## What is Ozone?

**Ozone is a colorless odorless gas made of oxygen.**

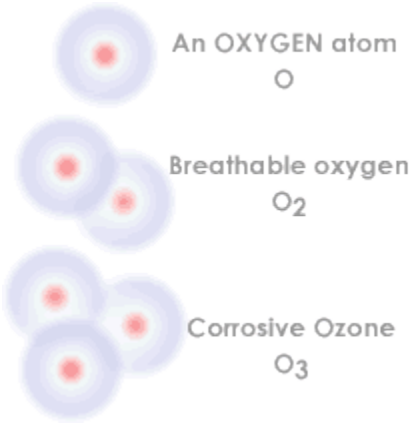
Most oxygen in the air is **$O_2$** - two joined oxygen atoms. This is the oxygen that sustains life.

Ozone is **$O_3$** - three oxygen atoms joined together.

**Ozone is ready to react ...**

... with whatever it meets. This makes it very useful for cleaning and disinfecting. But, when it comes in contact with living tissues like our lungs it can cause damage and illness. Ozone can also corrode building materials, statues and monuments, and natural rock features in the landscape.

**Ozone is made of Oxygen atoms**




**A recipe for ozone.**

Nobody puts ozone directly into the air. Instead, cars and trucks, gas stations and factories put the ingredients for ozone into the air every day.

The Air Quality Cookbook: OZONE

Ingredients:

VOC(volatile organic compounds)
NO (Nitrogen oxide)
NO2 (Nitrogen dioxide)

1. Release and mix INGREDIENTS: Combine the ingredients by releasing them into the air.
2. Cook using SUNLIGHT and HEAT: Allow the ingredients to react in the sunlight and high temperatures.
3. **OZONE!**

## What About the Ozone Layer ???

**I thought ozone was helpful.**

The ozone layer is great - when it's way up there.

The ozone layer protects life on earth from the sun's harmful ultraviolet rays. But the ozone layer is 10 - 30 miles above the earth; this is far above the air that we breathe. This protective shield becomes weaker when certain gases are able to travel to the ozone layer and destroy the ozone molecules. These destructive gases come from products like refrigerators, air

conditioners, cleansers, and aerosol cans (used for spray paint and hairspray). The gases are called halons and CFCs - for chlorofluorocarbons.

Closer to earth, ozone is an air pollutant that can be harmful. It is created and hangs around in the layer of air near the ground (from 0 to 10 miles high); where it affects everything it comes in contact with.

## Things That Affect Ozone Levels

**The amount of ingredient gases.**

More ingredient gases (VOC's and $NO_2$) can mean more ozone. Towns and cities that have more traffic or more industrial plants have a higher potential for ozone formation, especially towns that also experience many warm sunny days with little wind.

**Weather and Seasons: warm sunny days mean more ozone.**

Since sunlight and heat are the engines that drive ozone formation, warm sunny days should have more ozone than cool or cloudy days. Wind can also play a role. On windy days the wind can disperse the ozone, causing levels to drop. Ozone pollution can be especially bad during summer heat waves when the air does not mix very well and air pollution doesn't disperse.

**Time of Day: ozone levels build during the day.**

On a clear day, ozone levels can continue to rise all day long, and then decrease rapidly after sunset. Since heat, sunlight, the ingredient gasses each usually increase during the day, ozone formation also increases. When the sun goes down, there is no energy for ozone formation and fewer ingredient gases - so ozone levels drop.

## Ozone and Your Health

**Why ozone can hurt.**

The properties that make ozone a powerful cleaner, disinfectant, and bleaching agent also make ozone dangerous to living tissues.

When it comes in contact with living tissues, like our lungs, ozone attacks and damages cells lining the airways, this causes swelling and inflammation.

Some have compared ozone's effect to a sunburn ... inside your lungs.

Other health effects include:

- Irritation of the airway: a cough, an irritated throat, or an

uncomfortable feeling in your chest.

- Reduced lung function: you may not be able to breath as deeply or vigorously as you normally would.
- Worsened Asthma: ozone can aggravate the effects of asthma (see Asthma below).
- Potential health effects: ozone may aggravate the effects of emphysema and bronchitis, and may reduce the body's ability to fight infections in the respiratory system.

**Who should watch out for ozone?**

High ozone levels can affect anyone.

Some groups of people are particularly sensitive to ozone.

Sensitive Groups

- **Children**
  They spend more time outdoors, are more active, and their airways are not fully developed.
- **Adults exercising outdoors**
  Healthy persons engaged in physical activity breathe faster and more deeply. This increases the amount of ozone flowing into the lungs.
- **People with respiratory disease**
  Ozone can further irritate the airways of persons who already have diseases of the lung or airways.

**Summertime can be ozone time.**

First, there may be more ozone around. During the summer months high temperatures and bright sunshine lead to increased ozone formation. Second, people may spend more time outside engaged in physical activities.

**Asthma and ozone.**

Ozone can irritate the already sensitive airway of someone with asthma. When ozone levels are high, more asthmatics have asthma 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, which are the most common triggers for asthma attacks. (Allergens come from dust mites, cockroaches, pets, fungus, and pollen.) Also, asthmatics are more severely affected by the reduced lung function and irritation to the respiratory system caused by ozone.

**Ozone -- Air Quality Index (AQI) and Health Concerns**

| Air Quality Index Values | Air Quality Descriptor | Health Effects |
|---|---|---|
| 0 to 50 | Good | No health effects are expected. |
| 51 to 100* | Moderate | Unusually sensitive individuals may experience respiratory effects from prolonged outdoor exertion if you are unusually sensitive to ozone. |
| 101 to 150 | Unhealthy for Sensitive Groups | Member of sensitive group may experience respiratory symptoms (coughing, pains when taking a deep breath). |
| 151 to 200 | Unhealthy | Member of sensitive group have higher chance of experiencing respiratory symptoms (aggravated cough or pain), and reduces lung function. |
| 201 to 300 | Very Unhealthy | Members of sensitive groups experience increasingly severe respiratory symptoms and impaired breathing. |

* Generally, an AQI of 100 for ozone corresponds to an ozone level of 0.070 parts per million (averaged over 8 hours).

## Ozone Concentrations and Your Health

Two of the most important factors are the concentration of ozone and duration of exposure. Numerous epidemiological studies show the relationship between health effects and specific ozone ranges. EPA has gathered information about health effects through research, studies comparing health statistics and ozone levels in the communities, and controlled testing of human volunteers.

The EPA has developed the Air Quality Index (AQI) for reporting the levels of ozone and other pollutants, and their effects on human health. The AQI scale has been divided in different categories, which range from 0 to 300. Each category corresponds to a different health impact (Table1). The NAAQS for ozone are 0.120 ppm averaged over 1 hour (Applies only in limited areas) and 0.070 ppm averaged over 8 hours.

### 0.106 - 0.200(8-h) ppm (VERY UNHEALTHY)

At ozone concentrations from 0.106 to 0.200 ppm, sensitive people experience severe respiratory symptoms and impaired breathing.

Recent studies of humans exposed to these ozone concentrations have shown pulmonary function impairment during heavy exercise (7). Another study, conducted in Mexico City, shows that exposures from 0.170 to 0.250 ppm 1-h, increase the occurrence of respiratory symptoms, such as cough, phlegm, difficulty in breathing, and reduce PEFRs among children with mild asthma (2). In addition, ozone exposure to 0.30 ppm 1-h induces lower airway inflammation. This is manifested by PMN influx measured by bronchoalveolar lavage (3). Also, at this concentration with continuous exercise, FEV1 decreases.

### 0.086 to 0.105 ppm (UNHEALTHY)

**1 HOUR EXPOSURE.** A study conducted in Atlanta indicated that when the maximum 1-h ozone level equaled or exceeded 0.110 ppm, the number of emergency visits to the hospital for asthma or reactive airway disease increased in children. During this exposure, many children and adults progressively developed substernal pain on deep inspiration, coughing, and reduction of vital capacity and FEV1 (1). Other studies have associated 0.100 ppm ozone concentrations with increased respiratory hospital admission in elderly (12).

**8 HOURS EXPOSURE.** Reduction in lung function is observed with exposures of <0.12 ppm over 6-8 hours with moderate exercise, manifested by decrements in FEV1. (4,5). Also, 0.100 ppm ozone induces neutrophilic influx into the airway and resulting inflammation, and a decrease in forced expiratory volume (FEV1) and PEFR in asthmatic people (children and adults).

### 0.071 TO 0.085 ppm (UNHEALTHY FOR SENSITIVE GROUPS)

**1 HOUR EXPOSURE.** Sensitive people, active children and adults, and people with respiratory disease under **heavy** outdoor exertion, may experience respiratory symptoms such as coughing or pain when taking a deep breath, and reduced lung function. However, in a study of 154 children aged 10-12 years in Tennessee, 0.078 ppm of ozone was associated with decrements in FEV1 and FEF25-75 (5), and with

0.082 ppm an increase in asthma-related hospitals visits was observed.

**8 HOUR EXPOSURE.** In accordance with AQI, sensitive people, active children and adults, and people with respiratory disease under **prolonged** outdoor exertion, may experience respiratory symptoms such as coughing or pain when taking a deep breath, and reduced lung function, which can cause some breathing discomfort.

A series of studies conducted in the USA (1,3,6) demonstrated that with 0.09 ppm ozone, the number of hospital visits for asthma increased and people undergoing moderate exercise increased their sensitivity to ozone. In addition, other studies (1,6,8) have demonstrated that ozone concentrations at 0.080 ppm produce adverse effects on human health such as PEFR decrements in asthmatic children (6), decrements in FEV1 with intermittent exercise in healthy men (5,7), and increased hospital visits for asthma (1,8).

### 0.055 to 0.070 ppm (MODERATE)

**1 HOUR EXPOSURE.** In this specific range, based on the AQI standards, ozone health effects are not expected. However, a study in Mexico suggests that 0.065 ppm ozone increases respiratory symptoms in asthmatic children. (5).

**8 HOURS EXPOSURE.** Sensitive people may experience respiratory effects from prolonged exposure to ozone during outdoor exertion.

### to 0.054 ppm (GOOD)

In accordance with NAAQS and AQI, at ozone levels from 0.000 to 0.054 no health effects are expected and the air quality is considered "GOOD". However, recent studies have demonstrated that at these concentrations ozone can exert adverse health effects.

**1 HOUR EXPOSURE.** A study conducted in Brisbane, Australia by Simpson et al. demonstrated an association between 0.030 ppm ozone and daily mortality in the elderly (11). In a study in Mexico, the relationship between ozone exposure in asthmatic children (5-13 years of age) and mild asthma was evaluated. Exposure to 0.050 ppm increased the occurrence of lower respiratory symptoms such as cough, phlegm and difficulty breathing, and reduced PEFRs. (5).

**8 HOURS EXPOSURE.** No information available.

**24 HOURS EXPOSURE.** Sartor and co-authors (1994) analyzed low levels of ozone and daily mortality in Belgium. This study demonstrated a relationship between 0.050 ppm ozone, high temperatures, and the number of daily deaths (9). An increase in elderly deaths with 0.034 ppm for 24-h was also observed (9, 11). Schwartz utilized Medicare records for the years 1986-1989 to study the association between ozone concentrations and respiratory admissions among elderly. In this study a significant relationship was observed between 0.050 ppm 24-h ozone concentration and hospital admission for pneumonia. (12).

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Page content
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