



# PUBLIC HEALTH STATEMENT

## Chlorine Dioxide and Chlorite

CAS#: 10049-04-4 and 7758-19-2

Division of Toxicology

September 2004

This Public Health Statement is the summary chapter from the Toxicological Profile for Chlorine Dioxide and Chlorite. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFQA<sup>TM</sup>, is also available. This information is important because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about chlorine dioxide and chlorite and the effects of exposure to them.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Chlorine dioxide and chlorite have not been found in any of the 1,647 current or former NPL sites. Although the total number of NPL sites evaluated for these substances is not known, the possibility exists that chlorine dioxide and chlorite may be found in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to these substances may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you

come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to chlorine dioxide or chlorite, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with them. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

### 1.1 WHAT ARE CHLORINE DIOXIDE AND CHLORITE?

Chlorine dioxide is a yellow to reddish-yellow gas that can decompose rapidly in air. Because it is a hazardous gas, chlorine dioxide is always made at the location where it is used. Chlorine dioxide is used as a bleach at pulp mills, which make paper and paper products, and in public water-treatment facilities, to make water safe for drinking. It has also been used to decontaminate public buildings. Chlorine dioxide is soluble in water and will react rapidly with other compounds. When it reacts in water, chlorine dioxide forms chlorite ion, which is also a very reactive chemical. Because chlorine dioxide is very reactive, it is able to kill bacteria and microorganisms in water. About 5% of large water-treatment facilities (serving more than 100,000 persons) in the United States use chlorine dioxide to treat drinking water. An estimated 12 million persons may be exposed in this way to chlorine dioxide and chlorite ions. In communities that use chlorine dioxide to treat drinking water, chlorine dioxide and its by-product, chlorite ions, may be present at low levels in tap water.

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In this profile, the term “chlorite” will be used to refer to “chlorite ion,” which is a water-soluble ion. Chlorite ion can combine with metal ions to form solid salts (e.g., sodium chlorite). Sodium chlorite dissolves in water and forms chlorite ions and sodium ions. More than 80% of all chlorite (present as sodium chlorite) is used to make chlorine dioxide to disinfect drinking water. Sodium chlorite is also used as a disinfectant to kill germs.

### 1.2 WHAT HAPPENS TO CHLORINE DIOXIDE AND CHLORITE WHEN THEY ENTER THE ENVIRONMENT?

Chlorine dioxide is a very reactive compound. In air, sunlight quickly breaks chlorine dioxide apart into chlorine gas and oxygen. In water, chlorine dioxide reacts quickly to form chlorite ions. When chlorine dioxide reacts with dissolved organic compounds in water-treatment systems, it forms disinfection by-products, such as chlorite and chlorate ions.

Like chlorine dioxide, chlorite is very reactive. Since chlorite is an ionic compound, it will exist primarily in water. Chlorite ions are mobile in water, and may move into groundwater. However, the reaction of chlorite ions with soils and sediments may reduce the concentration of chlorite ions capable of reaching groundwater.

### 1.3 HOW MIGHT I BE EXPOSED TO CHLORINE DIOXIDE AND CHLORITE?

Chlorine dioxide is added to drinking water to protect people from harmful bacteria and other microorganisms. Most people will be exposed to chlorine dioxide and its disinfection by-product, chlorite ions, when they drink water that has been treated with chlorine dioxide. The EPA has set the maximum concentration in the drinking water at 0.8 milligrams per liter (mg/L) for chlorine dioxide and 1.0 mg/L for chlorite ion. The concentrations of chlorine dioxide and chlorite ion in your drinking water, however, may be lower or higher than these levels.

### 1.4 HOW CAN CHLORINE DIOXIDE AND CHLORITE ENTER AND LEAVE MY BODY?

Chlorine dioxide and chlorite usually enter the body when people drink water that has been disinfected with chlorine dioxide. Because chlorine dioxide rapidly breaks down in air to chlorine gas and oxygen, you would not likely breathe air containing dangerous levels of chlorine dioxide, but if you did, it could be absorbed across your lungs. You are not likely to encounter chlorite in the air you breathe. Whether chlorine dioxide or chlorite on your skin would be absorbed to any great extent is not known.

Both chlorine dioxide and chlorite act quickly when they enter the body. Chlorine dioxide quickly changes to chlorite ions, which are broken down further into chloride ions. The body uses these ions for many normal purposes. Some chloride ions leave the body within hours or days, mainly in the

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urine. Most chlorite that is not broken down also leaves the body in the urine within a few days after exposure to chlorine dioxide or chlorite.

### 1.5 HOW CAN CHLORINE DIOXIDE AND CHLORITE AFFECT MY HEALTH?

Both chlorine dioxide and chlorite react quickly in water and moist body tissues. If you were to breathe air containing chlorine dioxide gas, you might experience irritation in your nose, throat, and lungs. If you were to eat or drink large amounts of chlorine dioxide or chlorite, you might experience irritation in the mouth, esophagus, or stomach. Most people will not be exposed to chlorine dioxide or chlorite in amounts large enough to damage other parts of the body, but if you were, you might experience shortness of breath and other respiratory problems because of damage to the substances in blood that carry oxygen throughout the body.

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict

animal care guidelines because laws today protect the welfare of research animals.

Animal studies have shown effects of chlorine dioxide and chlorite that are similar to those seen in people exposed to very high amounts of these chemicals. In addition, exposure to high levels of chlorine dioxide and chlorite in animals both before birth and during early development after birth may cause delays in brain development. The levels to which the animals were exposed were much higher than levels that would likely be found in drinking water that has been disinfected with chlorine dioxide.

### 1.6 HOW CAN CHLORINE DIOXIDE AND CHLORITE AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

Children exposed to large amounts of chlorine dioxide or chlorite would likely be affected in the same manner as adults. Exposure to chlorine dioxide gas in young children, however, might more quickly reduce the ability of blood to carry oxygen than in adults, making breathing more difficult. If infants or babies still in their mother's womb were exposed to large amounts of chlorine dioxide, it might cause parts of their brains to develop more slowly. This has been seen in young animals, but has not actually been seen in humans.

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### 1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CHLORINE DIOXIDE AND CHLORITE

If your doctor finds that you have been exposed to substantial amounts of chlorine dioxide or chlorite, ask whether your children might also have been exposed. Your doctor might need to ask your state health department to investigate.

Families that drink water treated with chlorine dioxide may reduce the risk of exposure to chlorine dioxide and chlorite ions by drinking bottled water that has not been treated with chlorine dioxide or chlorite ions.

### 1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CHLORINE DIOXIDE AND CHLORITE?

Although no medical tests are available to determine whether you have been exposed to chlorine dioxide or chlorite, exposure to very large amounts may result in damage to red blood cells that can be observed through routine blood tests.

### 1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration

(FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as “not-to-exceed” levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for chlorine dioxide and chlorite include the following:

OSHA regulates the level of chlorine dioxide in workplace air. The occupational exposure limit for an 8-hour workday, 40-hour workweek is 0.1 parts per million (0.28 milligrams per cubic meter [ $\text{mg}/\text{m}^3$ ]). The EPA has set a maximum contaminant level of 1 mg/L for chlorite in drinking water and a goal of 0.8 mg/L for both the maximum residual disinfectant level for chlorine dioxide and the maximum contaminant level for chlorite in drinking water that has been treated with chlorine dioxide as a disinfectant.

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### 1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, your regional Nuclear Regulatory Commission office, or contact ATSDR at the address and phone number below.

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

Toxicological profiles are also available on-line at [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov) and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the information and technical assistance toll-free number at 1-888-42ATSDR (1-888-422-8737), by email at [atsdric@cdc.gov](mailto:atsdric@cdc.gov), or by writing to:

Agency for Toxic Substances and Disease Registry  
Division of Toxicology  
1600 Clifton Road NE  
Mailstop F-32  
Atlanta, GA 30333  
Fax: 1-770-488-4178

For-profit organizations may request a copy of final profiles from the following:

National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, VA 22161  
Phone: 1-800-553-6847 or 1-703-605-6000  
Web site: <http://www.ntis.gov/>

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