

# Sulfur Dioxide & Health

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## CATEGORIES

**Topics** Health, Air Pollution

**Programs** Outdoor Air Quality Standards, Exposure

**Type** Information

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## What is sulfur dioxide (SO<sub>2</sub>)?

Sulfur dioxide (SO<sub>2</sub>) is comprised of one atom of sulfur and two atoms of oxygen, and is a gas at ambient temperatures. It has a pungent, irritating odor. SO<sub>2</sub> is a member of a family of chemicals comprised of sulfur and oxygen that are collectively known as sulfur oxides (SO<sub>x</sub>).

## Where does sulfur dioxide come from?

SO<sub>x</sub>, including SO<sub>2</sub>, are emitted when sulfur-containing fuel is burned. Some examples of sources include motor vehicles, locomotives, ships, and off-road diesel equipment that are operated with fuels that contain high levels of sulfur. In addition, SO<sub>2</sub> and the other SO<sub>x</sub> are emitted from some industrial processes, such as natural gas and petroleum extraction, oil refining, and metal processing. They are also released during volcanic activity and from geothermal fields.

## Why do CARB and U.S. EPA focus on sulfur dioxide as a marker for sulfur oxides?

SO<sub>2</sub> is the most prevalent species of gaseous SO<sub>x</sub> in the atmosphere, with other species not present at concentrations relevant for human exposures. Because of this, most health studies have focused on SO<sub>2</sub>. Many human and animal exposure studies, as well as

epidemiological studies, have reported adverse health effects specifically attributable to SO<sub>2</sub> exposure. For this reason SO<sub>2</sub> is used as the indicator for the group of gaseous SO<sub>x</sub>. However, it should be noted that emissions of the SO<sub>x</sub> family of air pollutants are involved in a number of chemical reactions in the atmosphere where they are transformed into acids and particulate sulfates, and these pollutants can also contribute to adverse human health and environmental effects. Because the various SO<sub>x</sub> species arise from the same sources, control measures that focus on SO<sub>2</sub> also reduce emissions of the other SO<sub>x</sub> species.

It should be noted that the California ambient air quality standard is specifically for SO<sub>2</sub> while the national ambient air quality standard is for SO<sub>x</sub> as a group, with SO<sub>2</sub> the marker for determining attainment. In both cases, however, the intent is to control SO<sub>x</sub> emissions as a group.

## **What kinds of harmful effects can sulfur dioxide cause?**

Controlled human exposure and epidemiological studies show that children and adults with asthma are more likely to experience adverse responses with SO<sub>2</sub> exposure, compared with the non-asthmatic population. Effects at levels near the one-hour standard are those of asthma exacerbation, including bronchoconstriction accompanied by symptoms of respiratory irritation such as wheezing, shortness of breath and chest tightness, especially during exercise or physical activity. Also, exposure at elevated levels of SO<sub>2</sub> (above 1 ppm) results in increased incidence of pulmonary symptoms and disease, decreased pulmonary function, and increased risk of mortality. The elderly and people with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) are most likely to experience these adverse effects.

## **How does sulfur dioxide affect the environment?**

SO<sub>2</sub> deposition, along with that of other SO<sub>x</sub> species, contributes to soil and surface water acidification and acid rain. This acidification causes a variety of effects that harm susceptible aquatic and terrestrial ecosystems, including slower growth and injury to forests and localized extinction of fish and other aquatic species. SO<sub>2</sub> deposition also

promotes chemical reactions that facilitate the accumulation of mercury in water and soil. This can lead to elevated mercury levels in food, which in turn increases risk of adverse health effects in human populations due to mercury ingestion.

## Is sulfur dioxide a problem indoors?

The level of SO<sub>2</sub> indoors is largely driven by outdoor concentrations, and is typically lower than outdoors levels. The only known significant indoor source of SO<sub>2</sub> in the U.S. is unvented kerosene heaters, although this is not a common means of indoor heating in most of the country.

## What are the Ambient Air Quality Standards for sulfur dioxide?

	<b>1-Hour Average</b>	<b>24-Hour Average</b>	<b>Annual Average</b>
<b>National Ambient Air Quality Standard (SO<sub>x</sub> with SO<sub>2</sub> as the marker)</b>	0.075 ppm	0.14 ppm	0.030 ppm
<b>California Ambient Air Quality Standard (SO<sub>2</sub>)</b>	0.25 ppm	0.04 ppm	None

## RELATED RESOURCES

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**Selected References:  
Children's School Bus  
Exposure and  
Mitigation Studies**

**Estimating the Health  
Benefits of Reductions  
in Emissions of PM2.5  
or its Precursors:  
Short Description**

**CARB's Methodology  
for Estimating the  
Health Effects of Air  
Pollution**

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