

འབྲུག་གི་ རང་རླུང་སྤྱོད་ཚད་ཀྱི་གནས་ཚད།

## BHUTAN STANDARD

Indoor air quality



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**BHUTAN STANDARDS BUREAU**

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འབྲུག་གི་ རང་རྒྱུ་ལུས་ཚད་ཀྱི་གནས་ཚད།

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Director General  
Bhutan Standards Bureau  
Rijug Lam  
Thimphu-11001  
Tel: 00975-2-325104/325401  
Fax: 00975-2-323712/328298  
Web: [www.bsb.gov.bt](http://www.bsb.gov.bt)  
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## Table of contents

FOREWORD .....	iv
Introduction.....	v
1     Scope .....	1
2     Normative references.....	1
3     Terms and definition .....	1
4     Requirements.....	3
4.1   Organic and inorganic pollutant .....	3
5     Sampling and testing .....	3
5.1   Hydrocarbon .....	3
5.2   Inorganic pollutants .....	3
5.3   Particulate matter .....	3
5.4   Units of measurements .....	3
BIBLIOGRAPHY.....	8

## FOREWORD

This Bhutan Standard for Indoor Air Quality was developed by Bhutan Standards Bureau after the draft finalized by the Sustainability and Environment Technical (TC 10) and approved by the Bhutan Standards Bureau Board (BSB Board) on [Day Month](#) 2021.

The standard is drafted in accordance with the BSB Rule for Structure and Drafting of Bhutan Standards, 2017. Some of the elements of this standard may be the subject of copyrights. BSB shall not be held responsible for such copyrights. The *annex A* form the normative part of this standard.

This standard is subject to systematic review after five years to keep pace with environmental change, industrial and technological developments. Any suggestions and further information may be directed to the concerned Technical Committee.

## **Introduction**

Clean air is a basic requirement of life. The quality of air in indoor spaces where people spend a large part of their life is an essential for human well-being. Pollutants emitted from different sources lead to a broad range of health problems and may even be fatal. Therefore assessing and maintaining the pollutants' limit is essential for the health of the occupants.

The purpose of this Bhutan Standard for Indoor Air Quality are to define requirements, sampling and test methods for identified pollutants suitable for human occupancy. This standard provides the uniform basis for the protection of public health from adverse effects of indoor exposure to air pollution. The pollutants considered in this standard are common indoor air pollutants; hydrocarbon, halogenated hydrocarbons, inorganic pollutants and particulate matter.

The use of standard remains voluntary and when referenced by regulatory authorities as a basis for legislation, the standards become mandatory.





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## BHUTAN STANDARD FOR INDOOR AIR QUALITY

### 1 Scope

This standard prescribes the requirements, sampling and test methods for Indoor Air Quality suitable for human occupancy. The requirement for biological pollutants is not within the scope of this standard.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4226 *Air quality – General aspects – Units of measurements*

ISO 16000-1 *Indoor air- General aspects of sampling strategy*

ISO 16000-2 *Indoor air- Part 2: Sampling strategy for formaldehyde.*

ISO 16000-5 *Indoor air- Part 5: Sampling strategy for volatile organic compounds (VOCs).*

ISO 16000-37 *Indoor air – Part 37: Measurement of PM 2.5 mass concentration.*

### 3 Terms and definition

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

#### 3.1 Acceptable Indoor air quality

Air in an occupied space towards which substantial majority of occupants expressed no dissatisfaction and that not likely to contain contaminants at concentration leading to exposures that pose significant health risk.

#### 3.2 Acceptable perceived indoor air quality

Air in an occupied space towards which substantial majority of occupants express no dissatisfaction on the basis of odour and sensory irritation.

#### 3.3 Ambient air

Outdoor air to which people plants, animals or material may be exposed.

#### 3.4 Ambient air quality

State of the ambient air as indicated by the degree of contamination.

#### 3.5 Air pollutant

Any material emitted into the atmosphere either by human activity or natural processes and adversely affecting man or the environment.

#### 3.6 Air pollution

## **BTS 312:2021**

Usually the presence of substances in the atmosphere resulting either from human activity or natural processes, present in sufficient concentration, for a sufficient time and under circumstances such as to interfere with comfort, health or welfare of persons or the environment.

### **3.7 Halogenated hydrocarbon**

Hydrocarbons compound in which at least one hydrogen atom is replaced by halogen (E.g.  $C_2Cl_4$  – Tetrachloroethylene)

### **3.8 Hydrocarbons**

Organic compound consisting of only hydrogen and carbon (E.g.  $C_6H_6$  – Benzene)

### **3.9 Indoor air**

Air within an enclosed space, e.g., dwelling or public building.

### **3.10 Indoor Air Quality**

Quality of air inside the enclosed space, described in terms of odour, physical parameters, chemical and biological pollutants.

#### **3.10.1 Description for Indoor Air Quality**

The pollutants considered in this standard include hydrocarbon, halogenated hydrocarbon, inorganic pollutant, particulate matter and biological pollutant. For the purpose of households, the pollutants considered are;  $PM_{2.5}$ ,  $PM_{10}$ , benzene, formaldehyde, carbon monoxide, naphthalene, nitrogen dioxide, polycyclic-aromatic hydrocarbons (benzo[a]pyrene).

The limits related to individual biological pollutants cannot be specified as the health effects cannot be quantified precisely due to exposure to multiple agents simultaneously. The health risks of biological pollutants could be addressed through appropriate design and management.

The exposure limit prescribed are based on evidences and suspected health effects and an evaluation of human health risks for each pollutants.

### **3.11 Inorganic pollutant**

Air pollutants which does not have carbon-hydrogen bond (E.g. CO – Carbon Monoxide)

### **3.12 Particulate matter ( $PM_x$ )**

Particulate matter suspended in air which is small enough to pass through a size-selective inlet with a 50 % efficiency cut-off at  $x \mu m$  aerodynamic diameter.

**3.12.1  $PM_{2.5}$**  - Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at  $2.5 \mu m$  aerodynamic diameter.

**3.12.2  $PM_{10}$**  - Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at  $10 \mu m$  aerodynamic diameter.

### **3.13 Primary pollutant**

Air pollutant directly emitted from a source

### **3.14 Secondary pollutant**

Pollutants which may be produced in the atmosphere by physical or chemical processes from primary pollutant or other substances present as the result of emissions from stationary or mobile sources.

### **3.15 Suspended matter**

All particulate material which persists in the atmosphere or in a flue gas stream for lengthy periods because the particles are too small in size to have an appreciable falling velocity.

### **3.16 Volatile organic compound (VOC)**

Organic compound whose boiling point is in the range from (50 °C to 100 °C) to (240 °C to 260 °C)

Note 1 to entry: Boiling points of some compounds are difficult or impossible to determine because they decompose before they boil at atmospheric pressure. Vapour pressure is another criterion for classification of compound volatility that can be used for classification of organic chemicals.

## **4 Requirements**

### **4.1 Organic and inorganic pollutant**

The requirement affecting Indoor Air Quality shall conform to the *Annex A, Table 1*. The limits given in table are based on the exposure to single airborne chemicals through inhalation alone. They do not take account of additive, synergistic or antagonistic effects (except for the combined exposure to sulfur dioxide and particulate matter) or exposure through routes other than inhalation.

## **5 Sampling and testing**

The sampling strategy to aid the planning of indoor pollution monitoring shall conform to ISO 16000-1 *General aspects of sampling strategy*

### **5.1 Hydrocarbon**

**5.1.1** The sampling strategy for determination of formaldehyde shall be carried out in accordance to ISO 16000-2 *Indoor air- Part 2: Sampling strategy for formaldehyde*.

**5.1.2** The sampling strategy for determination of volatile organic compounds (except formaldehyde) shall be carried in accordance to ISO 16000-5 *Indoor air- Part 5: Sampling strategy for volatile organic compounds (VOCs)*.

### **5.2 Inorganic pollutants**

The sampling and determination of inorganic pollutants shall be carried out with standard methods/ validated test methods.

### **5.3 Particulate matter**

The sampling and determination/measurement of PM<sub>x</sub> concentration shall be carried in accordance to ISO 16000-37 *Indoor air – Part 37: Measurement of PM 2.5 mass concentration*.

### **5.4 Units of measurements**

For the purpose of reporting the air quality measurements, ISO 4226 *Air quality – General aspects – Units of measurements* shall be adhered.

**Annex A**

(Normative)

**Table 1. Indoor air quality exposure limit for individual pollutant (Clause 4)**

Sl. No.	Pollutant	Exposure limit (µg/m³)							
		10	15	30	1	8	24	1	1
		min	min	min	hour	hours	hours	week	year
Hydrocarbons									
1	Benzene <sup>a</sup>				No safe level				
2	Toluene	-	-	1000	-	-	-	260	-
3	Styrene	-	-	7	-	-	-	260	-
4	Polycyclic aromatic hydrocarbons <sup>b</sup>				No safe level				
Halogenated hydrocarbons									
1	Tetrachloroethylene	-	-	-	-	-	250	-	-
2	Trichloroethylene <sup>c</sup>				No safe level				
3	1,2-dichloroethane	-	-	-	-	-	700	-	-
Other hydrocarbons									
1	Formaldehyde	-	-	100	-	-	-	-	-
2	Naphthalene	-	-	-	-	-	-	-	10

Table 1 (Continued)

Inorganic pollutants									
1	Ammonia	-	-	-	1400	-	-	-	-
2	Carbon monoxide	-	1×10 <sup>5</sup>	6×10 <sup>4</sup>	3×10 <sup>4</sup>	1×10 <sup>4</sup>	7×10 <sup>3</sup>	-	-
3	Nitrogen dioxide	-	-	-	200	-	-	-	40
4	Sulfur dioxide	500	-	-	-	-	125	-	50
5	Ozone	-	-	-	-	120	-	-	-
6	Arsenic <sup>d</sup>	No safe level							
7	Cadmium	-	-	-	-	-	-	-	0.005
8	Manganese	-	-	-	-	-	-	-	0.5
9	Nickel <sup>e</sup>	No safe level							
10	Lead	-	-	-	-	-	-	-	0.5
11	Mercury	-	-	-	-	-	-	-	1
12	Radon <sup>f</sup>	No safe level							
Particulate matter									
1	PM2.5	-	-	-	-	-	25	-	10
2	PM10	-	-	-	-	-	50	-	20

<sup>a</sup> Estimated 6 deaths from cancer in population of 1 million through lifetime exposure of  $1 \mu\text{g}/\text{m}^3$

<sup>b</sup> Unit risk for lung cancer for PAH mixtures is estimated to be  $8.7 \times 10^{-5} \text{ ng}/\text{m}^3 \text{ B[a]P}$

## BTS 312:2021

<sup>c</sup> Estimated 4,3 deaths from cancer in population of 10 million through lifetime exposure of  $1 \mu\text{g}/\text{m}^3$

<sup>d</sup> Estimated 1500 deaths from cancer in population of 1 million through lifetime exposure of  $1 \mu\text{g}/\text{m}^3$

<sup>e</sup> Estimated 380 deaths from cancer in population of 1 million through lifetime exposure of  $1 \mu\text{g}/\text{m}^3$

<sup>f</sup> Estimated 30 to 60 deaths from in population of 1 million through lifetime exposure of  $1 \text{Bq}/\text{m}^3$



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**SUSTAINABILITY AND ENVIRONMENT TECHNICAL COMMITTEE (TC10)**

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Bhutan Standards Bureau (BSB)	Mr. Sherab Tenzin, Director General (Ex-officio member)

**Member Secretary**

Phurpa Wangdi  
Standardization Division  
Bhutan Standards Bureau