## SECTION 6 - HEALTH HAZARD DATA

**INGESTION (SWALLOWING):** Poisonous if swallowed. Causes severe irritation and inflammation of mouth, throat and stomach. Severe stomach pains follow with possible loss of consciousness. Blindness or death may occur.

**INHALATION (BREATHING):** Highly irritating to upper respiratory tract. May cause inflammation of lining of nose, throat and lungs with bronchopneumonia and edema possible from extremely irritating exposure.

**SKIN (DERMAL):** Contact with the liquid causes drying, cracking and scaling. Prolonged and repeated contact causes a hardening or tanning effect. May cause contact allergic dermatitis.

**EYE CONTACT:** Exposure to high vapor concentrations or contact with liquid causes tearing and severe irritation. Contact with liquid causes burns.

**PRIMARY ROUTES OF ENTRY:** Eyes, Nose, Mouth, Skin contact

**NOTES TO PHYSICIAN:** Pulmonary edema may occur. Signs and symptoms of pulmonary edema may be delayed for several hours.

# EMERGENCY FIRST AID PROCEDURES:

**INGESTION:** **GET IMMEDIATE MEDICAL ATTENTION.** Do **NOT** induce vomiting. Only if individual is fully conscious, give a cupful of water. If individual is drowsy or unconscious, do not give anything by mouth; place individual on left side with the head down. Contact a physician, medical facility or poison control center for advice. Do not leave individual unattended.

**INHALATION:** Remove patient from contaminated area. If breathing has stopped, give artificial respiration then oxygen if needed. **CONTACT A PHYSICIAN.**

**SKIN CONTACT:** Remove contaminated clothing and wash with large amounts of water. If irritation persists, **CONTACT A PHYSICIAN.**

**EYE CONTACT:** Flush eyes with plenty of running water for at least 15 minutes. **CONTACT A PHYSICIAN IMMEDIATELY.**

## SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE

**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Avoid breathing vapor. Ventilate area. Place leaking containers in well ventilated areas. Eliminate ignition sources. Contain spills with inert absorbent material.

**WASTE DISPOSAL METHODS:** **Dispose of spill residue in accordance with all local, state and federal regulations.**

**PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:** Small containers should be protected from physical damage. Detached storage is preferred. Outdoor storage facilities should be insulated and equipped with heating equipment to maintain ambient storage temperatures. Indoor storage areas should be sloped toward a retention area.

**MAINTENANCE PRECAUTIONS:** Storage areas should be equipped with maximum ventilation in case of spills.

**OTHER PRECAUTIONS:** Keep away from heat, sparks and flames. Keep containers closed. Use with adequate ventilation. Avoid breathing vapor. Avoid prolonged contact with skin. Wash thoroughly with soap and water after handling. Do not enter storage areas unless properly ventilated.

## SECTION 8 - CONTROL MEASURES

**RESPIRATORY PROTECTION:** Use full face NIOSH approved formaldehyde or acid gas cartridge or canister respirator within use limitations of these devices. In all other situations, use self-contained breathing apparatus (SCBA).

**VENTILATION:** **LOCAL EXHAUST: RECOMMENDED** **SPECIAL:** No information
MECHANICAL: Not recommended **OTHER:** No information

**EYE PROTECTION:** Use chemical safety goggles

**GLOVES:** Heavy duty neoprene or equal. Permeation/degradation values of chemical mixtures cannot be predicted from pure components or chemical classes. Thus, these materials are normally best estimates based on available pure component data. A significant difference in breakthrough time has been reported for generically similar gloves from different manufacturers.

**OTHER PROTECTIVE CLOTHING OR EQUIPMENT:** For operations where spills or splashing may occur, use an impervious body covering and shoe coverings. A safety shower and eye bath should be available.

**WORK PRACTICES:** Never use without proper ventilation. Always use proper protective clothing.

**HYGIENIC PRACTICES:** Observe good personal hygiene practices and recommended procedures. Wash exposed areas promptly and thoroughly after skin contact from working with this product and before eating, drinking, using tobacco products or restrooms.

**OTHER ENGINEERING CONTROLS:** None

**ADDITIONAL COMMENTS:** The data in the Material Safety Data Sheet relates only to specific material designated herein and does not relate to use in combination with any other material or in any process. The information set forth herein is furnished free of charge and is based on technical data that Pierce Chemicals/Royal Bond believes to be reliable. It is intended for use by persons having technical skill and at their own discretion and risk. Since conditions and use are outside of our control, we make no warranties, express or implied and assume no liability in connection with any use of the information.

End of 01185 Restoratone MSDS

# MATERIAL SAFETY DATA SHEET

## SECTION 1 - MANUFACTURER INFORMATION

**MANUFACTURER/DISTRIBUTOR:**
Pierce Chemicals/Royal Bond, Inc.
4722 Bronze Way
Dallas, Texas 75236-1997

EMERGENCY TELEPHONE: 1-800-424-9300
Telephone Number: (214) 333-4230
**DATE PREPARED/REVISED:** October 4, 2005
Prepared by: Pierce Royal Bond Research Department

TRADE NAME/SYNONYMS: **ULTRA 27**
CHEMICAL FAMILY: Arterial Embalming Emulsion
CHEMICAL NAME/SYNONYMS: Not applicable

Product Code: **01215**
FORMULA: Not applicable

DOT/UN HAZARD CLASSIFICATION:
Flammable Liquids, N.O.S.(Formaldehyde, Methanol), 3, UN1993, PG III, LTD QTY

## SECTION 2 - HAZARDOUS INGREDIENTS

PRODUCT CONTAINS HAZARDOUS INGREDIENTS: *YES*

| CHEMICAL NAME | SUBJECT TO SARA 313 | CAS NUMBER | % | PEL OSHA | TLV-ACGIH |
|---|---|---|---|---|---|
| Formaldehyde * | Yes | 50-00-0 | 26.4 | .75 ppm - 8 hr TWA<br>2 ppm - 15 min STEL | .3 ppm Ceiling, A2 |
| Methanol ** | Yes | 67-56-10 | 16.8 | 200 ppm - 260 mg/m³ | 200 ppm - 260 mg/m³ |
| Methoxymethanol | No | 4461-52-2 | 5.0 | No information | No information |
| | | | | | |
| | | | | | |

* The action level for formaldehyde is 0.5 ppm, measured as an 8 hour TWA.
** Potential contribution to overall exposure possible via skin absorption.
It is reported that formaldehyde is immediately dangerous to life and health at 100 ppm.

PRODUCT CONTAINS CARCINOGENS (NTP, IARC, OSHA) NTP: Yes IARC: Yes OSHA: Yes
CHEMICAL/COMMON NAME: ***Formaldehyde***
This product contains a chemical known to the state of California to cause cancer
Listed as an experimental animal carcinogen by IARC and NTP.
Listed as a probable human carcinogen by IARC.

## SECTION 3 - PHYSICAL/CHEMICAL CHARACTERISTICS

**BOILING POINT:** 222°F
**EVAPORATION RATE (BUTYL ACETATE=1):** <1
**MELTING POINT:** No information
**pH:** 6.37
**SOLUBILITY IN WATER:** Soluble

**SPECIFIC GRAVITY (WATER=1):** 1.06
**VAPOR DENSITY (AIR=1):** 1.1
**VAPOR PRESSURE (mm HG):** 103 mm Hg @ 73°F
**% VOLATILE BY WEIGHT:** 47.69

**APPEARANCE AND ODOR INFORMATION:** Milky pinkish-orange solution with pungent odor

## SECTION 4 - FIRE AND EXPLOSION HAZARD DATA

**FLASH POINT (METHOD USED):** 126° F (ASTM D93) **FLAMMABLE LIMITS LEL% = 6% UEL% = 73%**

**EXTINGUISHING MEDIA:** Use dry chemical, alcohol foam or $CO_2$. Water may be ineffective, but should be used to keep fire exposed containers cool.

**SPECIAL FIRE FIGHTING PROCEDURES:** Wear self-contained breathing apparatus (SCBA) and complete personal protective equipment. Diluting burning liquid with water spray reduces flame intensity.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Keep away from heat, sparks and flames.

## SECTION 5 - REACTIVITY DATA

UNSTABLE: NO **CONDITIONS TO AVOID:** Do not allow the inadvertent mixing of formaldehyde with hydrochloric acid since such
**STABLE:** YES mixtures may produce bis-chloro-methylether, a known carcinogen.

**INCOMPATIBILITY (MATERIALS TO AVOID):** Strong oxidizing agents, caustics, strong alkalies and inorganic acids.

**HAZARDOUS DECOMPOSITION OR BY-PRODUCTS:** Decomposition occurs from heat and reaction with materials above. Decomposition products include carbon dioxide, carbon monoxide, hydrogen and formaldehyde gas.

**HAZARDOUS POLYMERIZATION:** Will not occur
**CONDITIONS TO AVOID FOR POLYMERIZATION:** Not applicable

## SECTION 6 - HEALTH HAZARD DATA

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**INHALATION (BREATHING):** Highly irritating to upper respiratory tract. May cause inflammation of lining of nose, throat and lungs with bronchopneumonia and edema possible from extremely irritating exposure.

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**EYE CONTACT:** Exposure to high vapor concentrations or contact with liquid causes tearing and severe irritation. Contact with liquid causes burns.

**PRIMARY ROUTES OF ENTRY:** Eyes, Nose, Mouth, Skin contact

**NOTES TO PHYSICIAN:** Pulmonary edema may occur. Signs and symptoms of pulmonary edema may be delayed for several hours.

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**INHALATION:** Remove patient from contaminated area. If breathing has stopped, give artificial respiration then oxygen if needed. **CONTACT A PHYSICIAN.**

**SKIN CONTACT:** Remove contaminated clothing and wash with large amounts of water. If irritation persists, **CONTACT A PHYSICIAN.**

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**OTHER PRECAUTIONS:** Keep away from heat, sparks and flames. Keep containers closed. Use with adequate ventilation. Avoid breathing vapor. Avoid prolonged contact with skin. Wash thoroughly with soap and water after handling. Do not enter storage areas unless properly ventilated.

## SECTION 8 - CONTROL MEASURES

**RESPIRATORY PROTECTION:** Use full face NIOSH approved formaldehyde or acid gas cartridge or canister respirator within use limitations of these devices. In all other situations, use self-contained breathing apparatus (SCBA).

**VENTILATION:** **LOCAL EXHAUST: RECOMMENDED** **SPECIAL:** No information
MECHANICAL: Not recommended **OTHER:** No information

**EYE PROTECTION:** Use chemical safety goggles

**GLOVES:** Heavy duty neoprene or equal. Permeation/degradation values of chemical mixtures cannot be predicted from pure components or chemical classes. Thus, these materials are normally best estimates based on available pure component data. A significant difference in breakthrough time has been reported for generically similar gloves from different manufacturers.

**OTHER PROTECTIVE CLOTHING OR EQUIPMENT:** For operations where spills or splashing may occur, use an impervious body covering and shoe coverings. A safety shower and eye bath should be available.

**WORK PRACTICES:** Never use without proper ventilation. Always use proper protective clothing.

**HYGIENIC PRACTICES:** Observe good personal hygiene practices and recommended procedures. Wash exposed areas promptly and thoroughly after skin contact from working with this product and before eating, drinking, using tobacco products or restrooms.

**OTHER ENGINEERING CONTROLS:** None

**ADDITIONAL COMMENTS:** The data in the Material Safety Data Sheet relates only to specific material designated herein and does not relate to use in combination with any other material or in any process. The information set forth herein is furnished free of charge and is based on technical data that Pierce Chemicals/Royal Bond believes to be reliable. It is intended for use by persons having technical skill and at their own discretion and risk. Since conditions and use are outside of our control, we make no warranties, express or implied and assume no liability in connection with any use of the information.

**END OF 01215 (Ultra 27) MSDS**

Agency for Toxic Substances & Disease Registry

# ToxFAQs™ for Bis(chloromethyl) Ether

*(Éter Bis(Clorometílico) (/es/toxfaqs/es_tfacts128.html) )*

July 1999
CAS# 542-88-1
(/toxfaqs/tfacts128.pdf) **PDF Version, 145 KB** (/toxfaqs/tfacts128.pdf)

**This fact sheet answers the most frequently asked health questions about bis(chloromethyl) ether. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

**HIGHLIGHTS:** Bis(chloromethyl) ether is only used in small amounts inside fully enclosed systems to make other chemicals. Use of this chemical is highly restricted, so chances for exposure are very low. Bis(chloromethyl) ether is highly irritating to the skin, eyes, nose, throat, and lungs and it is a carcinogen. Bis(chloromethyl) ether has been found at 2 of the 1,518 National Priorities List sites identified by the Environmental Protection Agency (EPA).

## What is bis(chloromethyl) ether?

Bis(chloromethyl) ether is a clear liquid with a strong unpleasant odor. It does not occur naturally. It dissolves easily in water, but degrades rapidly and readily evaporates into air.

In the past, it was used to make several types of polymers, resins, and textiles, but its use is now highly restricted. Only small quantities of bis(chloromethyl) ether are produced in the United States. The small quantities that are produced are only used in enclosed systems to make other chemicals. However, small quantities of bis(chloromethyl) ether may be formed as an impurity during the production of another chemical, chloromethyl methyl ether.

## What happens to bis(chloromethyl) ether when it enters the environment?

Bis(chloromethyl) ether released to air can be broken down by reactions with other chemicals and sunlight, or it can be removed by rain.
In water, it is broken down quickly to formaldehyde and hydrochloric acid.
When released to soil, some will evaporate to the air but most of it will be broken down by reacting with soil moisture.
Bis(chloromethyl) ether does not build up in the food chain and does not last long in the environment.

## How might I be exposed to bis(chloromethyl) ether?

Because bis(chloromethyl) ether does not last long in the environment and because of its restricted use, you are not likely to be exposed to this chemical.

The most likely way to be exposed is by breathing it in the air if you work at, or live near, an industrial facility that makes or uses chemicals that may contain bis(chloromethyl) ether as a contaminant.

## How can bis(chloromethyl) ether affect my health?

Bis(chloromethyl) ether causes irritation to the skin, eyes, throat, and lungs. In some cases, damage to the lungs can be severe enough to cause death. Breathing low concentrations will cause coughing and nose, and throat irritation.

Animal studies show effects similar to those observed in people. These effects include irritation to the skin, nose, and lungs and lung damage (swelling and bleeding). Application of the liquid to the skin of mice and rabbits has produced hair loss, bleeding, swelling, and destruction of tissue.

We do not know if bis(chloromethyl) ether causes reproductive effects or birth defects in people or animals.

## How likely is bis(chloromethyl) ether to cause cancer?

There is evidence that bis(chloromethyl) ether causes lung cancer and other tumors in people and animals. The Department of Health and Human Services (DHHS) has determined that bis(chloromethyl) ether is a known human carcinogen.

## Is there a medical test to show whether I've been exposed to bis(chloromethyl) ether?

Because bis(chloromethyl) ether is broken down rapidly in the body, there are no specific tests to determine if someone has been exposed to this chemical. The only available medical tests involve physical examination of the nose and throat, chest x-rays, or other tests to identify damage to the respiratory tract. However, these tests are not specific for this chemical and can only be used after damage has occurred.

## Has the federal government made recommendations to protect human health?

The EPA recommends that levels in lakes and streams should be limited to 0.0000038 parts per billion parts of water (0.0000038 ppb) to prevent possible health effects from drinking water or eating fish contaminated with bis(chloromethyl) ether. Any release to the environment greater than 10 pounds of bis(chloromethyl) ether must be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) has set a limit of 1 ppb as the highest acceptable level in workplace air, and strict controls have been established to minimize exposure to this chemical.

The federal recommendations have been updated as of July 1999.

## Glossary

Carcinogen: A substance that can cause cancer.

CAS: Chemical Abstracts Service.

Evaporate: To change into a vapor or a gas.

National Priorities List: A list of the nation's worst hazardous waste sites.

Polymer: Chemical compounds consisting of repeating structural units.

ppb: Parts per billion.

Tumor: An abnormal mass of tissue.

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## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological Profile for bis(chloromethyl) ether (/ToxProfiles/TP.asp?id=919&tid=188) . Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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## Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

**For more information, contact:**
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-62
Atlanta, GA 30333
Phone: 1-800-CDC-INFO · 888-232-6348 (TTY)
Fax: 1-770-488-4178
Email: cdcinfo@cdc.gov (mailto:cdcinfo@cdc.gov)

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.

**Information line and technical assistance:**
Phone: 888-422-8737
FAX: (770)-488-4178

**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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the directions on the toxicological profile home page (http://www.atsdr.cdc.gov/toxprofiles/index.asp), which also contains other important information about the profiles.

- Page last reviewed: March 3, 2011
- Page last updated: March 3, 2011
- Content source: Agency for Toxic Substances and Disease Registry (http://www.atsdr.cdc.gov/)

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Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy NE, Atlanta, GA 30341
Contact CDC: 800-232-4636 / TTY: 888-232-6348

Agency for Toxic Substances & Disease Registry

# Public Health Statement for Bis(chloromethyl) Ether

December 1989
CAS# 542-88-1

**This Public Health Statement is the summary chapter from the Toxicological Profile for bis(chloromethyl) ether (/ToxProfiles/TP.asp?id=919&tid=188). It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™ (/toxfaqs/TF.asp?id=918&tid=188), 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.**

## 1.1 What is bis(chloromethyl) ether?

Bis(chloromethyl) ether (BCME) is a man-made chemical with a strong, unpleasant odor. It is a clear liquid at room temperature, but it readily evaporates into air. BCME undergoes chemical reactions easily, so it is broken down very rapidly when it comes into contact with water. Consequently, any BCME that might escape from a chemical plant or a chemical waste site into water or moist soil would be destroyed within a few minutes. BCME that escapes into air is also broken down by reacting with water and other chemicals, but this takes a few hours.

BCME was used in the past to make several types of polymers, resins and textiles. However, because BCME is believed to cause cancer in humans, these uses have been stopped. BCME is now used only in small amounts inside fully enclosed systems in chemical plants.

## 1.2 How might I be exposed to bis(chloromethyl) ether?

Since BCME has such limited use in the United States, chances for exposure to BCME are low. Some BCME can form as an impurity during the production of other chemicals, so exposure might occur in chemical plants that make or use these chemicals. Also, some BCME may exist in chemical waste sites, although this is not certain. Because BCME evaporates easily, the most likely way to be exposed to BCME in the workplace or around a waste site is by breathing air containing BCME vapors. However, information on levels of BCME which exist in air is not available.

## 1.3 How can bis(chloromethyl) ether enter and leave my body?

Because BCME is so quickly broken down by water, most BCME that contacts the body is quickly changed into other chemicals (formaldehyde and hydrochloric acid) before it passes through the outermost layer of cells contacted (e.g., the cells that line the nose, windpipe and lungs). Some BCME may enter into the blood or internal tissues, but this has not been studied and the amount may be too small to measure.

## 1.4 How can bis(chloromethyl) ether affect my health?

Studies of people exposed to BCME in the workplace show that breathing of BCME vapors causes irritation to the nose, throat, and lungs. Contact with the liquid is also highly irritating to skin. In animals, breathing in high levels of BCME causes swelling and bleeding in the lung and can cause death. Workers exposed to BCME have been shown to have a higher-than-expected incidence of lung

cancer. This observation is supported by studies in animals which also show that BCME can cause cancer.

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### .5 Is there a medical test to determine whether I have been exposed to bis(chloromethyl) ether?

Because BCME is broken down so rapidly in the body, there are no specific tests to determine if a human has been exposed to this compound. The only available medical tests are physical examination of the nose and throat, chest X-ray, and examination of the sputum for abnormal cell types. Unfortunately, these tests are not specific for this compound, and would reveal effects of the compound only after damage to the tissues had already occurred.

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### 1.6 What levels of exposure have resulted in harmful health effects?

No information exists for either animals or humans on harmful health effects following oral exposure, but oral exposure is of little concern since BCME breaks down in water or moist foods and exposure is not likely by this route. Direct skin contact with even small amounts (less than a drop) of the liquid form of BCME causes severe skin irritation at the site of contact. It is not known what levels result in health effects in people from breathing BCME. In animals, lung injury has occurred from short and long-term exposure to levels of 0.7 parts per million (ppm) BCME and greater. An increased number of deaths due to nasal tumors was seen in animals exposed to BCME in air at levels of 0.1 ppm for 6 months.

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### 1.7 What recommendations has the federal government made to protect human health?

The EPA recommends that levels in lakes and streams should be limited to 0.0000038 parts per billion parts of water (0.0000038 ppb) to prevent possible health effects from drinking water or eating fish contaminated with bis(chloromethyl) ether. Any release to the environment greater than 10 pounds of bis(chloromethyl) ether must be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) has set a limit of 1 ppb as the highest acceptable level in workplace air, and strict controls have been established to minimize exposure to this chemical.

The federal recommendations have been updated as of July 1999.

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### References

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological profile for bis(chloromethyl)ether (/ToxProfiles/TP.asp?id=919&tid=188). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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Contact CDC: 800-232-4636 / TTY: 888-232-6348

Agency for Toxic Substances & Disease Registry

# ToxFAQs™ for Cadmium

(*Cadmio* (/es/toxfaqs/es_tfacts5.html) )

September 2008

CAS# 7440-43-9

(/tfacts5.pdf) **PDF Version, 33 KB** (/tfacts5.pdf)

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**This fact sheet answers the most frequently asked health questions about cadmium. For more information, you may call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

---

## Highlights

Exposure to cadmium happens mostly in the workplace where cadmium products are made. The general population is exposed from breathing cigarette smoke or eating cadmium contaminated foods. Cadmium damages the kidneys, lungs, and bones. Cadmium has been found in at least 1,014 of the 1,669 National Priorities List sites identified by the Environmental Protection Agency (EPA).

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## What is cadmium?

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide).

All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics.

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## What happens to cadmium when it enters the environment?

- Cadmium enters soil, water, and air from mining, industry, and burning coal and household wastes.
- Cadmium does not break down in the environment, but can change forms.
- Cadmium particles in air can travel long distances before falling to the ground or water.
- Some forms of cadmium dissolve in water.
- Cadmium binds strongly to soil particles.
- Fish, plants, and animals take up cadmium from the environment.

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## How might I be exposed to cadmium?

- Eating foods containing cadmium; low levels are found in all foods (highest levels are found in shellfish, liver, and kidney meats).
- Smoking cigarettes or breathing cigarette smoke.
- Breathing contaminated workplace air.
- Drinking contaminated water.
- Living near industrial facilities which release cadmium into the air.

## How can cadmium affect my health?

Breathing high levels of cadmium can severely damage the lungs. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea.

Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage and fragile bones.

## How likely is cadmium to cause cancer?

The Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds are known human carcinogens.

## How can cadmium affect children?

The health effects in children are expected to be similar to the effects seen in adults (kidney, lung, and bone damage depending on the route of exposure).

A few studies in animals indicate that younger animals absorb more cadmium than adults. Animal studies also indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium.

We don't know if cadmium causes birth defects in people. The babies of animals exposed to high levels of cadmium during pregnancy had changes in behavior and learning ability. There is also some information from animal studies that high enough exposures to cadmium before birth can reduce body weights and affect the skeleton in the developing young.

## How can families reduce the risk of exposure to cadmium?

- In the home, store substances that contain cadmium safely, and keep nickel-cadmium batteries out of reach of young children.
- Cadmium is a component of tobacco smoke. Avoid smoking in enclosed spaces like inside the home or car in order to limit exposure to children and other family members.
- If you work with cadmium, use all safety precautions to avoid carrying cadmium-containing dust home from work on your clothing, skin, hair, or tools.
- A balanced diet can reduce the amount of cadmium taken into the body from food and drink. .

## Is there a medical test to determine whether I've been exposed to cadmium?

Cadmium can be measured in blood, urine, hair, or nails. Urinary cadmium has been shown to accurately reflect the amount of cadmium in the body.

The amount of cadmium in your blood shows your recent exposure to cadmium. The amount of cadmium in your urine shows both your recent and your past exposure.

## Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to cadmium in drinking water at concentrations of 0.04 ppm for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 0.005 ppm cadmium is not expected to cause any adverse effects.

The FDA has determined that the cadmium concentration in bottled drinking water should not exceed 0.005 ppm.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 5 ìg/m3 for an 8-hour workday, 40-hour workweek.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Cadmium (/ToxProfiles/TP.asp?id=48&tid=15) *(Draft for Public Comment)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

## Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

**For more information, contact:**
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-62
Atlanta, GA 30333
Phone: 1-800-CDC-INFO · 888-232-6348 (TTY)
Fax: 1-770-488-4178
Email: cdcinfo@cdc.gov (mailto:cdcinfo@cdc.gov)

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.

**Information line and technical assistance:**
Phone: 888-422-8737
FAX: (770)-488-4178

**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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Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy NE, Atlanta, GA 30341
Contact CDC: 800-232-4636 / TTY: 888-232-6348

Agency for Toxic Substances & Disease Registry

# ToxFAQs™ for Mercury

(*Mercurio* (/es/toxfaqs/es_tfacts46.html) )

April 1999

CAS# 7439-97-6

(/tfacts46.pdf) **PDF Version, 106 KB** (/tfacts46.pdf)

**This fact sheet answers the most frequently asked health questions about mercury. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

## Highlights

Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List sites identified by the Environmental Protection Agency.

## What is mercury?

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

## What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

## How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury).
- Practicing rituals that include mercury.

## How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

## How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney umors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

## How does mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also can pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

## How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

## Is there a medical test to show whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

## Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m3) and 0.05 mg/m3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological Profile for Mercury (/ToxProfiles/TP.asp?id=115&tid=24) . Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

## Where can I get more information?

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

**For more information, contact**:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-62
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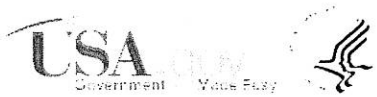

ATSDR Agency for Toxic Substances & Disease Registry

# Public Health Statement for Mercury

(*Mercurio* (/es/phs/es_phs46.html) )

March 1999

CAS# 7439-97-6

(/ToxProfiles/tp46-c1-b.pdf) **PDF Version, 121 KB** (/ToxProfiles/tp46-c1-b.pdf)

**This Public Health Statement is the summary chapter from the Toxicological Profile for Mercury (/ToxProfiles/TP.asp?id=115&tid=24) . It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™ (/toxfaqs/TF.asp?id=113&tid=24) , 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 mercury 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. Mercury has been found in at least 714 of the 1,467 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 mercury 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 mercury, 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 to which you're exposed, as well as your age, sex, diet, family traits, lifestyle, and state of health.

## 1.1 What is mercury?

Mercury occurs naturally in the environment and exists in several forms. These forms can be organized under three headings: metallic mercury (also known as elemental mercury), inorganic mercury, and organic mercury. Metallic mercury is a shiny, silver-white metal that is a liquid at room temperature. Metallic mercury is the elemental or pure form of mercury (i.e., it is not combined with other elements). Metallic mercury metal is the familiar liquid metal used in thermometers and some electrical switches. At room temperature, some of the metallic mercury will evaporate and form mercury vapors. Mercury vapors are colorless and odorless. The higher the temperature, the more vapors will be released from liquid metallic mercury. Some people who have breathed mercury vapors

report a metallic taste in their mouths. Metallic mercury has been found at 714 hazardous waste sites nationwide.

Inorganic mercury compounds occur when mercury combines with elements such as chlorine, sulfur, or oxygen. These mercury compounds are also called mercury salts. Most inorganic mercury compounds are white powders or crystals, except for mercuric sulfide (also known as cinnabar) which is red and turns black after exposure to light.

When mercury combines with carbon, the compounds formed are called "organic" mercury compounds or organomercurials. There is a potentially large number of organic mercury compounds; however, by far the most common organic mercury compound in the environment is methylmercury (also known as monomethylmercury). In the past, an organic mercury compound called phenylmercury was used in some commercial products. Another organic mercury compound called dimethylmercury is also used in small amounts as a reference standard for some chemical tests. Dimethylmercury is the only organic mercury compound that has been identified at hazardous waste sites. It was only found in extremely small amounts at two hazardous waste sites nationwide, but it is very harmful to people and animals. Like the inorganic mercury compounds, both methylmercury and phenylmercury exist as "salts" (for example, methylmercuric chloride or phenylmercuric acetate). When pure, most forms of methylmercury and phenylmercury are white crystalline solids. Dimethylmercury, however, is a colorless liquid.

Several forms of mercury occur naturally in the environment. The most common natural forms of mercury found in the environment are metallic mercury, mercuric sulfide (cinnabar ore), mercuric chloride, and methylmercury. Some microorganisms (bacteria and fungi) and natural processes can change the mercury in the environment from one form to another. The most common organic mercury compound that microorganisms and natural processes generate from other forms is methylmercury. Methylmercury is of particular concern because it can build up in certain edible freshwater and saltwater fish and marine mammals to levels that are many times greater than levels in the surrounding water.

Mercury is mined as cinnabar ore, which contains mercuric sulfide. The metallic form is refined from mercuric sulfide ore by heating the ore to temperatures above 1,000 degrees Fahrenheit. This vaporizes the mercury in the ore, and the vapors are then captured and cooled to form the liquid metal mercury. There are many different uses for liquid metallic mercury. It is used in producing of chlorine gas and caustic soda, and in extracting gold from ore or articles that contain gold. It is also used in thermometers, barometers, batteries, and electrical switches. Silver-colored dental fillings typically contain about 50% metallic mercury. Metallic mercury is still used in some herbal or religious remedies in Latin America and Asia, and in rituals or spiritual practices in some Latin American and Caribbean religions such as Voodoo, Santeria, and Espiritismo. These uses may pose a health risk from exposure to mercury both for the user and for others who may be exposed to mercury vapors in contaminated air.

Some inorganic mercury compounds are used as fungicides. Inorganic salts of mercury, including ammoniated mercuric chloride and mercuric iodide, have been used in skin-lightening creams. Mercuric chloride is a topical antiseptic or disinfectant agent. In the past, mercurous chloride was widely used in medicinal products including laxatives, worming medications, and teething powders. It has since been replaced by safer and more effective agents. Other chemicals containing mercury are still used as antibacterials. These products include mercurochrome (contains a small amount of mercury, 2%), and thimerosal and phenylmercuric nitrate, which are used in small amounts as preservatives in some prescription and over-the-counter medicines. Mercuric sulfide and mercuric oxide may be used to color paints, and mercuric sulfide is one of the red coloring agents used in tattoo

dyes.

Methylmercury is produced primarily by microorganisms (bacteria and fungi) in the environment, rather than by human activity. Until the 1970s, methylmercury and ethylmercury compounds were used to protect seed grains from fungal infections. Once the adverse health effects of methylmercury were known, the use of methymercury and ethylmercury as fungicides was banned. Up until 1991, phenylmercuric compounds were used as antifungal agents in both interior and exterior paints, but this use was also banned because mercury vapors were released from these paints.

## 1.2 What happens to mercury when it enters the environment?

Mercury is a naturally occurring metal found throughout the environment. Mercury enters the environment as the result of the normal breakdown of minerals in rocks and soil from exposure to wind and water, and from volcanic activity. Mercury releases from natural sources have remained relatively constant in recent history, resulting in a steady rise in environmental mercury. Human activities since the start of the industrial age (e.g., mining, burning of fossil fuels) have resulted in additional release of mercury to the environment. Estimates of the total annual mercury releases that result from human activities range from one-third to two-thirds of the total mercury releases. A major uncertainty in these estimates is the amount of mercury that is released from water and soils that were previously contaminated by human activities as opposed to new natural releases. The levels of mercury in the atmosphere (i.e., the air you breathe in the general environment) are very, very low and do not pose a health risk; however, the steady release of mercury has resulted in current levels that are three to six times higher than the estimated levels in the preindustrial era atmosphere.

Approximately 80% of the mercury released from human activities is elemental mercury released to the air, primarily from fossil fuel combustion, mining, and smelting, and from solid waste incineration. About 15% of the total is released to the soil from fertilizers, fungicides, and municipal solid waste (for example, from waste that contains discarded batteries, electrical switches, or thermometers). An additional 5% is released from industrial wastewater to water in the environment.

With the exception of mercury ore deposits, the amount of mercury that naturally exists in any one place is usually very low. In contrast, the amount of mercury that may be found in soil at a particular hazardous waste site because of human activity can be high (over 200,000 times natural levels). The mercury in air, water, and soil at hazardous waste sites may come from both natural sources and human activity.

Most of the mercury found in the environment is in the form of metallic mercury and inorganic mercury compounds. Metallic and inorganic mercury enters the air from mining deposits of ores that contain mercury, from the emissions of coal-fired power plants, from burning municipal and medical waste, from the production of cement, and from uncontrolled releases in factories that use mercury. Metallic mercury is a liquid at room temperature, but some of the metal will evaporate into the air and can be carried long distances. In air, the mercury vapor can be changed into other forms of mercury, and can be further transported to water or soil in rain or snow. Inorganic mercury may also enter water or soil from the weathering of rocks that contain mercury, from factories or water treatment facilities that release water contaminated with mercury, and from incineration of municipal garbage that contains mercury (for example, in thermometers, electrical switches, fluorescent light bulbs, or batteries that have been thrown away). Inorganic or organic compounds of mercury may be released to the water or soil if mercury-containing fungicides are used.

Microorganisms (bacteria, phytoplankton in the ocean, and fungi) convert inorganic mercury to methylmercury. Methylmercury released from microorganisms can enter the water or soil and remain

or water. Mercury usually stays on the surface of sediments or soil and does not move through the soil to underground water. If mercury enters the water in any form, it is likely to settle to the bottom where it can remain for a long time.

Mercury can enter and accumulate in the food chain. The form of mercury that accumulates in the food chain is methylmercury. Inorganic mercury does not accumulate up the food chain to any extent. When small fish eat the methylmercury in food, it goes into their tissues. When larger fish eat smaller fish or other organisms that contain methylmercury, most of the methylmercury originally present in the small fish will then be stored in the bodies of the larger fish. As a result, the larger and older fish living in contaminated waters build up the highest amounts of methylmercury in their bodies. Saltwater fish (especially sharks and swordfish) that live a long time and can grow to a very large size tend to have the highest levels of mercury in their bodies. Plants (such as corn, wheat, and peas) have very low levels of mercury, even if grown in soils containing mercury at significantly higher than background levels. Mushrooms, however, can accumulate high levels if grown in contaminated soils.

## 1.3 How might I be exposed to mercury?

Because mercury occurs naturally in the environment, everyone is exposed to very low levels of mercury in air, water, and food. Between 10 and 20 nanograms of mercury per cubic meter (ng/m$^3$) of air have been measured in urban outdoor air. These levels are hundreds of times lower than levels still considered to be "safe" to breathe. Background levels in nonurban settings are even lower, generally about 6 ng/m$^3$ or less. Mercury levels in surface water are generally less than 5 parts of mercury per trillion parts of water (5 ppt, or 5 ng per liter of water), about a thousand times lower than "safe" drinking water standards. Normal soil levels range from 20 to 625 parts of mercury per billion parts of soil (20–625 ppb; or 20,000–625,000 ng per kilogram of soil). A part per billion is one thousand times bigger than a part per trillion.

A potential source of exposure to metallic mercury for the general population is mercury released from dental amalgam fillings. An amalgam is a mixture of metals. The amalgam used in silver-colored dental fillings contains approximately 50% metallic mercury, 35% silver, 9% tin, 6% copper, and trace amounts of zinc. When the amalgam is first mixed, it is a soft paste which is inserted into the tooth surface. It hardens within 30 minutes. Once the amalgam is hard, the mercury is bound within the amalgam, but very small amounts are slowly released from the surface of the filling due to corrosion or chewing or grinding motions. Part of the mercury at the surface of the filling may enter the air as mercury vapor or be dissolved in the saliva. The total amount of mercury released from dental amalgam depends upon the total number of fillings and surface areas of each filling, the chewing and eating habits of the person, and other chemical conditions in the mouth. Estimates of the amount of mercury released from dental amalgams range from 3 to 17 micrograms per day (µg/day). The mercury from dental amalgam may contribute from 0 to more than 75% of your total daily mercury exposure, depending on the number of amalgam fillings you have, the amount of fish consumed, the levels of mercury (mostly as methylmercury) in those fish, and exposure from other less common sources such as mercury spills, religious practices, or herbal remedies that contain mercury. However, it should be kept in mind that exposure to very small amounts of mercury, such as that from dental amalgam fillings, does not necessarily pose a health risk.

Whether the levels of exposure to mercury vapor from dental amalgam are sufficiently high to cause adverse health effects, and exactly what those effects are, continues to be researched and debated by scientists and health officials. U.S. government summaries on the effects of dental amalgam conclude that there is no apparent health hazard to the general population, but that further study is needed to

determine the possibility of more subtle behavioral or immune system effects, and to determine the levels of exposure that may lead to adverse effects in sensitive populations. Sensitive populations may include pregnant women, children under the age of 6 (especially up to the age of 3), people with impaired kidney function, and people with hypersensitive immune responses to metals. If you belong to this group, you should discuss your medical condition with your dentist prior to any dental restoration work. Removal of dental amalgams in people who have no indication of adverse effects is not recommended and can put the person at greater risk, if performed improperly. Chelation therapy (used to remove metals from the body tissues) itself presents some health risks, and should be considered only when a licensed occupational or environmental health physician determines it necessary to reduce immediate and significant health risks due to high levels of mercury in the body.

Some religions have practices that may include the use of metallic mercury. Examples of these religions include Santeria (a Cuban-based religion whose followers worship both African deities and Catholic saints), Voodoo (a Haitian-based set of beliefs and rituals), Palo Mayombe (a secret form of ancestor worship practiced mainly in the Caribbean), and Espiritismo (a spiritual belief system native to Puerto Rico). Not all people who observe these religions use mercury, but when mercury is used in religious, ethnic, or ritualistic practices, exposure to mercury may occur both at the time of the practice and afterwards from contaminated indoor air. Metallic mercury is sold under the name "azogue" (pronounced ah-SEW-gay) in stores called "botanicas." Botanicas are common in Hispanic and Haitian communities, where azogue may be sold as an herbal remedy or for spiritual practices. The metallic mercury is often sold in capsules or in glass containers. It may be placed in a sealed pouch to be worn on a necklace or in a pocket, or it may be sprinkled in the home or car. Some people may mix azogue in bath water or perfume, or place azogue in devotional candles. Because metallic mercury evaporates into the air, these practices may put anyone breathing the air in the room at risk of exposure to mercury. The longer people breathe the contaminated air, the greater their risk will be. The use of metallic mercury in a home or an apartment not only threatens the health of the people who live there now, but also threatens the health of future residents who may unknowingly be exposed to further release of mercury vapors from contaminated floors or walls.

Metallic mercury is used in a variety of household products and industrial items, including thermostats, fluorescent light bulbs, barometers, glass thermometers, and some blood pressure devices. The mercury in these devices is contained in glass or metal, and generally does not pose a risk unless the item is damaged or broken, and mercury vapors are released. Spills of metallic mercury from broken thermometers or damaged electrical switches in the home may result in exposure to mercury vapors in indoor air. You must be careful when you handle and dispose of all items in the home that contain metallic mercury.

Very small amounts of metallic mercury (for example, a few drops) can raise air concentrations of mercury to levels that may be harmful to health. The longer people breathe the contaminated air, the greater the risk to their health. Metallic mercury and its vapors are extremely difficult to remove from clothes, furniture, carpet, floors, walls, and other such items. If these items are not properly cleaned, the mercury can remain for months or years, and continue to be a source of exposure.

It is possible for you to be exposed to metallic mercury vapors from breathing contaminated air around hazardous waste sites, waste incinerators, or power plants that burn mercury-containing fuels (such as coal or other fossil fuels), but most outdoor air is not likely to contain levels that would be harmful. Exposure to mercury compounds at hazardous waste sites is much more likely to occur from handling contaminated soil (i.e., children playing in or eating contaminated surface soil), drinking well-water, or eating fish from contaminated waters near those sites. Not all hazardous sites contain mercury, and not all waste sites that do contain mercury have releases of mercury to the air, water, or surface soils.

You can be exposed to mercury vapors from the use of fungicides that contain mercury. Excess use of these products may result in higher-than-average exposures. You may also be exposed to mercury from swallowing or applying to your skin outdated medicinal products (laxatives, worming medications, and teething powders) that contain mercurous chloride. Exposure may also occur from the improper or excessive use of other chemicals containing mercury, such as skin-lightening creams and some topical antiseptic or disinfectant agents (mercurochrome and thimerosal).

Workers are mostly exposed from breathing air that contains mercury vapors, but may also be exposed to other inorganic mercury compounds in the workplace. Occupations that have a greater potential for mercury exposure include manufacturers of electrical equipment or automotive parts that contain mercury, chemical processing plants that use mercury, metal processing, construction where building parts contain mercury (e.g., electrical switches, thermometers), and the medical professions (medical, dental, or other health services) where equipment may contain mercury (e.g., some devices that measure blood pressure contain liquid mercury). Dentists and their assistants may be exposed to metallic mercury from breathing in mercury vapor released from amalgam fillings and to a much lesser extent from skin contact with amalgam restorations. Family members of workers who have been exposed to mercury may also be exposed to mercury if the worker's clothes are contaminated with mercury particles or liquid.

Some people may be exposed to higher levels of mercury in the form of methylmercury if they have a diet high in fish, shellfish, or marine mammals (whales, seals, dolphins, and walruses) that come from mercury-contaminated waters. Methylmercury accumulates up the food chain, so that fish at the top of the food chain will have the most mercury in their flesh. Of these fish, the largest (i.e., the oldest) fish will have the highest levels. The Food and Drug Administration (FDA) estimates that most people are exposed, on average, to about 50 ng of mercury per kilogram of body weight per day (50 ng/kg/day) in the food they eat. This is about 3.5 micrograms (µg) of mercury per day for an adult of average weight. This level is not thought to result in any harmful effects. A large part of this mercury is in the form of methylmercury and probably comes from eating fish. Commercial fish sold through interstate commerce that are found to have levels of methylmercury above an "action level" of 1 ppm (established by the FDA) cannot be sold to the public. This level itself is below a level associated with adverse effects. However, if you fish in contaminated waters and eat the fish you catch, you may be exposed to higher levels of mercury. Public health advisories are issued by state and federal authorities for local waters that are thought to be contaminated with mercury. These advisories can help noncommercial (sport and subsistence) fishermen and their families to avoid eating fish contaminated with mercury. Foods other than fish that may contain higher than average levels of mercury include wild game, such as wild birds and mammals (bear) that eat large amounts of contaminated fish. People in the most northern climates may be exposed to high levels of mercury from eating meat or fat from marine mammals including whales, dolphins, walruses, and seals. These marine mammals are at or near the top of their marine food chain. Plants contain very little methylmercury or other forms of mercury. Mushrooms grown in mercury-contaminated soil may contain levels of mercury that could pose some risk to health, if large amounts were eaten.

## 1.4 How can mercury enter and leave my body?

A person can be exposed to mercury from breathing in contaminated air, from swallowing or eating contaminated water or food, or from having skin contact with mercury. Not all forms of mercury easily enter your body, even if they come in contact with it; so it is important to know which form of mercury you have been exposed to, and by which route (air, food, or skin).

When you swallow small amounts of metallic mercury, for example, from a broken oral thermometer,

virtually none (less than 0.01%) of the mercury will enter your body through the stomach or intestines, unless they are diseased. Even when a larger amount of metal mercury (a half of a tablespoon, about 204 grams) was swallowed by one person, very little entered the body. When you breathe in mercury vapors, however, most (about 80%) of the mercury enters your bloodstream directly from your lungs, and then rapidly goes to other parts of your body, including the brain and kidneys. Once in your body, metallic mercury can stay for weeks or months. When metallic mercury enters the brain, it is readily converted to an inorganic form and is "trapped" in the brain for a long time. Metallic mercury in the blood of a pregnant woman can enter her developing child. Most of the metallic mercury will accumulate in your kidneys, but some metallic mercury can also accumulate in the brain. Most of the metallic mercury absorbed into the body eventually leaves in the urine and feces, while smaller amounts leave the body in the exhaled breath.

Inorganic mercury compounds like mercurous chloride and mercuric chloride are white powders and do not generally vaporize at room temperatures like elemental mercury will. If they are inhaled, they are not expected to enter your body as easily as inhaled metallic mercury vapor. When inorganic mercury compounds are swallowed, generally less than 10% is absorbed through the intestinal tract; however, up to 40% may enter the body through the stomach and intestines in some instances. Some inorganic mercury can enter your body through the skin, but only a small amount will pass through your skin compared to the amount that gets into your body from swallowing inorganic mercury.

Once inorganic mercury enters the body and gets into the bloodstream, it moves to many different tissues. Inorganic mercury leaves your body in the urine or feces over a period of several weeks or months. A small amount of the inorganic mercury can be changed in your body to metallic mercury and leave in the breath as a mercury vapor. Inorganic mercury accumulates mostly in the kidneys and does not enter the brain as easily as metallic mercury. Inorganic mercury compounds also do not move as easily from the blood of a pregnant woman to her developing child. In a nursing woman, some of the inorganic mercury in her body will pass into her breast milk.

Methylmercury is the form of mercury most easily absorbed through the gastrointestinal tract (about 95% absorbed). After you eat fish or other foods that are contaminated with methylmercury, the methylmercury enters your bloodstream easily and goes rapidly to other parts of your body. Only small amounts of methylmercury enter the bloodstream directly through the skin, but other forms of organic mercury (in particular dimethylmercury) can rapidly enter the body through the skin. Organic mercury compounds may evaporate slowly at room temperature and may enter your body easily if you breathe in the vapors. Once organic mercury is in the bloodstream, it moves easily to most tissues and readily enters the brain. Methylmercury that is in the blood of a pregnant woman will easily move into the blood of the developing child and then into the child's brain and other tissues. Like metallic mercury, methylmercury can be changed by your body to inorganic mercury. When this happens in the brain, the mercury can remain there for a long time. When methylmercury does leave your body after you have been exposed, it leaves slowly over a period of several months, mostly as inorganic mercury in the feces. As with inorganic mercury, some of the methylmercury in a nursing woman's body will pass into her breast milk.

## 1.5 How can mercury affect my health?

The nervous system is very sensitive to mercury. In poisoning incidents that occurred in other countries, some people who ate fish contaminated with large amounts of methylmercury or seed grains treated with methylmercury or other organic mercury compounds developed permanent damage to the brain and kidneys. Permanent damage to the brain has also been shown to occur from exposure to sufficiently high levels of metallic mercury. Whether exposure to inorganic mercury

results in brain or nerve damage is not as certain, since it does not easily pass from the blood into the brain.

Metallic mercury vapors or organic mercury may affect many different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

Different forms of mercury have different effects on the nervous system, because they do not all move through the body in the same way. When metallic mercury vapors are inhaled, they readily enter the bloodstream and are carried throughout the body and can move into the brain. Breathing in or swallowing large amounts of methylmercury also results in some of the mercury moving into the brain and affecting the nervous system. Inorganic mercury salts, such as mercuric chloride, do not enter the brain as readily as methylmercury or metallic mercury vapor.

The kidneys are also sensitive to the effects of mercury, because mercury accumulates in the kidneys and causes higher exposures to these tissues, and thus more damage. All forms of mercury can cause kidney damage if large enough amounts enter the body. If the damage caused by the mercury is not too great, the kidneys are likely to recover once the body clears itself of the contamination.

Short-term exposure (hours) to high levels of metallic mercury vapor in the air can damage the lining of the mouth and irritate the lungs and airways, causing tightness of the chest, a burning sensation in the lungs, and coughing. Other effects from exposure to mercury vapor include nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Damage to the lining of the mouth and lungs can also occur from exposure to lower levels of mercury vapor over longer periods (for example, in some occupations where workers were exposed to mercury for many years). Levels of metallic mercury in workplace air are generally much greater than the levels normally encountered by the general population. Current levels of mercury in workplace air are low, due to increased awareness of mercury's toxic effects. Because of the reduction in the allowable amount of mercury in workplace air, fewer workers are expected to have symptoms of mercury toxicity. Most studies of humans who breathed metallic mercury for a long time indicate that mercury from this type of exposure does not affect the ability to have children. Studies in workers exposed to metallic mercury vapors have also not shown any mercury-related increase in cancer. Skin contact with metallic mercury has been shown to cause an allergic reaction (skin rashes) in some people.

In addition to effects on the kidneys, inorganic mercury can damage the stomach and intestines, producing symptoms of nausea, diarrhea, or severe ulcers if swallowed in large amounts. Effects on the heart have also been observed in children after they accidentally swallowed mercuric chloride. Symptoms included rapid heart rate and increased blood pressure. There is little information on the effects in humans from long-term, low-level exposure to inorganic mercury.

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.

Studies using animals indicate that long-term oral exposure to inorganic mercury salts causes kidney damage, effects on blood pressure and heart rate, and effects on the stomach. Study results also suggest that reactions involving the immune system may occur in sensitive populations after swallowing inorganic mercury salts. Some animal studies report that nervous system damage occurs after long-term exposure to high levels of inorganic mercury. Short-term, high-level exposure of laboratory animals to inorganic mercury has been shown to affect the developing fetus and may cause termination of the pregnancy.

Animals exposed orally to long-term, high levels of methylmercury or phenylmercury in laboratory studies experienced damage to the kidneys, stomach, and large intestine; changes in blood pressure and heart rate; adverse effects on the developing fetus, sperm, and male reproductive organs; and increases in the number of spontaneous abortions and stillbirths. Adverse effects on the nervous system of animals occur at lower doses than do harmful effects to most other systems of the body. This difference indicates that the nervous system is more sensitive to methylmercury toxicity than are other organs in the body. Animal studies also provide evidence of damage to the nervous system from exposure to methylmercury during development, and evidence suggests that the effects worsen with age, even after the exposure stops.

Some rat and mice strains that are susceptible to autoimmune responses develop kidney damage as a result of an immune response when exposed to relatively low levels of mercury vapor or mercury chloride.

Animals given inorganic mercury salts by mouth for most of their lifetime had increases in some kinds of tumors at the highest dose tested. Rats and mice that received organic mercury (methylmercury or phenylmercury) in their drinking water or feed for most of their lives had an increased incidence of cancer of the kidney, but this affected only the males that received the highest amount of mercury given (not the females). Since the high doses caused severe damage to the kidneys prior to the cancer, these animal studies provide only limited information about whether mercury causes cancer in humans. As a result, the Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified mercury as to its human carcinogenicity. The Environmental Protection Agency has determined that mercury chloride and methylmercury are possible human carcinogens.

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## 1.6 How can mercury affect children?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

Children are at risk of being exposed to metallic mercury that is not safely contained, to mercury that may be brought home on work clothes or tools, or to methylmercury-contaminated foods. Methylmercury eaten or swallowed by a pregnant woman or metallic mercury that enters her body from breathing contaminated air can also pass into the developing child. Inorganic mercury and methylmercury can also pass from a mother's body into breast milk and into a nursing infant. The amount of mercury in the milk will vary, depending on the degree of exposure and the amount of mercury that enter the nursing woman's body. There are significant benefits to breast feeding, so any concern that a nursing woman may have about mercury levels in her breast milk should be discussed with her doctor. Methylmercury can also accumulate in an unborn baby's blood to a concentration higher than the concentration in the mother.

For similar exposure routes and forms of mercury, the harmful health effects seen in children are

similar to the effects seen in adults. High exposure to mercury vapor causes lung, stomach, and intestinal damage and death due to respiratory failure in severe cases. These effects are similar to those seen in adult groups exposed to inhaled metallic mercury vapors at work.

Children who had been exposed to excessive amounts of mercurous chloride tablets for worms or mercurous chloride-containing powders for teething discomfort had increased heart rates and elevated blood pressure. Abnormal heart rhythms were also seen in children who had eaten grains contaminated with very high levels of methylmercury.

Other symptoms of poisonings in children who were treated with mercurous chloride for constipation, worms, or teething discomfort included swollen red gums, excessive salivation, weight loss, diarrhea and/or abdominal pain, and muscle twitching or cramping in the legs and/or arms. Kidney damage is very common after exposure to toxic levels of inorganic mercury. Metallic mercury or methylmercury that enters the body can also be converted to inorganic mercury and result in kidney damage.

Children who breathe metallic/elemental mercury vapors, eat foods or other substances containing phenylmercury or inorganic mercury salts, or use mercury-containing skin ointments for an extended period may develop a disorder known as acrodynia, or pink disease. Acrodynia can result in severe leg cramps; irritability; and abnormal redness of the skin, followed by peeling of the hands, nose, and soles of the feet. Itching, swelling, fever, fast heart rate, elevated blood pressure, excessive salivation or sweating, rashes, fretfulness, sleeplessness, and/or weakness may also be present. It was once believed that this syndrome occurred only in children, but recent reported cases in teenagers and adults have shown that they can also develop acrodynia.

In critical periods of development before they are born, and in the early months after birth, children and fetuses are particularly sensitive to the harmful effects of metallic mercury and methylmercury on the nervous system. Harmful developmental effects may occur when a pregnant woman is exposed to metallic mercury and some of the mercury is transferred into her developing child. Thus, women who are normally exposed to mercury vapors in the workplace (such as those working in thermometer/barometer or fluorescent light manufacturing or the chlor-alkali industry) should take measures to avoid mercury vapor exposures during pregnancy. Exposures to mercury vapors are relatively rare outside of the workplace, unless metallic mercury is present in the home.

As with mercury vapors, exposure to methylmercury is more dangerous for young children than for adults, because more methylmercury easily passes into the developing brain of young children and may interfere with the development process.

Methylmercury is the form of mercury most commonly associated with a risk for developmental effects. Exposure can come from foods contaminated with mercury on the surface (for example, from seed grain treated with methylmercury to kill fungus) or from foods that contain toxic levels of methylmercury (as in some fish, wild game, and marine mammals). Mothers who are exposed to methylmercury and breast-feed their infant may also expose the child through the milk. The effects on the infant may be subtle or more pronounced, depending on the amount to which the fetus or young child was exposed. In cases in which the exposure was relatively small, some effects might not be apparent, such as small decreases in IQ or effects on the brain that may only be determined by the use of very sensitive neuropsychological testing. In instances in which the exposure is great, the effects may be more serious. In some such cases of mercury exposure involving serious exposure to the developing fetus, the effects are delayed. In such cases, the infant may be born apparently normal, but later show effects that may range from the infant being slower to reach developmental milestones, such as the age of first walking and talking, to more severe effects including brain damage with

mental retardation, incoordination, and inability to move. Other severe effects observed in children whose mothers were exposed to very toxic levels of mercury during pregnancy include eventual blindness, involuntary muscle contractions and seizures, muscle weakness, and inability to speak. It is important to remember, however, that the severity of these effects depends upon the level of mercury exposure and the length of exposure. The very severe effects just mentioned were reported in large-scale poisoning instances in which pregnant and nursing women were exposed to extremely high levels of methylmercury in contaminated grain used to make bread (in Iraq) or seafood (in Japan) sold to the general population.

Researchers are currently studying the potential for less serious developmental effects, including effects on a child's behavior and ability to learn, think, and solve problems that may result from eating lower levels of methylmercury in foods. A main source of exposure to methylmercury for the pregnant woman and the young child is from eating fish. Most fish purchased in the market in the United States do not have mercury levels that pose a risk to anyone, including pregnant women. Since mercury accumulates in the muscles of fish, larger fish that feed on smaller fish and live for long periods usually have larger concentrations of methylmercury than fish that feed on plants. For example, shark and swordfish normally contain the highest levels of mercury out of all ocean fish. Scientists have an ongoing debate about the value of fish in the diet versus any risk from increased exposure of pregnant women to methylmercury that may be in the fish. The safety of most fish sold commercially in the United States is regulated by the FDA. These fish pose no health risk to those who purchase and eat them. Only fish or wildlife containing relatively high levels of methylmercury are of concern.

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## 1.7 How can families reduce the risk of exposure to mercury?

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

Children may be exposed to metallic mercury if they play with it. Metallic mercury is a heavy, shiny, silver liquid. When metallic mercury is spilled, it forms little balls or beads. Children are sometimes exposed to metallic mercury when they find it in abandoned warehouses or closed factories, and then play with it or pass it around to friends. Children have also taken metallic mercury from school chemistry and physics labs. Broken thermometers and some electrical switches are other sources of metallic mercury. Sometimes children find containers of metallic mercury that were improperly disposed of, or adults may bring home metallic mercury from work, not knowing that it is dangerous.

To protect your children from metallic mercury, teach them not to play with shiny, silver liquids. Schoolteachers (particularly science teachers) and school staff need to know about students' fascination with metallic mercury. Teachers and school staff should teach children about the dangers of getting sick from playing with mercury, and they should keep metallic mercury in a safe and secured area (such as a closed container in a locked storage room) so that children do not have access to it without the supervision of a teacher. Metallic mercury evaporates slowly, and if it is not stored in a closed container, children may breathe toxic mercury vapors.

In the past, mercurous chloride was widely used in medicinal products such as laxatives, worming medications, and teething powders. These older medicines should be properly disposed of and replaced with safer and more effective medicines. Other chemicals containing mercury, such as mercurochrome and thimerosal (sold as Merthiolate and other brands), are still used as antiseptics or as preservatives in eye drops, eye ointments, nasal sprays, and vaccines. Some skin-lightening creams contain ammoniated mercuric chloride and mercuric iodide. These and all other mercury-containing

medicines should be kept safely out of the reach of children to prevent an accidental poisoning. Nonmedicinal products, including some fungicides that contain mercury compounds and paints that contain mercuric sulfide or mercuric oxide, should also be safely stored out of the reach of children.

You should check to see if any medicines or herbal remedies that you or your child use contain mercury. Some traditional Chinese and Hispanic remedies for stomach disorders (for example, herbal balls) contain mercury, and if you give these remedies to your children, you may harm them. If you are pregnant or nursing a baby and you use mercury-containing ethnic or herbal remedies, you could pass some of the mercury to your unborn child or nursing infant.

If you use metallic mercury or azogue in religious practices, you may expose your children or unborn child to mercury or contaminate your home. Such practices in which mercury containing substances have traditionally been used include Santeria (a Cuban-based religion whose followers worship both African deities and Catholic saints), Voodoo (a Haitian-based set of beliefs and rituals), Palo Mayombe (a secret form of ancestor worship practiced mainly in the Caribbean), or Espiritismo (a spiritual belief system native to Puerto Rico).

Metallic mercury is used in a variety of household products and industrial items, including thermostats, fluorescent light bulbs, barometers, glass thermometers, and some blood pressure measuring devices. You must be careful when you handle and dispose of all items in the home that contain metallic mercury.

If small amounts of mercury are spilled, be very careful cleaning it up. Do not try to vacuum spilled metallic mercury. Using a vacuum cleaner to clean up the mercury causes the mercury to evaporate into the air, creating greater health risks. Trying to vacuum spilled metallic mercury also contaminates the vacuum cleaner. Also, take care not to step on the mercury and track it into other areas of the home. Metallic mercury vapors are very toxic and have no odor. Do not remain unnecessarily in that room, and try not to let metallic mercury contact your eyes, skin, or clothing. If you think you have been exposed directly to metallic mercury, wash yourself thoroughly and discard contaminated clothing by placing them in a sealed plastic bag. Perhaps the most important thing to remember if you break a household thermometer is do not panic. The amount of mercury contained in an oral thermometer is small and does not present an immediate threat to human health. However, if it is not properly cleaned up and disposed of, it may present a health risk over time, particularly to infants, toddlers, and pregnant women.

If a thermometer breaks on a counter top or uncarpeted floor, remove children from the area. Mercury is not absorbent, so do not try to wipe or blot it up with a cloth or paper towel; that will only spread the mercury and break it up into smaller beads, making it more difficult to find and remove. Instead, clean up the beads of metallic mercury by using one sheet of paper to carefully roll them onto a second sheet of paper, or by sucking very small beads of mercury into an eye dropper. After picking up the metallic mercury in this manner, put it into a plastic bag or airtight container. The paper and eye dropper should also be bagged in a zip-lock plastic container. All plastic bags used in the cleanup should then be taken outside of the house or apartment and disposed of properly, according to instructions provided by your local health department or environmental officials. Try to ventilate the room with outside air, and close the room off from the rest of the home. Use fans (that direct the air to the outside and away from the inside of the house) for a minimum of one hour to speed the ventilation.

If a thermometer breaks and the liquid/metallic mercury spills onto a carpeted floor, try to collect the mercury beads in the manner described in the above paragraph. Depending on the cut or pile of the carpeting, however, it may not be possible to collect all of the spilled mercury. Regardless, do not

vacuum. Instead, call your local (county, city, or state) health department and tell them of your situation. (You may also call the Agency for Toxic Substances and Disease Registry [ATSDR] toll-free at 1-888-42-ATSDR [1-888-422-8737] to obtain additional guidance, if local assistance cannot be obtained.)

If larger amounts of metallic mercury are found (for example, a jar of liquid mercury), it should be contained in an airtight container, and you should call your local health department for instructions on how to safely dispose of it. If the mercury is in an open container or the container does not have a lid, place a piece of plastic wrap around the top of the container to prevent vapors from escaping; then wash your hands thoroughly. If a larger amount is spilled, leave the area and contact your local health department and fire department. Do not simply throw metallic mercury away, but instead seek professional help.

ATSDR and EPA strongly recommend against the use of metallic (liquid) mercury that is not properly enclosed in glass, as it is in thermometers. This form of mercury should not be used or stored in homes, automobiles, day-care centers, schools, offices, or other public buildings. If you notice a child with metallic mercury on his or her clothing, skin, or hair, call the fire department and let them know that the child needs to be decontaminated.

Metallic or inorganic mercury can be carried into the home from a workers' contaminated clothing and shoes. Increased exposure to mercury has been reported in children of workers who are exposed to mercury at work, and increased levels of mercury were measured in places where work clothes were stored and in some washing machines. The children most likely to be exposed to risky levels of mercury are those whose parents work in facilities that use mercury (for example, a scientific glassware manufacturing plant or a chlor-alkali chemical plant), but where no protective uniforms or footgear are used. In some reported cases in which children were exposed in this way, protective clothing was used in the workplace by the parent, but work gloves, clothes, and boots, which were contaminated with mercury, were taken home, thus exposing family members. If you have questions or concerns about exposure to mercury at work, you have a right to obtain information from your employer about your safety and health on the job without fear of punishment. The Occupational Safety and Health Administration (OSHA) requires employers to provide Material Safety Data Sheets (MSDSs) for many of the chemicals used at the workplace. Information on these sheets should include chemical names and hazardous ingredients, important properties (such as fire and explosion data), potential health effects, how you get the chemical(s) in your body, how to properly handle the materials, and what to do in an emergency. Your occupational health and safety officer at work can and should tell you whether chemicals you work with are dangerous and likely to be carried home on your clothes, body, or tools, and whether you should be showering and changing clothes before you leave work, storing your street clothes in a separate area of the workplace, or laundering your work clothes at home separately from other clothes.

Your employer is legally responsible for providing a safe workplace and should freely answer your questions about hazardous chemicals. Your OSHA-approved state occupational safety and health program or OSHA can also answer any further questions you might have, and help your employer identify and correct problems with hazardous substances. If you would like to make a formal complaint about health hazards in your workplace, your OSHA-approved state occupational safety and health program or OSHA office will listen to your complaint and inspect your workplace when necessary.

One way in which people are routinely exposed to extremely small amounts of mercury is through the gradual (but extremely slow) wearing-away process of dental amalgam fillings, which contain approximately 50% mercury. The amount of mercury to which a person might be exposed from dental

amalgams would depend on the number of amalgams present and other factors. The Centers for Disease Control and Prevention (CDC) has determined that dental amalgam fillings do not pose a health risk, although they do account for some mercury exposure to those having such fillings. People who frequently grind their teeth or often chew gum can add to the small amount of mercury normally released from those fillings over time. If you are pregnant, the decision of whether to have dental amalgam or a non-mercury material used for fillings, or whether existing amalgam fillings should be repaired or replaced during pregnancy, should be made in consultation with your dentist. The practice of having all your dental amalgam fillings replaced with non-mercury filling materials just to remove the possibility of mercury exposure is not recommended by ATSDR. In fact, the removal of the mercury amalgam fillings would actually expose the patient to a greater amount of mercury for a while. Other sources of mercury may increase your overall exposure, such as the amount of fish consumed per week, especially if caught in local waters contaminated with mercury or of certain species known to be higher in mercury content (shark and swordfish), or an exposure to mercury from a nearby hazardous waste site or incinerator.

You or your children may be exposed to methylmercury when eating certain types of fish caught from contaminated waters, or when eating certain types of wildlife from mercury contaminated areas. Most states, Native American tribes, and U.S. Territories have issued fish and/or wildlife advisories to warn people about methylmercury contaminated fish and/or wildlife. Most of the methylmercury advisories relate to specific types of freshwater or saltwater fish or shellfish, or freshwater turtles. Each state, Native American tribe, or U.S. Territory sets its own criteria for issuing fish and wildlife advisories. A fish or wildlife advisory will specify which bodies of water or hunting areas have restrictions. The advisory will tell you what types and sizes of fish or game are of concern. The advisory may completely ban eating fish or tell you to limit your meals of a certain type of fish. For example, an advisory may tell you to eat a certain type of fish no more than once a month; or an advisory may tell you to eat only certain parts of fish or game, or how to prepare it to decrease your exposure to methylmercury. The fish or wildlife advisory may be stricter to protect pregnant women, nursing women, and young children. To reduce your children's exposure to methylmercury, you should follow the instructions recommended in the fish or wildlife advisories. Information on Fish and Wildlife Advisories in your state is available from your state public health or natural resources department. Signs may also be posted in certain fishing and hunting areas with information about contaminated fish or wildlife.

FDA currently advises that pregnant women and women of childbearing age who may become pregnant limit their consumption of shark and swordfish to no more that one meal per month. This advice is given because methylmercury levels are relatively high in these fish species. Women of childbearing age are included in this advice because dietary practices immediately before the pregnancy could have a direct bearing on fetal exposure during pregnancy, particularly during the earlier months of pregnancy.

FDA further advises that persons other than pregnant women and women of childbearing age in the general population limit their regular consumption of shark and swordfish (which typically contains methylmercury around 1 ppm) to about 7 ounces per week (about one serving) to stay below the acceptable daily intake for methylmercury. For fish species with methylmercury levels averaging 0.5 ppm, regular consumption should be limited to 14 ounces per week. Recreational and subsistence fishers who eat larger amounts of fish than the general population and routinely fish the same waterbodies may have a higher exposure to methylmercury if these waters are contaminated. People who consume greater than 100 grams of fish (approximately 3.5 ounces) every day are considered high-end consumers. This is over 10 times more than the amount of fish consumed by members of the general population (6.5 g/day). No consumption advice is necessary for the top ten seafood species

that make up about 80% of the seafood sold in the United States: canned tuna, shrimp, pollock, salmon, cod, catfish, clams, flatfish, crabs, and scallops. The methylmercury in these species is generally less than 0.2 ppm, and few people eat more than the suggested weekly limit of fish (i.e., 2.2 pounds).

If you are concerned about a mercury exposure or think that you or your child are experiencing the adverse effects of mercury, you should consult with a doctor or public health official who is familiar with the health effects of mercury.

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## 1.8 Is there a medical test to determine whether I have been exposed to mercury?

There are reliable and accurate ways to measure mercury levels in the body. These tests all involve taking blood, urine, or hair samples, and must be performed in a doctor's office or in a health clinic. Nursing women may have their breast milk tested for mercury levels, if any of the other samples tested are found to contain significant amounts of mercury. Most of these tests, however, do not determine the form of mercury to which you were exposed. Mercury levels found in blood, urine, breast milk, or hair may be used to determine if adverse health effects are likely to occur. Mercury in urine is used to test for exposure to metallic mercury vapor and to inorganic forms of mercury. Measurement of mercury in whole blood or scalp hair is used to monitor exposure to methylmercury. Urine is not useful for determining whether exposure has occurred to methylmercury. Levels found in blood, urine, and hair may be used together to predict possible health effects that may be caused by the different forms of mercury.

Blood and urine levels are used as markers to determine whether someone has been exposed to mercury. They are used to determine whether exposure to mercury has occurred and to give a rough idea of the extent of exposure, but they do not tell exactly how much exposure has occurred. Except for methylmercury exposures, blood is considered useful if samples are taken within a few days of exposure. This is because most forms of mercury in the blood decrease by one-half every three days if exposure has been stopped. Thus, mercury levels in the blood provide more useful information after recent exposures than after long-term exposures. Several months after an exposure, mercury levels in the blood and urine are much lower. Hair, which is considered useful only for exposures to methylmercury, can be used to show exposures that occurred many months ago, or even more than a year ago if the hair is long enough and careful testing methods are used. After short-term exposures to metallic mercury, mercury vapor can be detected in the breath, but this occurs to a significant extent only within a few days after exposure, and is not a method normally used to determine if mercury exposure has occurred.

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## 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, on the other hand, 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 available. For the most current information, check with the federal agency or organization that provides it for the substance in which you are interested. Some regulations and recommendations for mercury include the following:

EPA and FDA have set a limit of 2 parts inorganic mercury per billion (ppb) parts of water in drinking water. EPA is in the process of revising the Water Quality Criteria for mercury. EPA currently recommends that the level of inorganic mercury in rivers, lakes, and streams be no more than 144 parts mercury per trillion (ppt) parts of water to protect human health (1 ppt is a thousand times less than 1 part per billion, or ppb). EPA has determined that a daily exposure (for an adult of average weight) to inorganic mercury in drinking water at a level up to 2 ppb is not likely to cause any significant adverse health effects. FDA has set a maximum permissible level of 1 part of methylmercury in a million parts (ppm) of seafood products sold through interstate commerce (1 ppm is a thousand times more than 1 ppb). FDA may seize shipments of fish and shellfish containing more than 1 ppm of methylmercury, and may seize treated seed grain containing more than 1 ppm of mercury.

OSHA regulates levels of mercury in the workplace. It has set limits of 0.1 milligrams of mercury per cubic meter of air (mg/m3) for organic mercury and 0.05 mg/m3 for metallic mercury vapor in workplace air to protect workers during an 8-hour shift and a 40-hour work week. NIOSH recommends that the amount of metallic mercury vapor in workplace air be limited to an average level of 0.05 mg/m3 during a 10-hour work shift.

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## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for Mercury (/ToxProfiles/TP.asp?id=115&tid=24). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

## Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

**For more information, contact:**
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-62
Atlanta, GA 30333
Phone: 1-800-CDC-INFO · 888-232-6348 (TTY)
Fax: 1-770-488-4178
Email: cdcinfo@cdc.gov (mailto:cdcinfo@cdc.gov)

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.

**Information line and technical assistance:**
Phone: 888-422-8737
FAX: (770)-488-4178

**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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Agency for Toxic Substances & Disease Registry

# ToxFAQs™ for Hydrogen Chloride

*(Cloruro de Hidrógeno (/es/toxfaqs/es_tfacts173.html) )*

April 2002
CAS# 7647-01-0
(/toxfaqs/tfacts173.pdf) **PDF Version, 112 KB** (/toxfaqs/tfacts173.pdf)

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**This fact sheet answers the most frequently asked health questions about hydrogen chloride. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

**HIGHLIGHTS:** People working in occupations in which hydrogen chloride is used have the highest risk of being exposed to this compound. Exposure of the general population is minimal. Hydrogen chloride gas can cause irritation of the eyes, skin, and respiratory tract. Exposure to high levels can result in corrosive damage to the eyes, skin, and respiratory tissues, and could lead to pulmonary edema and even death in extreme cases. This substance has been found in at least 63 of the 1,585 National Priorities List sites identified by the Environmental Protection Agency (EPA).

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## What is hydrogen chloride?

At room temperature, hydrogen chloride is a colorless to slightly yellow, corrosive, nonflammable gas that is heavier than air and has a strong irritating odor. On exposure to air, hydrogen chloride forms dense white corrosive vapors. Hydrogen chloride can be released from volcanoes.

Hydrogen chloride has many uses, including cleaning, pickling, electroplating metals, tanning leather, and refining and producing a wide variety of products. Hydrogen chloride can be formed during the burning of many plastics. Upon contact with water, it forms hydrochloric acid. Both hydrogen chloride and hydrochloric acid are corrosive.

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## What happens to hydrogen chloride when it enters the environment?

Hydrogen chloride released to the atmosphere will be removed by rainfall.
Hydrogen chloride dissociates readily in water to chloride and hydronium ions (an ion is an electrically charged atom or molecule), which ultimately lowers the pH of the water (makes it more acidic).
If released to soil, hydrogen chloride will evaporate from dry soil surfaces and dissociate into chloride anions and hydronium ions in moist soil.
Hydrogen chloride does not accumulate in the food chain.

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## How might I be exposed to hydrogen chloride?

You may breathe in air that contains very low levels of hydrogen chloride gas. Naturally-occurring

(i.e., from volcanic eruptions) and other releases of hydrogen chloride are removed by rainfall, limiting the chances of exposure to high levels of this compound by breathing ambient air. Hydrogen chloride is used to produce other chemicals, or for applications such as a metal pickling, ore refining, food processing, manufacture of fertilizers and dyes, and in the rubber and textile industries. Workers in these occupations may inhale hydrogen chloride or get it on their skin. Soldering materials often contain hydrogen chloride and you may be exposed if you use these products during soldering.

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**How can hydrogen chloride affect my health?**

Hydrogen chloride is irritating and corrosive to any tissue it contacts. Brief exposure to low levels causes throat irritation. Exposure to higher levels can result in rapid breathing, narrowing of the bronchioles, blue coloring of the skin, accumulation of fluid in the lungs, and even death. Exposure to even higher levels can cause swelling and spasm of the throat and suffocation. Some people may develop an inflammatory reaction to hydrogen chloride. This condition is called reactive airways dysfunction syndrome (RADS), a type of asthma caused by some irritating or corrosive substances.

Depending on the concentration, hydrogen chloride can produce from mild irritation to severe burns of the eyes and skin. Long-term exposure to low levels can cause respiratory problems, eye and skin irritation, and discoloration of the teeth.

Swallowing concentrated hydrochloric acid will cause severe corrosive injury to the lips, mouth, throat, esophagus, and stomach.

We do not know if exposure to hydrogen chloride can result in reproductive effects.

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**How likely is hydrogen chloride to cause cancer?**

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified hydrogen chloride as to its carcinogenicity. IARC considers hydrochloric acid to be not classifiable as to its carcinogenicity to humans.

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**How does hydrogen chloride affect children?**

Children are probably affected by exposure to hydrogen chloride in the same ways as adults. We do not know whether children differ from adults in their susceptibility to hydrogen chloride. In general, children may be more vulnerable to corrosive agents than adults because of the smaller diameter of their airways.

We do not know if exposure to hydrogen chloride can result in birth defects or other developmental effects

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**How can families reduce the risk of exposure to hydrogen chloride?**

Most families will not be exposed to significant levels of hydrogen chloride gas.

Household products containing hydrochloric acid should be stored in safe containers, in safe locations, out of the reach of children.

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**Is there a medical test to show whether I've been exposed to hydrogen chloride?**

Specific tests for the presence of hydrogen chloride in the blood or urine are not generally useful. If a severe exposure has occurred, blood and urine analyses and other tests may show whether damage has occurred to the lungs or gastrointestinal tract. Some of these tests can be performed in a doctor's office. Some testing may require hospital facilities.

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**Has the federal government made recommendations to protect human health?**
The Occupational Safety and Health Administration (OSHA) has set a ceiling limit of 5 parts of hydrogen chloride per million parts of air (5 ppm) in workplace air.

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**References**
Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Managing Hazardous Materials Incidents. Volume III – Medical Management Guidelines for Acute Chemical Exposures: Hydrogen Chloride (/MMG/MMG.asp?id=758&tid=147) . Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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## Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

**For more information, contact:**
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-62
Atlanta, GA 30333
Phone: 1-800-CDC-INFO · 888-232-6348 (TTY)
Fax: 1-770-488-4178
Email: cdcinfo@cdc.gov (mailto:cdcinfo@cdc.gov)

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.

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Agency for Toxic Substances & Disease Registry

# ToxFAQs™ for Sulfur Dioxide

(*Anhídrido Sulfuroso* (/es/toxfaqs/es_tfacts116.html) )

June 1999

CAS# 7446-09-5

(/tfacts116.pdf) **PDF Version, 52 KB** (/tfacts116.pdf)

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**This fact sheet answers the most frequently asked health questions about sulfur dioxide. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

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## Highlights

Exposure to sulfur dioxide occurs from breathing it in the air. It affects the lungs and at high levels may result in burning of the nose and throat, breathing difficulties, and severe airway obstructions. This chemical has been found in at least 16 of 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

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## What is sulfur dioxide?

Sulfur dioxide is a colorless gas with a pungent odor. It is a liquid when under pressure, and it dissolves in water very easily.

Sulfur dioxide in the air comes mainly from activities such as the burning of coal and oil at power plants or from copper smelting. In nature, sulfur dioxide can be released to the air from volcanic eruptions.

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## What happens to sulfur dioxide when it enters the environment?

- When released into the environment, sulfur dioxide moves into the air.
- In the air, it can be converted to sulfuric acid, sulfur trioxide, and sulfates.
- Sulfur dioxide dissolves in water.
- Once dissolved in water, sulfur dioxide can form sulfurous acid.
- Sulfur dioxide can be absorbed into the soil, but we don't know if or how it moves in soil.

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## How might I be exposed to sulfur dioxide?

- Breathing air containing it or touching it.
- Working in industries where it occurs as a by-product, such as copper smelting or power

plants.
- Working in the manufacture of sulfuric acid, paper, food preservatives, or fertilizers.
- Living near heavily industrialized activities where sulfur dioxide occurs.

## How can sulfur dioxide affect my health?

Exposure to very high levels of sulfur dioxide can be life threatening. Exposure to 100 parts of sulfur dioxide per million parts of air (100 ppm) is considered immediately dangerous to life and health. Burning of the nose and throat, breathing difficulties, and severe airway obstructions occurred in miners who breathed sulfur dioxide released as a result of an explosion in a copper mine.

Long-term exposure to persistent levels of sulfur dioxide can affect your health. Lung function changes were seen in some workers exposed to low levels of sulfur dioxide for 20 years or more. However, these workers were also exposed to other chemicals, so their health effects may not have been from sulfur dioxide alone. Asthmatics have also been shown to be sensitive to the respiratory effects of low concentrations of sulfur dioxide.

Animal studies also show respiratory effects from breathing sulfur dioxide. Animals exposed to high concentrations of sulfur dioxide showed decreased respiration, inflammation of the airways, and destruction of areas of the lung.

## How likely is sulfur dioxide to cause cancer?

There are no studies that clearly show carcinogenic effects of sulfur dioxide in people or animals. Studies have investigated workers in the copper smelting and pulp and paper industries, but the results are inconclusive since the workers were also exposed to arsenic and other chemicals. The one available animal study suggests that sulfur dioxide may be a carcinogen in mice. The International Agency for Research on Cancer (IARC) has classified sulfur dioxide as Group 3, not classifiable as to human carcinogenicity.

## How does sulfur dioxide affect children?

Children who live in or near heavily industrialized areas where sulfur dioxide occurs may experience difficulty breathing, changes in the ability to breathe deeply, and burning of the nose and throat It is not known whether children are more vulnerable to these effects than adults. However, children may be exposed to more sulfur dioxide than adults because they breathe more air for their body weight than adults do.

Long-term studies surveying large numbers of children indicate that children who have breathed sulfur dioxide pollution may develop more breathing problems as they get older, may make more emergency room visits for treatment of wheezing fits, and may get more respiratory illnesses than other children. Children with asthma may be especially sensitive even to low concentrations of sulfur dioxide, but it is not known whether asthmatic children are more sensitive than asthmatic adults.

## How can families reduce the risk of exposure to sulfur dioxide?

Families living near heavily industrialized areas where sulfur dioxide occurs should limit their outdoor activities during times of high air pollution. By paying attention to news bulletins and air

pollution advisories, families can control the amount of their exposure. People with respiratory difficulties should pay special attention to these warnings, and asthmatic children's outdoor exercise should be limited when high levels of sulfur dioxide are present in air.

## Is there a medical test to show whether I've been exposed to sulfur dioxide?

Sulfur dioxide in the body is changed into other sulfur-containing chemicals in the body. These breakdown products can be measured in blood and urine, but this requires special equipment that is not routinely available in a doctor's office. Furthermore, exposure to chemicals other than sulfur dioxide can also produce sulfate, so the presence of sulfate breakdown products in your body does not necessarily mean you have been exposed to sulfur dioxide.

## Has the federal government made recommendations to protect human health?

EPA has set an air quality standard of 0.03 ppm for long-term, 1-year average concentrations of sulfur dioxide. Short-term, 24-hour air concentrations should not exceed 0.14 ppm more than once a year.

The Occupational Safety and Health Administration (OSHA) has set a limit of 2 ppm over an 8-hour workday, 40-hour workweek

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological Profile for Sulfur Dioxide (/ToxProfiles/TP.asp?id=253&tid=46). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

## Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

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# ToxFAQs™ for Nitrogen Oxides

*(Óxidos de Nitrógeno (/es/toxfaqs/es_tfacts175.html) )*

April 2002

CAS# Nitric Oxide 10102-43-9; Nitrogen Dioxide 10102-44-0

(/toxfaqs/tfacts175.pdf) **PDF Version, 116 KB** (/toxfaqs/tfacts175.pdf)

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**This fact sheet answers the most frequently asked health questions about nitrogen oxides. For more information, you may call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. 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.**

**HIGHLIGHTS:** Everybody is exposed to small amounts of nitrogen oxides in ambient air. Higher exposure may occur by burning wood or kerosene or near gas stoves or if you smoke. Exposure to high levels of nitrogen oxides can damage the respiratory airways. Contact with the skin or eyes can cause burns. Nitrogen dioxide and nitric oxide have been found in at least 9 and 6 of the 1,585 National Priorities List sites identified by the Environmental Protection Agency (EPA), respectively.

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## What are nitrogen oxides?

Nitrogen oxides are a mixture of gases that are composed of nitrogen and oxygen. Two of the most toxicologically significant nitrogen oxides are nitric oxide and nitrogen dioxide; both are nonflammable and colorless to brown at room temperature. Nitric oxide is a sharp sweet-smelling gas at room temperature, whereas nitrogen dioxide has a strong, harsh odor and is a liquid at room temperature, becoming a reddish-brown gas above 70°F.

Nitrogen oxides are released to the air from the exhaust of motor vehicles, the burning of coal, oil, or natural gas, and during processes such as arc welding, electroplating, engraving, and dynamite blasting. They are also produced commercially by reacting nitric acid with metals or cellulose.

Nitrogen oxides are used in the production of nitric acid, lacquers, dyes, and other chemicals. Nitrogen oxides are also used in rocket fuels, nitration of organic chemicals, and the manufacture of explosives.

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## What happens to nitrogen oxides when they enter the environment?

Nitrogen oxides are broken down rapidly in the atmosphere by reacting with other substances commonly found in the air. The reaction of nitrogen dioxide with chemicals produced by sunlight leads to the formation of nitric acid, which is a major constituent of acid rain. Nitrogen dioxide also reacts with sunlight, which leads to the formation of ozone and smog conditions in the air we breathe. Small amounts of nitrogen oxides may evaporate from water, but most of it will react with water and form nitric acid.

When released to soil, small amounts of nitrogen oxides may evaporate into air. However, most of it will be converted to nitric acid or other compounds.

Nitrogen oxides do not build up in the food chain.

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## How might I be exposed to nitrogen oxides?