



UNITED ARAB EMIRATES
MINISTRY OF CLIMATE CHANGE
& ENVIRONMENT

Guideline for calculating the Emirati Air Quality Index (EAQI)

2023

■ Scope

All entities operating and overseeing air quality stations in UAE and reporting the information to the public in terms of pollution exposure and health related matters.

■ The mechanism for calculating the Emirati Air Quality Index

The Emirati Air Quality Index is designed to reflect the status of air quality in a given area in terms of pollution concentration and its effects on human health. This is done in order to provide the general population with recommendations to prevent the potential negative health impacts from the exposure to such pollution.

An Air Quality Index focuses on health effects that may be experienced within a few hours or days after breathing polluted air, and uses a normalized scale from 0 to 500. The higher the index value, the greater the level of pollution and the greater the health concern. The Index categories are described below.

I. Index categories, values and colour coding

The Emirati Air Quality Index value ranges from 0 to 500, and it is segmented into six categories named by descriptor words chosen to indicate the relationship between the air quality and public health. Each category has a designated colour from a predetermined colour-scale as depicted in **Table 1**.

Table 1: Emirati Air Quality Index: Category values, description and colours

| Emirati air quality index value | Colour | Index category (in English) | Index category (in Arabic) | Category description |
|---------------------------------|--------|--------------------------------|----------------------------|--|
| 0-50 | Green | Good | جيد | No risk for the population |
| 51-100 | Yellow | Moderate | متوسط | Acceptable for the majority of the population |
| 101-150 | Orange | Unhealthy for sensitive groups | غير صحي للمجموعات الحساسة | Sensitive individuals should avoid exposure |
| 151-200 | Red | Unhealthy | غير صحي | Greater proportion of the public may be affected |
| 201-300 | Purple | Very unhealthy | غير صحي بتاتا | Everyone may experience health effects |
| 301-500 | Maroon | Hazardous | خطر | Entire population expected to be affected |

It is understood that there may be not safe level of pollution at which health effects are not likely to occur, however National Standards are designed with the intend to protect public health with an adequate margin of safety.

The Emirati Air Quality Index incorporates the pollutants O₃, SO₂, NO₂, CO, PM₁₀ and PM_{2.5} in harmony with the pollutants controlled by the National Ambient Air Quality Standards^{1 2}.

As ambient concentrations of pollutants in the air increase, the proportion of individuals likely to experience effects and the seriousness of the health effects also increases. Different population groups are more sensitive to the harmful effects of the different air pollutants, and to advise each group the six categories have been defined as follows:

- **Good:** Indicates that the air quality is considered satisfactory and the air pollution concentrations poses no risk for the population.
- **Moderate:** In this range, the air quality is considered acceptable. The large majority of the population will not experience any effects. However, for some pollutants there may be a moderate health concern for a very small number of unusually sensitive people. This level is set in alignment to the National Ambient Air Quality Standard.
- **Unhealthy for sensitive groups:** Exposure to ambient concentrations just above the numerical level of the National Standard is not likely to result in concern for most healthy people. This category is intended to serve as a warning so that sensitive individuals can take appropriate 'exposure avoidance' behaviour.
- **Unhealthy:** In this range, exposure is associated with an increase in the number of individuals who could potentially experience effects, and includes a greater proportion of the members of the public.
- **Very unhealthy:** Everyone may experience more serious health effects when pollution concentrations are found within this range. It is at this level when health alerts are triggered.
- **Hazardous:** Corresponds to a level of pollution concentrations at which the entire population is expected to be affected. It is at this level when warnings for emergency conditions are issued.

Sensitive individuals refer to people with an increased risk to air pollution, either due to medical conditions, exposure conditions, or innate susceptibility. Sensitive individuals may include people with heart and lung diseases, older adults, infants and children, pregnant women, people with diabetes, etc.

¹ UAE Cabinet Decree 12 of 2006 Regarding Regulation Concerning Protection of Air from Pollution, Annex 8

² PM_{2.5} ambient air quality standard is not currently included in the cabinet decree 12 of 2006, but given the health concerns related to PM_{2.5} exposure a reference value is included in this Guideline.

II. Table of concentrations and sub-indices categories

The designation of a category is done for each pollutant based on its individual concentration level, by the means of *breaking points*. The breaking points act as the concentration range for which a category spans.

Table 2 below presents the breaking points for each pollutant. The setting of the breaking points follows best practices and best available science; further details of the rationale are provided in the Annex.

These breaking points per pollutant are presented again in more detail in **Table 3** under the methodology section, reflecting the changes for the numerical rounding conventions when calculating the Emirati Air Quality Index (EAQI).

Table 2: Breaking points for O3, CO, SO2, NO2 and PM10 sub indices of the Emirati Air Quality

| Sub-indices values | Ozone (O ₃) | | Carbon Monoxide (CO) | Sulphur Dioxide (SO ₂) | | Nitrogen Dioxide (NO ₂) | Particulate Matter (PM ₁₀) | Particulate Matter (PM _{2.5}) |
|--------------------|-------------------------|----------|----------------------|------------------------------------|------------|-------------------------------------|--|---|
| | µg/Nm ³ | | mg/Nm ³ | µg/Nm ³ | | µg/Nm ³ | µg/Nm ³ | µg/Nm ³ |
| | 1-hour | 8-hour | 8-hour | 1-hour | 24-hour | 1-hour | 24-hour | 24-hour |
| 50 | - | 0-100 | 0-5 | 0-92 | - | 0-100 | 0-75 | 0-50 |
| 100 | - | >100-120 | >5-10 | >92-350 | - | >100-400 | >75-150 | >50-60 |
| 150 | 200 -322 | >120-167 | >10-14.3 | >350-485 | - | >400-677 | >150-250 | >60-75 |
| 200 | > 322 - 400 | >167-206 | >14.3-17.8 | >485-797 | - | >677-1221 | >250-350 | >75-150 |
| 300 | > 400 - 792 | >206-392 | >17.8-35 | - | >797-1583 | >1221-2349 | >350-420 | >150-250 |
| 500 | >792 - 1184 | - | >35-58 | - | >1583-2631 | >2349-3853 | >420-600 | >250-500 |

III. Methodology for determination of the Emirati Air Quality Index

The Emirati Air Quality Index is calculated following the US-EPA AQI methodology³ adjusted to the UAE country conditions as per **Table 2**. The Emirati Air Quality Index corresponds to the highest value calculated for each pollutant as described below:

Step 1: Estimate the average concentration of each pollutant in the corresponding averaging period. If the averaging period is more than 1 hour, the moving average shall be used, with the last hour of the range being the hour for reporting of the Index.

- Ozone (O₃): 1-hour average and 8-hours rolling average
- Carbon Monoxide (CO): 8-hours rolling average
- Sulphur Dioxide (SO₂): 1-hour average and 24-hour rolling average
- Nitrogen Dioxide (NO₂): 1-hour average
- Particulate Matter (PM₁₀): 24-hours rolling average
- Particulate Matter (PM_{2.5}): 24-hours rolling average

Step 2: Truncate to decimal or integer as defined below, following the rounding and truncating rules described in [section IV \(Rules for rounding and truncating\)](#)

Step 3: Using **Table 3**, find the correspondent upper and lower breaking points that contain the truncated concentration.

Note that **Table 3** reflects the changes for the numerical rounding conventions when calculating the Emirati Air Quality Index and shall be the one used within the computing.

³ US Environmental Protection Agency (2018) Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI) Available at: <https://www.airnow.gov/sites/default/files/2020-05/aqi-technical-assistance-document-sept2018.pdf> (pg. 9-12)

Table 3: Breakpoint for Emirati AQI calculation

| Ozone (O3) µg/Nm3 | | | | Carbon Monoxide (CO) mg/Nm3 | | Sulphur Dioxide (SO2) µg/Nm3 | | | | Nitrogen Dioxide (NO2) µg/Nm3 | | PM10 µg/Nm3 | | PM2.5 µg/Nm3 | | Sub-Index Value | | Category |
|------------------------|------------------------|------------------------|------------------------|--------------------------------|------------------------|---------------------------------|------------------------|------------------------|------------------------|----------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|-----------------------|-----------------------|--------------------------------|
| 1-hour ave | | 8-hour ave | | 8-hour ave | | 1-hour ave | | 24-hour ave | | 1-hour ave | | 24-hour ave | | 24-hour ave | | <i>I_{Lo}</i> | <i>I_{Hi}</i> | |
| <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | <i>BP_{Lo}</i> | <i>BP_{Hi}</i> | | | |
| - | - | 0 | 100 | 0.0 | 5.4 | 0 | 92 | - | - | 0 | 100 | 0 | 75 | 0.0 | 50.4 | 0 | 50 | Good |
| - | - | 101 | 120 | 5.5 | 10.4 | 93 | 350 | - | - | 101 | 400 | 76 | 150 | 50.5 | 60.4 | 51 | 100 | Moderate |
| 200 | 322 | 121 | 167 | 10.5 | 14.4 | 351 | 485 | - | - | 401 | 677 | 151 | 250 | 60.5 | 75.4 | 101 | 150 | Unhealthy for sensitive groups |
| 323 | 400 | 168 | 206 | 14.5 | 17.9 | 486 | 797 | - | - | 678 | 1221 | 251 | 350 | 75.5 | 150.4 | 151 | 200 | Unhealthy |
| 401 | 792 | 207 | 392 | 18.0 | 35.4 | - | - | 798 | 1583 | 1222 | 2349 | 351 | 420 | 150.5 | 250.4 | 201 | 300 | Very unhealthy |
| 793 | 1184 | - | - | 35.5 | 58.4 | - | - | 1584 | 2631 | 2350 | 3853 | 421 | 600 | 250.5 | 500.4 | 301 | 500 | Hazardous |

Step 4: Use Equation 1 to calculate a sub-index for each of the six pollutant

$$SI_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} (C_p - BP_{Lo}) + I_{Lo}$$

Where,

SI_p = Sub-index for pollutant p

C_p = The truncated concentration of pollutant p

BP_{Hi} = the concentration breakpoint that is greater than or equal to C_p

BP_{Lo} = the concentration breakpoint that is less than or equal to C_p

I_{Hi} = the index value corresponding to BP_{Hi}

I_{Lo} = the index value corresponding to BP_{Lo}

Notes:

- Ozone (O₃):**
- a) Estimate the 1-hour and 8-hour sub-indexes, and select the value which corresponds to the maximum of both sub-indexes.
 - b) For 1-hour O₃ values below the National Standard, the Sub-Index is calculated using 8-hour O₃ concentrations
 - c) For 8-hour O₃ values above 392µg/Nm³, the Sub-Index is calculated using 1-hour O₃ concentrations

Sulphur Dioxide (SO₂): For 1-hour SO₂ values above 797µg/Nm³, the Sub-Index is calculated with 24-hour SO₂ concentrations

Step 5: Round the sub-index calculated to the nearest integer ([see section IV](#))

Step 6: From the six sub-indexes calculated, select the sub-index with the highest value and its correspondent category, the highest value and its correspondent category will represent the Emirati Air Quality Index.

IV. Rules for rounding and truncating

Rounding and truncating conventions are in place to avoid situations where a health advisory could be issued that describes the air as unhealthy, when in fact the numerical level of the standard has not been exceeded.

Truncating: Truncating is a method of approximating numbers. When truncating, all digits after the desired level of accuracy are removed, and using only the remaining digits. For example, the number 38.4567 truncated to the integer would be 38, the same number truncated to one decimal will be 38.4

For all sub-indices estimations, the concentrations of pollutants O₃, SO₂, NO₂, and PM₁₀ are truncated to the nearest 1 ug/m³, nearest 0.1 mg/m³ for CO and nearest 0.1 ug/m³ for PM_{2.5}.

The truncated concentrations are used as inputs for the sub-indices calculations.

Rounding: Rounding means replacing a number with an approximate value that has a shorter, simpler, or more explicit representation. This technique is used to obtain a value that is easier to report and communicate than the original.

For the calculation of the resulting Emirati Air Quality Index, the index value obtained is rounded to the nearest whole number (not decimals). For example, 50.4 is rounded to 50, while 50.6 rounds to 51.

Example

The 8-hour average concentration of Ozone is 135.4850 µg/Nm³. First, truncate the value to 135. Then, refer to the 8-hour ozone columns in **Table 3** searching for the values that fall above and below 135 (in this case 125 and 169). Identify the correspondent sub-index values, 101 and 150 for this example.

Used the gathered numbers in Equation 1:

$$SI_{O_3} = \frac{150 - 101}{167 - 121} (135 - 121) + 101 = \frac{49}{46} (14) + 101 = 115.913 = 116$$

This means that an Ozone 8-hour average value of 135.4850 µg/Nm³ corresponds to the Sub-index value of 116 for ozone.

Do the same for all other five pollutants.

Suppose you have a CO value of 2.965 mg/m³, an SO₂ value of 100.678 µg/Nm³, NO₂ value of 98.896 µg/Nm³, PM₁₀ value of 63.521 µg/Nm³ and PM_{2.5} value of 60.256 µg/Nm³. Apply the equation five times:

$$SI_{CO} = \frac{50-0}{5.4-0} (2.9 - 0.0) + 0 = 27$$

$$SI_{SO_2} = \frac{100 - 51}{350 - 93} (100 - 93) + 51 = 52$$

$$SI_{NO_2} = \frac{50 - 0}{100 - 0} (98 - 0) + 0 = 49$$

$$SI_{PM_{10}} = \frac{50 - 0}{75 - 0} (63 - 0) + 0 = 42$$

$$SI_{PM_{2.5}} = \frac{100 - 51}{60.4 - 50.5} (60.2 - 50.5) + 51 = 99$$

The Emirati Air Quality Index Value is 116 and category 'Unhealthy for sensitive groups', being Ozone the driving pollutant.

V. Reporting period

The Emirati Air Quality Index is to be reported hourly, in the closest hour to the availability of the readings.

The moving or rolling average is adopted for the purposes of calculating concentrations for pollutants with a reference period of more than 1 hour, as per Error! Reference source not found..

VI. Data validation procedures

- a) For 8 and 24-hour rolling averages, there should be at least 6 and 18 valid hourly averages respectively.
- b) In the event of absence of sufficient valid data to calculate the rolling average (less than 6- 18 hours), and all the available hourly values are below the standards then report the sub-index for the respective pollutant as (null).

- c) In the event of absence of sufficient valid data to calculate the rolling average (less than 6- 18 hours), and if at least one of the hourly values is above the standards then use the maximum hourly value to estimate the sub- index.
- d) When the hourly concentration of the pollutants exceeds the following values presented in Table 4, it shall be reported as null.

Table 4: Threshold for validation of maximum hourly concentration

| Pollutant | Max recorded hourly concentration |
|-------------------------------------|-----------------------------------|
| CO mg/m ³ | 150.4 |
| SO ₂ µg/m ³ | 1750.4 |
| NO ₂ µg/m ³ | 2000.4 |
| O ₃ µg/m ³ | 1000.4 |
| PM ₁₀ µg/m ³ | 2500.0 |
| PM _{2.5} µg/m ³ | 2500.0 |

Annex:

Rational of sitting the breaking points upon best practices and best available science

- a) For all pollutants, the upper/higher breakpoint in the 'Moderate' category corresponds to the National Ambient Air Quality Standards.
- b) For Ozone, the 8-hour running average is used, as it most closely represents the exposure likely to be harmful to human health. Effects on health occur from Ozone exposure over several hours. The 'Good' category is set in accordance to the WHO Air Quality Guideline level⁴. Breakpoints for other categories are in accordance to the US-EPA guidance for the Air Quality Index⁵.
- c) For Carbon Monoxide, the running 8-hour average provides the most suitable control to keep blood carboxyhaemoglobin levels below 2.5% where health effects (including a safety margin) can be observed. Breakpoints are in accordance to the US-EPA guidance for the Air Quality Index.
- d) For Sulphur Dioxide, the hourly average provides the best available averaging period as the effects of sulphur dioxide exposure occur very rapidly. Breakpoints are set in accordance to the US-EPA guidance for the Air Quality Index. US-EPA does not define breakpoints for the 1-hour SO₂ in the 'Very unhealthy' and 'Hazardous' categories. For those, the 24-hour SO₂ concentrations (rolling averages) are used.
- e) For Nitrogen Dioxide, the hourly averaging period is used since the effects on health in experimental studies on people with asthma were detectable within an hour of exposure. Breakpoints are set in accordance to the US-EPA guidance for the Air Quality Index.
- f) For PM₁₀, evidence indicates that acute health effects occur after pollution episodes lasting at least 24 hours, therefore the averaging period should be 24 hours (rolling average). Breakpoints are in accordance to the US-EPA guidance for the Air Quality Index.
- g) For PM_{2.5}, in the absence of a National Ambient Air Quality Standards, the upper/higher breakpoint in the 'Moderate' category corresponds to the proposed ambient standard for the UAE. The upper/higher breakpoint in the 'Good' category corresponds to the WHO Interim target 2, and the upper/higher breakpoint in the 'Unhealthy for sensitive groups' category corresponds to the WHO Interim target 1. All other breakpoints are in accordance to the US-EPA guidance for the Air Quality Index.
- h) For the purposes of conversions between ppb and µg/Nm³, the appropriated conversion factors at 25 degrees Centigrade and at an absolute pressure of 760 millimetres of mercury (1 atm) has been used, as per Cabinet Decree 12 of 2006 Regarding Regulation Concerning Protection of Air from Pollution, Annex 8

⁴ World Health Organization (2021) WHO global air quality guidelines: particulate matter (PM10 and PM2.5) ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide.

⁵ US Environmental Protection Agency (2018) Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI) Available at: <https://www.airnow.gov/sites/default/files/2020-05/aqi-technical-assistance-document-sept2018.pdf>