



# PUBLIC HEALTH STATEMENT

## SULFUR MUSTARD

CAS#: 505-60-2

Division of Toxicology

September 2003

This Public Health Statement is the summary chapter from the Toxicological Profile for Sulfur Mustard. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance 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 sulfur mustard and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Sulfur mustard has been found in at least 3 of the 1,636 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which sulfur mustard is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are 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 sulfur mustard, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

### 1.1 WHAT IS SULFUR MUSTARD?

Sulfur mustard is a thick liquid, which was made for use as a chemical weapon. Presently, the chemical is found at a few Army facilities in large quantities and at several locations in smaller quantities. It is often called by its common name, 'mustard gas.' However, the term 'mustard gas' can be confusing, since it is stored as a liquid and is not likely to change into a vapor immediately if it is released at ordinary temperatures. As a liquid, it is colorless when pure and it is brown when mixed with other chemicals. It is odorless when pure, but can have a slight garlic smell when mixed with other chemicals. It dissolves easily in fats, oils, alcohol, and gasoline. Sulfur mustard dissolves slowly in unstirred water, but within minutes in stirred water. When it does dissolve, it reacts with water and turns into different chemicals. It was used in chemical warfare as early as World War I and as late as the Iran-Iraq War in 1980-1988. It is not used in the United States, except for laboratory testing of health effects and antidotes. More information on the physical and chemical properties of sulfur mustard can be found in Chapters 4 and 5. Information about mustard agents other than sulfur mustard, such as nitrogen mustard, thickened mustard, and lewisite, is not included in this document.

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### 1.2 WHAT HAPPENS TO SULFUR MUSTARD WHEN IT ENTERS THE ENVIRONMENT?

Sulfur mustard is not found naturally in the environment in any amount. If sulfur mustard is accidentally spilled at an Army base where it is stored, it could be released into the environment. Currently, all of the sulfur mustard at these Army bases is being destroyed by burning or neutralization. U.S. law requires that the Department of Defense destroy all sulfur mustard by 2004. However, complete destruction of sulfur mustard may continue beyond this date. Once all of the sulfur mustard is destroyed, it will no longer be dangerous. If sulfur mustard is put on soil, it will remain there for at least a day, but may remain for several days or longer. The time it takes for sulfur mustard to disappear from soil depends on how hot it is outside and how strongly the wind is blowing. If it is hot and the wind is strong, then sulfur mustard will disappear faster. When sulfur mustard disappears from soil, it becomes a vapor or changes into other compounds if the soil is wet. If sulfur mustard is buried underground, it may not disappear for several years. Sulfur mustard will not move through soil to underground water. If sulfur mustard is put in water, it dissolves within minutes if the water is stirred, and slowly if it is not. When it does dissolve, it reacts with water and changes to other compounds. The time necessary for a quantity of sulfur mustard that is dissolved in water to decrease by half is about 2 minutes at 40 °C (104 °F). If large amounts of sulfur mustard are spilled into water, most of the sulfur mustard will change to other compounds very slowly or not at all. If sulfur mustard is released into air, it will react with components in the air to form other compounds.

The time necessary for a quantity of sulfur mustard in air to decrease by half is about 2 days at 25 °C (77 °F). Because sulfur mustard changes to other chemicals in the environment, it will not concentrate in plants or animals.

### 1.3 HOW MIGHT I BE EXPOSED TO SULFUR MUSTARD?

Sulfur mustard is not currently being produced in the United States. The general public might be exposed through accidental release from the Army bases where it is stored. These storage areas are heavily guarded, and storage buildings are sealed. People who work at Army bases that store sulfur mustard are more likely to be exposed than the general public. However, the Army has taken many precautions to protect the public from exposure to sulfur mustard. The general public may be exposed to sulfur mustard at hazardous waste sites that contain sulfur mustard. In addition, the use of sulfur mustard by terrorists is of concern. Persons involved in the transport or disposal of sulfur mustard may be exposed to mustard agents generated unintentionally through mishap. Spouses, children, and others may be exposed if workers unknowingly bring the mustard agents out of the factory on their skin or clothing. Sulfur mustard readily passes through ordinary clothing. Mixed in water, sulfur mustard changes its form within minutes, so it is very unlikely that you would drink it. The likelihood of the general population being exposed by way of water (drinking, cooking, bathing, and swimming) is therefore very small. Sulfur mustard does not occur naturally; therefore, there are no background levels in the soil, air, water, or food. If it is accidentally released, it will stay in the air or on the ground for 1-3 days. Under certain

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conditions, it may remain on the ground or in water for long periods.

### 1.4 HOW CAN SULFUR MUSTARD ENTER AND LEAVE MY BODY?

Sulfur mustard can enter your body easily and quickly if it gets in your eyes or on your skin, or if you breathe sulfur mustard vapors. It can easily pass through your clothing to get onto your skin. It is possible that you could come into contact with sulfur mustard at hazardous waste sites that contain this material. Sulfur mustard changes into other chemicals in your body, and these chemicals mostly leave your body in the urine within a few weeks.

### 1.5 HOW CAN SULFUR MUSTARD AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Sulfur mustard can harm you depending on how

much of the chemical you were exposed to and for how long. Sulfur mustard may make your eyes burn, your eyelids swell, or cause you to blink a lot. Sulfur mustard may burn your skin and cause skin blisters within a few days. Your eyes and the parts of your body that are sweaty are the most likely to be harmed. If you breathe it, sulfur mustard can cause coughing, bronchitis, and long-term respiratory disease. Sulfur mustard may affect reproduction. Some men exposed to sulfur mustard during war have reported decreased sexual drive and have had problems with sexual function due to scarring of genital tissues and lower sperm counts. The International Agency for Research on Cancer has determined that sulfur mustard is carcinogenic to humans. The Department of Health and Human Services has also determined that sulfur mustard is a known carcinogen. It can cause cancer in your airways, lungs, skin, and maybe other areas of your body later in life. If you are exposed to a very large amount of sulfur mustard, you can eventually die from it. Some of the chemicals that are formed when sulfur mustard is burned or spilled into water can also be irritating to the skin.

### 1.6 HOW CAN SULFUR MUSTARD AFFECT CHILDREN?

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

Sulfur mustard causes the eyes and skin of children to burn similarly to adults; however, the burns may be more severe in children. Blisters may appear sooner in children than adults, as early as 4 hours after sulfur mustard contacts the skin. Coughing and vomiting have been reported as early symptoms of

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exposure to sulfur mustard in children. Sulfur mustard vapors are heavier than air and since young children are closer to the ground or floor because of their height, they may be exposed to more sulfur mustard vapors than adults during accidental exposures. Sulfur mustard may cause birth defects or affect the development of children. An increased incidence of birth defects has been reported among newborn babies of sulfur mustard victims exposed during war. Studies in animals also indicate that sulfur mustard may affect development. It is not known if sulfur mustard can cross the placenta or be passed to infants in breast milk.

### **1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO SULFUR MUSTARD?**

If your doctor finds that you have been exposed to significant amounts of sulfur mustard, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

The risk of exposure to sulfur mustard to the general public may be slightly greater for those who live or work near Army bases and other facilities that store it. However, the Army has instituted precautions to protect the public from exposure to sulfur mustard. Sulfur mustard is currently being destroyed at these facilities, and thus the risk of exposure due to accidents is decreasing.

### **1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO SULFUR MUSTARD?**

Sulfur mustard or some of the chemicals that it

makes in your body can be found by testing your urine or blood. However, a test for sulfur mustard exposure is not readily available at local physicians' offices or hospitals. A urine or blood sample may be sent to a special laboratory for testing. For further assistance, see Section 1.10.

### **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. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8 hour workday or a 24 hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes

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available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for sulfur mustard include the following:

The federal government considers sulfur mustard an extremely hazardous substance. In 1985, Congress directed the U.S. Army to begin destroying the stockpile of U.S. chemical agents including sulfur mustard. As a result, the U.S. Army's Chemical Stockpile Disposal Program (CSDP) was started. As part of this program, the U.S. Army has continued to study how workers and the general public might best be protected from harm by sulfur mustard. The U.S. Army is the primary source of safety recommendations for sulfur mustard. The federal government has recommended maximum concentrations in air to which the general public should be exposed for different lengths of time. The maximum concentration for long-term exposure is 0.0001 milligrams per cubic meter of air. Higher concentrations may be tolerated for shorter periods. Stored quantities of 500 pounds or more must be reported to the State Emergency Response Commission, the fire department, and the Local Emergency Planning Committee. Spills of over 1 pound must be reported to the National Response Center. For more information, see Chapter 8.

The National Advisory Committee has developed acute exposure guideline levels (AEGLs) to protect people from the harmful effects of a short-term (8 hours or less) exposure to sulfur mustard. Three types of AEGLs have been developed: AEGL-1, AEGL-2, and AEGL-3. For sulfur mustard, the AEGL-1 values range from 0.40 mg/m<sup>3</sup> for a 10 minute exposure to 0.008 mg/m<sup>3</sup> for an 8 hour exposure; exposure to higher concentrations may

result in eye irritation. The AEGL-2 values range from 0.60 mg/m<sup>3</sup> for 10 minutes to 0.013 mg/m<sup>3</sup> for 8 hours; exposure to higher concentrations may result in swelling of the eyes, sensitivity to light, and eye irritation. The AEGL-3 values range from 3.9 mg/m<sup>3</sup> for 10 minutes to 0.27 mg/m<sup>3</sup> for 8 hours; exposure to higher concentrations may result in death.

### 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 or:

Agency for Toxic Substances and Disease Registry  
Division of Toxicology  
1600 Clifton Road NE, Mailstop F-32  
Atlanta, GA 30333

#### Information line and technical assistance:

Phone: 888-422-8737  
FAX: (770)-488-4178

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.

#### To order toxicological profiles, contact:

National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
Phone: 800-553-6847 or 703-605-6000

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### **Reference**

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological profile for Sulfur Mustard. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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