



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS A 1964 : 2005

**Indoor air—Sampling strategy for
volatile organic compounds (VOCs)**

ICS 13.040.20

Reference number : JIS A 1964 : 2005 (E)

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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/CD 16000-5 : 2002** *Indoor air—Part 5: Sampling strategy for volatile organic compounds (VOCs)* 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.

Date of Establishment: 2005-11-01

Date of Public Notice in Official Gazette: 2005-11-01

Investigated by: Japanese Industrial Standards Committee

Standards Board

Technical Committee on Architecture

JIS A 1964 : 2005, First English edition published in 2006-07

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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

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Printed in Japan

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Indoor air—Sampling strategy for volatile organic compounds (VOCs)

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO/CD 16000-5** *Indoor air—Part 5: Sampling strategy for volatile organic compounds (VOCs)* published in 2002 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).

1 Scope This Standard is intended as an aid to the measurement plan of volatile organic compounds (hereafter referred to as “VOCs” indoor pollution.

Remarks: 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/CD 16000-5:2002 *Indoor air—Part 5: Sampling strategy for volatile organic compounds (VOCs)* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS A 1960 *Indoor air—General aspects of sampling strategy*

Remarks : **ISO/DIS 16000-1** *Indoor air—Part 1: General aspects of sampling strategy* is equivalent to the said standard.

JIS A 1966 *Indoor air—Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography—Pumped sampling*

Remarks : **ISO/DIS 16017-1** *Indoor, ambient and workplace air—Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography—Part 1: Pumped sampling* is equivalent to the said standard.

3 Definitions of volatile organic compounds (VOCs) Numerous volatile organic compounds (VOCs) are present in indoor environments. Depending on their boiling points, they are present in the gas phase, bound to suspended particle matter or deposited dusts. A working group of the World Health Organization (WHO) classified volatile organic compounds based on the boiling points as shown in table 1 [1]. In this Standard, VVOC, SVOC and POM are excluded.

Table 1 Classification of organic pollutants of indoor air [WHO 1989] [1]

Designation	Abbreviation (¹)	Boiling point range		Examples of sampling method(²)
		Lower limit of temperature	Upper limit of temperature	
Very volatile organic compounds	VVOC	< 0	50 to 100	Activated carbon, cooled sampling method, molecular sieves, canister method
Volatile organic compounds	VOC	50 to 100	240 to 260	Tenax, graphitized carbon, activated carbon
Semi-volatile organic compounds	SVOC	240 to 260	380 to 400	PUF (³), XAD-2(⁴)
Particulate organic matter	POM	> 380	—	Filter

Notes (¹) These abbreviations are used.

VVOC : Very Volatile Organic Compounds

VOC : Volatile Organic Compounds

SVOC : Semi-volatile Organic Compounds

POM : Particulate Organic Matter

(²) The WHO information has been supplemented.

(³) Polyurethane foam

(⁴) XAD-2 resin : Amberlite It is the resin of copolymer of XAD-2, styrene and divinylbenzene, with macro network structure. It well adsorbs substances such as polycyclic aromatic compounds.

This classification is based primarily on the boiling point and also takes into account aspects of the analysis, especially sampling. Since the state transition of substances is not steady, it is not practical to specify sharp limits for the boiling point ranges and the sampling methods according to temperature.

4 Sources and occurrence conditions Several hundred VOCs have been detected in indoor air hitherto. The sources are various and the most important sources are building materials, interior materials, human activities (for example, the activities related to smoking, repairing working and hobby work). The surrounding air (outdoor air) is also important depending on circumstances.

Recently, care shall be taken about the fact that the emission patterns continue to vary due to rapid development of products.

When the measurement method is considered, the emission characteristics of sources are especially important. The concentrations of VOCs in indoor air vary depending on rooms and vary especially as time elapses even in the same room. The following class of compounds can be frequently detected in indoor air.

- Alkanes, cycloalkanes
- Aromatic hydrocarbons
- Halogenated hydrocarbons
- Terpenes
- Aldehydes
- Ketones
- Alcohols, alkoxyalcohols
- Esters

This list does not include a number of groups of compounds such as carboxylic acids, isocyanates or amines. This is because these compounds generate in indoor air but can not be detected or can be only unsufficiently detected by the analytical methods applied usually for VOCs analysis.

For the analysis of these special VOCs including a number of polar compounds, not the above-mentioned method but the comparatively complicated techniques are required. Therefore, analysis for VOCs is scarcely carried out except that it is certainly necessary.

5 Measurement methods The methods for determining VOCs in indoor air may be divided into short-term and long-term measurement methods, herewith assuming that the determination of individual VOC is considered. However, the information of VOCs existing in indoor air can be determined in some case depending on a preliminary testing way even if VOCs are individually not separated.

The sampling and analytical methods to be used for analysis are described in **JIS A 1960** and **JIS A 1966**.

Information : The contents in this clause are equivalent to **ISO/DIS 16000-1: 2001** and **ISO 16017-1:2000**.

5.1 Short-term measurements Short-term measurements are generally understood as a sampling period of less than one hour.

The VOCs are concentrated in the sampling medium by being drawn through the sorbent using suction pumps (active sampling).

5.2 Long-term measurements Although it is possible to perform long-term measurement according to the active sampling with low air flow rate, the passive sampling is chosen for the long-term measurement.

The passive sampling predominantly works according to the diffusion principle and gives an integrated measurement value as a mean value over the selected exposure period (usually from several hours to several weeks). In this method, the short term peak concentrations contribute to raise slightly the mean value.

The passive sampler for VOCs is described in the bibliography [2]. The performance evaluation method for these passive samplers is also described in the bibliography [2].

When the passive sampling is adopted, the applied method should be described including the performance characteristics and uncertainty of measurement.

The information related to the use of passive sampler is as shown is Annex C.

5.3 Screening test The characteristics of screening test is to be capable of indicating the present air pollution quickly beforehand without a large-scale apparatus in spite of being insufficient at measurement place.

In the screening test, direct indicators are often used. These meters are generally possible to record continuously. This type of meter is provided with various detectors, such as flame ionization detector = FID, photo ionization detector = PID, photo acoustic sensor = PAS, and is much effective for searching the sources of indoor VOCs in some case.

In this type of instruments, some are not reacted with VOCs but reacted with VVOCs and SVOCs.

The preliminary test for VOCs requires to use a measurable detector as considering that the level of concentration is in the range of $\mu\text{g}/\text{m}^3$ being in common indoors. The one capable of measuring is commercially available on the market in Japan.

The detector on the market using oxidization reagent system is not capable of detecting VOCs until the range of concentration has reached to the unit of mg/m^3 . In addition, various compounds (such as aliphatic compounds, aromatic compounds, alcohols, ketones, esters) have different relative sensitivity. When these preliminary test methods are utilized, care shall be taken also of the principle of measurement plan as described in detail in the following.

6 Sampling plan The procedure when carrying out indoor air analysis depends on the measurement purpose and the emission characteristics of possible sources. Since sources that emit continuously and over long periods are typically the most important, the following specially target these types of sources.

For making the monitoring of continuous sources to be a purpose, the influence of intermittent sources shall be eliminated (see table 2). For the purpose, the VOCs caused by the intermittent sources shall be eliminated from the room as much as possible by ventilating sufficiently before measurement.

6.1 Measurement objectives and environmental conditions Before indoor air measurements are carried out, objectives of such measurements shall be clearly defined.

Basically, the following objectives for measurements are considered.

- A Confirmation of conformity to the guideline value in Japan
- B Confirmation of conformity to the guideline value in WHO
- C Determination of the average concentration over a relatively long period
- D Determination of the concentration occurring under the special condition
- E Identification of sources
- F Checking the success of remedial activities

Also, independently of the objectives A to F, it shall be made clear in advance whether it is wished to determine the concentration of single VOC, a relatively small number of predetermined VOCs, or VOCs as many as possible. If necessary, the measurement strategy shall be orientated accordingly.

Depending on the objective, different environmental conditions shall be maintained or recorded before and during measurements, which principally relate to the ventilation condition, the room temperature and the relative humidity.

A Confirmation of conformity to the guideline value in Japan

In the measurement of newly-build housing, the objective room is hermetically closed at least for 5 h after ventilated for 30 min, and then the air is sampled approximately for 30 min. The sampling time should be around 2 o'clock to 3 o'clock in the afternoon. During the hermetical period after ventilated, all the openings facing to outside air shall be shut, and all other fittings and doors, and doors of built-in furniture and fixtures in the room shall be opened.

When there is a normally ventilation system, the system may be operated during all the sampling period. At such a time, the opening related to the normally ventilation system need not to shut even during the hermetical period.

In the measurement of the housing in resident condition, sampling shall be carried out for 24 h under the condition of making daily life.

B Confirmation of conformity to the guideline value in WHO

In many cases, indoor air analyses are initiated by various types of complaints, which are expressed by the room occupants.

Complaints of this type can range from the perception of unknown and frequently unpleasant odours, to headaches, nausea or irritation of the nose, throat or eyes.

If VOC guideline values exist and these are time-related, the measuring or sampling period shall correspond to the specified time interval.

VOC measurement is carried out under the conditions described below.

After intensive ventilation for 30 minutes, doors and windows of naturally ventilated rooms are kept closed for about eight hours (optimally overnight). Prior to measurement, additional sealing measures such as taping over window and door gaps are not required.

Sampling is then performed for at most 60 min as doors and windows kept closed.

To obtain information on the effectiveness of ventilation, the room is ventilated intensively after sampling by opening doors and windows for five minutes. Doors and windows are reclosed and after one hour a further sample is taken.

When rooms are ventilated by mechanical ventilation or air conditioning systems the system shall be operated for three hours under the normal operating conditions prior to sampling.

If room occupants make complaints during unusual conditions, for clarification, measurement should also be performed under these conditions.

The VOC concentration level depends, if conditions are otherwise constant, on the indoor air temperature to a large extent, and possibly also on the relative humidity.

To obtain meaningful indoor air VOC concentrations, it is therefore essential to perform the measurement under the climate conditions under which the room being investigated is usually used.

C Determination of the average concentration over a relatively long time period

To carry out long-term measurements such as actual measurement surveys, diffusive samplers are generally used. In these cases, the room does not need to be prepared if the measurement period exceeds 24 h.

Usually, the sampling period does not exceed one month. In each case, the performance of the sampler used, the stability of the sampling medium, and the amount of chemical substances collected shall be the decisive factors.

In the case of long-term monitoring, the room occupants should continue their usual ventilation behaviour and other activities. The common activities shall be asked for and shall be documented before the examination. It is of particular importance here to obtain knowledge of the activity of intermittent sources. If deviations therefrom occur during the sampling period, these shall also be documented.

D Determination of the concentration occurring under special conditions

In some cases, it can also be of interest to obtain information on the level of VOC concentrations under special conditions. Such special conditions may occur, firstly, if a room is used under unfavourable climatic conditions, for example at temperatures outside in summer which the room occupants cannot alter this. Secondly, the emission of VOC from sources, which emit temporarily, for example when a solvent is used, can also be an unusual situation of this type. Accordingly a short-term measurement is performed under the conditions, which are expected to give rise to elevated VOC concentrations.

E Identification of sources

When an abnormally high level of VOC concentration is observed in indoor air, it is required to find what a method is suitable for the reduction of such concentration. For that purpose, the knowledge related to the VOCs sources is indispensable. For the first step to identify the source, the information obtained from the analytical results shall be carefully examined. And the general knowledge related to the emission characteristic and specific odour of material shall be considered.

The information related to the expected sources such as building materials, interior materials, office supplies, chemicals for cleaning are understood in more detail according to the following investigation.

Concerning the measurement methods, in addition to sensory inspection, the techniques suitable for searching VOCs sources are as follows.

- Compare the measurement results of air at the centre in room with the measurement results of air in the neighbourhood of the expected sources. Use a direct indicator, if possible.
- Use a portable type emission test container capable of setting on flat surface.
- Carry out the sampling and analysis of material.