

Health & Safety Department (Environmental Health Section)

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Any modification to the document must be reviewed and approved
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1. Introduction

The Environmental Indoor Air Quality Index (EIAQI) is a scientifically developed metric aimed at evaluating and conveying the quality of indoor air across various building types. It provides a standardized approach to measuring indoor air pollutants and thermal comfort parameters, allowing stakeholders to effectively assess and manage indoor environments. Unlike traditional IAQ assessments that rely on individual pollutant thresholds, the EIAQI integrates multiple parameters into a comprehensive index, providing a clear and actionable representation of indoor air quality. This approach supports data-driven decision-making, ensuring that indoor spaces are safe, comfortable, and conducive to health and well-being.

Monitoring indoor air quality is essential for protecting public health, enhancing occupant productivity, and ensuring compliance with regulations. Poor IAQ has been associated with respiratory illnesses, cardiovascular issues, cognitive impairments, and overall reduced well-being. Considering that individuals spend most of their time indoors, whether at home, work, or public spaces, maintaining high indoor air quality is a critical public health priority. Effective management of IAQ leads to enhanced indoor comfort, improved energy efficiency in buildings, and long-term sustainability in urban environments. Furthermore, the growing adoption of IoT-based air quality monitoring systems has made real-time assessments and immediate corrective actions more achievable, reinforcing the importance of proactive IAQ monitoring.

The EIAQI is different from the Outdoor Air Quality Index (OAQI), which primarily focuses on external atmospheric conditions and their impact on ambient air quality. In contrast to outdoor air, indoor environments are affected by specific factors such as building materials, ventilation effectiveness, occupant activities, and localized sources of pollution. Consequently, the EIAQI is specifically designed to address these indoor variables, ensuring a more accurate evaluation of air quality within enclosed spaces. While outdoor AQI provides valuable insights for managing urban air pollution, the EIAQI serves as an essential tool for indoor environment management, complementing broader air quality initiatives within the built environment. By integrating indoor-specific parameters, exposure thresholds, and pollutant breakpoints, the EIAQI ensures that buildings in Dubai meet the highest standards of indoor air quality, fostering healthier indoor spaces for all occupants.

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2. Purpose

The purpose of this document is to provide a standardized framework for assessing and monitoring indoor air quality in buildings and facilities across Dubai. It outlines the methodology for developing and applying the Environmental Indoor Air Quality Index (EIAQI), ensuring alignment with local regulations and international best practices. The guideline supports accurate, health-based IAQ evaluation, enables data-driven decision-making, and facilitates regulatory compliance. It is intended for use by building owners, facility managers, and stakeholders to improve indoor environmental conditions, protect public health, and enhance the well-being, safety, and comfort of occupants.

3. Scope

This guideline applies to all buildings and facilities in Dubai, especially those equipped with IoT-based or smart indoor air quality monitoring systems, excluding medical healthcare facilities with special requirements. This guideline is intended for use by authorities, facility owners, building managers, and other stakeholders responsible for maintaining indoor air quality and ensuring a safe and healthy indoor environment.

4. Objective

The primary aim of this guideline is to provide a structured methodology for assessing and interpreting indoor air quality conditions using the Environmental Indoor Air Quality Index (EIAQI). These guidelines seek to enhance regulatory compliance, support sustainable building management, and protect occupants (especially vulnerable groups) from indoor air pollutants. Furthermore, they contribute to the integration of indoor air quality monitoring into building management systems, promote continuous air quality improvement, and ensure alignment with Dubai's environmental and public health policies.

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5. Definitions and terms

Built environment	The term-built environment refers to the human-made surroundings that provide the setting for human activity.
Indoor air	The air in an enclosed occupiable space.
Contaminant	An unwanted airborne constituent with the potential to reduce acceptability of the air.
Thermal Comfort	A combination of air temperature, humidity, and airflow that affects human comfort.
EIAQI	Environmental Indoor air quality index (EIAQI) is a descriptive scale used to show how polluted and comfort the indoor air is.

6. Framework for Developing the EIAQI

The Environmental Indoor Air Quality Index (EIAQI) is developed based on internationally recognized methodologies for assessing indoor air quality (IAQ) and includes regulatory thresholds, exposure limits, and health risk assessments. This framework ensures the scientific integrity, enforceability, and practical applicability of the EIAQI in various indoor environments within the jurisdiction of Dubai Municipality.

6-1 Principles for EIAQI Development

The EIAQI is based on the following key principles:

1. **Scientific Validity:** Based on epidemiological data, exposure-response relationships, and toxicological studies from sources such as the World Health Organization (WHO), the U.S. Environmental Protection Agency (EPA), and ISO standards.
2. **Regulatory Alignment:** Ensures compliance with Dubai Municipality IAQ regulations, as well as local and international IAQ standards.

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3. Health-Based Risk Assessment: Evaluates short-term (1-hour, 30-min, 15-min) and long-term (8-hour and 24-hour) exposure risks, particularly for sensitive groups such as children, the elderly, and individuals with respiratory conditions.
4. Indoor-Specific Exposure Considerations: Incorporates pollutant sources unique to indoor environments, such as building materials, HVAC systems, and human activities, which differ from outdoor air pollution sources.
5. Thermal Comfort and Ventilation Factors: Includes parameters such as temperature, humidity, and airflow, as they directly impact occupant health, productivity, and overall IAQ perception.
6. Enforceability and Practicality: Designed for real-world application in commercial, residential, educational, and industrial buildings (offices, reception area, dining rooms, etc.), with clear compliance mechanisms and monitoring requirements.

6-2 Parameters Selection for EIAQI

The selection of pollutants and environmental parameters for inclusion in the EIAQI is based on:

- Scientific Evidence: Pollutants with proven adverse health effects at common indoor exposure levels.
- Regulatory Requirements: Pollutants regulated under Dubai Municipality IAQ standards and global IAQ guidelines.
- Data Availability: Parameters that can be measured using IoT-based IAQ monitoring systems with validated sensor accuracy.
- Public Health Significance: Pollutants with significant impacts on occupant well-being, comfort, and cognitive performance.

6-3 Core Indoor Pollutants in EIAQI

The EIAQI focuses on key indoor air pollutants selected based on their prevalence in indoor environments, relevance to occupant health, and feasibility of measurement. The complete list of core pollutants included in the EIAQI is detailed in Section 7-1. These pollutants represent critical factors for evaluating air quality in a wide range of building types under Dubai Municipality's jurisdiction.

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6-4 Data Collection & Monitoring Approach: Appendix-1

To ensure accurate IAQ assessment, data collection and monitoring methods must be:

1. Real-Time & Continuous Monitoring: Using IoT-based smart sensors to provide real-time data on IAQ conditions.
2. Short-Term & Long-Term Exposure Assessment: Incorporating 1-hour exposure limits for immediate risk assessment and 8-hour & 24-hour averages for long-term trends.
3. Multi-Point Monitoring: Sensors should be installed at multiple locations within a building to account for spatial variations in IAQ.
4. Calibration & Standardization: Devices must comply with ISO 17025, to ensure data accuracy.

7. Methodology for Determining the EIAQI

The methodology for calculating the EIAQI aims to translate pollutant concentration levels and environmental parameters into a standardized numerical index. This methodology allows for uniform interpretation, risk assessment, and decision-making in indoor air quality management.

7-1 Selection of Indoor Air Pollutants

The EIAQI calculation is based on key indoor air pollutants known to impact human health and comfort. The selected pollutants for EIAQI determination include:

1. **Particulate Matter (PM₁₀ and PM_{2.5}):** Fine and coarse particulates that affect respiratory health.
2. **Carbon Dioxide (CO₂):** A marker of ventilation efficiency and indoor air stagnation.
3. **Carbon Monoxide (CO):** A hazardous gas affecting oxygen transport in the blood.
4. **Volatile Organic Compounds (VOCs):** Emissions from building materials, furnishings, and human activities.
5. **Formaldehyde (HCHO):** A common VOC from adhesives, paints, and composite wood products.
6. **Nitrogen Dioxide (NO₂):** A combustion byproduct affecting respiratory health.
7. **Ozone (O₃):** A secondary indoor pollutant resulting from air purifiers and photocopiers.
8. **Relative Humidity (%):** Impacts occupant comfort and potential mold growth.
9. **Temperature (°C):** Affects thermal comfort and perception of air quality.

Each of these pollutants is assigned a **sub-index value** based on concentration levels and their respective health impact thresholds.

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7-2 Pollutant Concentration Measurement

7-2-1 Sampling and Monitoring Protocols

- Indoor air quality measurements shall be conducted using calibrated sensors and certified monitoring devices.
- Measurement points should be strategically placed to represent typical occupant exposure, avoiding direct pollutant sources such as printers or kitchens.
- Sampling duration: Continuous real-time monitoring or periodic sampling over a minimum of 8 hours to capture variations.
- Short-term exposure levels (1-hour concentrations) should also be measured to assess acute exposure risks.

7-2-2 Data Collection Methods

Data collection is performed using IoT-based IAQ monitoring systems or handheld measurement devices.

7-3 Categorization of Overall EIAQI with Color Codes

To ensure clarity and usability, the EIAQI **follows internationally recognized color-coding systems**. The EIAQI is divided into six categories, each associated with a color code to facilitate easy interpret

Table No.1: EIAQI Categories and Color Codes:

EIAQI Score	Category	Color Code	Health Impact
0-50	Good	Green	Indoor air quality is healthy, no risk.
51-100	Moderate	Yellow	Air quality is acceptable, but some pollutants may pose a concern.
101-150	Unhealthy for Sensitive Groups	Orange	Individuals with respiratory conditions, children, elderly, may experience effects.
151-200	Unhealthy	Red	Increased health risks, discomfort for occupants.
201-300	Very Unhealthy	Purple	Severe health effects; mitigation required.
301-500	Hazardous	Maroon	Dangerous indoor air quality; immediate intervention needed.

7-4 Pollutant Breakpoints

Each pollutant is assigned breakpoints that correspond to specific EIAQI categories (Good, Moderate, Unhealthy, etc.).

Table NO.2: Pollutant Breakpoints for EIAQI Calculation:

Particulate Matter (PM _{2.5}) (µg/m ³)	Particulate Matter (PM ₁₀) (µg/m ³)	Carbon Dioxide (CO ₂) (ppm)	Carbon Monoxide (CO) (ppm)	Volatile Organic Compounds (VOCs) (mg/m ³)	Formaldehyde (HCHO) (µg/m ³)	Nitrogen Dioxide (NO ₂) (ppb)	Ozone (O ₃) (ppb)	Sub Index Values	Index category
0-12	0-50	400-600	0-4	0-0.3	0-50	0-50	0-50	(0-50)	Good
12.1-35	51-100	601-1000	4.1-9	0.31-0.6	51-80	51-100	51-100	(51-100)	Moderate
35.1-55	101-150	1001-1500	9.1-15	0.61-1	81-100	101-150	101-150	(101-150)	Unhealthy for Sensitive Groups
55.1-150	151-250	1501-2500	15.1-30	1.1-1.5	101-300	151-200	151-200	(151-200)	Unhealthy
150.1-250	251-350	2501-5000	30.1-50	1.51-2	301-500	201-300	201-300	(201-300)	Very Unhealthy
>250	>350	>5000	>50	>2	>500	>300	>300	(301-500)	Hazardous

7-5 Thermal Comfort Breakpoints

Thermal comfort parameters impact occupant satisfaction, health, and cognitive performance.

Table NO.3: Thermal Comfort Breakpoints for EIAQI Calculation:

Temperature (°C)	Relative Humidity (%RH)	Sub Index Values	Thermal Sensation
22 – 25.5	40 – 60	(0-50)	Comfortable
20-21.9 or 26-28	35-39.9 or 60.1-65	(51-100)	Slight discomfort
18-19.9 or 28.1-30	30-34.9 or 65.1-70	(101-150)	discomfort
16-17.9 or 30.1-32	25-29.9 or 70.1-75	(151-200)	Significant thermal stress
14-15.9 or 32.1-34	20-24.9 or 75.1-80	(201-300)	Severe discomfort
<15.9 or >34	<20 or >80	(301 500)	Extreme discomfort

7-6 Weight Assignment for Pollutants

Each pollutant is assigned a weight (W) based on its health impact severity.

The weighted sub-index is calculated as: $I_w = I_p \times W_p$

Where (I_w) is the weighted sub-index for each pollutant, I_p is Sub-index value for each pollutant, W_p is Weighting factor based on health impact.

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Table NO.4: Weight Assignment for Pollutants

Parameter	Weighting Factor (W _p)	Justification (Health Impact Severity & IAQ Relevance)
PM _{2.5}	0.25	Highest risk pollutant for respiratory & cardiovascular health.
PM ₁₀	0.14	Coarse particulates, slightly lower risk than PM _{2.5} .
CO ₂	0.13	Ventilation indicator; linked to cognitive decline at high levels.
CO	0.08	Acute toxicity; carbon monoxide poisoning risk.
VOCs	0.08	Strong indoor exposure source (furniture, paint, cleaners).
Formaldehyde	0.07	Carcinogen; causes respiratory & neurological effects.
NO ₂	0.07	Combustion pollutant; respiratory inflammation & chronic exposure risk.
O ₃	0.04	Less common indoors but still oxidative & irritative.
Temperature	0.06	Thermal comfort impact, linked to occupant productivity.
Humidity	0.08	Strong impact on mold growth, asthma, & air quality perception.

Calculation of Sub-Indices for Individual Pollutants

Each pollutant's concentration is converted into a **sub-index value (Ip)** using the following equation:

$$Ip = \left(\frac{C - C_L}{C_H - C_L} \right) \times (I_H - I_L) + I_L$$

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Where:

- I_p = Sub-index for the pollutant
- C = Measured concentration of the pollutant
- C_L = Lower concentration limit of the EIAQI category
- C_H = Upper concentration limit of the EIAQI category
- I_L = Lower sub-index value of the EIAQI category
- I_H = Upper sub-index value of the EIAQI category

Each pollutant's sub-index is determined using the EIAQI breakpoint table, which categorizes air quality into Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, and Hazardous as Table NO.1: EIAQI Categories and Color Codes.

7-7 Rules of Rounding and Cutting

- Values are rounded to the nearest whole number.
- Decimal values < 0.5 are rounded **down**, whereas ≥ 0.5 are rounded **up**.

7-8 Determination of the Final EIAQI Score:

7.8.1 Overall Approach to EIAQI Determination

The Environmental Indoor Air Quality Index (EIAQI) is determined using a dual-method approach to ensure both real-time risk communication and comprehensive IAQ assessment.

1- Real-Time EIAQI Determination (Dominant Pollutant Approach):

- The EIAQI score at the end of each hour is determined using the highest sub-index method, also known as the dominant pollutant approach.
- This ensures that the worst pollutant dictates the final EIAQI, immediately reflecting the most hazardous indoor air condition.
- This method is used for real-time IAQ alerts and regulatory actions.

$$EIAQI = \max(I_{p1}, I_{p2}, \dots, I_{pn})$$

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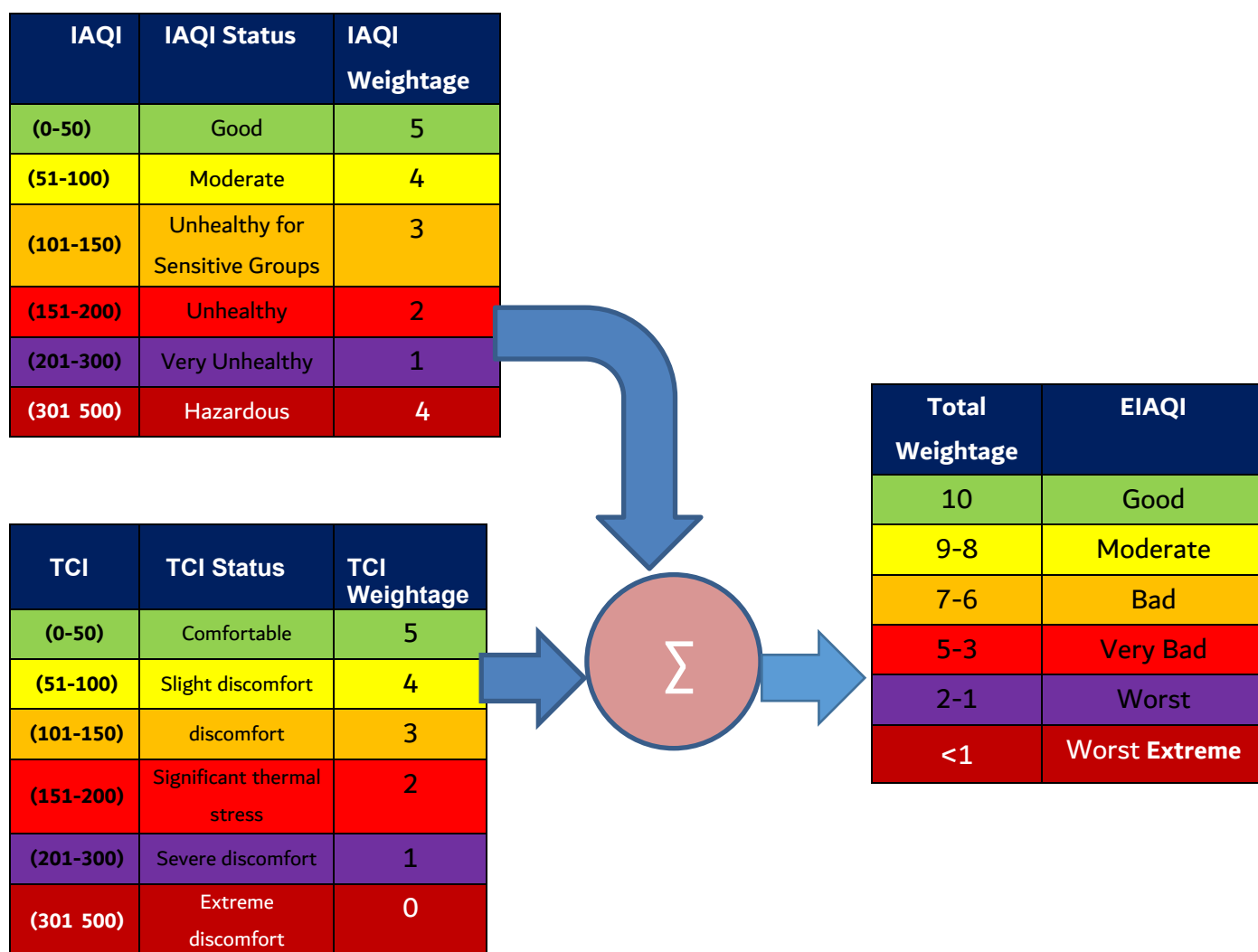
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2- Comprehensive EIAQI Assessment (Weighted Summation Approach)

- For longer-term IAQ reporting, a mathematical model is applied using the weighted summation approach.
- This approach calculates a cumulative EIAQI value for:
 - 8-hour averaging for short-term IAQ trends.
 - 24-hour averaging for comprehensive daily IAQ assessment.

$$EIAQ = \sum_{l=1}^n (I \times w_p)$$

FIGURE No.1. Calculation procedures for EIAQI:



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7.8.2 Calculation Approach:

Step 1: Compute Individual Pollutant Sub-Indices (I_p), Each pollutant's sub-index I_p is calculated using the breakpoint equation-1. For example, see **(Appendex-2)**

- This process is repeated for all pollutants.

Step 2: Determine the Real-Time EIAQI (Dominant Pollutant Approach). For example, see **(Appendex-2)**

- The highest I_p value determines the real-time EIAQI.

Step 3: Compute the Weighted Summation EIAQI for Reporting. For example, see **(Appendex-2)**

- To calculate the 8-hour and 24-hour EIAQI, each I_p is multiplied by its assigned weight W_p .

7.9 Regulatory Compliance and Reporting Requirements:

see **Appendex-1**

- The real-time EIAQI (based on the dominant pollutant) is used for immediate regulatory alerts and intervention.
- The weighted summation EIAQI (for 8-hour and 24-hour assessments) is used for detailed compliance reporting to regulatory agencies and stakeholders.
- Owners and Managements bodies must ensure that EIAQI threshold values are met, and non-compliance is addressed through enforcement measures according to Dubai Municipality IAQ regulation.
- Buildings with high-risk occupants (e.g., schools, elderly care homes) must implement enhanced IAQ monitoring protocols and additional mitigation strategies, as required by sector-specific IAQ guidelines.

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8. Appendixes

Appedex-1:

General Requirements

To ensure the accuracy, reliability, and regulatory compliance of indoor air quality (IAQ) assessment, data collection and monitoring shall adhere to the following legally enforceable requirements.

1. Continuous and Real-Time Monitoring:

- Indoor air quality parameters shall be monitored continuously using IoT-enabled or any smart sensors that provide real-time data transmission.
- Monitoring systems shall support automated data logging with timestamps to ensure traceability and compliance reporting.
- Real-time data shall be accessible to regulatory authorities for verification and enforcement purposes.

2. Short-Term and Long-Term Exposure Assessment:

- Data collection shall incorporate multiple exposure timeframes to assess both immediate and cumulative health risks:
 - 1-hour averaging for immediate risk assessment and compliance with short-term exposure limits (STELs).
 - 8-hour and 24-hour averaging for long-term IAQ trend analysis and regulatory compliance.
- The monitoring system shall automatically aggregate exposure data and generate compliance reports based on Dubai Municipality thresholds.

3. Multi-Point Monitoring and Spatial Coverage

- To account for spatial variations in IAQ, monitoring shall be conducted at multiple representative locations within the building, including but not limited to:
 - Occupied spaces (e.g., offices, residential areas, classrooms, shopping Malls,...etc).
 - Ventilation inlets and outlets to assess air distribution efficiency.
 - It is not in mandatory for High-risk zones such as kitchens, restrooms, storage areas for chemicals, and HVAC equipment rooms.
- The number and placement of monitoring devices shall be determined based Risk Assessments and on building size, occupancy density, and HVAC design, ensuring statistically valid data collection.

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4. Calibration, Standardization, and Compliance

- All IAQ monitoring devices and sensors shall be:
 - Calibrated and certified in accordance with ISO 17025.
 - Subject to routine calibration and performance validation by accredited laboratories or authorized service providers.
 - Equipped with data integrity safeguards, including tamper-proof logging mechanisms and cybersecurity protocols.
- Sensors must be capable of detecting and quantifying all regulated IAQ pollutants, including PM_{2.5}, PM₁₀, CO₂, CO, VOCs, Formaldehyde, NO₂, O₃, Temperature, and Humidity, at regulatory detection limits.

5. Data Storage, Access, and Reporting

- IAQ monitoring data shall be securely stored for a minimum period of five (5) years to ensure regulatory auditability.
- Data access shall be restricted to authorized personnel.
- IAQ compliance reports must be automatically generated at predefined intervals (hourly, daily, monthly) and submitted to the relevant regulatory authority for oversight and enforcement when required.

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Appedex-2:

Example:

For calculating the sub-index range let's assume the measured PM_{2.5} concentration indoors for 8-hour is 55 µg/m³.

Step 1: Compute Individual Pollutant Sub-Indices (I_p), Each pollutant's sub-index I_p is calculated using the breakpoint equation-1.

From the EIAQI Breakpoints Table, the range for PM_{2.5} is: (35.1-55).

Since **55 µg/m³** falls in the range **(35 - 55 µg/m³)**, the corresponding sub-index range is **101 - 150**.

- C = 55 µg/m³
- C_L = 35 µg/m³
- C_H = 55 µg/m³
- I_L = 101
- I_H = 150

$$I_{PM2.5} = \frac{(55-35)}{(55-35)} \times (150-101) + 101 =$$

$$I_{PM2.5} = \frac{20}{20} \times 49 + 101$$

$$I_{PM2.5} = 1.0 \times 49 + 101 = 150$$

The sub-index for **PM_{2.5} (I_p)** is 150, which falls under the "Unhealthy for Sensitive Groups" category. Which is means that an PM_{2.5} 8-hour average value of **55 µg/m³** corresponds to the Sub-index value of 150 for PM_{2.5} .

- This process is repeated for all pollutants.

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Step 2: Determine the Real-Time EIAQI (Dominant Pollutant Approach)

The highest I_p value determines the real-time EIAQI:

The Real-Time EIAQI Calculation (1-Hour Monitoring Data) for all parameters as follow:

Pollutant	Measured I_p
PM _{2.5}	150
PM ₁₀	110
CO ₂	98
CO	85
VOCs	107
Formaldehyde	95
NO ₂	102
O ₃	88
Temperature	80
Humidity	90

- Final Real-Time EIAQI = **150** (Unhealthy for Sensitive Groups, Orange), which (Determined by PM_{2.5} as the dominant pollutant).

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Step 3: Compute the Weighted Summation EIAQI for Reporting:

To calculate the **8-hour and 24-hour EIAQI**, each I_p is multiplied by its assigned weight W_p .

Pollutant	Measured I_p	Weight (W_p)	Weighted I_w ($I_p \times W_p$)
PM _{2.5}	150	0.25	37.5
PM ₁₀	110	0.14	15.4
CO ₂	98	0.13	12.74
CO	85	0.08	6.8
VOCs	107	0.08	8.56
Formaldehyde	95	0.06	5.7
NO ₂	102	0.08	8.16
O ₃	88	0.06	5.28
Temperature	80	0.06	4.8
Humidity	90	0.08	7.2
Total Weighted I_w	104.89	EIAQI = 105	Category: Unhealthy for Sensitive Groups ()

- Final EIAQI for 8-hour Reporting: 105 (Unhealthy for Sensitive Groups, Orange)
- Regulatory Interpretation: IAQ needs improvement; certain groups may be at risk.

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- Dubai Smart City Environmental Monitoring Framework (2023)

For (suggestions, comments, and complaints)	For further information
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