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EPA

Air Quality Index

A Guide to Air Quality and Your Health

AQI

"Local air quality is unhealthy today."

"It's a code red day for ozone."

Increasingly, radio, TV, and newspapers are providing information like this to local communities. But what does it mean to you ...if you plan to be outdoors that day? ...if you have children who play outdoors? ...if you are retired? ...if you have asthma? This booklet will help you understand what this information means to you and your family and what you can do to protect your health.

"Today's Air Quality Index is 105, which is unhealthy for sensitive groups."

Air Quality Index

A Guide to Air Quality and Your Health

Local air quality affects how we live and breathe. Like the weather, it can change from day to day or even hour to hour. The U.S. Environmental Protection Agency (EPA) and others are working to make information about outdoor air quality as available to the public as information about the weather. A key tool in this effort is the Air Quality Index, or AQI. EPA and local officials use the AQI to provide the public with timely and easy-to-understand information on local air quality and whether air pollution levels pose a health concern.

This booklet tells you about the AQI and how it is used to provide air quality information. It also tells you about the possible health effects of major air pollutants at various levels and suggests actions you can take to protect your health when pollutants in your area reach unhealthy concentrations.

Air quality directly affects our quality of life.

What is the AQI?

The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health concerns you should be aware of. The AQI focuses on health effects that can happen within a few hours or days after breathing polluted air. EPA uses the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect against harmful health effects.

How does the AQI work?

You can think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health danger. For example, an AQI value of 50 represents good air quality and little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. So, AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy—at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Understanding the AQI

The purpose of the AQI is to help you understand what local air quality means to your health. To make the AQI as easy to understand as possible, EPA has divided the AQI scale into six categories, shown below:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Each category corresponds to a different level of health concern. For example, when the AQI for a pollutant is between 51 and 100, the health concern is "Moderate." Here are the six levels of health concern and what they mean:

- **"Good"** The AQI value for your community is between 0 and 50. Air quality is considered satisfactory and air pollution poses little or no risk.

- **"Moderate"** The AQI for your community is between 51 and 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of individuals. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.

- **"Unhealthy for Sensitive Groups"** Certain groups of people are particularly sensitive to the harmful effects of certain air pollutants. This means they are likely to be affected at lower levels than the general public. For example, children and adults who are active outdoors and people with respiratory disease are at greater risk from exposure to ozone, while people with heart disease are at greater risk from carbon monoxide. Some people may be sensitive to more than one pollutant. When AQI values are between 101 and 150, members of sensitive groups may experience health effects. The general public is not likely to be affected when the AQI is in this range.

- **"Unhealthy"** AQI values are between 151 and 200. Everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects.

- **"Very Unhealthy"** AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects.

- **"Hazardous"** AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.

AQI colors

EPA has assigned a specific color to each AQI category to make it easier for people to understand quickly the significance of air pollution levels in their communities. For example, the color orange means that conditions are "unhealthy for sensitive groups"; the color red means that conditions may be "unhealthy" for everyone, and so on. You may see these colors when the AQI is reported in the newspaper or on television, or on your state or local air pollution agency's web site. The colors can help you rapidly determine whether air pollutants are reaching unhealthy levels in your area.

How is a community's AQI calculated?

Air quality is measured by networks of monitors that record the concentrations of the major pollutants at more than a thousand locations across the country each day. These raw measurements are then converted into AQI values using standard formulas developed by EPA. An AQI value is calculated for each of the individual pollutants in an area (ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide). Finally, the highest of the AQI values for the individual pollutants becomes the AQI value for that day. For example, if on July 12 a certain area had AQI values of 90 for ozone and 88 for sulfur dioxide, the AQI value would be 90 for the pollutant ozone on that day.

Children active outdoors can be sensitive to some air pollutants.

When and how is the AQI reported to the public?

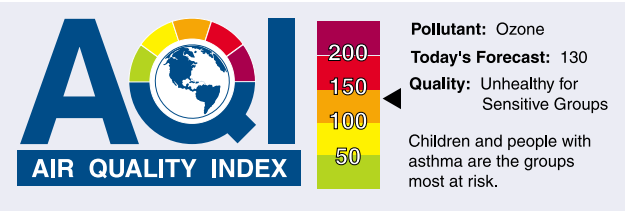
In large metropolitan areas (more than 350,000 people), state and local agencies are required to report the AQI to the public daily. When the AQI is above 100, they must also report which groups (e.g., children, people with asthma or heart disease) may be sensitive to the specific pollutant. If two or more pollutants have AQI values above 100 on a given day, agencies will report all the groups that are sensitive to those pollutants. Although it is not required, many smaller communities also report the AQI as a public health service.

Many metropolitan areas also report an AQI forecast that allows local residents to plan their activities to protect their health.

The AQI is a national index, so the values and colors used to show local air quality and the associated level of health concern will be the same everywhere you go in the U.S. Look for the AQI to be reported in your local newspaper, on television and radio, on the Internet, and on state and local telephone hotlines.

■ AQI in the Newspaper

Newspapers may use different formats to report the AQI. Here is one example:



■ AQI in Television and Radio Weather Reports

Your local television or radio weathercasters may use the AQI to provide information about air quality in your area. Here's the type of report you might hear:

> *The Air Quality Index today was 160, a code red day. Air quality was unhealthy due to ozone. Hot, sunny weather and stagnant air caused ozone in Center City to rise to unhealthy levels. Children and people with asthma are the groups most at risk.*

You might also hear your weathercasters use the AQI to forecast air quality levels for the coming day. They may provide suggestions about how to protect your health when the air is unhealthy to breathe:

> *Tomorrow, the AQI for Center City is predicted to be between 160 and 170, a code red day. This means that air pollution will be at unhealthy levels. The combination of cold winter air and morning rush-hour traffic will cause carbon monoxide to rise to unhealthy levels. People with heart disease should plan to limit moderate exertion and avoid sources of carbon monoxide, such as heavy traffic.*

■ **AQI on the Internet**

EPA's AirNow web site (**www.epa.gov/airnow**) contains general information about air pollution plus real-time and forecast data for ground-level ozone. The web site also contains facts about the health and environmental effects of air pollution, steps you can take to protect your health and reduce pollution, and links to state and local air pollution control agency web sites with local AQI information.

What are typical AQI values in most communities?

In many U.S. communities, AQI values are mostly below 100, with values greater than 100 occurring several times a year. Several metropolitan areas in the United States have more severe air pollution problems, and the AQI in these areas may often exceed 100. AQI values higher than 200 are very infrequent, and AQI values above 300 are extremely rare.

AQI values can vary significantly from one season to another. In winter, for example, carbon monoxide is likely to be the pollutant with the highest AQI values in some areas, because cold weather makes it difficult for car emission control systems to operate effectively. In summer, ozone is the most significant air pollutant in many communities, since it forms in the presence of heat and sunlight.

AQI values also can vary depending on the time of day. For example, ozone levels often peak in the afternoon, while carbon monoxide is usually a problem during morning or evening rush hours.

How can I avoid being exposed to harmful air pollutants?

The following charts and text tell you where each pollutant comes from, what health effects may occur for each pollutant, and what you can do to protect your health.

Air Quality Index (AQI): Ozone

Index Values	Levels of Health Concern	Cautionary Statements
0 - 50	Good	None
51 - 100*	Moderate	Unusually sensitive people should consider limiting prolonged outdoor exertion.
101 - 150	Unhealthy for Sensitive Groups	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
151 - 200	Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.
201 - 300	Very Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.
301 - 500	Hazardous	Everyone should avoid all outdoor exertion.

*Generally, an AQI of 100 for ozone corresponds to an ozone level of 0.08 parts per million (averaged over 8 hours).

What is ozone?

Ozone is an odorless, colorless gas composed of three atoms of oxygen. Ozone occurs both in the Earth's upper atmosphere and at ground level. Ozone can be good or bad, depending on where it is found:

■ **Good Ozone.** Ozone occurs naturally in the Earth's upper atmosphere—10 to 30 miles above the Earth's surface—where it forms a protective layer that shields us from the sun's harmful ultraviolet rays. This beneficial ozone is gradually being destroyed by manmade

chemicals. An area where ozone has been significantly depleted—for example, over the North or South pole—is sometimes called a "hole in the ozone."

■ **Bad Ozone.** In the Earth's lower atmosphere, near ground level, ozone is formed when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources react chemically in the presence of sunlight. Ozone at ground level is a harmful pollutant. Ozone pollution is a concern during the summer months, when the weather conditions needed to form it—lots of sun, hot temperatures—normally occur.

The risk of exposure to unhealthy levels of ozone is greatest during summer months.

What are the health effects and who is most at risk?

Roughly one out of every three people in the United States is at a higher risk of experiencing ozone-related health effects. Sensitive people include children and adults who are active outdoors, people with respiratory disease, such as asthma, and people with unusual sensitivity to ozone.

■ One group at high risk from ozone exposure is active children because this group often spends a large part of the summer playing outdoors. However, people of all ages who are active outdoors are at increased risk because, during physical activity, ozone penetrates deeper into the parts of the lungs that are more vulnerable to injury.

■ People with respiratory diseases that make their lungs more vulnerable to ozone may experience health effects earlier and at lower ozone levels than less sensitive individuals.

■ Though scientists don't yet know why, some healthy people experience health effects at more moderate levels of outdoor exertion or at lower ozone levels than the average person.

■ Ozone can irritate the respiratory system, causing coughing, throat irritation, and/or an uncomfortable sensation in the chest.

■ Ozone can reduce lung function and make it more difficult to breathe deeply and vigorously. Breathing may become more rapid and shallow than normal. This reduction in lung function may limit a person's ability to engage in vigorous outdoor activities.

■ Ozone can aggravate asthma. When ozone levels are high more people with asthma have attacks that require a doctor's attention or the use of additional medication. One reason this happens is that ozone makes people more sensitive to allergens, the most common triggers of asthma attacks.

■ Ozone can increase susceptibility to respiratory infections.

■ Ozone can inflame and damage the lining of the lungs. Within a few days, the damaged cells are shed and replaced—much like the skin peels after a sunburn. Animal studies suggest that if this type of inflammation happens repeatedly over a long time period (months, years, a lifetime), lung tissue may become permanently scarred, resulting in less lung elasticity, permanent loss of lung function, and a lower quality of life.

Air Quality Index (AQI): Particulate Matter (PM)

Index Values	Levels of Health Concern	Cautionary Statements*	
		$PM_{2.5}$	PM_{10}
0 - 50	Good	None	None
51 - 100**	Moderate	None	None
101 - 150	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.	People with respiratory disease, such as asthma, should limit outdoor exertion.
151 - 200	Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.	People with respiratory disease, such as asthma, should avoid outdoor exertion; everyone else, especially the elderly and children, should limit prolonged outdoor exertion.
201 - 300	Very Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.	People with respiratory disease, such as asthma, should avoid any outdoor activity; everyone else, especially the elderly and children, should limit outdoor exertion.
301 - 500	Hazardous	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.	Everyone should avoid any outdoor exertion; people with respiratory disease, such as asthma, should remain indoors.

* PM has two sets of cautionary statements, which correspond to the two sizes of PM that are measured:

- Particles up to 2.5 micrometers in diameter ($PM_{2.5}$)
- Particles up to 10 micrometers in diameter (PM_{10})

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- An AQI of 100 for $PM_{2.5}$ corresponds to a $PM_{2.5}$ level of 40 micrograms per cubic meter (averaged over 24 hours).
- An AQI of 100 for PM_{10} corresponds to a PM_{10} level of 150 micrograms per cubic meter (averaged over 24 hours).

What is particulate matter?

The term "particulate matter" (PM) includes both solid particles and liquid droplets found in air. Many manmade and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. These solid and liquid particles come in a wide range of sizes. Particles less than 10 micrometers in diameter tend to pose the greatest health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter are referred to as "fine" particles. Sources of fine particles include all types of combustion (motor vehicles, power plants, wood burning, etc.) and some industrial processes. Particles with diameters between 2.5 and 10 micrometers are referred to as "coarse." Sources of coarse particles include crushing or grinding operations, and dust from paved or unpaved roads.

What are the health effects and who is most at risk?

Both fine and coarse particles can accumulate in the respiratory system and are associated with numerous health effects. Coarse particles can aggravate respiratory conditions such as asthma. Exposure to fine particles is associated with several serious health effects, including premature death. Adverse health effects have been associated with exposures to PM over both short periods (such as a day) and longer periods (a year or more).

- When exposed to PM, people with existing heart or lung diseases—such as asthma, chronic obstructive pulmonary disease, congestive heart disease, or ischemic heart disease—are at increased risk of premature death or admission to hospitals or emergency rooms.
- The elderly also are sensitive to PM exposure. They are at increased risk of admission to hospitals or emergency rooms and premature death from heart or lung diseases.
- When exposed to PM, children and people with existing lung disease may not be able to breathe as deeply or vigorously as they normally would, and they may experience symptoms such as coughing and shortness of breath.
- PM can increase susceptibility to respiratory infections and can aggravate existing respiratory diseases, such as asthma and chronic bronchitis, causing more use of medication and more doctor visits.

Air Quality Index (AQI): Carbon Monoxide (CO)

Index Values	Levels of Health Concern	Cautionary Statements
0 - 50	Good	None
51 - 100*	Moderate	None
101 - 150	Unhealthy for Sensitive Groups	People with cardiovascular disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.
151 - 200	Unhealthy	People with cardiovascular disease, such as angina, should limit moderate exertion and avoid sources of CO, such as heavy traffic.
201 - 300	Very Unhealthy	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.
301 - 500	Hazardous	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.

* An AQI of 100 for carbon monoxide corresponds to a CO level of 9 parts per million (averaged over 8 hours).

What is carbon monoxide?

Carbon monoxide (CO) is an odorless, colorless gas. It forms when the carbon in fuels does not completely burn. Vehicle exhaust contributes roughly 60 percent of all carbon monoxide emissions nationwide, and up to 95 percent in cities. Other sources include fuel combustion in industrial processes and natural sources such as wildfires. Carbon monoxide concentrations typically are highest during cold weather, because cold temperatures make combustion less complete and cause inversions that trap pollutants low to the ground.

What are the health effects and who is most at risk?

Carbon monoxide enters the bloodstream through the lungs and binds chemically to hemoglobin, the substance in blood that carries oxygen to cells. In this way, carbon monoxide reduces the amount of oxygen reaching the body's organs and tissues.

- People with cardiovascular disease, such as angina, are most at risk from carbon monoxide. These individuals may experience chest pain and more cardiovascular symptoms if they are exposed to carbon monoxide, particularly while exercising.

Vehicle exhaust contributes roughly 60 percent of all carbon monoxide emissions nationwide.

- People with marginal or compromised cardiovascular and respiratory systems (for example, individuals with congestive heart failure, cerebrovascular disease, anemia, chronic obstructive lung disease), and possibly fetuses and young infants, may also be at greater risk from carbon monoxide pollution.

- In healthy individuals, exposure to higher levels of carbon monoxide can affect mental alertness and vision.

Air Quality Index (AQI): Sulfur Dioxide (SO_2)

Index Values	Levels of Health Concern	Cautionary Statements
0 - 50	Good	None
51 - 100*	Moderate	None
101 - 150	Unhealthy for Sensitive Groups	People with asthma should consider limiting outdoor exertion.
151 - 200	Unhealthy	Children, asthmatics, and people with heart or lung disease should limit outdoor exertion.
201 - 300	Very Unhealthy	Children, asthmatics, and people with heart or lung disease should avoid outdoor exertion; everyone else should limit outdoor exertion.
301 - 500	Hazardous	Children, asthmatics, and people with heart or lung disease should remain indoors; everyone else should avoid outdoor exertion.

* An AQI of 100 for sulfur dioxide corresponds to an SO_2 level of 0.14 parts per million (averaged over 24 hours).

What is sulfur dioxide?

Sulfur dioxide (SO_2), a colorless, reactive gas, is produced during the burning of sulfur-containing fuels such as coal and oil, during metal smelting, and by other industrial processes. Major sources include power plants and industrial boilers. Generally, the highest concentrations of sulfur dioxide are found near large industrial sources.

What are the health effects and who is most at risk?

- Children and adults with asthma who are active outdoors are most vulnerable to the health effects of sulfur dioxide. The primary effect they experience, even with brief exposure, is a narrowing of the airways (called bronchoconstriction), which may cause symptoms such as wheezing, chest tightness, and shortness of breath. Symptoms increase as sulfur dioxide concentrations and/or breathing rates increase. When exposure ceases, lung function typically returns to normal within an hour.

Children and adults with asthma who are active outdoors are most vulnerable to the health effects of sulfur dioxide.

- At very high levels, sulfur dioxide may cause wheezing, chest tightness, and shortness of breath in people who do not have asthma.
- Long-term exposure to both sulfur dioxide and fine particles can cause respiratory illness, alter the lung's defense mechanisms, and aggravate existing cardiovascular disease. People who may be most susceptible to these effects include individuals with cardiovascular disease or chronic lung disease, as well as children and the elderly.

Air Quality Index (AQI): Nitrogen Dioxide (NO_2)

Index Values	Levels of Health Concern	Cautionary Statements
0 - 50	Good	None
51 - 100	Moderate	None
101 - 150	Unhealthy for Sensitive Groups	None
151 - 200	Unhealthy	None
201* - 300	Very Unhealthy	Children and people with respiratory disease, such as asthma, should limit heavy outdoor exertion.
301 - 500	Hazardous	Children and people with respiratory disease, such as asthma, should limit moderate or heavy outdoor exertion.

* Short-term health effects for nitrogen dioxide do not occur until AQI values are above 200; therefore, the AQI is not calculated below 201 for NO_2. An AQI of 201 for NO_2 corresponds to an NO_2 level of 0.65 parts per million (averaged over 24 hours).

What is nitrogen dioxide?

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas formed when another pollutant (nitric oxide) combines with oxygen in the atmosphere. Once it has formed, nitrogen dioxide reacts with other pollutants (volatile organic compounds). Eventually these reactions result in the formation of ground-level ozone. Major sources include automobiles and power plants.

What are the health effects and who is most at risk?

- In children and adults with respiratory disease, such as asthma, nitrogen dioxide can cause respiratory symptoms such as coughing, wheezing, and shortness of breath. Even short exposures to nitrogen dioxide affect lung function.
- In children, short-term exposure can increase the risk of respiratory illness.
- Animal studies suggest that long-term exposure to nitrogen dioxide may increase susceptibility to respiratory infection and may cause permanent structural changes in the lungs.

For more information on air quality in your area, visit EPA's AirNow web site at http://www.epa.gov/airnow or call EPA's Office of Air and Radiation at (202) 564-7400.

For technical information on reporting the AQI, see EPA's publication *Guideline for Reporting of Daily Air Quality—Air Quality Index (AQI),* EPA-454/R-99-010, at http://www.epa.gov/airnow/publications.html.

The focus of the AQI is on outdoor air quality. For information on indoor air quality, contact EPA's Indoor Air Quality Information Clearinghouse at (800) 438-4318.