

## 1. PUBLIC HEALTH STATEMENT

This public health statement tells you about manganese and the effects of exposure to it.

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. Manganese has been found in at least 869 of the 1,699 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which manganese is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance 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 manganese, 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 it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

## 1. PUBLIC HEALTH STATEMENT

## 1.1 WHAT IS MANGANESE?

<b>Description</b>	<p>Manganese is a naturally occurring substance found in many types of rocks and soil. Pure manganese is a silver-colored metal; however, it does not occur in the environment as a pure metal. Rather, it occurs combined with other substances such as oxygen, sulfur, and chlorine. Manganese is a trace element and is necessary for good health.</p>
<b>Uses</b> <ul style="list-style-type: none"> <li>• <b>Manufacturing</b></li>   <li>• <b>Consumer products</b></li> </ul>	<p>Manganese is used principally in steel production to improve hardness, stiffness, and strength. It is used in carbon steel, stainless steel, high-temperature steel, and tool steel, along with cast iron and superalloys.</p> <p>Manganese occurs naturally in most foods and may be added to food or made available in nutritional supplements. Manganese is also used in a wide variety of other products, including:</p> <ul style="list-style-type: none"> <li>• fireworks</li> <li>• dry-cell batteries</li> <li>• fertilizer</li> <li>• paints</li> <li>• a medical imaging agent</li> <li>• cosmetics</li> </ul> <p>It may also be used as an additive in gasoline to improve the octane rating of the gas.</p> <p>Small amounts of manganese are used in a pharmaceutical product called mangafodipir trisodium (MnDPDP) to improve lesion detection in magnetic resonance imaging of body organs.</p>

Chapters 4, 5, and 6 have more information on the properties and uses of manganese and how it behaves in the environment.

## 1. PUBLIC HEALTH STATEMENT

## 1.2 WHAT HAPPENS TO MANGANESE WHEN IT ENTERS THE ENVIRONMENT?

<b>Sources</b>	Manganese is a normal constituent of air, soil, water, and food. Additional manganese can be found in air, soil, and water after release from the manufacture, use, and disposal of manganese-based products.
<b>Breakdown</b>	<p>As with other elements, manganese cannot break down in the environment. It can only change its form or become attached or separated from particles. The chemical state of manganese and the type of soil determine how fast it moves through the soil and how much is retained in the soil. In water, most of the manganese tends to attach to particles in the water or settle into the sediment.</p> <p>The manganese-containing gasoline additive may degrade in the environment quickly when exposed to sunlight, releasing manganese.</p>

For more information on manganese in the environment, see Chapter 6.

## 1.3 HOW MIGHT I BE EXPOSED TO MANGANESE?

<b>Food – primary source of exposure</b>	The primary way you can be exposed to manganese is by eating food or manganese-containing nutritional supplements. Vegetarians who consume foods rich in manganese such as grains, beans and nuts, as well as heavy tea drinkers, may have a higher intake of manganese than the average person.
<b>Workplace air</b>	Certain occupations like welding or working in a factory where steel is made may increase your chances of being exposed to high levels of manganese.
<b>Water and soil</b>	Because manganese is a natural component of the environment, you are always exposed to low levels of it in water, air, soil, and food. Manganese is routinely contained in groundwater, drinking water and soil at low levels. Drinking water containing manganese or swimming or bathing in water containing manganese may expose you to low levels of this chemical.

## 1. PUBLIC HEALTH STATEMENT

<b>Air</b>	<p>Air also contains low levels of manganese, and breathing air may expose you to it. Releases of manganese into the air occur from:</p> <ul style="list-style-type: none"> <li>• industries using or manufacturing products containing manganese,</li> <li>• mining activities, and</li> <li>• automobile exhaust.</li> </ul> <p>Lifestyle traits may also lead to exposure to manganese. People who smoke tobacco or inhale second-hand smoke are typically exposed to manganese at levels higher than those not exposed to tobacco smoke.</p>
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See Chapter 6 for more information on how you might be exposed to manganese or its compounds.

## 1.4 HOW CAN MANGANESE ENTER AND LEAVE MY BODY?

<p><b>Enter your body</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul> <ul style="list-style-type: none"> <li>• <b>Ingestion</b></li> </ul> <ul style="list-style-type: none"> <li>• <b>Dermal contact</b></li> </ul>	<p>When you breathe air containing manganese, a small amount of the manganese will enter your body through your lungs and the remainder can become trapped in your lungs. Some of the manganese in your lungs can also be trapped in mucus which you may cough up and swallow into your stomach.</p> <p>Manganese in food or water may enter your body through the digestive tract to meet your body's needs for normal functioning.</p> <p>Only very small amounts of manganese can enter your skin when you come into contact with liquids containing manganese.</p>
<b>Leave your body</b>	<p>Once in your body, manganese-containing chemicals can break down into other chemicals. However, manganese is an element that cannot be broken down. Most manganese will leave your body in feces within a few days.</p>

For more information on how manganese enters and leaves the body, see Chapter 3.

## 1.5 HOW CAN MANGANESE AFFECT MY HEALTH?

This section looks at studies concerning potential health effects in human and animal studies.

<b>General population</b>	<p>Manganese is an essential nutrient, and eating a small amount of it each day is important to stay healthy.</p>
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## 1. PUBLIC HEALTH STATEMENT

<p><b>Workers</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul>	<p>The most common health problems in workers exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as “manganism.” Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations in the work place.</p> <p>The inhalation of a large quantity of dust or fumes containing manganese may cause irritation of the lungs which could lead to pneumonia.</p> <p>Loss of sex drive and sperm damage has also been observed in men exposed to high levels of manganese in workplace air.</p> <p>The manganese concentrations that cause effects such as slowed hand movements in some workers are approximately twenty thousand times higher than the concentrations normally found in the environment. Manganism has been found in some workers exposed to manganese concentrations about a million times higher than normal air concentrations of manganese.</p>
<p><b>Laboratory animals</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul>	<p>Respiratory effects, similar to those observed in workers, have been observed in laboratory monkeys exposed to high levels of manganese.</p>
<p><b>Laboratory animals</b></p> <ul style="list-style-type: none"> <li>• <b>Oral</b></li> </ul>	<p>Manganese has been shown to cross the blood-brain barrier and a limited amount of manganese is also able to cross the placenta during pregnancy, enabling it to reach a developing fetus.</p> <p>Nervous system disturbances have been observed in animals after very high oral doses of manganese, including changes in behavior.</p> <p>Sperm damage and adverse changes in male reproductive performance were observed in laboratory animals fed high levels of manganese. Impairments in fertility were observed in female rodents provided with oral manganese before they became pregnant.</p> <p>Illnesses involving the kidneys and urinary tract have been observed in laboratory rats fed very high levels of manganese. These illnesses included inflammation of the kidneys and kidney stone formation.</p>
<p><b>Cancer</b></p>	<p>The EPA concluded that existing scientific information cannot determine whether or not excess manganese can cause cancer.</p>

Further information on the health effects of manganese in humans and animals can be found in Chapters 2 and 3.

## 1. PUBLIC HEALTH STATEMENT

**1.6 HOW CAN MANGANESE AFFECT CHILDREN?**

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

<b>Effects in children</b>	<p>Studies in children have suggested that extremely high levels of manganese exposure may produce undesirable effects on brain development, including changes in behavior and decreases in the ability to learn and remember. In some cases, these same manganese exposure levels have been suspected of causing severe symptoms of manganism disease (including difficulty with speech and walking). We do not know for certain that these changes were caused by manganese alone. We do not know if these changes are temporary or permanent. We do not know whether children are more sensitive than adults to the effects of manganese, but there is some indication from experiments in laboratory animals that they may be.</p>
<b>Birth defects</b>	<p>Studies of manganese workers have not found increases in birth defects or low birth weight in their children.</p> <p>No birth defects were observed in animals exposed to manganese</p> <p>In one human study where people were exposed to very high levels of manganese from drinking water, infants less than 1 year of age died at an unusually high rate. It is not clear, however, whether these deaths were attributable to the manganese level of the drinking water. The manganese toxicity may have involved exposures to the infant that occurred both before (through the mother) and after they were born.</p>

## 1. PUBLIC HEALTH STATEMENT

**1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO MANGANESE?**

<b>Avoid inhalation of manganese at work</b>	High levels of airborne manganese are observed in certain occupational settings such as steel factories or welding areas. You should take precautions to prevent inhalation of manganese by wearing an appropriate mask to limit the amount of manganese you breathe.
<b>Avoid wearing manganese dust-contaminated work clothing in your home or car</b>	Workers exposed to high levels of airborne manganese in certain occupational settings may accumulate manganese dust on their work clothes. Manganese-contaminated work clothing should be removed before getting into your car or entering your home to help reduce the exposure hazard for yourself and your family.
<b>Avoid inhalation of welding fumes at home</b>	If you weld objects around your home, do so in a well-ventilated area and use an appropriate mask to decrease your risk of inhaling manganese-containing fumes. Children should be kept away from welding fumes.
<b>Diet</b>	Children are not likely to be exposed to harmful amounts of manganese in the diet. However, higher-than-usual amounts of manganese may be absorbed if their diet is low in iron. It is important to provide your child with a well-balanced diet.
<b>Water</b>	While tap and bottled water generally contain safe levels of manganese, well water may sometimes be contaminated with sufficiently high levels of manganese to create a potential health hazard. If drinking water is obtained from a well water source, it may be wise to have the water checked for manganese to ensure the level is below the current guideline level established by the EPA.
<b>Smoking</b>	Manganese is a minor constituent of tobacco smoke. Avoiding tobacco smoke may reduce your family's exposure to manganese.

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

## 1. PUBLIC HEALTH STATEMENT

**1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO MANGANESE?**

<b>Detecting exposure</b>	<p>Several tests are available to measure manganese in blood, urine, hair, or feces. Because manganese is normally present in our body, some is always found in tissues or fluids.</p> <p>Normal ranges of manganese levels are about 4–15 µg/L in blood, 1–8 µg/L in urine, and 0.4–0.85 µg/L in serum (the fluid portion of the blood).</p>
<b>Measuring exposure</b>	<p>Because excess manganese is usually removed from the body within a few days, past exposures are difficult to measure with common laboratory tests.</p> <p>A medical test known as magnetic resonance imaging, or MRI, can detect the presence of increased amounts of manganese in the brain. However, this type of test is qualitative, and has not been shown to reliably reflect or predict toxicologically meaningful exposures.</p>

Information about tests for detecting manganese in the body is given in Chapters 3 and 7.

**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.



## 1. PUBLIC HEALTH STATEMENT

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 manganese include the following:

<b>Drinking water</b>	The EPA has established that exposure to manganese in drinking water at concentrations of 1 mg/L for 1 or 10 days is not expected to cause any adverse effects in a child.  The EPA has established that lifetime exposure to 0.3 mg/L manganese is not expected to cause any adverse effects.
<b>Bottled water</b>	The FDA has established that the manganese concentration in bottled drinking water should not exceed 0.05 mg/L.
<b>Workplace air</b>	OSHA set a legal limit of 5 mg/m <sup>3</sup> manganese in air averaged over an 8-hour work day.

For more information on regulations and advisories, see Chapter 8.

**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 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 that result 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 toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), or by writing to:

Agency for Toxic Substances and Disease Registry  
 Division of Toxicology and Human Health Sciences (proposed)  
 1600 Clifton Road NE  
 Mailstop F-62  
 Atlanta, GA 30333  
 Fax: 1-770-488-4178

## 1. PUBLIC HEALTH STATEMENT

Organizations for-profit may request copies of final Toxicological 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/>