependent upon the available resources, costs, data requirements and the time available for carrying out the study.

8 Sampling location In addition to the changes in the concentration of a substance over time, account shall also be taken of the temperature distribution over spatial variation. For measurements to be made in a building, it is therefore necessary to specify both the room to be monitored and a suitable sampling location in that room. The choice of the room depends on the purpose of the measurement. In buildings equipped with air-conditioning systems, measurements carried out in the intake and exhaust air may indicate sources of air pollutants.

Although it is frequently the purpose of a measurement to identify the pollutant sources in a room, the emphasis is generally on determining the exposure of the occupants to the pollutants. It is not possible in every case to specify beforehand the most appropriate location of the sampling device. In private dwellings, a choice may

have to be made between the living area and the sleeping area. If sources are involved that are associated with certain activities of the inhabitants, it is often useful to sample in the living area, especially if the pollution-producing activities occur there. However, exposure to long-term emitting sources (e.g. building products) may be better characterized by a measurement made in the bedroom, because that is where people spend more time. In private dwellings, it is important that measurements should not have an effect on the normal use of the rooms.

In the case of measurements made in large rooms (halls, large offices, etc.), the possibility of subdividing the room shall be considered in selecting the sampling location and in evaluating the measurement result. This applies in particular to short-term measurements.

If the living room is closer to an outside pollutant source (e.g. a dry-cleaning establishment), it would not be logical to sample only in the bedroom.

The centre of the room is generally considered the most suitable location for sampling.

However, if this is not possible the sampler should be located no closer than 1 m to any wall. Samples should be taken about 0.75 m to 1.5 m above the floor, since this is the approximate height of the average breathing zone.

Alternative locations may be required in specific circumstances, for example when measuring the emissions from cooking stoves. These emissions, which cause thermal movement of air in the room, result in marked concentration gradients.

For example, significantly lower concentrations of NO_2 may be observed below the working level of a gas cooker than above it. Such concentration gradients may also be characteristic of other sources and may even be used to locate a source in a room. To this end, it is advisable to subdivide the room into different areas and to simultaneously sample each area. However, such a procedure is only successful if the individual areas of the room can be classified as similar in terms of ventilation, which is not always the case, particularly in artificially ventilated rooms.

In occupied premises, care should be taken to assure that the sampling equipment is protected as much as possible from human intervention.

The prevailing movement of air in a room, which depends on the nature and extent of the ventilation, may also be of great importance in specifying the measurement point, particularly if diffusive samplers are to be employed. Diffusive samplers that have a large cross-section (so-called badge-type samplers) may under-estimate the concentration if the face air velocity is too low, as may occur particularly in the corners of rooms. Places in the sun, nearby heating systems, with noticeable draught and nearby ventilation channels should be avoided, because this may influence the measurement results.

9 Parallel outdoor air measurements Due to the permanent exchange between indoor and outdoor air caused by infiltration and ventilation processes, it may be important to supplement indoor air measurements with a simultaneous measurement of the outdoor air[4] (If possible at the same altitude of the building).

The pollutant source can be detected by the circumstances. The outdoor air samples should be taken in the vicinity of the building but not closer than 1 m.

In making such measurements, it should be remembered that vertical concentration gradients may occur, for example for the components of vehicle exhaust gases in street canyons. If the building is equipped with an air-conditioning system, the outdoor air should be sampled near the air intake.

Information on the wind direction, wind velocity and other weather conditions at the time of sampling may be of interest.

Annex A (informative)

Types of indoor environment and important sources of air pollutants

This Annex is to supplement the matters related to the text and not to constitute the provisions of this Standard.

Annex A table A.1 Important types of indoor and the sources of air pollutants frequently encountered in them

Type of indoor environment	Emitting sources or processes
Private dwellings and living rooms	
a) General sources	People, building materials, renovation materials, cleaning agents, pesticides, outdoor air, open type heating appliances, microbial growth
b) Special areas	
Kitchens	Gas appliances, cooking, cleaning products
Living rooms, bedrooms, bathrooms	Tobacco smoke, fireplaces, pesticides, cosmetics, disinfectants
Basements, hobby rooms	Tobacco smoke, soil outgassing
Garages	Fuel, solvents
Public buildings	
a) General sources	People, building materials, renovation materials, cleaning agents, pesticides, outdoor air
b) Special areas	
Offices	Offices machines and supplies
Schools and day care centres	Teaching materials, toys
Hospitals	Disinfectants, cleaning agents, anesthetics
Garages	Fuel
Swimming pools	Outgassing from water
Transport vehicles	Fuel, internal fitting materials, outdoor air

Annex B (informative)
Sources of indoor air pollutants

This Annex is to supplement the matters related to the text and not to constitute the provisions of this Standard.

Annex B table B.1 Sources of indoor air pollutants and their most important emissions

Source/cause	Process/activity	Products used/sources a narrower sense	Substances emitted
1 Biological sources			
People, domestic animals	Breathing	—	Carbon dioxide, water vapour, odorous substances from food, bacteria and viruses
	Sweating	—	Water vapour, odoriferous substances
	Digestion, excretion, skin scaling	—	Intestinal gases, odoriferous substances, decomposition products of excrement or pathological excretions, bacteria and viruses, allergenic dust
Cockroaches, dust mites and other insects	Excretion	—	Allergenic dusts
Rats, mice and other pets	Excretion	—	Odoriferous substances, bacteria, viruses, allergenic dusts
	Loss of hair, skin scaling	—	Allergenic dust
House plants	Evaporation	—	Terpenes, odoriferous substances, water vapour
Mould growth	Metabolism, spore release	—	Odoriferous substances, fungal propagules, bacterial mycotoxins
2 Building products and building equipment			
Buildings and materials	Product processing, outgassing, ageing, abrasion, decomposition	Building substances, building preservatives, insulating materials, sealing materials, paints, concrete additives	Various gaseous and particles, (e.g. solvents), plasticizers, monomers, oligomers, wood preservatives, flame-proofing agents, fibres (asbestos, mineral wool), radon (e.g. granite), amines and ammonia
Ventilation and air-conditioning system	Operating and maintenance	Scrubbers, filters, insulating and sealing materials, deposits	Microorganisms (e.g. legionella), pesticide fibres, odoriferous substances
Room furnishings	Product processing, renovation, outgassing	Furniture, floor coverings, curtains, paints and varnishes, wall coverings	Plastics, resins, monomers, oligomers (e.g. formaldehyde), fibres, solvents, plasticizers, stabilizers, biocides

Annex B table B.1 (concluded)

Source/cause	Process/activity	Products used/sources a narrower sense	Substances emitted
3 Indoor activity			
Cooking and heating appliances	Combustion processes (heating, cooking)	Coal, heating oil, gas, fuelwood	Gases (e.g. municipal, bottled, natural), heating oil vapour [For example, carbon dioxide, carbon monoxide, nitrogen oxides, water vapour, suspended particulate matter, hydrocarbons and many other organic substances (e.g. combustion and carbonization products)]
Cosmetic products	Cosmetic care	Cosmetics	Solvents, propellants, perfumes, inorganic and organic aerosols (e.g. dyes, pigments, lacquers, resins), halocarbons
Sanitation products	Cleaning	Detergents, cleaning agents, polishes, disinfectant, pesticides	Ammonia, chlorine, organic solvents, pesticides, bactericides and chlorine components, ozone
Home office	Office activities	Office supplies, EDP equipment, copiers	Organic solvents, low-volatility organic substances (plasticizers, flameproofing agents), toner components, ozone
Hobby and DIY (do-it-yourself) products	DIY activities, renovation, painting and the like	Paints, lacquers, adhesives, sprays, handicraft products, soldering irons	Gaseous and aerosol-type substances such as propellants, dusts, suspended particulate matter, metal vapours, monomers, biocides
Tobacco	Smoking	Tobacco smoke	Carbon monoxide, nitrogen oxides, nicotine, aldehydes, nitrosamines and numerous other organic substances (e.g. polycyclic aromatic hydrocarbons, aerosols)
Garage, store room	Storage	Fuels, paints, lacquers, cleaning agents, etc.	Fuel vapours, exhaust gas, solvents
4 Transportation			
Vehicles	Vehicle (car, rolling stock, truck, RV, bus)	Fuels, plastic and rubber material, insulating material	Vehicle exhaust gases and particles (e.g. carbon monoxide, nitrogen oxides, hydrocarbons, polycyclic aromatics, benzene, lead-containing suspended particulate matter, diesel soot), plasticizers (e.g. phthalates) and other additives, aldehydes, monomers (e.g. styrene), ozone (air-craft cabins)
5 Outdoor air pollution			
Emissions due to human activities	Ventilation, infiltration and diffusion through building exterior	Trade and industrial establishments, traffic, house fire, agriculture, outside burning	Gases and aerosol-type substances such as propellants, solvents, ammonia, odorous substances, polycyclic aromatics
Natural emissions	Ventilation, penetration of soil gases, dust	Plants in flower, occurrence of radium in soil, sea spray, soil resuspension, natural decay	Pollen, radon, methane, sea salts particles, microbes
Livestock	Excretion	Intestinal gases, odoriferous substances, decomposition products of excrement or pathological excretions, bacteria and viruses, allergenic dust	Ammonia, sulfur compounds

Annex C (informative)
Examples of substances and their sources

This Annex is to supplement the matters related to the text and not to constitute the provisions of this Standard.

Annex C table C.1 Sources frequently detected and their possible sources

The list below shows polluting substances frequently detected and their possible sources. Substances and other substance groups are not listed for which only a small amount of information about their concentration range is available. These include examples of diisocyanates, phthalates, nitrosamines, amines and pesticides.

Pollutant	Source	Remarks
Hydrocarbons		
Benzene	Open fires, tobacco smoke, vehicle exhaust gases, petrol, gasoline	—
Toluene	Paints and varnishes, wood preservatives, adhesives, printing ink, solvents, felt-tip pen, vehicle exhaust gases, petrol	AQG(1): 7.5 mg/m^3 (24 h) 1 mg/m^3 (odour evaluation time is 30 min) Guideline value of Health, Labour and Welfare Ministry(2): 0.260 mg/m^3
Styrene	Polystyrene (residual monomer), hobby goods (e.g. casting resin, melting granules)	AQG(1): 800 μg/m^3 (24 h) 70 μg/m^3 (odour evaluation time is 30 min) Guideline value of Health, Labour and Welfare Ministry(2): 0.220 mg/m^3
Other aromatics	Solvents, landfill, vehicle exhaust	
C_6 to C_{15} alkanes	Vehicle exhaust gases, petrol, cleaning agents, paints and varnishes	
4-phenylcyclohexene/ trimeric isobutene	Carpet	
Polycyclic aromatic hydrocarbons (PAH)	Open fires, tobacco smoke	
Terpenes (e.g. Δ^3-carene), pinene, limonene	Turpentine oil (paints and varnishes, wood preservatives, furniture-care agents), bath additives, cleaning products	
Halogenated hydrocarbons		
Tetrachloroethene	Dry cleaning	AQG: 5 mg/m^3 (24 h)
Dichloromethane	Propellants, paints strippers, solvents	AQG: 3 mg/m^3 (24 h)
Trichloroethene	Solvents	AQG: 1 mg/m^3 (24 h)
1,1,1-Trichloroethane	Correction fluid	—

Annex C table C.1 (continued)

Pollutant	Source	Remarks
Halogenated hydrocarbons (with moderate and low volatility)		
p-dichlorobenzene	Disinfectants, deodorant, moth ball	Guideline value of Health(2), Labour and Welfare Ministry(2): 0.240 mg/m^3
HCH isomers (e.g. lindane)	Wood preservatives, pesticide, paints, and varnishes	—
Pentachlorophenol	Wood preservatives, paints and varnishes, fungicides	—
Polychlorinated biphenyls (PCB)	Sealing compounds, capacitors in fluorescent lamps, fire extinguishing	—
Dioxins/furans	Halogen-containing combustibles in open fires, wood preservatives (as an impurity), fire extinguishing agents, brominated phenyl ethers in plastics	—
Other hydrocarbons		
Aldehydes	—	—
Formaldehyde	Open fires, tobacco smoke, chipboards,	AQG(2): 0.1 mg/m^3 (30 min) Guideline value of Health, Labour and Welfare Ministry(2): 0.10 mg/m^3
Acetaldehyde	Open fires	Guideline value of Health(2), Labour and Welfare Ministry(2): 0.048 mg/m^3
Acrolein, hexanal, nonanal	Open fires, radiator varnish	
Ketones (acetone, 2-butone, methyl isobutyl ketone)	Adhesives, nail varnish remover	—
Alcohols (ethanol, propanol, 2-propanol, glycols)	Paints and varnishes, furniture-care agents, cosmetics, adhesives, disinfectants, antifreeze (in motor vehicles), paint strippers, felt-tip pens, carpet	—
1-ethythexanol	PVC flooring	—
Glycol ethers	Cleaning agents, paint solvents	—
Phenols	Paint stripper, disinfectants, wood preservatives (carbolineum), tobacco smoke	—
Esters	Paints and varnishes, furniture-care agents, adhesives, stain removers, shoe polishes, nail-varnish remover, solvents	—
Phthalates	Floor covering, plastics	—
TXIB(3), texanol	PVC products	—
Nicotine	Tobacco smoke	—

Annex C table C.1 (concluded)

Pollutant	Source	Remarks
Inorganic components		
Carbon monoxide (CO)	Open fires, tobacco smoke, vehicle exhaust gases	AQG: 60 mg/m^3 (30 min) 30 mg/m^3 (1 h) 10 mg/m^3 (8 h) Control criterion of building environmental hygiene(4): 10 ppm
Carbon dioxide (CO_2)	Open fires, tobacco smoke, people, vehicle exhaust gases	Control criterion of building environmental hygiene(4): 1 000 ppm
Nitrogen dioxide (NO_2)	Open fires, tobacco smoke, vehicle exhaust gases	AQG: 400 μg/m^3 (1 h) 150 μg/m^3 (24 h)
Sulfur dioxide (SO_2)	Sulfur-containing fuels	AQG: 500 μg/m^3 (10 min) 350 μg/m^3 (1 h)
Ozone (O_3)	Photocopiers, laser printers	AQG: 200 μg/m^3 (1 h) 65 μg/m^3 (24 h)
Ammonia	Flooring, concrete, levelling agents, motar/plasters	—
Radon	Uranium and radium deposits close to the surface, building materials (granite, pumice stone and hot spring deposit), artificial plaster	—
Mercury	Broken thermometer	1 μg/m^3 (yearly average)
Lead	Paints	—
Particles matters		See [1] for dose-response relationship
Dusts	Suspended dusts	
Asbestos	Insulating materials, freeable asbestos	
Fibrous dusts	Mineral wool, building materials	
Aerosols	Tobacco smoke	
Suspended particulates		

NOTES (1) AQG: Air Quality Guidelines of the World Health Organization (1987)

(2) The Ministry of Health, Labour and Welfare: The interium report of the study meeting concerning sick house (indoor air pollution) problem – No. 4 – The 8th and 9th summary (2002) [5]

(3) TXIB : 2, 2, 4-Trimethyl-1, 3-pentanediol disobutyrate (TXIB) plasticizer for polyvinylchloride

(4) The Law Concerning the Securing of Hygenic Environment in Building (2003)

Annex D (informative)

Guidelines for information to be recorded during indoor air sampling

This Annex is to supplement the matters related to the text and not to constitute the provisions of this Standard.

It is of great benefit for the evaluation of the results to document the conditions in as much detail as possible during sampling. The following documentation scheme lists the desirable information. If necessary, some parts of the scheme may be omitted or new ones added. The final structure of the protocol should be fixed, together with the individual planning of the measurements.

A Sample information

A1 Sample number

A2 Pollutant monitored

A3 Reason for the measurement

A4 Address

B Time and type of sampling/monitoring

B1 Time of sampling/monitoring

Start Date: _____ Time of day: _____

Finish Date: _____ Time of day: _____

B2 Type of sampling/monitoring

☐ Active sampling

☐ Diffusive sampling

C Location of sampling/measurement

C1 Type of building/utilisation

☐ Residential building

☐ School/kindergarten

☐ Office building

☐ Hospital

☐ Shop

☐ Other building

C1-1 Type of building

☐ Traditional wooden house, prefabricated house (wooden type, steel type, concrete type), 2 × 4

☐ RC, SRC

C2 Years of building _____ years after completing of interior finish

C3 Environment around building (< 2 km)

C3-1 Area

☐ Agricultural and mountain villages

☐ Urban (suburban)

☐ Urban (central part)

C3-2 Amount of automobile traffic

☐ Area of little amount of automobile traffic

☐ free of much amount of automobile traffic

C3-3 Land use

☐ Residential area

☐ Commercial area

☐ Industrial area

☐ Chemically industrial area

☐ Coexistence of residential and industrial area

C3-4 Others

☐ Soil pollution

☐ Work in the neighbouring building, use of medicine and other characteristics conditions

C4 Outdoor parameters during measurement

Mean outside temperature _____ °C

Mean wind velocity _____ m/s

Mean wind direction _____

Mean relative humidity _____ %

Sunshine ☐ Yes ☐ No

Rain ☐ Yes ☐ No

Snow cover ☐ Yes ☐ No

C5 Utilization and heating of room

C5-1 Utilization of room

☐ Living room

☐ Kitchen

Heat source of cooking stove gas/electricity

☐ Bedroom

☐ Office

☐ Classroom

☐ Other room: which one? _____

Area: _____ m^2

Height: _____ m

☐ Plan classified by story of building to be measured, presence of windows, direction, presence of furniture and fittings

C5-2 Division of heating

Type of heating: _____

☐ Using time of heating apparatus, etc. _____

☐ Type of heating energy source:

☐ Oil

☐ Gas

☐ Coal

☐ Wood

☐ Electric

C6 Position of room in building (provide a sketch, if necessary)

☐ Room inside without window

☐ Room has _____ outer walls

Outer wall(s) directed to _____

Windows directed to:

☐ south

☐ north

☐ west

☐ east

Room directed to _____ (e.g. road courtyard)

C7 Siting of sampling equipment/measuring instrument in room (provide a sketch, if necessary)

Position of sampling

Distance from wall: _____ m

Height above floor: _____ m

C8 Number of story of building or rooms

☐ _____ story above ground _____ story under ground,

number of floor of measured room _____ floor

C9 Presence of residence and use

☐ Unoccupied

☐ Term of residence or use

C10 Handling of curtains and shutters

D Ventilation conditions before sampling/measurement

D1 Room with window ventilation (openable windows)

Type of window

- ☐ Single/double window
- ☐ Insulated glass window with rubber seal

The sealing provided by the windows in the room is

- ☐ Obviously good
- ☐ Obviously poor

D2 Ventilation state before measurement

- ☐ Room thoroughly ventilated

  Time: _____ min
- ☐ Windows and doors kept closed after ventilation

  Time: _____ h
- ☐ Normal ventilation pattern used by room occupants (regular mechanical ventilation)

D3 Confirmation of operation condition of ventilation and air conditioning system

Have the machines operated before sampling? : ☐ Yes ☐ No

How many hours have the machines operated? :

- ☐ Operating time of machines _____ hours
- ☐ Stopping time of machines _____ hours

D4 Information of ventilation and air conditioning system

- ☐ Type, performance, quality, dimensions and location of ventilation facilities
  - ☐ Humidifier
  - ☐ Heating type
  - ☐ Spraying type
  - ☐ Evaporating type
  - ☐ Introduction amount of outside air at the operating time of system _____ m^3/hr
- ☐ Date of last maintenance of system _____
  - ☐ Overall
  - ☐ Partial

E Room climate and ventilation conditions during sampling/measurement

E1 Room with window ventilation

☐ Windows and doors closed

☐ Normal ventilation pattern used by room occupants

window _____ open/close

door _____ open/close

E2 Room with ventilation and air-conditioning system

☐ System normally in operation

☐ System switched off

E3 Indoor-air parameters

☐ Mean room temperature _____ °C

☐ Mean relative room humidity _____ %

F Room fittings and condition

F1 Floor, wall, cell, cave backing

☐ Paper wall coverings

☐ Plastic wall coverings

☐ Painted plaster

☐ Coated boards

☐ Wood panelling

☐ Carpeted floor / tatami mat / claywall / fabric wall / paint / solid sawn lumber / flooring material

Bonded? ☐ Yes ☐ No

Age _____ years

☐ Plastic floor

Bonded? ☐ Yes ☐ No

Age _____ years

☐ Floor tile

☐ Other _____

F1-1 Furnitured or unfurnitured, its material and finishing _____

F2 Renovation

☐ Renovation within the last three months

What was renovated? _____

☐ Other changes to the room or its immediate vicinity (for example, adjacent rooms) within the last three months?

What were they? _____

F3 New furniture within the last three months

☐ Yes ☐ No

F4 Visible mold

☐ Yes ☐ No

Description: _____

G Activities of room users

G1 Number of people

Normal occupancy: _____ individuals

During sampling/measurement, _____ individuals were permanently in the room.

G2 Tobacco smoke (smoking habit of user or occupancy)

☐ Non-smoking room

☐ Smoking room

Average amount of tobacco consumed in the room per day
cigarettes/cigars/pipes

☐ There was smoking in the room before the start of the measurement

What? _____ (e.g. cigarettes/cigars/pipes)

How much? _____

☐ There was smoking in the room during the measurement

What? _____

How much? _____

When was the last time? _____

G3 Use of products in room/work (laundry, cleaning etc.)

Products were used in the room for the following purposes:

☐ Floor cleaning

Trade names of products _____

☐ rarely ☐ frequently

☐ Floor care

Trade names of products _____

☐ rarely ☐ occasionally ☐ frequently

☐ Furniture care

Trade names of products _____

☐ rarely ☐ frequently