United States
Environmental Protection
Agency

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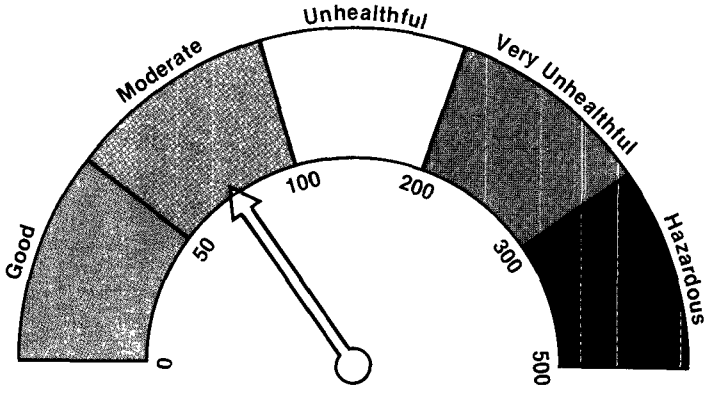
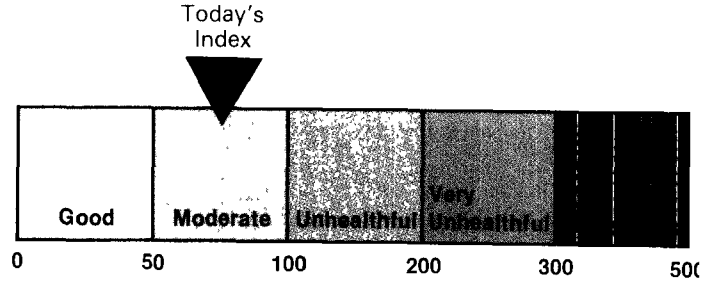
EPA

Measuring Air Quality

The New Pollutant Standands Index



Examples of possible PSI report for television



The American people, especially those who suffer from illnesses aggravated by air pollution, need accurate, timely, and easily understandable information about daily levels of air pollution. This information would allow them to modify their activities when air pollution levels are high, or to take other temporary measurers to protect themselves.

One way of conveying air pollution information is to report the concentration of each pollutant. However, different pollutants affect health at different concentrations; thus, anyone wanting to act on the information must remember several different sets of numbers. An air pollution index can avoid this problem by relating similar degrees of health effects to a uniform numerical scale that is based on actual pollutant concentrations

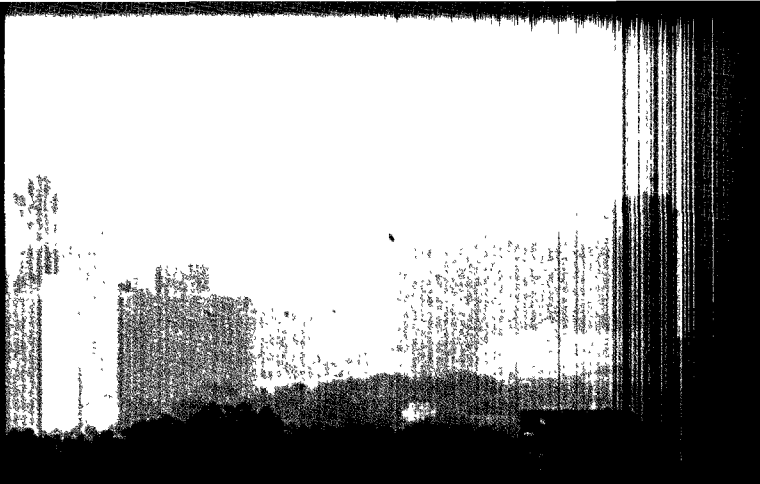
In recent years, a number of cities and States have developed various indices to respond to the public need for daily reports on air pollution levels. Of all those indices used to date, however, no two have been the same. An air quality index of 25 in one city, for example, might not represent the same level of air pollution as an index value of 25 in another city. And, depending on how the index is determined, the air quality might be called "excellent" in one, and "unhealthy" in the other. Thus, instead of clarifying the health implications of air pollutants, the use of differing indices has added to the public's confusion, especially when two different systems were operated side by side in neighboring cities or States.

To avoid this confusion and to provide clear, consistent advice to the public, the U.S. Environmental Protection Agency (EPA), in cooperation with the Council on Environmental Quality (CEQ) and other agencies, developed the Pollutant Standards

Index (PSI)

PSI provides a simple, uniform way to report daily air pollution concentrations, to tell the public about the general health effects associated with these concentrations, and to describe some general precautionary steps that can be taken (Table 1). PSI is a reporting tool that converts the pollutant concentrations measured in a community's air to a simple number on a scale of 0 to 500. Intervals on the PSI scale are related to the potential health effects of the daily measured concentrations of five major pollutants: carbon monoxide, photochemical oxidants, nitrogen dioxide, sulfur dioxide, and particulate matter. The intervals and the terms describing the air quality levels, are:

From 0 to 50, "good"
Above 50, "moderate"
Above 100, "unhealthful"
200 to 299, "very unhealthful"
300 and above, "hazardous"



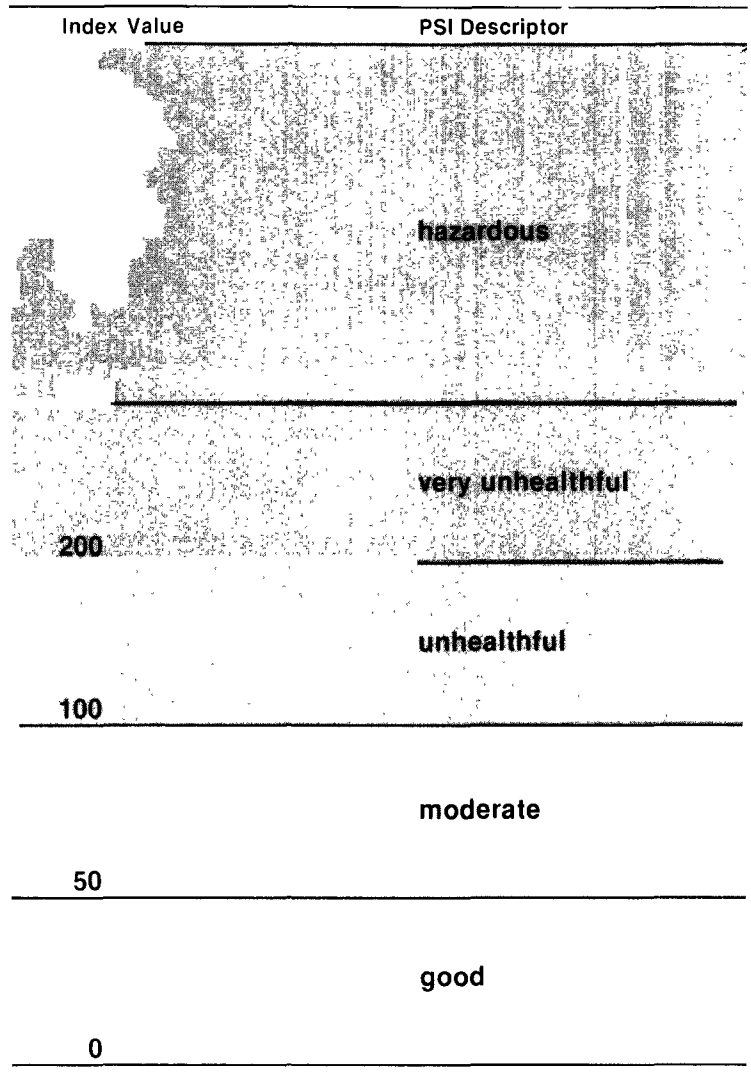
The index value of 100 was selected to correspond to the short-term (24 hours or less) National Ambient Air Quality Standard (NAAQS) set by EPA to represent the concentration for each pollutant below which adverse health effects have not been observed. Each value has built into it a margin of safety that, based on our current knowledge, protects the highly susceptible members of the public.

For each air pollutant, the observed concentration is first divided by the NAAQS value, creating a dimensionless number, or "subindex." Then, PSI is reported as the maximum subindex. The particular pollutant responsible for this maximum subindex also is reported. On days when two or more pollutants violate their respective NAAQS — that is, have PSI values greater than 100 — then each pollutant also will be reported.

The highest PSI value, 500, corresponds to the "significant harm level," established by EPA as the concentration of each pollutant that never should be reached. As air

quality approaches this level, the sick and elderly may die prematurely, and even healthy persons will experience symptoms that will affect their normal activity. State and local agencies are required to take emergency action to prevent air pollution from reaching the significant harm level, such as restricting auto traffic and manufacturing activities.

Once the value of 100 had been selected, four equal intervals between 100 and 500



were marked off at index values of 200, 300, and 400. The index intervals between these points approximate the concentration ranges in which adverse health effects increase in severity, and the number and types of people affected rise as well. The actual values of these points are not known with great precision, and, of course, a given health effect does not start or stop exactly one index number above a given point.

General Health Effects	Cautionary Statements
Premature death of ill and elderly Healthy people will experience adverse symptoms that affect their normal activity.	All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion and avoid traffic
Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons.	Elderly and persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity.
Significant aggravation of symptoms and decreased exercised tolerance in persons with heart or lung disease with widespread symptoms in the healthy population	Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity
Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the health population	Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity.

Table 1, PSI values, descriptor words, generalized health effects, and cautionary statements

Federal Episode Criteria

PSI is a standardized reporting system for advising the public of any adverse health effects due to air pollution, no matter what the level may be. Its official use is not intended as a substitute for the actions local and State governments must take to limit the adverse effects of air pollution during air pollution episodes. For these emergency situations, EPA has published Federally suggested episodes criteria which specify three stages of air pollution levels: Alert, Warning, and Emergency Each stage calls for different control actions, such as reducing traffic, limiting fuel use, restricting incineration, and reducing manufacturing activities. To determine which stage is to be called, officials examine not only current pollutant concentrations, but also prevailing and predicted metrological conditions. PSI values of 200, 300, and 400 for the most part correspond to the Alert, Warning, and Emergency levels in recommended episode criteria. However, because many factors, including meteorological conditions, are taken into account before triggering episode control actions, reported PSI values and the calling of an episode do not always exactly correspond.

How PSI Will Be Reported

PSI places maximum emphasis on acute health effects occurring over very short time periods — 24 hours or less — rather than chronic effects occurring over months or years. It therefore facilitates protection of public health during such periods by providing information on which individuals can act to reduce their exposure to air pollution. It stresses reporting on the basis of the sampling stations with the highest pollutant concentrations, and assumes that areas of the community where pollutants

are not measured also are experiencing high concentrations Because the Federal health-related air pollution standards include a safety factor, warning the public when a standard (a PSI value of 100) is reached at some location is reasonably conservative action.

Because of variations in air quality data—collection points among the cities, PSI should not be used to compare the relative healthfulness of different cities. Such comparisons depend on other factors, such as the total area of the community that is affected by high concentrations, the duration of these concentrations, and the number of people actually exposed.

PSI is a health-based index and so does not take into account the damage air pollutants can do to animals, vegetation, and materials (building materials and metals for example). The PSI system is designed to minimize confusion between health impact and the other environmental effects suspected to occur at these same concentrations. Local regulatory agencies reporting the index, however, also can point out the possible occurrence of agricultural and property damage in their areas at appropriate PSI values.

PSI allows for flexible reporting A typical radio announcement might read: "The pollution index today is 150, and the air is considered unhealthful. The pollutant causing this condition is photochemical oxidants. Patients with respiratory ailments and heart diseases should reduce physical exertion and outdoor activity. The forecast for tomorrow calls for no change in the index." A more detailed account could be provided by recorded telephone reports or newspapers.

As presently designed, PSI reports on five major air pollutants. However, it need not be limited to these; it also could accommodate other substance on which minimum acceptable standards are set to protect public health. PSI does not take into account the possible adverse effects associated with combinations of pollutants (synergism), but may be modified in the future to include such effects as more research knowledge is obtained.

Carbon monoxide (CO) is a by-product of the incomplete burning of fuels — notably by automobiles in most large urban areas — and is also released by some industrial processes. It is inhaled and enters the blood stream; there it binds chemically to hemoglobin, the substance that carries oxygen to the cells, thereby reducing the amount of oxygen delivered to all tissues of the body. The percentage of hemoglobin inactivated by CO depends on the amount of air breathed, the concentration of CO in

air, and length of exposure. Cigarette smoke contains CO. Therefore cigarette smokers have a portion of their hemoglobin inactivated by this source as well as by air pollution.

CO weakens the contractions of the heart, thus reducing the amount of blood pumped to various parts of the body and, therefore, the oxygen available to the muscles and various organs. In a healthy person, this effect significantly reduces the ability to perform physical exercises. But in a patient with heart disease, who is unable to compensate for the decrease in oxygen, the effect can threaten life. Changes have been observed in the electrocardiograms of persons with coronary artery disease after they have been in heavy freeway traffic, where they would receive a fairly high exposure to the carbon monoxide coming out of tailpipes of motor vehicles.

Individuals with anemia, emphysema, or other lung disease, as well as those living at high altitudes, are likely to be more

susceptible to the effects of CO. Even at relatively low concentrations, CO can affect mental function, visual activity, and alertness.

Photochemical oxidants are not released directly into the atmosphere but are produced by a complex series of chemical reactions that occur when nitrogen dioxide and reactive organic substances — such as hydrocarbons in auto exhaust, gasoline vapors, or vapors from other sources such as cleaning solvents — are exposed to sunlight. This type of pollution first gained attention in the 1940's as Los Angeles "smog." Since then, photochemical smog has been observed frequently in many other cities as well.

Ozone, the main constituent of photochemical oxidants, and peroxyacyl nitrates are associated with a number of health effects in humans. Peroxyacyl nitrates and other chemicals such as aldehydes cause the eye irritation that is characteristic of photochemical pollution. The principal health effect of ozone is on the respiratory system, where it severely irritates the mucous membrances of the nose and throat Ozone impairs normal functioning of the lungs and reduces the ability to perform physical exercises; the effects are more severe in individuals with chronic lung disease. The length of exposure, frequency of exposure, and ozone concentration are significant in determining the effects. Individuals with asthma or diseases of the heart and circulatory system experience symptoms at lower concentrations than normal people do. It also appears that ozone in combination with sulfur dioxide has a greater effect on respiratory function than either pollutant alone.

Nitrogen dioxide (NO_2) is one of a family of oxides of nitrogen. Those nitrogen oxides

important in air pollution usually enter the air as the result of high-temperature combustion processes, such as those occurring in automobiles and power plants. NO_2 plays an important role in the atmospheric reactions which generate photochemical oxidants.

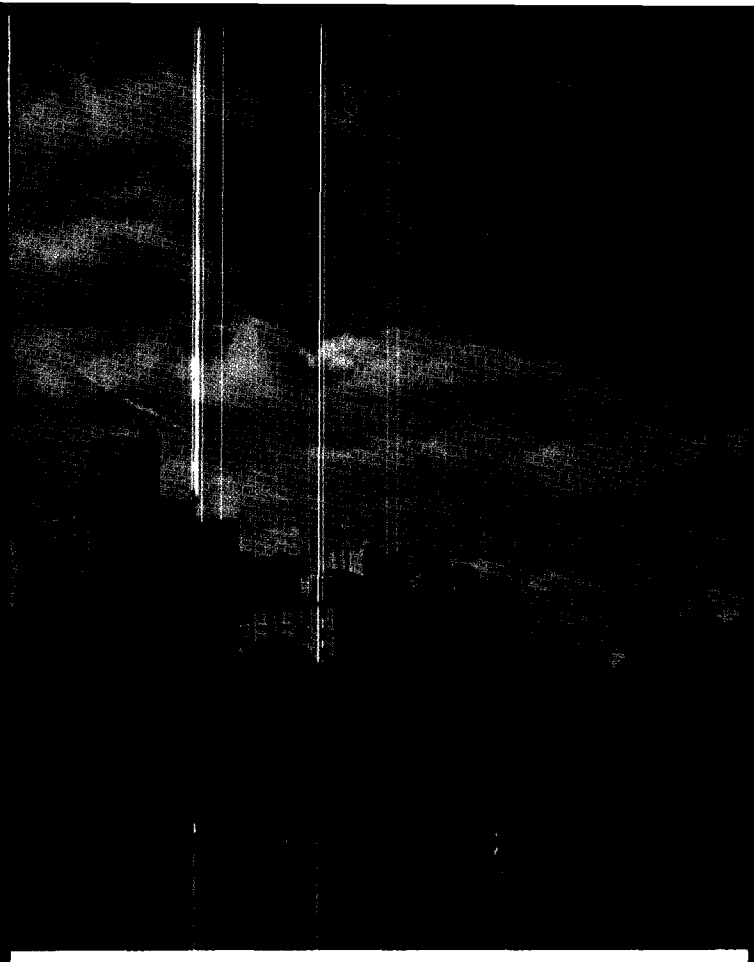
Based on occupational exposures of miners, chemists, and other industrial workers, continued or frequent exposure to high levels of NO_2 has been shown to produce pulmonary edema. In a community where NO_2 concentrations were elevated, children exposed to peak NO_2 ambient concentrations of about 225 micrograms per cubic meter, appeared to suffer higher bronchitis rates than normal. Such high concentrations are not believed to occur often or in many cities at present, and the health effects of high air pollutant concentrations for short periods of time are uncertain and still under study Symptoms may be aggravated in individuals with chronic bronchitis and emphysema Animal studies suggest that NO_2 exposure impairs resistance to infections.

Sulfur dioxide (SO_2) is one of a number of sulfur containing compounds found in the atmosphere. It enters the air primarily from the burning of coal and oil, but also from various other industrial processes. Studies of serious air pollution episodes have found an increase in death rates among people with existing heart and lung disease when high concentrations of SO_2 are present in combination with high concentrations of total suspended particulate matter Even at concentrations of these pollutants in the atmosphere lower than those found during episodes, prevalence of acute and chronic respiratory diseases increases, and chronic respiratory disease may be aggravated.

Other sulfur compounds such as sulfuric acid, sulfates, and sulfites, formed when

SO_2 reacts in the atmosphere may be more irritating to the respiratory system than SO_2 However, at present not enough is known about these pollutants to permit EPA to take any specific regulatory steps, other than controlling SO_2, which generally lowers the concentrations of the other sulfur compounds.

Total suspended particulate (TSP) matter is the general term for particles found in the atmosphere. Most of the TSP is composed of dust, soot, organic matter, and compounds containing sulfur, nitrogen, and metals. Some particles may be formed in the air as result of various chemical and physical processes, which causes the chemical composition of TSP to differ widely with time and geographical location. While certain components in TSP are considered to be inactive in the human body, other components, such as sulfates, nitrates, and metals, are being studied to determine their contribution, if any, to the



adverse health effects observed from elevated TSP levels. When airborne particles are inhaled, they may irritate the respiratory system, or damage the clearance mechanism of the lungs, thereby contributing to acute respiratory illnesses in much the same way as gaseous pollutants do. Prolonged inhalation of certain components of airborne particles may increase the number of cases and the severity of chronic respiratory diseases.

For More Information

A copy of the *Federal Task Force Report on Air Quality Indicators* can be obtained from the Council on Environmental Quality, 722 Jackson Place, N.W., Washington, D.C. 20006. *The Guideline for Public Reporting of Daily Air Quality—Pollutant Standards Index (PSI).* EPA-450/2-76-013, can be obtained from the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

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