Regulated Air Pollutants & How to Choose an Air Monitoring Device


Source: EEA, 2017c, 2017d.

Source: U.S. EPA Air Quality System
Introduction

The air quality in the U.S. and the EU has improved significantly since the formation of the Environmental Protection Agency (EPA) in the U.S. in 1970 and EEA in the EU in 1994.

But pollutant concentrations are still much higher than the maximum acceptable limits. More than a million people die each year in the U.S. and the EU because of polluted air. The medical debt attributable to air pollutants amounts to billions of dollars.

Active campaigning by the increasing number of environmental bodies is raising public awareness around air quality. Consequently, governments all around the world are under an increasing pressure to exercise stricter industrial air emissions controls and air quality monitoring. The French government has already made air monitoring mandatory in schools and daycares. The EU has issued one last warning to the UK, Poland, and seven other member states to respect the pollutant limits. With penalties ranging upwards of millions of dollars, member states face significant risks if they fail to comply.

Clearly, air pollution is now a top health and environmental issue. It’s just a matter of time before air monitoring becomes mandatory for most industries in the developed nations.
Air pollution kills more than a million people each year in the U.S. and the EU.
To help you stay ahead of the compliance curve, learn about the regulated air pollutants and the changing air monitoring trends, in this paper we briefly discuss:

**Major air pollutants**
why they are dangerous and require regulation and monitoring.

**How to choose a near-reference air monitoring device**
so you can make an educated decision and choose the right device for your needs.

**Near-reference air monitoring devices**
to end your search for a device that is accurate and simple yet affordable.
Section 1

Major Air Pollutants
In the U.S., air pollution is regulated by the Clean Air Act. It requires the EPA to set NAAQS (National Ambient Air Quality Standards) for six major pollutants commonly referred to as the Criteria Pollutants. The EU regulates Ammonia and Volatile Organic Compounds in addition to the six Criteria Pollutants.
Ground Level Ozone

Ozone is good or bad depending on where it is found. High up in the atmosphere it protects us from harmful radiation but at the ground level, it is toxic.

Sources

Ozone is not emitted directly into the air. It is formed when NO\textsubscript{x} react with VOCs in the presence of sunlight.

Health Effects

By constricting airway muscles, ozone causes wheezing and shortness of breath. It leads to and worsens respiratory diseases including asthma and bronchitis.

Nitrogen Dioxide

All oxides of nitrogen are pollutants. Since NO\textsubscript{2} occurs in higher concentration than other oxides, controlling its emissions ensures control of other nitrogen oxide pollutants.

Sources

It is released when fossil fuel is burnt in vehicles and machinery.

Health Effects

As discussed above, it reacts in the atmosphere to form ozone which in turn has many adverse health effects. NO\textsubscript{2} too is damaging to the respiratory system.
**Particulate Matter (PM)**

Solid or liquid particles in the air are referred to as Particulate Matter. Their size varies from large particles like soot and dirt to particles too small to be seen with the naked eye. Particles between 2.5 and 10 micrometres in size are referred to as PM$_{10}$ and smaller as PM$_{2.5}$.

**Sources**

PM is most commonly formed during construction activities such as crushing and grinding. It is also released in smaller amounts from sources such as unpaved roads, smokestacks, fires etc.

**Health Effects**

PM$_{10}$ and PM$_{2.5}$ lodge deep in the airway and cause respiratory and heart diseases. PM combined with heavy metals (released from formerly contaminated sites) are toxic. Lead toxicity from contaminated PM is fairly common.

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**Lead**

**Sources**

Lead is released when garbage containing lead is burnt. Other major sources of lead are ore/metals processing and leaded aviation fuel, waste incinerators, and lead-acid batteries. Lead is found in highest concentrations around lead smelters.

**Health Effects**

Lead is toxic to children and infants even at low levels. It causes neurological damage in children and cardiovascular diseases in adults.
**Sulphur Dioxide**

Like Nitrogen Dioxide, Sulphur Dioxide is the most common source of sulphur oxides. Controlling the levels of $SO_2$ controls the levels of other sulphur oxides, all of which have adverse health effects.

**Sources**

Burning of fossil fuel by power plants and other industrial facilities releases most of the $SO_2$ found in the atmosphere. Smaller sources of emissions are industrial processes such as metal extraction.

**Health Effects**

$SO_2$ causes respiratory and cardiovascular diseases. It reacts with other elements in the atmosphere to form sulphuric acid (acid rain) which damages buildings and the environment. By combining with fine particles, it forms haze which decreases visibility.

**Carbon Monoxide**

A colourless and odourless gas, CO readily dissolves in blood.

**Sources**

CO is released when something is burned. In the outdoor air, the greatest sources of CO are vehicles and machinery burning fossil fuels.

**Health Effects**

Even low concentrations of CO in the outdoor air aggravate heart diseases. High level of CO in the indoor air causes dizziness, confusion and death.
Ammonia

Sources
The single major source of ammonia is agriculture.

Health Effects
It is corrosive to skin and eyes and causes fluid to accumulate in the lungs leading to death.

Non-Methane Volatile Organic Compounds

VOCs emitted by industrial processes and transportation are regulated in the EU. Methane, a VOC and greenhouse gas, is not regulated as its primary source is agriculture. But in its 2017 report, EEA recognized methane from agriculture as a major pollutant that requires regulation.

Sources
The major source of VOC in the EU is solvent and product use industry followed by the burning of fossil fuels in vehicles and equipment.

Health Effects
VOCs cause cancer. They react with NO\textsubscript{x} to form Ground Level Ozone.
Section 2

How to Choose an Air Monitoring Device
To improve the measurement of air quality, governments are encouraging industries to use near-reference air monitoring devices along with traditional reference stations.

Governments themselves are increasingly using near-reference devices to identify polluted areas in cities. Offices are also using these devices to detect poor indoor air quality that affects worker productivity.
Not all near-reference air monitoring devices are the same. You must keep a few factors in mind before making your purchase decision. To begin, you should first determine:

- The specific pollutants to measure
- The field conditions you might encounter
- The duration for data collection

For example, if you are a university student and are collecting data to demonstrate local air pollution, you do not need high accuracy and precision. But if you have mining, construction or oil & gas operations, then you likely need a combination of reference stations and highly accurate near-reference air monitoring devices to obtain useful results.
To assist organizations in choosing the right near-reference air monitoring device, the U.S. EPA prepared an Air Sensor Guidebook. The guidebook recognizes near-reference air monitoring devices as an emerging and revolutionary technology.

The guide lists and explains factors that one should keep in mind when purchasing an air monitoring device. Below we have summarized those factors for your convenience. You can find the complete EPA guidebook here:

https://www.epa.gov/air-sensor-toolbox/how-use-air-sensors-air-sensor-guidebook
Detection Range and Detection Limit

Pollutant concentrations in the ambient air depend on the proximity to the pollutant source. The main pollutants’ average range (minimum to maximum concentration) in outdoor air is listed in the table below.

You must ensure that the device you choose is sensitive across the entire range of the pollutant.

<table>
<thead>
<tr>
<th>Air Pollutant</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone (O₃)</td>
<td>0-150 ppb</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>0-0.3 ppm</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO₂)</td>
<td>0-100 ppb</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>0-50 ppb</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>350-600 ppm</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>1500-2000 ppb</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOC)</td>
<td>5-100 µg/m³ (24hrs)</td>
</tr>
<tr>
<td>Benzene</td>
<td>0-3 µg/m³ (24hrs)</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM₂.₅)</td>
<td>0-40 µg/m³ (24hrs)</td>
</tr>
<tr>
<td>Particulate Matter (PM₁₀)</td>
<td>0-100 µg/m³ (24hrs)</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0-0.1 µg/m³ (24hrs)</td>
</tr>
<tr>
<td>Black Carbon (BC)</td>
<td>0-15 µg/m³ (24hrs)</td>
</tr>
</tbody>
</table>

Concentration range of common air pollutants in ambient air

Calibration Requirements

Calibration compares the response of the instrument to a known reference value. Before buying the device, you must ensure that:

- the manufacturer has calibrated the device and
- the product manual contains proper instructions on calibration and information on how long the calibration will last
Precision and Bias

Precision and bias determine the overall accuracy of the device. Precision is the number of times the device reproduces the measurement under identical circumstances. Bias is the error in the device—how much higher or lower than the true measurement the device measures.

The acceptable ranges for bias and precision are given in the table below. Depending on your monitoring objective, you must ensure that the device has no more error.

<table>
<thead>
<tr>
<th>Air Monitoring Objective</th>
<th>Pollutant</th>
<th>Precision &amp; Bias Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>All</td>
<td>&lt;50%</td>
</tr>
<tr>
<td>Identification of specific localized areas for pollution</td>
<td>All</td>
<td>&lt;30%</td>
</tr>
<tr>
<td>Extra data points in addition to reference monitoring</td>
<td>All</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Indoor</td>
<td>All</td>
<td>&lt;30%</td>
</tr>
<tr>
<td>Regulatory</td>
<td>Criteria Pollutants (O\textsubscript{3}, CO, SO\textsubscript{2}, NO\textsubscript{2}, PM\textsubscript{2.5}, PM\textsubscript{10})</td>
<td>&lt;10%</td>
</tr>
</tbody>
</table>

Acceptable ranges for bias and precision

Response Time

If your objective is to measure rapid changes in pollutant concentrations then a portable device that takes measurements in real-time is much more suitable than a stationary device.
Durability
If you plan to measure outdoor air quality then your device must be weatherproof as varying temperatures and weather conditions can damage the device.

Packaging
Outdoor monitoring devices are enclosed in a package. In addition to ensuring that the package is weatherproof, you must pay attention to the packaging material. Poor quality plastics can react with pollutants and skew the measurements.

Usability
Device usability refers to the ease of operating the device. Devices that provide ultimate accuracy are usually challenging to operate, requiring an advanced operator. If your project involves community engagement then you should opt for an easy to use device.

Cost
The cost of an air monitoring device varies with sensitivity and accuracy. The more accurate the results the more expensive the device. Unless you need results with absolute accuracy, you should prefer portable, new-generation near-reference air monitoring devices to the highly expensive stationary reference stations. Even if you are required to monitor air quality to utmost accuracy, you should use the modern air monitoring devices to supplement the data from the reference stations for better results.

The process of charging the device battery and data transmission from the device too should influence your decision.
Plastic coating in packages can react with pollutants, skewing the measurements.
Section 3

Ecomesure Air Monitoring Device

Simple • Accurate • Affordable
Understanding the changing air monitoring needs and trends, Ecomesure Labs, has designed air monitoring devices that are compact in size, accurate, easy to use, and affordable.

The devices monitor indoor as well as outdoor air, even in extreme conditions.

Industries requiring accurate measurements use these devices for extra data points in addition to the conventional reference stations. Organizations like public bodies, governments, universities, and offices, that require accurate but not extremely precise results depend on these devices alone for air monitoring.

**Ecomesure is Next-Generation Air Monitoring**

Unlike the conventional monitoring stations, these devices are fully automated and eliminate the need for trained personnel for measurements. The devices encrypt and send data to a secure cloud platform, accessible from any device, anywhere in the world.

The devices easily connect with any existing devices and with each other to provide you with rich seamless data.
Devices are plug and play

- **Install effortlessly** in 1 step
- **Set-up conveniently** with its plug & play system
- **Receive exceptional customer support** at all stages of use
- **Maintain the device painlessly**, with only an annual, one-step, sensor replacement
- **Choose to get an annual audit** of the device
- **Add and remove sensors** to meet your varying needs
- **Connect easily to a safety supply** in the event of power failure or choose to run on solar panel
- **Receive training** to master data analysis
Enjoy convenience and stay assured of data security

Secure Password Access | Encoded and Encrypted Data Transmission | Automatic Software Updates | Internal Memory

Ecomesure Indoor and Outdoor air-monitoring devices offer you convenience and security.

- **Up to 2 years of data storage on the internal memory** in the absence of Internet connection
- **Encoded and encrypted data transmission**: 256 bit encryption possible, the highest authorized for civil applications
- **Secure password access to the web platform**
- **Automatic software updates**

Learn More About the Ecomesure Devices

To learn the details, specifications, and applications of the Ecomesure devices or to determine if the devices meet your needs, get in touch with us at info@nimonik.com or 1-888-608-7511
Section 4

Conclusion
Governments all around the world are making air quality regulation stricter. Near-reference air monitoring devices are an emerging technology that has indoor and outdoor applications. They can help you take protective measures when the air quality begins to deteriorate. But all near-reference devices are not the same. You should choose your device carefully keeping in mind a clear objective and factors discussed in the paper.
About Nimonik

Great companies need to audit and manage their environmental, safety and quality requirements. Nimonik works with companies around the world to help them meet their compliance obligations effectively and efficiently.

Nimonik integrates company-specific requirements, 90,000 regulations, and 3,000 industry standards with an easy to use software. Businesses, large and small, in every industry rely on Nimonik to keep their operations running smoothly.