1. PUBLIC HEALTH STATEMENT FOR MOLYBDENUM

This Public Health Statement summarizes the Agency for Toxic Substances and Disease Registry’s (ATSDR) findings on molybdenum, including chemical characteristics, exposure risks, possible health effects from exposure, and ways to limit exposure.

The U.S. 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 sites targeted for long-term federal clean-up activities. The EPA has found molybdenum in at least 86 of the 1,832 current or former NPL sites. The total number of NPL sites evaluated for molybdenum is not known. But the possibility remains that as more sites are evaluated, the sites where molybdenum is found may increase. This information is important because these future sites may be sources of exposure, and exposure to molybdenum may be harmful.

If you are exposed to molybdenum, many factors determine whether you’ll be harmed. These include how much you are exposed to (dose), how long you are exposed (duration), how often you are exposed (frequency), and how you are exposed (route of exposure). You must also consider the other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

WHAT IS MOLYBDENUM?

Molybdenum is a chemical element with the symbol Mo. Pure molybdenum exists as a dark-gray or black powder with a metallic luster or as a silvery-white mass. It does not occur naturally in the pure metallic form. It is principally found as oxide or sulfide compounds. Therefore, almost all exposure is to a molybdenum compound rather than the actual metal alone. Important naturally occurring molybdenum compounds are the minerals molybdenite, powellite, wulfenite, ferrimolybdite, and ilsemannite. Molybdenum has a very high melting point and it is used widely in industry to make steel alloys.

Molybdenum occurs naturally in all plants and animals. Low levels of molybdenum are required for good health in humans and animals.

WHAT HAPPENS TO MOLYBDENUM WHEN IT ENTERS THE ENVIRONMENT?

Molybdenum can enter the environment through releases from mining, milling, and smelting operations and coal-fired power plants. The primary source of molybdenum in air is from coal combustion.

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Molybdenum released to the air will settle to the ground by gravity or in rain and snow. Molybdenum can also be directly released into surface water. When molybdenum is released into soil or water, it can become attached to the organic material and other components (such as clay, sand, etc.) in the top layers of the soil or in the water and may not move far from where it is released. The soil conditions, especially the acidity of the soil, will influence the binding of molybdenum to soil and sediment. Molybdenum does not break down in the environment.

HOW MIGHT I BE EXPOSED TO MOLYBDENUM?

Molybdenum is common in the environment. The primary way that you may be exposed to molybdenum is by eating food containing molybdenum. Grains, legumes, nuts, and dairy products have the highest levels of molybdenum. You may also be exposed to molybdenum in some nutritional supplements. You may be exposed to small amounts of molybdenum by breathing air, by drinking water, and by skin contact with soil and water. You may be exposed to higher levels of molybdenum in drinking water if you live near industries using molybdenum and the industries release molybdenum into the waterways.

HOW CAN MOLYBDENUM ENTER AND LEAVE MY BODY?

Molybdenum can enter your body when you breathe air, drink water, or eat food containing molybdenum. When you breathe air containing molybdenum, molybdenum particles can be deposited in your lungs. Some of these particles can be coughed up and swallowed. Particles deposited deeper in the lungs are likely to pass through the lining of the lungs and enter the bloodstream. Some of the molybdenum in the lungs may stay there for years. At least half of ingested molybdenum will enter the bloodstream. The amount of molybdenum absorbed depends on what other food and beverages are ingested. We do not have any information on whether molybdenum can enter the body through the skin. Molybdenum in the blood will be distributed throughout the body, with the highest amounts found in the liver and kidneys. Molybdenum leaves your body in urine and feces, mostly in urine. Generally, the amount of molybdenum in your body remains constant (the amount that enters your body equals the amount that leaves). More information on how molybdenum enters and leaves the body is presented in Chapter 3.
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HOW CAN MOLYBDENUM AFFECT MY HEALTH?

Molybdenum is essential for good health. An intake of 45 micrograms of molybdenum per day (μg/day) is recommended for adults. On average, adults in the United States ingest 76–109 μg molybdenum per day.

Exposure to high levels of molybdenum can be harmful. Long-term exposure of rats and mice to molybdenum dust in the air can cause damage to the nasal cavity, epiglottis, and lungs. Studies in animals suggested that ingesting large amounts of molybdenum, at least 1,000 times higher than needed for health may damage the male and female reproductive system and might cause kidney and liver damage.

A study in mice provides some evidence that exposure to inhaled molybdenum can result in lung cancer. Molybdenum has not been classified as to carcinogenicity by the Department of Health and Human Services (HHS), the International Agency for Research on Cancer (IARC), or EPA.

More detailed information on the health effects of molybdenum in humans and animals can be found in Chapter 3.

HOW CAN MOLYBDENUM AFFECT CHILDREN?

This section discusses potential health effects of molybdenum exposure in humans from when they're first conceived to 18 years of age.

Children need small amounts of molybdenum to maintain good health. It is likely that the adverse health effects observed in adults exposed to higher than normal levels of molybdenum would also be observed in children. We do not know if children would be more susceptible to the toxicity of molybdenum than adults. We do not have enough information to determine whether molybdenum can cause birth defects or affect growth. Studies in humans and laboratory animals show that molybdenum is transferred from the mother to the fetus. Molybdenum has also been found in breast milk.

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HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO MOLYBDENUM?

If your doctor finds that you have been exposed to significant amounts of molybdenum, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate. You may also contact the state or local health department with health concerns.

Molybdenum is part of the natural environment and you need some molybdenum in your diet to maintain good health. Families can be exposed to more molybdenum than is needed for health if they live near natural or industrial sources of molybdenum, such as mining sites. If you live in an area with high levels of molybdenum in drinking water, you may consider using bottled drinking water.

If you are exposed to molybdenum at work, you can wear protective equipment and can remove contaminated clothing before going home.

ARE THERE MEDICAL TESTS TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO MOLYBDENUM?

Molybdenum is normally found in all tissues of the body, as well as in blood, urine, and feces. High levels of molybdenum in the blood or urine can show that you have been exposed to higher than normal levels of molybdenum. Measuring blood molybdenum levels may only tell you if you have been very recently exposed to molybdenum. Urinary molybdenum levels are more likely to give information on long-term exposure to molybdenum. Tests to measure molybdenum levels in the body are not usually available at a doctor’s office because they require special equipment. Although these tests can show that you have been exposed to higher than normal molybdenum levels, they cannot be used to predict how much molybdenum you have been exposed to or whether the exposure will result in an adverse health effect. More detailed information on the measurement of molybdenum is provided in Chapters 3 and 7.

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

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but are not enforceable 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 as “not-to-exceed” levels; that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value usually based on levels that affect animals; levels are then adjusted to help protect humans. Sometimes these not-to-exceed levels differ among federal organizations. Different organizations use different exposure times (e.g., an 8-hour workday or a 24-hour day), different animal studies, or emphasize some factors over others, depending on their mission.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that issued the regulation or recommendation.

The Institute of Medicine has made recommendation of the amount of molybdenum that is needed for good health; these values are called Recommended Dietary Allowances (RDAs). The RDAs are specific for different age groups:

- 17 μg/day for children aged 1–3 years
- 22 μg/day for children aged 4–8 years
- 34 μg/day for children aged 9–13 years
- 43 μg/day for teens aged 14–18 years
- 45 μg/day for adults
- 50 μg/day for pregnant and nursing women

EPA has determined that exposure to drinking water containing 0.08 milligrams per liter (mg/L) is not expected to cause effects that are harmful to children exposed for 1 or 10 days. Lifetime exposure to drinking water containing 0.04 mg/L is not likely to cause adverse health effects.

OSHA has set a limit of 5 milligrams per cubic meter (mg/m³) for soluble molybdenum compounds and 15 mg/m³ for insoluble molybdenum compounds and total dust in workroom air to protect workers during an 8-hour work shift (40-hour work week). NIOSH has not established a guideline for exposure to molybdenum to protect workers exposed up to 10 hours per workday. However, NIOSH has established a level of 5,000 mg/m³ for insoluble molybdenum compounds and 1,000 mg/m³ for soluble molybdenum
compounds that it considers immediately dangerous and likely to cause death or immediate or delayed permanent adverse health effects, or to prevent escape.

Further information on regulations and guidelines pertaining to molybdenum is provided in Chapter 8.

WHERE CAN I GET MORE INFORMATION?

If you have any questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below. You may also contact your doctor if experiencing adverse health effects or for medical concerns or questions. ATSDR can also provide publicly available information regarding medical specialists with expertise and experience recognizing, evaluating, treating, and managing patients exposed to hazardous substances.

- Call the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636) or
- Write to:
  Agency for Toxic Substances and Disease Registry
  Division of Toxicology and Human Health Sciences
  1600 Clifton Road NE
  Mailstop F-57
  Atlanta, GA 30329-4027

Toxicological profiles and other information are available on ATSDR’s web site: http://www.atsdr.cdc.gov.