

Committee on Sick House Syndrome: Indoor Air Pollution
Progress Report No.2
- Summary on the discussions at the 4th and 5th meetings -

15 December 2000

1. Guideline values of individual Volatile Organic Compounds (VOCs)

Scientific discussion leading to establishment of the setting of guideline values for indoor air concentration of ethylbenzene, styrene, chlorpyrifos and di-*n*-butyl phthalate is summarized.

(1) Outline of guideline values for indoor air concentrations

The guideline values for indoor air concentration mean that, given the current available scientific knowledge, no adverse health effects would be caused in humans with the lifetime exposure of the chemical at the level any more than the value. These values may be revised in the future, as necessary, depending on further available knowledge and/or progress in international assessment works based on such scientific knowledge.

The four chemicals newly given the guideline values - ethylbenzene, styrene, chlorpyrifos and di-*n*-butyl phthalate - were selected according to the criteria for the selection of VOCs subject to the guideline, Progress Report No.1, 26 June 2000.

The guideline values for indoor air concentration of these chemicals were all set up based on chronic toxicity via a long-term exposure.

It is hoped that the setting of the guideline values will promote mitigation in indoor air pollution, as a result, ensure comfortable and healthy indoor environment.

VOCs	Toxicity endpoint	Guideline value for indoor air concentration *
Formaldehyde	Nose, throat irritation in humans	100 $\mu\text{g}/\text{m}^3$ (0.08ppm)
Toluene	Effects on CNS ** -behavior functions, and development/ reproduction in humans	260 $\mu\text{g}/\text{m}^3$ (0.07ppm)
Xylene	Altered development of CNS** in offspring whose mother rat exposed during its pregnancy period	870 $\mu\text{g}/\text{m}^3$ (0.20ppm)
<i>p</i> -Dichlorobenzene	Liver/kidney effects in beagles dogs	240 $\mu\text{g}/\text{m}^3$ (0.04ppm)
Ethylbenzene	Liver/kidney effects in mice and rats	3800 $\mu\text{g}/\text{m}^3$ (0.88ppm)
Styrene	Brain/kidney effects in rats	220 $\mu\text{g}/\text{m}^3$ (0.05ppm)
Chlorpyrifos	Altered development of CNS** and morphological effects on brain in offspring whose mother rat exposed	1 $\mu\text{g}/\text{m}^3$ (0.07ppb) For children: 0.1 $\mu\text{g}/\text{m}^3$ (0.007ppb)
Di- <i>n</i> -butyl phthalate	Abnormal genitals in offspring whose mother rat exposed	220 $\mu\text{g}/\text{m}^3$ (0.02ppm)

* At 25 degree Celsius

** central nervous system

(2) Sampling and analytical methods

2-1 Ethylbenzene and styrene

The standard sampling/analytical methods of indoor air pollutants, which are provided in the Progress Report No.1, 26 June 2000, should be followed.

2-2 Chlorpyrifos and di-*n*-butyl phthalate

The sampling and analysis procedure for chlorpyrifos involves collection from air onto sorbent tubes and subsequent analysis by gas chromatography with MS. (solvent tube/solvent extraction/ GC-MS) It is recommended that the sampling be conducted at the height of 30 cm from the floor, and in a newly-built house, for at least two hours. It is advised that the capacity of sampler be large enough not to break down.

The sampling and analysis procedure for di-*n*-butyl phthalate involves collection from air onto sorbent tubes and subsequent analysis by gas chromatography with MS. (sorbent tube/solvent extraction/GC-MS or sorbent tube/thermal desorption and GC-MS)

The details of these sampling and analytical methods have still to be finalized.

Other possible analytical methods may be alternatively used for sampling/analysis as long as they are as equally or more accurate. A simple and comprehensive analytical method may be used for a screening purpose, but it should be ensured that underestimating the chemical pollution be avoided. Final assessment on measured concentrations should be made by the standard methods mentioned above.

2. Approach to guideline value of Total Volatile Organic Compounds (TVOCs)

It is indeed arduous to set up the TVOC guideline value based on toxicological data. However, if an approach and advisable value for the TVOC indicating the extent of indoor air quality can be provided, as low as reasonably achievable, by making the best of the realities on indoor VOC concentrations, it may then be useful to promote mitigation in indoor air pollution, as a result, ensure comfortable and healthy indoor environment.

(1) TVOC advisable value for indoor air quality

The advisable TVOC value for indoor air quality is 400 $\mu\text{g}/\text{m}^3$. This value is gained, as low as reasonably achievable, from the actual investigation of residential indoor VOC concentration in our country and an assumption. The TVOC advisable value is expected to be use for indicating the extent of indoor air quality. As it is not based on toxicological data, it must be treated separately from each individual VOC guideline value. Research and studies are further promoted to validate the advisable value and to set up the TVOC guideline based on health assessment. However, further attention should be paid to the pollutant sources and ventilation, and further efforts should be made to improve the house design and living and, as a result, to enhance indoor air quality.

Individual VOC guideline value and TVOC advisable value

The individual VOC guideline value means that, based on health assessment, no adverse effects would be caused in humans with lifetime exposure of the chemical at the

level no more than the value. However, the indoor environment with the VOC concentration under the value can not always be healthy and comfortable because, as a matter of the fact, a number of VOCs constitute and affect the indoor air. It is therefore necessary to provide guideline values for other VOCs in order. The work requires a great amount of time, while the pollution by chemicals having yet to gain the guideline values may increase. Accordingly, the TVOC is thought to be an important complementary indicator to prevent indoor pollution from expanding and to achieve more healthy indoor air environment. However, undertaking TVOC's health assessment still lacks data. Consequently, the advisable value has been gained, as low as reasonably achievable, from the actual investigation of residential indoor VOC concentration in our country. The individual VOC guideline value and TVOC advisable value should be treated separately from each other.

If the TVOC guideline value were provided based on health assessment, the indoor air environment should meet both guideline values of individual VOCs and the TVOC, and otherwise, the indoor air quality would be considered inappropriate. Bearing this in mind, it is recommended that all stakeholders use the TVOC advisable value for monitoring the extent of indoor air quality in further efforts to ensure comfortable and healthy indoor environment.

Approach to the interpretation of the TVOC analytical results

The TVOC advisable value has to do with the condition that a quite amount of time has passed since the habitation started. It is probable that, not long after the habitation, the measured TVOC will exceed the advisable value.

It is also noted that all the chemicals comprising the TVOC do not have cause for concerns about adverse health effects and that the TVOC may include chemicals derived from the sources normally used in residential environment.

Therefore, if the measured TVOC turned out to exceed the advisable value, the interpretation should be made taking into consideration the background factors such as the timing of the conduct of sampling and analysis, chemicals included in the TVOC analysis and the indoor chemical sources.

This refers to the Progress Report No.1, 26 June 2000, which describes the importance to further explore the methodology to assess the measured values, or how to interpret individual measured values with multiple background factors in relation to the guideline values.

(2) Sampling and analytical methods

While the detailed TVOC analytical procedures are still under preparation, the scheme refers to the European Commission Joint Research Center Environment Institute' report "Indoor Air Quality & Its Impact On Man: Report No.19: Total Volatile Organic Compounds (TVOC) in Indoor Air Quality Investigations, 1997". The report recommends the rationale and procedures to determine the TVOC. The following approach will then be taken

☆Sampling, sample transfer to the analytical system and separation

The standard sampling/analytical methods of indoor air pollutants, which are provided in the Progress Report No.1, 26 June 2000, should be followed. The indoor air is then sampled in no less than two samplers.

☆Detection and quantification of VOCs

- For the screening approach to the TVOC, use direct-reading instruments, and combine the indicated total area under the chromatographic curve with the response factor of toluene, that is, calculate the sum of concentrations of unidentified VOCs using the response factor of toluene.
- If the screening resulted in exceeding the TVOC advisable value, then use GC/MS and, based on individual response factors, quantify as many VOCs as possible. Calculate the sum of the concentrations of the identified compounds.
- Deduct from the directly-read sum the toluene equivalents of identified peaks, and add the sum of the concentrations of the identified compounds based on individual response factors. This amount is considered as the TVOC.
- Interim list of minimum number of compounds to include in the TVOC analysis has still to be completed. Actual investigation of the TVOC is underway.

☆Examples of compounds to include in TVOC analysis

- Aromatic hydrocarbons: toluene, ethylbenzene, xylene, styrene, etc.
- Aliphatic hydrocarbons: nonane, decane, tridecane, tetradecane, etc.
- Oxygenated hydrocarbons: 1-butanol, nonanal, methylethylketone, etc.
- Halogenated hydrocarbons: trichlorethylene, 1,1,1,trichlorethane, etc.
- Others: ethyl acetate, butyl lactate, etc.

3. Scope of the indoor air quality guideline

Any indoor air environment should be subject to these guidelines provided by the Committee unless there are particular chemical sources essential for productive life. Especially, any indoor air environment, where susceptible groups such as children, elderly, pregnant and patient will be probably exposed, should be subject to more thorough air quality control. Stakeholders' continual monitoring should enhance the effectiveness.

Indoors air environment

Residence (detached, apartments, etc.), office, store, sales, hospital / medical institution, school / educational institution, kindergarten / nursery, handicapped institution, nursing home for the elderly, hotel and inn, recreation facility, gymnasium / sport facility, library, restaurant and bar, theater / cinema, public bath, governmental office, underground shopping center, car, train, etc.

4. Inventory of sampling and analytical instruments for indoor air chemicals

An inventory on available analytical methods and instruments for indoor air chemicals, according to sampling and analytical mechanism and other characteristics, and the purposes, such as screening and evaluation based on the guideline values, has been developed to meet needs of users.

The Committee itself by no means verifies the listed information. It is attributed to a questionnaire completed by individual enterprises in the marketing survey, which was undertaken with the assistance from the Foundation of Building Environment Control and Education Center. Therefore, it is hoped that the inventory will be used as technical references for the users and clients.

The information will be updated according to the research and development of new analytical instruments or the improvement, as appropriate. The inventory will be made available not only on the Internet web-site of the Foundation or the Ministry of Health and Welfare, but also attached to a manual for analysis of indoor air pollutants and for consulting, which is under preparation.

5. Preparation for a manual for analysis of indoor air pollutants and for consulting

☆Manual for analysis of indoor air pollutants

The standard sampling/analytical methods of indoor air pollutants, which are provided in the Progress Report No.1, 26 June 2000, does not describe the details of applications. Conducting analysis can reveal the realities of indoor air pollutants, but it can not give solutions to all the relevant problems. Furthermore, it can be expensive and burdensome to the clients. It is therefore necessary to make these understood sufficiently by the clients on the conduct of analysis. Consequently, the following items should be described in the manual:

- Characteristics and selection of analytical methods
- Questionnaire requested of the clients on the conduct of analysis
- Indoor / ambient conditions and findings on the spot to be recorded
- Points to consider for advice on the spot
- Examples of questions & answers
- Others

☆Manual for consulting

The cause of indoor air pollution is attributed to the residence itself and to the way of living along with changes in the residential design. Relevant information and advice have so far been lacked. Only fragments of information made available, and the uncertainty and inadequacy of information can then cause uneasiness and/or doubt to increase. Consequently, the following items should be described in the manual:

- Basic flow for coping with consultation
- Indoor air pollutant VOCs
- Sources of indoor air pollutant VOCs
- Specifications of building materials
- Others

6. Subjects expected for and after the next Committee

(1) VOCs subject to newly setting up the guideline value

According to the criteria for the selection of VOCs subject to the guideline, Progress Report No.1, 26 June 2000, the following compounds have been selected:

- Tetradecane
- Nonanal

- Di-(2-ethyl-)hexyl phthalate
- Diazinone

(2) Subjects regarding analytical methods

☆Phthalic esters

Di-n-butyl phthalate has gained the guideline value and other phthalic esters will then follow. Because of the nature of phthalic esters, sampling and analytical methods should be different from those of other VOCs. The draft will be reviewed through public comments and then finalized.

☆Chlorpyrifos

Because of the nature of termiticide with the guideline value set up at much lower concentration level, sampling and analytical methods should be different from those of other VOCs. The draft will be reviewed through public comments and then finalized.

☆Manual for the TVOC analysis

Different methods and procedures may well alter measured TVOC level. Therefore, it is necessary to provide minimum standard analytical procedures:

- A list of minimum number of VOCs included in the TVOC analysis and reference standards
- Description of sampling, separation, detection and quantification
- Analytical window
- Screening and standard analysis

☆Update of the inventory on available analytical methods and instruments

Analytical methods and instruments are needed to be update any time. The current inventory is based on a questionnaire completed by individual enterprises. If the experimental verification were carried out by the third, the results would rather be included in the inventory.

☆Completion of the manual for analysis of indoor air pollutants and for consulting

(3) Collection of terminology and acronyms regarding Sick House Syndrome: Indoor Air Pollution

A collection of relevant terminology and acronyms will supplement the manual for

analysis and consulting and the inventory on analytical methods and instruments. It will serve as a textbook for awareness raising and proper understanding and consultant training. It will be made useful to the general public as well as the regulatory authorities.

(4) Information disclosure and continual monitoring system for indoor air quality

Information disclosure is requested of manufacturers and/or suppliers of chemical sources such as building materials and household products. It is then important to develop a continual monitoring system for indoor air quality. The constructor or the management would check the building/house for indoor air pollution periodically. They would also disclose the information on indoor air quality themselves or responding to the request of residents and those who carry on business and activities in the building/house.

Therefore, the organization of such system, for instance, co-operating with the analytical institutes, the building/house management and/or the residents, would be considered. Data on the measured pollutant concentration would be periodically collected from these monitors, published and utilized for the assessment of indoor air environment.

Appendix

Member of the Committee on Sick House Syndrome: Indoor Air Pollution

Dr Shunichi ARAKI
Dr Masanori ANDO
Dr Kouichi IKEDA
Dr Satoshi ISHIKAWA
Dr Iwao UCHIYAMA
Dr Haruhiko SAKURAI
Dr Shin-ichi TANABE
Dr Yoshiteru TSUCHIYA
Dr Yuzo HAYASHI (Chairperson)
Dr Masao HIROSE

Secretariat for the Committee

Mr. Akira KAWAHARA
Mr. Jun YOSHIDA
Mr. Kazuhiro KENMOTSU
Mr. Hideyuki HIRANO