Nitrogen Dioxide & Health

CATEGORIES

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What is nitrogen dioxide (NO_2)?

Nitrogen Dioxide (NO_2) is a pungent gas that, along with fine airborne particulate matter, contributes to the reddish-brown haze characteristic of smoggy air in California. NO_2 is comprised of one atom of nitrogen and two atoms of oxygen, and is a gas at ambient temperatures. It has a pungent smell, and is brownish red in color. NO_2 is a member of a family of chemicals comprised of nitrogen and oxygen that are collectively known as nitrogen oxides. The two most prevalent nitrogen oxides are NO_2 and nitric oxide (NO), and the combination is often referred to as NO_X.

Where does nitrogen dioxide come from?

Although NO_2 can be directly emitted from combustion sources, much of the NO_2 in the ambient air is formed in the atmosphere through reactions between nitric oxide (NO) and other air pollutants that require the presence of sunlight (photochemical reactions). NO_2 contributes to formation of several other air pollutants, including ozone (O_3), nitric acid (HNO_3), and nitrate (NO_3^-) -containing particles that also form through photochemical reactions. NO_2 levels in air vary with direct emission levels, as well as with changing atmospheric conditions, particularly the amount of sunlight.

Why do CARB and U.S. EPA focus on nitrogen dioxide?

Air quality regulators have selected NO_2 as the marker for controlling ambient levels of NO_X for several reasons. Much of the information on oxides of nitrogen is specifically for NO_2. This includes information on the distribution in air, human exposure and dose, and health effects. There is only limited information for NO and NO_X, as well as large uncertainty in relating health effects to NO or NO_X exposure. In addition, emissions of NO_2 are highly correlated with those of other oxides of nitrogen and with several other traffic-related pollutants. Consequently, control measures that reduce emissions of NO_2 will also reduce emissions of other NO_X species, as well. NO_2 is an important precursor of anthropogenic O_3, and it is the key agent in the formation of several airborne toxic substances, including nitric acid (HNO_3), fine particles, peroxyacetyl nitrate, nitrosamines, and nitro-polycyclic aromatic hydrocarbons (nitro-PAHs).

It should be noted that the California ambient air quality standard is specifically for NO_2, while the national ambient air quality standard is for NO_X as a group, with NO_2 the marker for determining attainment. In both cases, however, the intent is to control NO_X emissions as a group.

What kinds of harmful effects can nitrogen dioxide cause?

A large body of health science literature indicates that exposure to NO_2 can induce adverse health effects. The strongest health evidence, and the health basis for the ambient air quality standard for NO_2, is results from controlled human exposure studies that show that NO_2 exposure can intensify responses to allergens in allergic asthmatics. In addition, a number of epidemiological studies have demonstrated associations between NO_2 exposure and premature death, cardiopulmonary effects, decreased lung function growth in children, respiratory symptoms, emergency room visits for asthma, and intensified allergic responses.

Who is at the greatest risk from exposure to nitrogen dioxide?

Infants and children are particularly at risk because they have disproportionately higher exposure to NO_2 than adults due to their greater breathing rate for their body weight and their typically greater outdoor exposure duration. Several studies have shown that long-

term NO_2 exposure during childhood, the period of rapid lung growth, can lead to smaller lungs at maturity in children with higher compared to lower levels of exposure. In addition, children with asthma have a greater degree of airway responsiveness compared with adult asthmatics. In adults, the greatest risk is to people who have chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease.

How does nitrogen dioxide affect the environment?

With few exceptions, NO_2 can injure vegetation, including trees, forests and crops. This has only been reported when the cumulative duration of exposures was at least 0.2 ppm for 100 hours or longer during the growing season. Also, NO_2 can contribute to the reduction of visibility both directly, by selectively absorbing the shorter blue wavelengths of visible light, and indirectly by contributing to the formation of nitrate aerosol haze that decreases visibility.

Is nitrogen dioxide a problem indoors?

Indoor levels of NO_2 are determined primarily by the presence of NO_2-emitting appliances, the indoor-outdoor air exchange rate, (i.e., whether or not windows are open), and the effects of season. Gas stoves and space heaters are the most common indoor sources of NO_2 emissions. Other possible sources include improperly vented furnaces, water heaters, and clothes dryers. Winter levels are typically higher than those in summer, due to greater use of gas appliances in winter, and reduced use of windows for ventilation.

What are the Ambient Air Quality Standards for nitrogen dioxide?

Ambient air quality standards define the maximum amount of pollutant that can be present in outdoor air without harming human health. In 2007, after an extensive review of the scientific literature, the Board lowered the state one-hour standard for NO_2 to 0.18 ppm and retained the annual average standard of 0.030 ppm based on evidence for adverse health effects at the level of the existing one-hour standard. The national standard was more recently revised in 2010 following an exhaustive review of new literature pointed to evidence for adverse effects in asthmatics at lower NO_2

concentrations than the existing national standard.

	1-Hour Average	Annual Average
National Ambient Air Quality Standard	0.100 ppm*	0.053 ppm
California Ambient Air Quality Standard	0.18 ppm	0.030 ppm

* The official level of the 1-hour NO_2 standard is 100 ppb, equal to 0.100ppm, which is shown here for the purpose of clearer comparison to the other standards.

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Regulation for Limiting Ozone Emissions from Air Cleaning Devices

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