Beryllium

What Is It? Beryllium is a hard, grayish metal that occurs naturally as a component of certain rocks, soil, coal, oil, and volcanic dust. Beryllium minerals have been known since ancient times as the gemstones emerald, aquamarine, and beryl. Compounds of beryllium are either white or colorless and do not have a particular smell. Because it is an element, beryllium does not degrade nor can it be destroyed.

Symbol:	**Be**
Atomic Number: *(protons in nucleus)*	**4**
Atomic Weight:	**9**

How Is It Used? Beryllium is used primarily in metal alloys (mainly with copper) for instruments, aircraft parts, springs, electrical connectors, and other industrial components. It is also incorporated into ceramics used in electrical insulators, microwave ovens, and rocket nozzles. Pure beryllium metal is used in missile and rocket parts, aircraft, heat shields, mirrors, and nuclear weapons.

What's in the Environment? The concentration of beryllium in the earth's crust generally ranges from 1 to 15 milligrams per kilogram (mg/kg), or parts per million (ppm). The average concentration of naturally occurring beryllium in U.S. soils is 0.6 ppm, and levels typically range from 0.1 to 40 ppm. Concentrations in sandy soil are estimated to be up to 250 times higher than in interstitial water (the water in the pore space between the soil particles), with much higher concentration ratios in loam and clay soils.

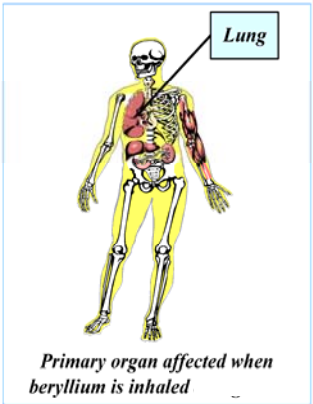
Beryllium naturally enters waterways through the weathering of rocks and soils that contain this metal. It can also be released to surface waters from industrial waste discharges. Beryllium levels in drinking water range from 0.01 to 0.7 parts per billion (ppb). It is also naturally present in various foods, with a median concentration of 22.5 µg/kg reported across 38 different food types, ranging from less than 0.1 µg/kg to 2,200 µg/kg (in kidney beans). One cigarette contains about 0.5 to 0.7 µg beryllium, with about 5 to 10% escaping into sidestream smoke.

The major source of environmental releases from human activities is combustion of coal and fuel oil. Air concentrations of beryllium are typically less than 0.0005 microgram per cubic meter ($\mu g/m^3$). The form usually released to the atmosphere is beryllium oxide, which eventually falls on land or water either in rain and snow or as dry particles. This oxide does not dissolve easily and does not move readily in soil or water, and it is considered unlikely to accumulate in plants and animals. The typical ratio of the beryllium concentration in plants to that in soil estimated to be low, at 0.0015 (or 0.15%).

What Happens to It in the Body? Beryllium can enter the body by eating food, breathing air, or smoking a cigarette. Children, and to a lesser extent adults, can also be exposed to a limited extent by ingesting soil. The internal fate of beryllium depends on the form that enters the body. Most beryllium compounds do not dissolve easily and are not well absorbed (less than 1%) from the gastrointestinal tract, so they are generally excreted in the feces. Dermal absorption is also expected to be very low, although information is limited. The beryllium that is absorbed is excreted very slowly, and it tends to accumulate in bone as well as other tissues and organs. Dusts and fumes containing beryllium can be inhaled and deposited in the lungs. Some deposited particles can clear from the lungs slowly, and soluble beryllium compounds can be converted to less soluble compounds. The biological half-life of inhaled, soluble beryllium compounds is about 2 to 8 weeks. Inhaled beryllium is excreted mainly in the urine.

What Are the Primary Health Effects? Inhalation of beryllium can result in two types of respiratory disease, acute beryllium disease and chronic beryllium disease (also referred to as berylliosis). Both forms can be fatal. The acute disease usually occurs after exposure to high levels (more than 1 mg/m^3) of the relatively soluble forms of beryllium, with symptoms ranging from inflammation of the nasal passages to severe chemical pneumonia. Some people can get chronic beryllium disease from breathing low levels, occurring in less than 15% of those exposed to more than 0.0005 mg/m^3. This disease is a type of immune

response only observed in sensitized individuals, and it involves the formation of granuloma and development of fibrosis of the lung. There can be a protracted latency period (up to 25 years) before the onset of any symptoms following exposure. In contrast, ingesting beryllium has generally not been reported to cause effects in humans because very little is absorbed into the body. Contact dermatitis is the most common effect of beryllium on the skin, and contact with scraped or cut skin can cause rashes or ulcers. In its current narrative for the cancer weight of evidence, the U.S. Environmental Protection Agency (EPA) describes beryllium as a likely human carcinogen for the inhalation pathway and states that the carcinogenic potential of ingested beryllium cannot be determined. Under the previous 1996 cancer guidelines, EPA classified beryllium as a probable human carcinogen.



Primary organ affected when beryllium is inhaled

What Is the Risk? The EPA has developed toxicity values (see box below) to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting beryllium. The toxicity value for estimating the risk of getting cancer following inhalation exposure is called an inhalation unit risk (UR), which is an estimate of the chance that a person will get cancer from continuous exposure to a chemical in air at a unit concentration of 1 mg/m^3. The toxicity value for non-cancer effects from inhalation exposure is called a reference concentration (RfC), which is an estimate of the highest concentration in air that could be breathed every day without causing an adverse effect. The value for evaluating the possibility of non-cancer effects from oral exposure is the reference dose (RfD). The UR and RfC for beryllium are based on studies of humans exposed to beryllium in the workplace, and the RfD was developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a mg/kg-day basis for humans. To illustrate how the UR is applied, the EPA estimates that a person would have a one-in-a-million chance of developing cancer if exposed to air containing beryllium at a concentration of 0.0004 $\mu g/m^3$ every day over a lifetime. (A microgram is one millionth of a gram.) Using the RfD, it is estimated that 150-pound (lb) person could safely ingest 0.14 mg of beryllium every day without experiencing any adverse effects (2.2 lb = 1 kg, or 1,000 g, or 1 million mg).

Chemical Toxicity Values		
Cancer Risk	**Non-Cancer Effect**	
Inhalation UR	***Oral RfD***	***Inhalation RfC***
2.4 per mg/m^3	0.002 mg/kg-day	0.00002 mg/m^3

What Are Current Limits for Environmental Releases and Human Exposure? To help track facility releases to the environment, the Superfund amendments that address emergency planning and community right-to-know require immediate reporting of a release of 10 lb (4.54 kg) or more of any beryllium compound that occurs within a 24-hour period, and also require normal releases to be reported annually and entered into a nationwide Toxics Release Inventory. For drinking water supplies, the EPA has established a maximum beryllium level of 4 µg/liter. For workers exposed over regular work days, the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have established protective levels of 0.0005 and 0.002 mg/m^3 of beryllium and beryllium compounds, respectively. In addition, the EPA restricts industrial releases of beryllium to 10 g in a 24-hour period or an amount that would result in atmospheric levels of 0.01 $\mu g/m^3$ or less averaged over 30 days.

Where Can I Find More Information? More information on beryllium can be found in the primary information source for this overview, the Toxicological Profile for Beryllium, prepared by the Agency for Toxic Substances and Disease Registry (ATSDR) and available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html. Other web-based sources of information include the ATSDR ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).