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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.

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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 in 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 m² is regulated by the Law Concerning the Securing of Hygienic 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.

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

where, C_i : the mass concentration of substance in indoor air (mg/m³)
 Q : the strength of the source (mg/h)
 V : the volume of the room (m³)
 n : the number of air changes (h⁻¹)
 C_a : the mass concentration of substance in outdoor-air (mg/m³)
 A : the elimination factor (h⁻¹)
 t : the time (h)

Remarks : The “strength (mg/h)” is different from the “emission speed (mg/m²·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 many 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