

**CHEMICAL FACT SHEETS**

**Arsenic**

**Chromium**

**Copper**

**Cyanide**

**Lead**

**Manganese**

**Mercury**

**Nickel**

**Selenium**

**Silver**

**Zinc**

## Frequently Asked Questions & Answers about ARSENIC

### **What Is Arsenic?**

Arsenic mineral is a gray, brittle, metal-like substance that is a natural part of the earth's soil and rocks. It is not commonly found in its elemental form, but rather as an arsenic compound associated with other naturally occurring elements and compounds. Arsenic compounds are present in many kinds of rocks, especially in ores that contain copper or lead. Arsenic levels in soil vary from one part arsenic per million parts of soil up to about 100 ppm. It can be released into the environment by natural sources such as erosion from mineral deposits and volcanic eruptions. Arsenic is found in water, both above-ground and underground. Arsenic can also be released into the air in dust from the soil.

Approximately half of the arsenic released to the air comes from soil dust. The other half comes from human activity such as industrial processes. Roughly 75% of human-induced arsenic compound emissions result from the processing of metal to ore.

Human activities can release arsenic into the soil, air, and water.

- ◆ **Soil releases:** Industrial processes account for nearly 95% of all arsenic released into land. Arsenic is also released into the soil as a result of pesticide application, solid waste disposal, and sewage sludge.
- ◆ **Air releases:** About half of the arsenic released into the air (about 8,500 tons each year) comes from natural sources like volcanic eruptions and forest fires. Airborne arsenic releases also come from various industrial processes, agricultural products, and electricity production.
- ◆ **Water releases:** Most of the arsenic released into the water results from natural, weather-related processes.

### **Does The Mining Industry Release Arsenic Into The Environment?**

In addition to metal ore processing and the production of metal, very small amounts of arsenic are naturally present in rocks and soils. These compounds may be released into the environment by moving these materials as well as by the natural erosion process.

Arsenic is also present in coal used to generate electricity. When coal is burned, ash is produced which contains most of the naturally occurring arsenic. More than 99% of the ash is collected and is either sent to specially-designed ash ponds or disposal sites or recycled into commercial products.

### **How Could Arsenic Affect Me?**

Arsenic's naturally low-level presence in the environment and routine arsenic compound releases discussed here generally are considered to be a low risk to public health. Interestingly, very small amounts of arsenic in people's diets may actually improve health.

### **What Does EPA Say?**

The U.S. Environmental Protection Agency (EPA) acknowledges that arsenic is a naturally occurring substance that will always be present in the environment. Nonetheless, EPA monitors the amount of arsenic in drinking water and has acted to curb manmade arsenic releases by curtailing the use of arsenic in pesticides. EPA acknowledges that low levels of arsenic will be present in soil, food, water, and air regardless of whether it is produced by human activities.

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### **Arsenic (As) Chemical Backgrounder**

#### **Description:**

Arsenic (C.A.S. 7440-38-2) is a naturally occurring element in the earth's crust. Pure arsenic is a gray-colored metal, but is rare in the environment. Arsenic is usually found combined with one or more other elements such as oxygen, chlorine, and sulfur. In combination, such arsenic is referred to as inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. The organic forms are usually less toxic than the inorganic forms.

Arsenic is produced primarily as a by-product from the operation of copper and lead smelters. The major uses of arsenic in the U.S. are as wood preservatives (74 percent of all arsenic), agricultural products (19 percent), glass (3 percent), nonferrous alloys (2 percent), and other uses (2 percent).

#### **Chemical and physical properties:**

Synonyms for arsenic are arsenic-75, metallic arsenic, arsenic black, arsenicals, and colloidal arsenic. The inorganic arsenic compounds are solids at normal temperatures and are not likely to volatilize. In water, they range from quite soluble (sodium arsenite and arsenic acid) to practically insoluble (arsenic trisulfide).

Some organic arsenic compounds are gases or low-boiling liquids at normal temperatures. Poisonous gas is produced by arsenic in a fire. Arsenic near acid or acid mist can release a very deadly gas, arsine. Twenty-one arsenic compounds are considered to be of concern because of their toxicity and/or presence in the environment.

#### **Health effects:**

Large doses of inorganic arsenic can cause death. Arsenic is a known poison and a known carcinogen that has been shown to cause skin and lung cancer. It also may damage a developing fetus and should be handled as a potential teratogenic agent (causing developmental malformations), as some arsenic compounds are known teratogens.

Oral exposure to inorganic arsenic can cause digestive tract pain, nausea, vomiting, diarrhea, decreased production of red and white blood cells, abnormal heart function, blood vessel damage, liver and/or kidney injury, and impaired nerve function, causing a "pins and needles" effect in the feet and hands. Oral exposure to inorganic arsenic can also cause a pattern of skin abnormalities, including the appearance of dark and light spots on the skin, and small "corns" on the palms, soles, and trunk, which may ultimately progress to skin cancer. In addition, arsenic ingestion is reported to increase the risk of cancer inside the body, especially in the liver, bladder, kidney, and lung.

## **Arsenic (As) Chemical Backgrounder (continued)**

### **Health effects: (continued)**

Skin contact with arsenic can cause burning, itching and a rash. Breathing arsenic can irritate the nose and throat; eye contact can cause red, watery eyes and irritation. Long-term exposure can cause an ulcer or hole in the "bone" dividing the inner nose, hoarseness, and sore eyes.

Populations relying on groundwater or surface water near geologic or man-made sources of arsenic may receive higher than typical exposures. These areas include industrialized areas and areas where large quantities of arsenic are disposed of in landfills, as in parts of Pennsylvania, southern New York, Ohio, Indiana, and Washington; areas of high historical pesticide use, with soil low in available ferrous and aluminum hydroxides; and areas of high natural levels of arsenic-containing mineral deposits, as in the western U.S. Populations in the area of copper and other types of metal smelters may be exposed to above-average levels of arsenic both through the air and as a result of atmospheric deposition in soil and water. Individuals with protein-poor diets or choline (of the Vitamin B complex) deficiency may be more sensitive to arsenic than the general population.

### **Economics:**

No arsenic producers currently operate in the U.S., and all raw materials for production of arsenic-containing products must be imported. Until 1985, arsenic trioxide was produced in the U.S. only at the ASARCO smelter in Tacoma, Washington. Annual production was 7,300 metric tons (16 million pounds) in 1983, but production decreased to 2,200 metric tons (4.8 million pounds) in 1985. In 1979, the U.S. imported 8,940 metric tons (19.5 million pounds) of arsenic in the form of arsenic metal or inorganic arsenic compounds. By 1985, imports had risen to 19,000 metric tons (41.5 million pounds) and increased to nearly 28,000 metric tons (61.2 million pounds) in 1986 after domestic production ceased.

### **Regulation:**

The Occupational Safety and Health Administration issues permissible exposure limits for inorganic arsenic; the Food and Drug Administration issues permissible levels of arsenic in muscle meats, edible meat by-products, and eggs. EPA offices overseeing regulations and guidelines applicable to arsenic include Air Quality Planning and Standards, under National Emissions Standards for Hazardous Air Pollutants; Water Regulations and Standards, under the National Pollutant Discharge Elimination System; Drinking Water; Emergency and Remedial Response; Solid Waste; and Pesticide Programs.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of arsenic and arsenic compounds into the air, water, or land must be reported annually and entered into the national Toxic Release Inventory (TRI) data base. Total emissions of arsenic in 1987 were reported to be 88,000 pounds, and of arsenic compounds, 130,000 pounds. Arsenic was released in 24 states, the top three being Texas (52,858 pounds), South Carolina (9,173 pounds), and Arizona (8,770 pounds). Arsenic compounds were released in 30 states, the top three being Montana (51,000 pounds), Arizona (4,100 pounds), and Texas (4,094 pounds).

## Frequently Asked Questions & Answers about

### CHROMIUM

#### **What Is Chromium?**

Chromium is a gray, solid material that is found naturally in rocks, animals, plants, soil, and volcanic dust and gas. It is an essential nutrient for humans that promotes the metabolism of sugar, protein, and fat, so small amounts of chromium in the diet are necessary for good health.

#### **How Is Chromium Used?**

Chromium exists naturally on the earth's surface, but releases to the atmosphere are usually attributed to human activities. Airborne chromium usually settles back to earth within 10 days, so chromium levels in the atmosphere are very low.

Airborne chromium releases result from the following:

- ◆ metal fabrication
- ◆ cement production
- ◆ use of asbestos-lined brakes
- ◆ waste incineration
- ◆ automotive catalytic converters
- ◆ cooling towers that use chromate chemicals as rust inhibitors (currently being phased out)
- ◆ fossil fuel (natural gas, oil, and coal) combustion

#### **Does The Mining Industry Release Chromium Into The Environment?**

Very small amounts of chromium are naturally present in rocks and soils and are released into the environment by moving these materials as well as by the natural erosion process.

Coal-burning electric utilities in the U.S. are responsible for about 2% of human-induced chromium releases into the atmosphere each year.

#### **How Could I Be Exposed To Chromium?**

Exposure to chromium can occur in the following ways: food consumption (accounts for more than 96% of daily chromium exposure for most people), inhalation, drinking water, skin contact (from using consumer products like wood preservatives, cleaning products, cement, and textiles.)

People who work in industries that use chromium such as chromate and chrome pigment production, stainless steel production, welding, chrome plating, leather tanning, painting, copy machine service, and manufacturing of batteries, dyes, and cement can be exposed to higher levels of the metals.

#### **What Does EPA Say?**

EPA has concluded that chromium from coal-burning power plants readily converts to a form that does not pose a risk to human health. The Agency does not consider the cancer risk from ingestion of chromium to be a serious health threat. Nonetheless, to protect safe drinking water, EPA has set a maximum level of 100 parts of chromium per billion parts of water (ppb).

## **TRI/Right-To-Know Communications Handbook**

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Standards from the Occupational Health and Safety Administration (OSHA) regulate the amount of chromium present in workplace air.

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## **Chromium (Cr) and Chromium Compounds** **Chemical Background**

### **Description:**

Chromium (C.A.S. 7440-47-3) is an odorless, hard, steel-gray, lustrous metal available in crystals or powder. It has several different forms, the most common of which are the metal, chromium (0); chromium (III) compounds; and chromium (VI) compounds. Chromium (III) occurs naturally in the environment; types (0) and (VI) are produced by industrial processes.

Chromium is used as an alloying and plating element on metal and plastic substrates for corrosion resistance in chromium-containing and stainless steels, and in protective coatings for automotive and equipment accessories. It is also used in nuclear and high temperature research.

In 1987, consumption of chromium, ferroalloys, metals, and other chromium-containing materials by end use was: stainless and heat-resisting steel, 79%; full-alloy steel, 8%; super-alloys, 3%; and other alloys, 10%.

Trivalent chromium compounds (III) include chromic oxide ( $\text{Cr}_2\text{O}_3$ ); chromium acetate ( $\text{Cr}[\text{CH}_3\text{COO}]_3 \cdot \text{H}_2\text{O}$ ); chromium nitrate ( $\text{Cr}[\text{NO}_3]_3 \cdot 9\text{H}_2\text{O}$ ); chromium chloride ( $\text{CrCl}_3$ ); ferrochromite ( $\text{FeCr}_2\text{O}_4$ ); chromium phosphate ( $\text{CrPO}_4$ ); chromium sulfate ( $\text{Cr}_2[\text{SO}_4]_3$ ); and sodium chromite ( $\text{NaCrO}_2$ ). Hexavalent chromium compounds (VI) include ammonium dichromate ( $[\text{NH}_4]_2\text{Cr}_2\text{O}_7$ ); barium chromate ( $\text{Ba} \cdot \text{CrH}_2\text{O}_4$ ); calcium chromate ( $\text{CaCrO}_4$ ); chromium trioxide ( $\text{CrO}_3$ ); lead chromate ( $\text{PbCrO}_4$ ); sodium dichromate ( $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ ); strontium chromate ( $\text{SrCrO}_4$ ); potassium chromate ( $\text{K}_2\text{CrO}_4$ ); potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ); sodium chromate ( $\text{Na}_2\text{CrO}_4$ ); and zinc chromate ( $\text{ZnCrO}_4$ ). Other compounds include chromium carbonate ( $\text{Cr}_2\text{O}_3 \cdot x\text{Cr}$ ) and lead chromate oxide ( $\text{CrO}_4\text{Pb} \cdot \text{OPb}$ ).

Chromium and its compounds are used in refractories, drilling muds, electroplating cleaning agents in the metal finishing industry, mordants in the textile industry, catalytic manufacture, fungicides and wood preservatives, and in the production of chromic acid and specialty chemicals. They are also used as a constituent of inorganic pigments, and a sensitizer in the photographic industry. Chromium compounds are used as dyes and pigments and in medicinal astringents and antiseptics. Other uses for chromium and its compounds include organic chemical synthesis, leather treatment, photomechanical processing, and industrial water treatment, including treatment of cooling tower water.

Chromium trioxide is used for metal plating and treatment, wood treatment and preservative, and in the manufacture of chromated copper arsenate. Chromium acetate, sodium chromate and potassium chromate are used in the tanning and textile industries.

## **Chromium (Cr) and Chromium Compounds** **Chemical Backgrounder (continued)**

### **Chemical properties:**

Chromium is insoluble in hot and cold water, nitric acid, and aqua regia, but is soluble in dilute sulfuric acid and hydrochloric acid. Barium chromate is insoluble in both cold and hot water but is soluble in mineral acid and acids. Chromic oxides are soluble in cold water, but insoluble in alcohol; acrid smoke and irritating fumes are emitted when it is heated to decomposition. Chromium carbonate is soluble in water containing carbon dioxide, but insoluble in alcohol. Chromium phosphate is slightly soluble in cold water, soluble in acids and alkalies, and insoluble in acetic acid.

Chromium trioxides are soluble in alcohol, ethanol, sulfuric acid, and nitric acid; when heated to decomposition, chromium trioxides emit smoke and irritating fumes. Lead chromate is insoluble in water, acetic acid, and ammonia, but is soluble in acid and alkalies; when heated to decomposition, emits toxic fumes of lead. Potassium chromate and potassium dichromate are soluble in cold and hot water and insoluble in alcohol. Sodium chromed is soluble in cold water and methanol, and only slightly soluble in alcohol. Sodium dichromate is soluble in cold and hot water and insoluble in alcohol; toxic fumes of sodium monoxide are emitted when this compound is heated to decomposition. Strontium chromate is soluble in cold and hot water, hydrochloric acid, nitric acid, acetic acid, and ammonium salts. Zinc chromate is insoluble in cold water and acetone, dissolves in hot water, and is soluble in acid and liquid ammonia.

### **Health effects:**

Chromium and certain chromium compounds are classified as substances known to be carcinogenic, according to the National Toxicology Program's Fifth Annual Report on Carcinogens. In the national Toxic Release Inventory, EPA classifies chromium as a "de minimis" carcinogen, meaning that the minimum amount of the chemical set by OSHA is considered to be carcinogenic.

Chromium compounds vary greatly in their toxic and carcinogenic effects. Trivalent chromium compounds are considerably less toxic than the hexavalent compounds and are neither irritating nor corrosive. There is inadequate evidence for carcinogenicity of chromium oxide, and chromium acetate. There is sufficient evidence for carcinogenicity of barium chromate, calcium chromate, chromium trioxide, lead chromate, sodium dichromate, and strontium chromate. These compounds have not been evaluated for their carcinogenicity: chromium carbonate, chromium phosphate, cobalt chromium alloy, lead chromate oxide, potassium chromate, potassium dichromate, sodium chromate, and zinc chromate.

The major acute effect from ingested chromium is acute renal tubular necrosis. Exposure to chromium, particularly in the chrome production and chrome pigment industries, is associated with cancer of the respiratory tract. Hexavalent chromium compounds are corrosive and cause chronic ulceration and perforation of the nasal septum. They also cause chronic ulceration of other skin surfaces. The general populations can be exposed to chromium through the air, water, soils, and food.

## **Chromium (Cr) and Chromium Compounds** **Chemical Backgrounder (continued)**

### **Economics:**

In 1988, combined production of chromium ferroalloys and chromium metal was 263.7 million pounds. U.S. production for chromium trioxide as of January 1990, was 122 million pounds; sodium dichromate was 332 million pounds. In 1986, 3.9 million pounds of zinc chromate were produced.

The major U.S. producers of metallurgical and refractory chromium and chromium chemicals in 1988 were: Metallurgical Elkem Metals Co., Marietta, OH, and Alloy, W.V.; Macalloy Inc., Charleston, S.C; Shieldalloy Corp., Newfield, N.J.; Moore McCormack Resources Inc., Beverly, OH; Satra Concentrates Inc., Steubenville, OH; SKW Alloys, Inc., Calvert City, KY, and Niagara Falls, N.Y.. Refractory Dresser Industries Inc., Hammond, IN; General Refractories Co., Lehi, UT; Kaiser Aluminum and Mineral Corp., Plymouth Meeting, PA; National Refractories and Mineral Corp., Moss Landing, CA, and Columbiana, OH; North American Refractories Co. Ltd., Womelsdorf, PA; Chemicals \_ American Chrome and Chemical Inc., Corpus Christi, TX; and Occidental Chemical Corp., Castle Hayne, N.C.

Chromite ore has not been mined in the U.S. since 1961. Today, the U.S. receives all chromium from other countries. In 1988, chromite ore and ferrochromium alloys were imported mainly from South Africa, Zimbabwe, and Turkey.

In 1988, the following amounts of chromium materials were imported: chromite, 678,096 tons; ferrochromium, 464,825 tons; chromium metal, 4,519 tons; ferrochrome-silicon alloys, 10,700 tons; chemicals, 7,376 tons; and pigments, 10,517 tons.

### **Regulations:**

EPA regulates chromium and its compounds under the Clean Water Act; Comprehensive Environmental Response, Compensation, and Liability Act; Resource Conservation and Recovery Act; Superfund Amendments and Reauthorization Act; and Toxic Substances Control Act. The Food and Drug Administration regulates the use of chromium as an indirect food additive, and the use of chromium oxide in drugs and cosmetics. OSHA has established permissible exposure limits for chromium and chromium compounds.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of chromium and chromium compounds into the air, water, and land must be reported annually and entered into the national Toxic Release Inventory. Total releases of chromium in 1988 were 21,296,563 pounds; those releases ranked 44th of the 302 chemicals entered into the 1988 TRI. Total releases of chromium compounds were 33,644,953 pounds; those releases ranked 34th of the 302 chemicals entered into the 1988 TRI. Of the chromium releases, 2.19% were released into the air; .39% to surface water; 43.56 on land; .13 underground; 2.35% to public sewage; and 51.38% off-site. Of the chromium compounds releases, 209,985 pounds, or .6%, were released into surface water; 15,847,614 pounds, or 47% were released on land; 685,331 pounds, or 2%, were released into the air.

## Frequently Asked Questions & Answers about

### COPPER

#### **What Is Copper?**

Copper, a salmon-pink metal containing both silver and gold, is non-magnetic, tough, moderately hard, resistant to wear, and has a bright metallic luster when polished. The strength, ductility, corrosion resistance and ability to conduct heat and electricity make copper an element of great importance.

#### **Where Does Copper Come From?**

The primary sources of copper for the mining industry are the mineral copper sulfides, oxides and carbonates that are found in igneous rock distributed throughout the world.

#### **How Is Copper Used?**

Historically, copper was used for making tools and weapons and as an ornamental metal. Today copper is used in electroplating, wiring, plumbing, medicine and agriculture. Copper is the standard benchmark for electrical conductivity. It conducts electrical current better than any other metal except silver.

#### **Does The Mining Industry Release Copper Into The Environment?**

Copper is a very abundant, naturally occurring element present in the earth's crust. Most of the world's copper is mined in the U.S. and copper is "released" into the environment during the mining process as these materials are removed from the earth, transported and processed. Copper is also released naturally by the weather and natural erosion process.

#### **How Could I Be Exposed To Copper?**

Copper is a natural element found in the earth's crust. As a result, most of the world's surface water and ground water used for drinking, contains copper. Naturally occurring copper in drinking water is safe to drink, even in instances where the copper level is high enough to add a metallic taste to the water.

Copper is an essential nutrient required by the body in daily dietary amounts of 1 to 2 milligrams for adults (½ to 1 milligram for children). Too little copper in the body can actually lead to disease. Copper is involved in maintaining the balance of other useful metals in the body such as zinc and molybdenum. Sources of copper in our diet include drinking water, potatoes, legumes, nuts, grains, fruits and chocolate.

Copper is used in many consumer products. In a small number of these products, copper is released during the course of their normal use. An example is copper in roadway dust, shed from automobile brakes during their normal use.

#### **What Are The Health Risks Associated With Copper?**

Like all substances, excessive copper can make people ill when ingested and may cause stomach upset, nausea, and diarrhea but this only occurs in cases where the copper levels significantly exceed the World Health Organization limits for copper in drinking water. In fact, the World Health Organization has concluded that copper deficiency is much more of a global problem than copper toxicity.

Acute copper poisoning is a rare event, largely restricted to the accidental drinking of solutions of copper nitrate or copper sulphate, which should be kept out of easy access in the home. These and organic copper salts are powerful emetics and inadvertent large doses are normally rejected by vomiting. Chronic copper poisoning is also very rare and the few reports refer to patients with liver disease. The capacity for healthy human livers to excrete copper is considerable and it is primarily for this reason that no cases of chronic copper poisoning have been reported.

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### **Copper (Cu) Chemical Backgrounder**

#### **Description:**

Copper (CAS# 7440-50-8), one of the chemical elements, is a reddish, lustrous and malleable solid. It is used as a metal for electrical and electronic products in building construction, industrial machinery and equipment, and heating, chemical, and pharmaceutical machinery. It is used in alloys, inorganic pigments, electroplated protective coatings and undercoatings, cooking utensils, corrosion-resistant piping, insulation for liquid fuels, coins, cement, food and drugs, metallurgy, nylon, paper products, dyes, pollution control devices, printing and photocopying, pyrotechnics, wood preservatives, insecticides, fungicides, and herbicides. It is also used to manufacture anti-fouling paints, corrosion inhibitors, electrolysis and electroplating processes, fabric and textiles, flameproofing, fuel additives, glass, and ceramics.

#### **Chemical properties:**

Copper is an odorless solid, but can produce dust and mist. It is insoluble in hot and cold water, soluble in nitric acid and hot sulfuric acid, and very slightly soluble in hydrochloric acid and ammonium hydroxide. It becomes dull when exposed to air. It is attacked by acetic and organic acids; very slowly attacked by cold hydrochloric acid and diluted sulfuric acid; and readily attacked by alkalis, diluted nitric acid, hot concentrated sulfuric acid, and hydrobromic acid. It is incompatible with oxidizers, alkalis, sodium azide, and acetylene. It conducts heat and electricity well.

#### **Health effects:**

Exposure to copper can irritate the nasal mucous membranes, pharynx, and eyes, and cause chest pains, vomiting, nasal perforation, and dermatitis. Exposure to copper fumes and dust can irritate the upper respiratory tract, and cause congestion of nasal mucous membranes, ulceration and perforation of the nasal septum, discoloration of the skin, and pharyngeal congestion. Fumes from the heating of metallic copper can cause upper respiratory irritation, chills, aching muscles, nausea, gastric pain, and diarrhea. Inhalation of copper salts can cause salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis, and diarrhea. Acute poisoning from inhalation of copper containing dust has caused symptoms of heavy metal poisoning. Chronic exposure to copper can cause anemia. Copper is less toxic than its salt compounds.

#### **Economics:**

U.S. manufacturers of copper are ALFA Products, Danvers, MA; American Chemet Corp., Deerfield, IL; Anderson Physics Labs, Inc., Urbana, IL; ASARCO Inc., New York, NY; Atlantic Equipment Engineers, Bergenfield, NJ; Atlantic Powdered Metals, New York, NY; Belmont Metals, Inc., Brooklyn, NY; Cerac, Inc., Milwaukee, WI; Chemtech Industries, Inc., St. Louis, MO; Consolidated Astronautics, Smithtown, NY; Fidelity Chemical Products Corp., Newark, NJ; Gerald Metals, Inc., Stamford, CT; GFS Chemicals, Columbus, OH; AD Mackay, Inc., Darien, CT; Ney Products, Inc., Brooklyn, NY; Noah Chemical Division, San Antonio, TX;

### **Copper (Cu) Chemical Backgrounder (continued)**

#### **Economics:**

U.S. manufacturers of copper (continued) Reade Metals and Minerals Corp., Rumson, NJ; Ruger Chemical Co., Inc., Irvington, NJ; SCM Metal Products, Gainesville, FL; Tafa Inc., Bow, NJ; United Mineral and Chemical Corp., New York, NY; Var-Lac-Oid Chemical Co., Inc., Bergenfield, NJ; and Wilshire Chemical Co., Inc., Gardena, CA.

#### **Regulation:**

Copper is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund); Federal Insecticide, Fungicide, and Rodenticide Act; National Primary Drinking Water Regulations of the Safe Drinking Water Act; Clean Water Act, as Primary Pollutant; and Emergency Planning and Community Right-to-Know Act. The U.S. Occupational Safety and Health Administration issues permissible exposure limits for copper of 1 mg/m<sup>3</sup>, time-weighted average.

Under the Emergency Planning and Community Right-to-Know Act, releases of more than one pound of copper into the air, water, or land must be reported annually and entered into the national Toxic Release Inventory (TRI). In 1996, 22,958,759 pounds of copper were released. Of those releases, 4,316,839 pounds were fugitive or nonpoint air emissions; 707,505 pounds, stack or point air emissions; 46,778 pounds, surface water discharges; 41,032 pounds, releases through underground injection; 406,184 pounds, RCRA landfills; 2,946,824 pounds, on-site land releases; and 14,493,597 pounds, transfers off-site to disposal. Those releases represent an increase from 1995 releases of 16,610,765 pounds, and 1994 releases of 15,157,185 pounds, but a decrease from 1988 (baseline) releases of 27,275,146 pounds.

In 1996, 737,221,219 pounds of copper were used for energy recycling on-site; 123,097 pounds, recovery on-site; 41,621,864 pounds, treated on-site; 539,177,912 pounds, transferred to recycling; 63,810 pounds, transferred to energy recovery; 1,224,559 pounds, transferred to treatment; 370,317 pounds, transferred to publicly owned treatment works; and 1,004 pounds, transferred to other off-site uses.

### Frequently Asked Questions About CYANIDE

#### **What Is Cyanide?**

Cyanide is a compound of carbon and nitrogen, two of the most common elements in the earth's crust. It is produced naturally in a number of microorganisms, insects and plants. It existed on earth before life began and was one of the fundamental building blocks in the evolution of life. Today it is a chemical manufactured for use in a number of important industries.

The EPA reported in December 1981 cyanide risk assessment, *An Exposure and Risk Assessment for Cyanide* (EPA-440/4-85-008):

- ◆ The overall acute risks to humans as a result of cyanide in the environment appear to be negligible. This is because of the ability of humans to detoxify cyanide rapidly at low exposure levels typically found in the environment.
- ◆ Approximately 90% of the cyanide released into the atmosphere was from automobiles. (Since 1981 automobile emissions have been greatly reduced. Today the main releases of cyanide into the world's atmosphere come from incomplete combustion in bush fires, wood burning and from volcano eruptions.)
- ◆ Approximately two-thirds of the cyanide entering surface waters was via sewage treatment plants originating from road salt, metal finishing and organic chemical industries. (Since 1981 releases from metal finishing and the chemical industries have been substantially reduced.)

#### **How Is Cyanide Used?**

- ◆ About 80% of the cyanide produced is used in the manufacture of synthetic organic compounds.
- ◆ About 20% of the cyanide is used in mining in the form of sodium cyanide.

#### **Why Is Cyanide the Chemical Of Choice for Gold Recovery?**

Cyanide is one of the very few chemical reagents that will dissolve gold in water, using only oxygen from the air as an oxidizing agent. Other chemicals will work but only in much higher concentrations using much stronger oxidizing agents e.g. chlorine, nitric acid or hypochloride. At these higher concentrations they can be more dangerous to handle than cyanide. Therefore, cyanide is the chemical of choice for the recovery of gold from ores. It has been used in metal extraction since 1887 and is safely used and managed in gold recovery around the world.

#### **How Could Cyanide Affect Me?**

Cyanide is used at mines in very low concentrations in water, typically 0.01% to 0.05% cyanide. Its use is tightly controlled and monitored at the mine site. Employees are trained to handle cyanide very carefully and the manufacture, transport, storage, use and disposal of cyanide are strictly regulated and have been accomplished safely for decades.

### Frequently Asked Questions About CYANIDE (continued)

- ◆ At gold mines, all tanks, pipes, ponds and other areas that contain cyanide are required by law to have appropriately designed and engineered containment facilities. This means that if there is any problem, there is a back-up system to contain the material.
- ◆ Cyanide in mining solutions is collected either to be recycled or effectively destroyed to permitted levels on-site after gold is removed.
- ◆ Cyanide is destroyed quickly when required using several commonly available chemicals kept at all mines.
- ◆ Cyanide is naturally degraded, generally by oxidation, and is not persistent in the environment.
- ◆ Cyanide does not bioaccumulate and is not carcinogenic, mutagenic or tetragenic.
- ◆ While cyanide is common in nature in small dosages, it can be hazardous to health in higher dosages if improperly handled or managed.

#### **Where Can I Get More Information?**

- ◆ The National Mining Association, 1130 17th Street, NW, Washington, DC 20036
- ◆ The Gold Institute, 1112 16th Street, Suite 240, Washington, DC 20036
- ◆ Office of Water, U.S. Environmental Protection Agency
- ◆ The International Council of Metals and The Environment  
294 Albert Street, Suite 506, Ottawa, Ontario, Canada K1P 6E6
- ◆ *The Cyanide Monograph*, Dr. T.I. Mudder (Editor), 1998;  
*The Chemistry and Treatment of Cyanidation Wastes*,  
A.C.S. Smith and Dr. T.I. Mudder, 1991, Mining Journal Books, London, United Kingdom
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1992, Western Australian Department of Minerals and Energy
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B. Ballantyne and T. Marrs, 1987, Wright Publishers, Bristol, United Kingdom
- ◆ “Cyanide Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review”,  
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## **Chemical Backgrounder**

**Calcium Cyanide (Ca(CN)<sub>2</sub>)**  
**Copper Cyanide (CuCN)**  
**Cyanogen ((CN)<sub>2</sub>)**  
**Cyanogen Chloride (CNCl)**  
**Potassium Cyanide (KCN)**  
**Potassium Silver Cyanide (KAg(CN)<sub>2</sub>)**  
**Sodium Cyanide (NaCN)**

### **Description:**

Cyanides are a group of compounds based on a common structure formed when elemental nitrogen and carbon are combined. Cyanides are produced by certain bacteria, fungi, and algae, and may be found in food and plants. Cyanide itself is an ion, or combining form that carries a positive or negative charge. It is a powerful and rapid-acting poison.

When cyanide combines with metals and organic compounds, it forms simple and complex salts and compounds.

Sodium cyanide and potassium cyanide are examples of simple cyanide salts. Cyanide salts are mainly used in electroplating, metallurgy, and the production of organic chemicals; in photographic development; as anti-caking agents in road salts; in the extraction of gold and silver from ores; and in the making of plastics. Minor uses of cyanide salts include use as insecticides and rodenticides, as chelating agents, and in the manufacture of dyes and pigments. Cyanogen chloride is used as an insecticide.

Of the cyanide compounds, sodium cyanide and potassium cyanide are the most likely to be found in the environment from industrial activities.

### **Chemical properties:**

Calcium cyanide (CAS #592-01-8) is a white or colorless powder of crystals. It has a faint bitter almond odor. It is soluble in water with gradual liberation of hydrogen cyanide. It is a deadly poison when inhaled or digested. When heated to decomposition, it emits toxic fumes. Synonyms for calcium cyanide are calcyanide, cyanogas, calcid, calcyan, and cyanide of calcium.

Copper cyanide (CAS #544-92-3) is a white solid that is insoluble in water. It is a poison that reacts violently with magnesium. When heated to decomposition, it emits very toxic fumes. Synonyms for copper cyanide are cupricin and cuprous cyanide.

Cyanogen (CAS #460-19-5) is a colorless gas with an almond-like odor. It is soluble in water, ethanol, and ethyl ether. It is a poison that is very toxic to the eye. It is a very dangerous fire hazard via heat, flames, and oxidizers. When heated to decomposition or on contact with acid, acid fumes, water, or steam, it will react to produce highly toxic fumes. Synonyms for cyanogen are carbon nitride, dicyanogen, ethanedinitrile, and oxalonitrile.

## **Chemical Backgrounder (continued)**

**Calcium Cyanide (Ca(CN)<sub>2</sub>)**  
**Copper Cyanide (CuCN)**  
**Cyanogen ((CN)<sub>2</sub>)**  
**Cyanogen Chloride (CNCl)**  
**Potassium Cyanide (KCN)**  
**Potassium Silver Cyanide (KAg(CN)<sub>2</sub>)**  
**Sodium Cyanide (NaCN)**

### **Chemical properties: (continued)**

Cyanogen chloride (CAS #506-77-4) is a colorless gas with a highly irritating odor. It is soluble in water, ethanol, and ethyl ether. It is a poison that is very toxic to the eye. When heated to decomposition or on contact with water or steam, it will react to produce highly toxic and corrosive fumes. Synonyms for cyanogen chloride are chlorcyan, chlorine cyanide, and chlorocyanogen.

Potassium cyanide (CAS #151-50-8) is a white solid or colorless water solution with a faint bitter almond odor. As a solution, it is slightly soluble in ethanol. It is a poison that reacts with acid or acid fumes to emit deadly hydrogen cyanide. When heated to decomposition, it emits very toxic fumes. As a solid, potassium cyanide is incompatible with nitrogen trichloride, perchloryl fluoride, sodium nitrite, acids, alkaloids, chloral hydrate, and iodine. A synonym for potassium cyanide is potassium salt of hydrocyanic acid.

Potassium silver cyanide (CAS #506-61-6) is a poisonous, white solid made of crystals which are light-sensitive. It is soluble in water and acids, and slightly soluble in ethanol. It emits very toxic fumes when heated to decomposition. Synonyms for potassium silver cyanide are potassium argentocyanide and potassium dicyanoargentate.

Sodium cyanide (CAS #143-33-9) is a white crystalline solid that is odorless when dry, but emits a slight odor of hydrogen cyanide in damp air. It is slightly soluble in ethanol and formamide. It is very poisonous. It explodes if melted with nitrite or chlorate at about 450 degrees F. It produces a violent reaction with magnesium, nitrites, nitrates, and nitric acid. On contact with acid, acid fumes, water, or steam, it will produce toxic and flammable vapors. Synonyms for sodium cyanide are hydrocyanic acid, sodium salt; and cyanide of sodium.

### **Health effects:**

Exposure to large amounts of all forms of cyanide for a short time can harm the brain, lungs, and heart, and cause coma and death. The health effects of all forms of cyanide are similar when large amounts are eaten, drunk, breathed, or touched. The first symptoms of cyanide poisoning are rapid, deep breathing and shortness of breath, followed by convulsions and loss of consciousness. In cases of acute cyanide poisoning, death is extremely rapid. Death may occur after ingestion of even small amounts of sodium cyanide or potassium cyanide and can occur within minutes or hours.

## **Chemical Backgrounder (continued)**

**Calcium Cyanide (Ca(CN)<sub>2</sub>)**  
**Copper Cyanide (CuCN)**  
**Cyanogen ((CN)<sub>2</sub>)**  
**Cyanogen Chloride (CNCl)**  
**Potassium Cyanide (KCN)**  
**Potassium Silver Cyanide (KAg(CN)<sub>2</sub>)**  
**Sodium Cyanide (NaCN)**

### **Health effects: (continued)**

Exposure to small amounts of cyanide compounds over long periods of time is reported to cause loss of appetite, headache, weakness, nausea, dizziness, and symptoms of irritation of the upper respiratory tract and eyes.

Exposure to potassium cyanide or sodium cyanide can cause asphyxiation and death, weakness, headaches, confusion, nausea, vomiting, increased respiratory rate, and slow respiratory gasping. Potassium cyanide as a solid may cause poisoning when ingested, inhaled, or absorbed through the skin. Strong solutions are corrosive to skin, eyes, and mucous membranes.

### **Economics:**

In 1990, the last year for which data are available, the U.S. companies that produced cyanide compounds were Matheson Gas Products, Inc., Gloucester, MA, cyanogen; DuPont, Memphis, TN, and W.R. Grace, Nashua, NH, potassium cyanide; Dow Chemicals, Freeport, TX, and DuPont, Memphis, TN, and Texas City, TX, sodium cyanide.

### **Regulation:**

Cyanide compounds are regulated under the Emergency Planning and Community Right-to-Know Act; the Clean Air Act; the Comprehensive Environmental Response, Compensation and Liability Act; the National Primary Drinking Water Regulations under the Safe Drinking Water Act; and the Resource Conservation and Recovery Act.

The Occupational Safety and Health Administration (OSHA) sets a permissible exposure limit, time-weighted average of 5 mg/m<sup>3</sup> for cyanide salts.

Releases of more than one pound of cyanide compounds into the air, water, and land must be reported annually and entered into the national Toxic Release Inventory. In 1993, 3,291,307 pounds of cyanide compounds were released by 175 facilities. Of those releases, 56,544 pounds were fugitive or nonpoint air emissions; 842,184 pounds were stack or point air emissions; 97,666 pounds were surface water discharges; 2,288,870 pounds were released by underground injection; and 6,043 pounds were released to land.

## **Chemical Backgrounder (continued)**

**Calcium Cyanide (Ca(CN)<sub>2</sub>)**  
**Copper Cyanide (CuCN)**  
**Cyanogen ((CN)<sub>2</sub>)**  
**Cyanogen Chloride (CNCl)**  
**Potassium Cyanide (KCN)**  
**Potassium Silver Cyanide (KAg(CN)<sub>2</sub>)**  
**Sodium Cyanide (NaCN)**

### **Regulation: (continued)**

In 1993, 601,766 pounds of cyanide compounds were transferred: 24,600 pounds were transferred to recycling; 2,008 pounds were transferred to energy recovery; 325,721 pounds were transferred to treatment; 99,903 pounds were transferred to publicly owned treatment works; 149,034 pounds were transferred to disposal; and 149,034 pounds were transferred off-site.

Total 1993 releases of cyanide compounds represented a decrease from releases in 1992, which totaled 4,115,279 pounds; 1991, 4,785,796 pounds; and 1988 (baseline), 5,256,589 pounds.

According to EPA waste management information, 525,897 pounds of cyanide compounds in 1993 were recycled on-site; 15,533 pounds were recycled off-site; 193,000 pounds were used for energy recovery on-site; 1,758 pounds were used for energy recovery off-site; 10,816,903 pounds were treated on-site; 454,805 pounds were treated off-site; and 3,343,675 pounds were released or disposed of.

In 1993, the states in which the largest amounts of cyanide compounds were released were Texas (1,629,506 pounds); Louisiana (976,041 pounds); Ohio (293,397 pounds); Indiana (122,982 pounds); Maryland (105,836 pounds); West Virginia (52,600 pounds); Pennsylvania (32,694 pounds); Kentucky (18,668 pounds); Illinois (13,601 pounds); and Alabama (12,739 pounds).

The 10 facilities which released the largest amounts of cyanide compounds in 1993 were DuPont Beaumont Plant, Beaumont, TX (998,792 pounds); Degussa Carbon Black Ivanhoe, Louisa, LA (526,000 pounds); Cytec Industry Inc. Fortier Plant, Westwego, LA (450,041 pounds); BP Chemicals Inc., Lima, OH (280,000 pounds); DuPont Victoria Plant, Victoria, TX (251,557 pounds); BP Chemicals Inc. Green Lake, Port Lavaca, TX (170,011 pounds); Bethlehem Steel Corp. Sparrows Point, Sparrows Point, MD (105,828 pounds); Bethlehem Steel Corp. Burns Harbor Division, Burns Harbor, IN (101,255 pounds); Sterling Chemicals Inc., Texas City, TX (92,570 pounds); and Degussa Corp., Aransas Pass, TX (68,000 pounds).

## Frequently Asked Questions & Answers about

### LEAD

#### **What Is Lead?**

Lead is a naturally occurring, bluish-gray metal that has no taste or smell. It is found in small amounts in soil and water.

#### **How Is Lead Used?**

Lead has a variety of uses, including the following:

- ◆ roofing
- ◆ x-ray shields
- ◆ batteries
- ◆ metal products (sheet lead, solder, some brass and bronze products, pipes, etc.)
- ◆ iron and steel production
- ◆ ceramic glaze

#### **Where Can Lead Be Found?**

Automotive emissions that have settled result in lead in the soil. Lead is also found in paint in older houses. Remodeling older homes often disturbs lead-based paints and produces lead dust.

Since the late 1970s, the U.S. has slowly reduced air emissions of lead. The largest decreases were made in industrial process releases and, since leaded gas was outlawed, auto emissions. According to the EPA, approximately 900 tons of lead and lead compounds were released into the air from large industrial facilities in 1996.

A very small amount of lead was released to surface water in 1996 (less than .4% of documented releases). In addition to industrial sources, urban industrial runoff and settling of airborne lead particles are significant sources for lead in bodies of water.

#### **Does The Mining Industry Release Lead Into The Environment?**

Small amounts of lead occur naturally in soils, rocks and groundwater and are released to land by moving these materials as well as by the natural erosion process. Lead concentrations in the soil are between one part of lead per million parts of soil (ppm) and 300 ppm.

#### **How Could I Be Exposed To Lead?**

Most human's intake of lead can be attributed to consumption of food and drinking water that contains lead (smoking, wine consumption) as well as inhalation of airborne particles or skin contact (proximity to lead paint).

Very small quantities of lead are found in lakes, rivers, and groundwater that supply drinking water. In fact, more than 99% of all publicly supplied water contains less than three parts lead for every billion parts of water (ppb), which is considered extremely good.

#### **What Does EPA Say?**

EPA regulates the amount of lead released to the air and water, and the Consumer Product Safety Commission sets lead standards for consumer products and school facilities.

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### **Lead (Pb) Chemical Backgrounder**

#### **Description:**

Lead (CAS# 7439-92-1) is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It has no characteristic taste or smell. It may be used in the form of metal, either pure or alloyed with other metals, or as chemical compounds, primarily oxides. The commercial importance of lead is based on its ease of casting, high density, low melting point, low strength, ease of fabrication, acid resistance, electrochemical reaction with sulfuric acid, and chemical stability in air, water, and soil.

Lead is used in the production of some types of batteries; ammunition; electrical equipment; television glass; metal products such as sheet lead, solder, and pipes; and ceramic glazes. Some chemicals containing lead, such as tetraethyl lead and tetramethyl lead, were formerly used as gasoline additives, but the last producer of these additives in the United States stopped making them in early 1991. The Clean Air Act banned the sale of leaded gasoline after December 31, 1995.

Other chemicals containing lead are used in paint. The amount of paint added to paints and ceramic products, caulking, gasoline additives, and solder has been reduced in recent years because of lead's harmful human health effects. However, the use of lead in ammunition and roofing has increased in recent years.

Lead is also used in radiation shields for protection against X-rays and in a large variety of medical equipment (electronic ceramic parts of ultrasound machines, intravenous pumps, fetal monitors, and other surgical equipment); scientific equipment (circuit boards for computers and other electronic circuitry); and military equipment (jet turbine engine blades, and military tracking systems).

Almost all lead-producing mines in the U.S. are underground operations. Lead obtained as a byproduct from open-pit copper mines is the only source of above-ground lead. Most lead used from industry comes from mined ores or from recycled scrap metal of batteries.

#### **Chemical properties:**

Metallic lead does not dissolve in water or organic solvents, and does not burn. It is soluble in nitric acid and hot concentrated sulfuric acid. It is incompatible or reactive with strong oxidizers, hydrogen peroxide, chlorine trifluoride, zirconium disodium acetylide, and acids. It is a moderate fire hazard in the form of dust when exposed to heat or flame; it is a moderate explosion hazard in the form of dust when exposed to heat or flame. When heated, it emits highly toxic fumes; it can react vigorously with oxidizing materials.

Synonyms for lead are plumbum, lead metal, and pigment metal.

### **Lead (Pb) Chemical Backgrounder (continued)**

#### **Health effects:**

Lead is listed as a known or suspected carcinogen in the EPA's Toxic Release Inventory (TRI); it is not listed as a carcinogen in The Seventh Annual Report on Carcinogens, 1994, National Toxicology Program. The effects of lead are the same regardless of whether it enters the body through breathing or swallowing. If ingested, lead can accumulate in body organs, including the brain, and result in lead poisoning (plumbism) and even death. At high levels of exposure, lead can severely damage the brain and kidneys of adults and children.

The principal routes of excess exposure to lead are lead in air from combustion of lead-containing car exhausts or industrial emissions; lead-based paint; hand-to-mouth activities of young children living in lead-polluted environments; and lead dust brought home by industrial workers.

In children, lead poisoning can impair development, and result in a lower IQ, shortened attention span, and hyperactivity. Although children ingest less lead in their diets and inhale less lead than adults do, on a dose-per-body-weight basis children may have two to three times the exposure. Children absorb 50 percent of ingested lead, a rate five times greater than adults. Children with sickle-cell anemia are at greater risk of developing nervous system effects due to lead absorption. Children are exposed to lead through swallowing lead paint chips, or putting hands, toys, or objects soiled with lead dust or dirt in their mouths. Lead poisoning in children can cause progressive mental deterioration, including a loss of motor skills, severe hyperkinetic and aggressive behavior disorders, and poorly controlled convulsive disorder. Exposure to lead in fetuses is also particularly dangerous because of their sensitivity during development. Lead exposure to pregnant women may cause premature births, smaller babies, decreased mental ability in the infant, and even abortion.

In adults, lead exposure may decrease reaction time, possibly affect the memory, and cause weakness in fingers, wrists, or ankles. It may cause anemia, weakness, lassitude, insomnia, facial pallor, weight loss, anorexia, malnutrition, constipation, nausea, abdominal pain, vomiting, gingival lead line, tremors, encephalopathy, nephropathy, and hypotension. It may increase blood pressure in middle-aged men. High levels of exposure to lead may damage the male reproductive systems. Other organs affected by lead exposure are the gastrointestinal tract, central nervous system, kidneys, blood, and gingival tissue.

#### **Economics:**

During 1990, mine production of recoverable lead in the U.S. was 484,000 metric tons; production of refined lead from primary sources totaled 404,000 metric tons. Lead production by recovery from secondary sources totaled 922,000 metric tons. Old scrap accounted for 94 percent of total secondary lead production. Consumption of lead in the U.S. in 1990 was 1,275,000 metric tons.

### **Lead (Pb) Chemical Backgrounder (continued)**

#### **Economics: (continued)**

During 1989, nine mines in southeastern Missouri produced 89 percent of the total domestic output of lead ores and concentrates; lead-producing mines in Idaho, Alaska, and Montana contributed 10 percent of the domestic output. The remainder was a byproduct from the mining of other commodities in Arizona, California, Colorado, Idaho, Illinois, Nevada, New Mexico, Tennessee, and Utah.

During 1990, 93,000 metric tons of lead metal were imported for consumption in the U.S. Lead exports totaled 74,000 metric tons in 1990.

#### **Regulation:**

The Occupational Safety and Health Administration (OSHA) has issued a permissible exposure limit, for an eight-hour time-weighted average, for lead of 50 mg/m<sup>3</sup> (and an action level of 30 mg/m<sup>3</sup>). EPA offices regulating lead are Air and Radiation; Drinking Water; Emergency and Remedial Response; Solid Waste; and Toxic Substances. The Food and Drug Administration regulates lead as a leaching solution for pottery flatware, small and large hollowware, cups and mugs, and pitchers. The Consumer Product Safety Commission has banned lead paint from household use and interstate commerce if the lead content exceeds .06 percent of total weight of solids or paint film. The Department of Housing and Urban Development requires testing and elimination of lead-based paint in federally funded housing and housing rehabilitation programs, public housing, and Native American housing. It has set an action level for lead-based paint of 1.0 mg/cm<sup>2</sup>. HUD last month announced regulations requiring sellers and landlords to give information about lead on their properties to buyers and renters.

Lead is regulated under the Emergency Planning and Community Right-to-Know Act (EPCRA); Clean Air Act; Comprehensive Environmental Response, Compensation and Liability Act; National Primary Drinking Water Regulations, under the Safe Drinking Water Act; and as a priority pollutant, under the Clean Water Act.

Under EPCRA, releases of more than one pound of lead into the air, water, or land must be reported annually and entered into the TRI. In 1993, 4,056,624 pounds of lead were released by 551 facilities; those releases were the 48th largest of the TRI's 336 chemicals and chemical categories. Of those releases, 236,287 pounds were fugitive or nonpoint air emissions; 459,607 pounds were stack or point air emissions; 24,575 pounds were surface water discharges; and 3,336,155 pounds were released to land. In 1993, 42,795,974 pounds of lead were transferred; 40,096,726 were transferred to recycling; 7,815 pounds were transferred to energy recovery; 520,158 pounds were transferred to treatment; 28,085 pounds were transferred to publicly owned treatment works; 2,142,440 pounds were transferred to disposal; and 750 pounds were transferred to other off-site locations.

### **Lead (Pb) Chemical Backgrounder (continued)**

**Regulation: (continued)**

Releases of lead in 1993 represented increases from 1992 releases of 2,545,365 pounds, and 1991 releases of 3,788,617 pounds. They represented a decrease from releases in the base year, 1988, of 7,839,398 pounds.

According to EPA waste management information for 1993, 282,954,083 pounds of lead were recycled on-site; 40,606,123 pounds, recycled off-site; 34,925 pounds, used for energy recovery on-site; 7,232 pounds, used for energy recovery off-site; 8,044,440 pounds, treated on-site; 868,209 pounds, treated off-site; and 5,973,268 pounds, released or disposed of.

In 1993, the 10 states in which the largest amounts of lead were released are Missouri (2,563,291 pounds); Arizona (455,805 pounds); Illinois (160,467 pounds); Michigan (149,033 pounds); Texas (74,617 pounds); Massachusetts (73,627 pounds); Iowa (72,914 pounds); Ohio (53,021 pounds); Virginia (52,015 pounds); and New Jersey (48,330 pounds).

The 10 facilities releasing the largest amounts of lead in 1993 were Asarco Inc., Glover Plant, Annapolis, MO (2,556,161 pounds); Magma Copper Co., San Manuel, AZ (455,300 pounds); GMC Powertrain Group, Saginaw Grey Iron, Saginaw, MI (135,360 pounds); Granite City Steel, Granite City, IL (103,105 pounds); Concord Wire Co., Worcester, MA (71,638 pounds); Griffin Pipe Products Co., Lynchburg, VA (50,812 pounds); Griffin Pipe Products Co., Council Bluffs, IA (46,942 pounds); Kerr-McGee Chemical Corp., Hamilton, MS (44,000 pounds); Griffin Pipe Products Co., Florence, NJ (37,628 pounds); and Asarco Inc., El Paso, TX (31,150 pounds).

## Frequently Asked Questions & Answers about

### MANGANESE

#### **What Is Manganese?**

Manganese is a silver-colored metal. In nature, it combines with other elements to form manganese compounds. These compounds are naturally present in soil, rocks, and water. The levels in the soil vary from 10 to 5,000 parts of manganese for every million parts of soil (ppm).

#### **Where Is Manganese Released?**

Manganese is released into the environment by the natural erosion of rocks and soils. Most manganese is released by these natural sources. Manganese released by human sources comes mainly from steel mills. Total emissions of manganese have dropped dramatically over the past 20 years.

- ◆ **Air releases:** In 1978, U.S. industry emitted 18,000 tons of manganese into the air. In 1995, air releases of manganese and manganese compounds were 1,750 tons.
- ◆ **Water releases:** Analysis of background levels in surface water and groundwater indicate that human activities are responsible for only a fraction of total water-borne manganese. Most of it is naturally occurring.
- ◆ **Land releases:** In 1996, EPA's TRI reported that 30,595 tons of manganese and manganese compounds were released to the soil by industrial sources in the U.S.

#### **Does The Mining Industry Release Manganese Into The Environment?**

Very small amounts of manganese are naturally present in rocks and soils and are released into the environment by moving these materials as well as by the natural erosion process.

Manganese is also present in coal which is used to generate electricity. When coal is burned, ash is produced which contains most of the naturally occurring manganese. More than 99% of the ash is collected and is either sent to ash ponds or disposal sites or recycled into commercial products.

#### **What Does The EPA Say?**

EPA has determined that the level of manganese exposure due to burning coal for electricity is well below the level at which health effects are seen.

#### **How Could I Be Exposed To Manganese?**

Manganese exists naturally in the human body. The total amount of manganese tends to remain stable even when consumption rates are high. Generally, about 3-5% of the manganese intake will remain in the body.

Food is the largest source of manganese intake by humans. Trace amounts of manganese are found in most foods. Manganese levels in drinking water are very low -- about four parts of manganese to every billion parts of water (ppb). Exposure to manganese through food and water is of little concern since most of it is regulated by the body.

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### **Manganese (Mn) Chemical Backgrounder**

#### **Description:**

Manganese (C.A.S. 7439-96-5) is an abundant element and naturally occurring substance found in many types of rock. Pure manganese is a silver-colored metal, similar to iron in its physical and chemical properties. Manganese does not occur in the environment as a pure metal, but is a component of more than 100 minerals, including sulfides, oxides, carbonates, silicates, phosphates, and borates. It is combined with other elements or chemicals such as oxygen, sulfur, and chlorine to make compounds that do not evaporate. The most important manganese compounds are manganous chloride ( $MnCl_2$ ); manganous sulfate ( $MnSO_4$ ); manganese tetroxide ( $Mn_3O_4$ ); manganese dioxide ( $MnO_2$ ); and potassium permanganate ( $KMnO_4$ ). Chemical Abstract Service (C.A.S) No. 7439-96-5.

Rocks containing high levels of manganese compounds are mined and used to produce manganese metal, which is mixed with iron to make various types of steel. Most manganese is used to produce ferromanganese, or metallic manganese, which is used in the production of steel to improve hardness, stiffness, and strength. It is used in carbon steel, stainless steel, high-temperature steel, and tool steel, along with cast iron and superalloys.

Manganese dioxide is commonly used in production of dry-cell batteries, matches, fireworks, porcelain and glass-bonding materials, amethyst glass, and as the starting material for production of other manganese compounds. Manganese chloride is used as a precursor for other manganese compounds, as a catalyst in the chlorination of organic compounds, in animal feed to supply essential trace minerals, and in dry-cell batteries.

Manganese sulfate is used in glazes, varnishes, ceramics, and fertilizers; as a fungicide; and as a nutritional supplement. Potassium permanganate is used as an oxidizing agent, a disinfectant, and an anti-algal agent; for metal cleaning, tanning, and bleaching; and as a preservative for fresh flowers and fruits. The organomanganese compound MMT is used as an antiknock additive in unleaded gasoline in some countries, but is currently banned for that purpose in the United States.

#### **Chemical properties:**

Manganese can change from one compound to another, either by natural or human processes, but it does not break down or disappear in the environment. Some manganese compounds can dissolve in water, and low levels of these compounds are normally present in lakes, streams, and the ocean. Manganese decomposes in water and dissolves in dilute mineral acids. Manganese tetroxide and manganese dioxide are insoluble in water, and soluble in hydrochloric acid. Manganous chloride is soluble in alcohol, and insoluble in ether. Manganous sulfate is insoluble in alcohol. Potassium permanganate is soluble in sulfuric acid and acetone.

### **Manganese (Mn) Chemical Backgrounder (continued)**

#### **Chemical properties: (continued)**

When exposed to flame, manganese dust or powder is a moderate fire hazard. It will react with water or steam to produce hydrogen; it is incompatible with oxidizers.

Synonyms for manganese are colloidal manganese, elemental manganese, and cutaval.

#### **Health effects:**

The amount of manganese in a normal diet is enough to meet daily needs with no ill health effects. Exposure to too much manganese can cause mental and emotional disturbances, and slow and clumsy body movements; this combination of symptoms is a disease called manganism. Manganism occurs because too much manganese injures a part of the brain that helps control body movements. Some of the symptoms of manganism can be reduced by medical treatment, but the brain injury is permanent.

Breathing too much manganese dust can cause irritation of the lungs. Sometimes this makes breathing difficult and increases the chances of getting a lung infection, such as pneumonia. Inhalation or ingestion of manganese dust or fumes can cause Parkinson's, asthenia, insomnia, mental confusion, metal fume fever, weakness, spastic gait, paralysis, dry throat, cough, tight chest, dyspnea, rales, flu-like fever, low back pain, vomiting, malaise, and fatigue.

A common effect in men who are exposed to high levels of manganese dust in air is impotence.

#### **Economics:**

The United States currently relies on imports to fill its need for manganese, which were 1.1 billion pounds in 1988. Ferromanganese is also imported, with import quantities ranging from 730 to 990 million pounds per year.

Producers of manganous chloride are Chemetals Incorporated, Baltimore, MD; Mineral Research and Development Corp., Harrisburg, NC; New Hampshire Oak General Chemical Corp., Claymont, DE; and Procter & Gamble Co., Richardson-Vicks Inc., subsidiary, J.T. Baker Inc., subsidiary, Phillipsburg, NJ.

Producers of manganese dioxide are American Minerals Inc., Camden, NJ, New Castle, DE, El Paso, TX, and Rosiclare, IL; Carus Corp., La Salle, IL; Chemetals Incorporated, Baltimore, MD, and New Johnsonville, TN; Eagle-Picher Industries, Inc., Joplin, MO; Kerr-McGee Corp., Henderson, NV; Phillip Brothers Chemicals, Inc., Bowmanstown, PA, and Quincy, IL; Procter & Gamble Co., Richardson-Vicks, Inc., subsidiary, J.T. Baker Inc., subsidiary, Phillipsburg, NJ; and Shepherd Color Co., Cincinnati, OH.

Producers of manganese sulfate are American Micro Trace Corp., Fairbury, NE; Koch Industries, Inc, Pittsburg, KS; Phillip Brothers Chemicals, Inc, the Prince Manufacturing Co., subsidiary, Bowmanstown, PA, and Quincy, IL; and Procter & Gamble Co., Richardson-Vicks, Inc., subsidiary, J.T. Baker Inc., subsidiary, Phillipsburg, NJ.

### **Manganese (Mn) Chemical Backgrounder (continued)**

**Regulation:**

The Occupational Safety and Health Administration (OSHA) issues permissible exposure limits (time weighted average) for manganese fume, as manganese, of 1 mg/m<sup>3</sup>; manganese cyclopentadienyl tricarbonyl, as manganese, of .1 mg/m<sup>3</sup>; and manganese tetroxide of 1 mg/m<sup>3</sup>. Offices within the Environmental Protection Agency that issue regulations for manganese are Air Quality Planning and Standards, Water Regulation and Standards, Emergency and Remedial Response, Solid Waste, and Toxic Substances.

The Food and Drug Administration regulates manganese concentrations in bottled water. The Department of Justice's Drug Enforcement Agency ranks potassium permanganate as an essential chemical in illegal drug production; records of sales and uses are required for amounts over 500 kg.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of manganese and manganese compounds into the air, land, and water must be reported annually and entered into the national Toxic Release Inventory (TRI).

## Frequently Asked Questions & Answers about MERCURY

### **What Is Mercury?**

Mercury is a silver-colored metal that is liquid at room temperature. It is not commonly found in its metallic form but rather as a mercury compound associated with other naturally occurring elements and compounds. Small amounts of mercury are naturally present in soil and water. Levels in soil average less than one part mercury for every million parts soil (ppm).

Approximately 43% of mercury releases can be attributed to natural sources such as volcanoes, the ocean, and soils and human activities account for approximately 57%. Most manmade mercury releases come from mining, coal and oil combustion, and burning waste from cities and hospitals. Mercury releases from human activities peaked in the 1980s and are continuing to decline due to improved collection efficiencies and product substitution.

### **Where Does Mercury Come From?**

Mercury enters the environment through natural processes and as a result of human activity. Mercury is released through:

- ◆ weathering of rocks containing mercury
- ◆ volcanic eruptions
- ◆ mining of ores that contain mercury
- ◆ fossil fuel (oil and coal) combustion

### **Does The Mining Industry Release Mercury Into The Environment?**

Very small amounts of mercury are naturally present in rocks and soils and are released into the environment by moving these materials as well as by the natural erosion process. In addition, small amounts of mercury are released into the environment as a result of the mining industry's efforts to recover the metal during refining.

### **How Could I Be Exposed To Mercury?**

Since mercury occurs naturally in the environment, everyone is exposed to very low background levels that are not harmful to human health. The body naturally eliminates low concentrations of mercury, so background exposure is not considered harmful.

Main sources of mercury exposure are:

- ◆ food containing mercury (particularly fish and shellfish)
- ◆ some dental and medical treatments (including tooth fillings)
- ◆ drinking water
- ◆ mining production sites
- ◆ coal-fired power plants
- ◆ recycling facilities, municipal or medical incinerators

It is very rare to inhale high concentrations of mercury vapor or to swallow large amounts of mercury. The mercury releases discussed in this paper are too low to cause adverse health effects.

### **What Does EPA Say?**

EPA is unable to estimate the health risk posed by mercury emissions to the air. EPA and other federal agencies are currently conducting studies on whether mercury emissions from power plants pose a significant risk to human health. See *EPA's Report to Congress on Utility Air Emissions* (following this section) for more information.

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### **Mercury (Hg) Chemical Backgrounder**

#### **Description:**

Mercury (C.A.S. 7439-97-6) is an element that occurs naturally in the environment. It is a silver-white, heavy metal that is liquid at room temperature; as a solid, it is tin-white and can be cut with a knife. It can also be found in compounds with other chemicals such as chlorine in the same way that sodium is found in table salt.

Mercury is used in pure form in thermometers, barometers, and other consumer products. Batteries containing mercury are used in devices ranging from guided missiles and space craft to hearing aids, cameras, toys, portable radios, calculators, measuring devices, smoke alarms, self-winding watches, and radio microphones. Electric or mercury lamps are used for outdoor lighting, including floodlights and street lights, motion picture projection, health treatment, and photography. Mercury is also used as a catalyst in the production of vinyl chloride monomer, urethane foam, and anthraquinone. It is used in diuretics, antiseptics, and skin preparations.

Prior to August 20, 1990, mercury was added to paints as an anti-mildew agent, antibacterial agent, and fungicide; about one-third of all interior latex paint contained varying levels of mercury. (Oil-based paint does not contain mercury.) Mercury is also used in pigments, refining, lubrication oils, and dental amalgams.

Mercury in one form, "organic mercury," can become highly concentrated in the flesh of certain fish. For this reason relatively low levels of mercury contamination in the ocean and lakes can lead to toxic contamination of these fish. Organic compounds of mercury are phenylmercury acetate (C<sub>8</sub>H<sub>8</sub>HgO<sub>2</sub>) and methylmercuric chloride (CH<sub>3</sub>HgCl). Other compounds of mercury, called "inorganic mercury," are mercury, mercuric II acetate or mercury salt (HgC<sub>4</sub>H<sub>6</sub>O<sub>4</sub>c), mercuric II chloride (HgCl<sub>2</sub>c), and mercurous I chloride (Hg<sub>2</sub>Cl<sub>2</sub>c).

#### **Chemical properties:**

Synonyms for mercury are colloidal mercury; kwik; liquid silver; quicksilver; metallic mercury; and hydrargyrum.

Mercury that is released into the environment will remain there indefinitely. The form that mercury exists in (organic or inorganic) may change with time. Some or all of released organic mercury will slowly decompose to become inorganic mercury. Some portion of released inorganic mercury will be slowly transformed into organic mercury by bacteria in soil or water.

Mercury is not flammable and does not have an odor. Some mercury salts and organic compounds are soluble in water, depending on the chemical species.

### Mercury (Hg) Chemical Backgrounder (continued)

#### **Health effects:**

Mercury, in both inorganic and organic forms, is toxic to humans and can cause death. The organic forms of mercury such as methylmercuric chloride and phenylmercuric acetate have been found to be more toxic than inorganic forms such as mercuric chloride. More severe effects on developing nervous systems are generally observed following exposure to organic mercury.

Deaths have been reported following acute exposure to high unspecified concentrations of metallic mercury vapor caused by a loss of respiratory function as a result of severe pulmonary tissue damage. Oral ingestion of single doses of mercuric chloride has led to poisoning and death caused by shock, cardiovascular collapse, acute renal failure, and severe gastrointestinal damage. Most reported cases of poisoning from organic mercury compounds are a result of the ingestion of contaminated fish or grains.

Long-term exposure to either organic or inorganic mercury can irreversibly damage the brain, kidneys, or developing fetuses. The form of mercury and the way humans are exposed to it influence which of these health effects will be more severe.

For example, organic mercury that is eaten in contaminated fish or grain will tend to cause greater harm to the brain and developing fetuses than to the kidney; inhaled inorganic mercury vapor will tend to cause greater harm to the brain; and inorganic mercury that is eaten or drunk in contaminated food or water will tend to cause greater harm to the kidneys.

Effects to the developing fetus include brain damage. Effects in adults briefly exposed to mercury include shakiness, tremors, and memory loss.

#### **Economics:**

Mercury is produced mainly by mining. Five percent of the world mercury production is a by-product of gold mining, and most of the remaining mercury is produced from underground mines. Some salvage is done on scrap materials as well.

U.S. production of mercury in 1985 was 1,254,000 pounds; world production in 1986 was 13,376,000 pounds. In 1986, almost 1,520,000 pounds of mercury were imported to the United States.

#### **Regulation:**

The U.S. Food and Drug Administration (FDA) has issued permissible levels of mercury in bottled water. The Occupational Safety and Health Administration (OSHA) has issued permissible exposure limits for mercury.

The U.S. Environmental Protection Agency prohibited adding mercury to paint after August 20, 1990. However, paint manufactured before that ban can still be sold.

### **Mercury (Hg) Chemical Backgrounder (continued)**

**Regulation: (continued)**

EPA offices overseeing regulations and guidelines for mercury are Air Quality Planning and Standards, Water and Standards, Emergency and Remedial Response, Solid Waste, and Toxic Substances.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of mercury into the air, water, or land must be reported annually and entered into the National Toxic Release Inventory (TRI).

Total emissions of mercury into the air in 1987 were 130,579 pounds; emissions of mercury compounds were 2,368 pounds. Mercury was released in Alabama, Delaware, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Minnesota, Missouri, North Carolina, New Jersey, New York, Ohio, Texas, Wisconsin, and West Virginia. Mercury compounds were released in New Jersey, New York, South Carolina, Tennessee, and West Virginia.

## Frequently Asked Questions & Answers about NICKEL

### **What Is Nickel?**

Pure nickel is a hard, silvery-white metal. It is released into the environment by volcanoes, forest fires, vegetation, and human activities.

### **Where Does Nickel Come From?**

Nickel is found in all soil. Soil-based concentrations range from 400 to 80,000 parts of nickel for every billion parts of soil (ppb). Nickel enters streams and bodies of water through natural weathering and erosion processes as well as by settling of atmospheric nickel emissions. Water-borne nickel often accumulates in sediments. Nonetheless, nickel levels in surface water are normally very low (often undetectable).

Most manmade nickel releases (75%) are to land. The largest sources of nickel in the soil are:

- ◆ waste from metal manufacturing
- ◆ commercial waste
- ◆ urban refuse
- ◆ coal ash
- ◆ sewage sludge

The remainder of human-induced nickel releases are atmospheric. Approximately 295 tons of nickel and nickel compounds were released from manmade sources to the air. Atmospheric emissions remain airborne for about 30 days, and eventually settle back to earth.

### **How Is Nickel Used?**

High natural, land-based nickel concentrations are frequently mined. There is only one nickel mine operating in the U.S., but active mines are found in Canada, Cuba, Indonesia, the Dominican Republic, the Philippines, and Brazil. Most of the nickel used in the U.S. is produced from recycled nickel alloys and is used to produce metals such as steel.

Nickel is often alloyed with iron, copper, chromium, or zinc to make products like stainless steel, metal coins, and industrial items. Nickel can also combine with chlorine, sulfur, or oxygen to form compounds used in nickel plating, color ceramics, and batteries.

### **Does The Mining Industry Release Nickel Into The Environment?**

Very small amounts of nickel are naturally present in rocks and soils and are released into the environment by moving these materials as well as by the natural erosion process.

Nickel is also naturally present in fossil fuels like coal, which is burned to generate electricity. The burning of coal produces ash which contains much of the naturally occurring nickel. Power plants are equipped with devices that capture more than 99% of the ash which is then sent to disposal sites, or is recycled into commercial products.

### **What Does EPA Say?**

Based on EPA estimates, the health risk associated with electric utility nickel emissions is very low. However, research is underway to assess any potential health effects related to nickel.

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### **Nickel (Ni) Chemical Backgrounder**

#### **Description:**

Nickel (C.A.S. 7440-02-0) is a naturally occurring silvery metal found in the earth's crust in the form of various nickel minerals. Nickel and its compounds can be detected in all parts of the environment, including plants, animals and soil.

Primary nickel is recovered from mined ore and nickel matte, and secondary nickel is recovered from scrap metal. Industry uses nickel to make steels and alloys, permanent magnet materials, and nickel-cadmium batteries, and in electroplating and ceramics. A large resource of yet-untapped nickel lies in the seabed.

Fuel oil combustion leads to releases of nickel to the atmosphere. Other sources include emissions from mining and refining operations, municipal waste incineration, and windblown dust. Minor sources of atmospheric nickel are volcanoes, steel production, gasoline and diesel fuel combustion, vegetation, nickel alloy production, and coal combustion. Sources of nickel in water and soil include stormwater runoff, soil contaminated with municipal sewage sludge, wastewater from municipal sewage treatment plants, and groundwater near landfill sites.

#### **Chemical and physical properties:**

The nickel compounds include: nickel oxide, green; nickel oxide, black; nickel acetate; nickel carbonyl; nickel hydroxide; nickel sulfide; nickel subsulfide; nickel powder; nickel chloride; nickel chloride hexahydrate; nickel sulfate hexahydrate; and nickel nitrate hexahydrate.

Soluble compounds include: nickel acetate, nickel sulfate hexahydrate, nickel nitrate hexahydrate, and nickel chloride.

Several forms of nickel oxide have commercial and/or environmental significance. The various nickel oxide species have markedly different physicochemical characteristics and biological effects; as a result, it is important to distinguish between various nickel oxide species, particularly nickel oxide black, which is chemically reactive, and nickel oxide green, which is inert and refractory.

#### **Health effects:**

Workers' inhalation of nickel refinery dust, which contains nickel subsulfide, has resulted in increased numbers of deaths from lung and nasal cavity cancers, and possibly cancer of the voice box. The nickel compounds implicated as potential carcinogens are insoluble dusts of nickel subsulfide and nickel oxides, the vapor of nickel carbonyl, and soluble aerosols of nickel sulfate, nitrate, or chloride. Evidence for the carcinogenicity of nickel metal and other compounds is relatively weak or inconclusive.

### **Nickel (Ni) Chemical Backgrounder (continued)**

#### **Health effects: (continued)**

The most common adverse effects of nickel exposure are skin allergies, specifically dermatitis. Rhinitis, nasal sinusitis, and nasal mucosal injury are among the effects reported in workers chronically exposed to nickel compounds. Asthma has been reported in nickel platers exposed to nickel sulfate, and in welders exposed to nickel oxides.

Because there are no nickel refineries in the U.S., there is very little exposure to nickel refinery dust and nickel subsulfide. Occupational exposure to nickel metal has not been associated with cancer.

The lung is the target organ for nickel toxicity in humans. After comparing ambient air nickel levels with nickel levels in work places associated with adverse effects, EPA has concluded that "human health effects other than cancer appear to be limited to the occupational environment."

Very small amounts of nickel have been shown to be essential for normal growth and reproduction in some species of animals; therefore, small amounts of nickel may also be essential to humans.

#### **Economics:**

The last nickel mine and smelter in the U.S., Hanna Mining Co. in Riddle, Oregon, closed in 1987. The U.S. then was producing less than 1 percent of all the nickel mined in the world. Currently, more nickel is recovered from metal scrap than is obtained from domestic and imported ore combined.

#### **Regulation:**

OSHA issues permissible exposure limits for nickel and soluble nickel compounds. Under the Emergency Planning and Community Right-to-Know Act, release of more than one pound of nickel and nickel compounds into the air, water, and land must be reported annually and entered into the national Toxic Release Inventory.

In 1987, 489,132 pounds of nickel and 265,436 pounds of nickel compounds were reported as being released into the atmosphere. Nickel releases were reported in every state except Alaska, Arizona, Hawaii, Idaho, Montana, North Dakota, South Dakota, and Wyoming. Nickel compounds were reported released in every state except Alaska, Arkansas, Colorado, Delaware, Hawaii, Iowa, Mississippi, Nebraska, New Hampshire, Nevada, North Dakota, Oregon, South Dakota, and Wyoming. Of the 51.3 million kilograms of nickel emitted into the atmosphere worldwide, 52% come from residual and fuel oil consumption; 14% are from nickel mining and refining operations; 10% from incineration; 9.3% from naturally windblown dust; and 4.9% from volcanoes.

### Frequently Asked Questions & Answers about SELENIUM

#### **What Is Selenium?**

Selenium is a very unique, photosensitive element. Selenium is most commonly found as a gray, hexagonal solid although it may also be found as dark gray lustrous rods or dark red crystals.

#### **Where Does Selenium Come From?**

Selenium is the 70<sup>th</sup> most prevalent element in the earth's crust. It occurs naturally in igneous rocks, in soils and in the selenides of base metals and in sulfide deposits of zinc, silver, copper and nickel. Some plants contain selenium which they accumulate through the soil.

Selenium can be produced by treating electrolytic copper refinery "slimes" that contain selenides. These are converted to water soluble selenites by smelting, roasting or direct oxidation and then reduced to the metal.

Treatment of flue dust formed in sulfuric acid manufacture also produces selenium.

#### **How Is Selenium Used?**

Selenium is valued for both its semiconductor and its photo-reactive properties. Its compounds are used in many industrial and commercial enterprises. It is used in the production of rectifiers (which convert alternating to direct current), in the production of steel ware, in photography and television cameras, in photoelectric cells, the vulcanization of rubber (to increase resistance to abrasion) and the creation of lubricants and pharmaceuticals. Selenium is also used in the glass and ceramics industries to create ruby glass, red enamels and colored glazes.

#### **Does The Mining Industry Release Selenium Into The Environment?**

Very small amounts of selenium are naturally present in rocks and soils and are released into the environment by moving these materials as well as by the natural erosion process.

#### **What Are The Health Risks Associated With Selenium?**

Copper and lead selenides are not toxic and even small doses of some selenides are used in medicines.

Safe concentrations (no more than 3 parts per million) of selenium exist in food due to plants' absorption of the element through the soil.

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### **Selenium (Se) Chemical Backgrounder**

#### **Description:**

Selenium (C.A.S. 7782-49-2) is a naturally-occurring element widely but unevenly distributed in the earth's crust and commonly found in sedimentary rock formations. It is also manufactured for industrial uses. Humans are exposed to selenium daily in their food, particularly in grains, cereals, meat, seafoods and drinking water. Industry uses selenium as a black, gray or red odorless solid to manufacture "electric eyes," photographic exposure meters, rectifiers for home entertainment equipment, xerography, red or black glass, anti-dandruff shampoos, and pigments in plastics, paints, enamels, inks and rubber. It is also used in veterinary medicine and as a fungicide and insecticide.

In some regions of the U.S., soils contain high levels of selenium and selenium compounds, which accumulate in plants and can be toxic to grazing livestock. In fresh water containing elevated levels of selenium, such as in the highly publicized Kesterson Reservoir in California, fish may contain extremely high levels of selenium. The Kesterson Reservoir receives selenium-laden water runoff from nearby agricultural areas.

#### **Health effects:**

Selenium and its compounds, particularly selenium dioxide and hydrogen selenide, can cause eye irritation. Inhalation of selenium dust, a concentrated mist of selenium, selenium dioxide or hydrogen selenide, can irritate the nose, throat and bronchial tubes and cause headaches, dizziness and malaise. Exposure to high concentrations of selenium dioxide can cause bronchial spasms, symptoms of asphyxiation and bronchitis.

Ingestion of high doses of selenium compounds can cause pulmonary edema and lung lesions. Acute oral doses of selenium compounds can cause aches and pains, irritability, chills and tremors. Both acute inhalation of and acute oral exposure to selenium compounds cause respiratory distress. Repeated exposure to selenium can cause metallic taste, a garlic odor to the breath, fatigue, irritability, depression and pallor. Repeated exposure to selenium compounds in food can cause dental cavities and loss of nails and hair. Repeated higher exposures to selenium also may cause liver damage. Inhalation of selenium, selenium dioxide and hydrogen selenide can cause indigestion and nausea. Most studies have not found a link between selenium and cancer; there are no studies available about the reproductive effects of selenium. It is not known if selenium causes lung damage. In industrial uses, electronics and photography account for 46% of selenium use; glass industry, 27%; pigments, 14%; miscellaneous, 13%.

#### **Regulation:**

Permissible exposure limits of selenium are regulated by OSHA; the FDA regulates permissible levels of selenium in bottled water. Several EPA offices regulate selenium: the Office of Drinking Water; the Office of Water Regulations and Standards, under the National Pollutant Discharge Elimination System; the Office of Emergency and Remedial Response; the Office of Solid Waste; and the Office of Toxic Substances, as a pollutant under the Emergency Planning and Community Right to Know Act.

## Frequently Asked Questions & Answers about SILVER

### **What Is Silver?**

Silver is a white, lustrous, corrosion resistant, metallic element that was valued throughout history for its strength, ductility, and malleability, as well as its use as a sterile container and a medium of exchange. Today, silver is also valued for its thermal and electrical conductivity and its reflectivity of and sensitivity to light.

### **Where Does Silver Come From?**

Silver is a rare element, occurring in less than 1 hundred-millionth of the earth's crust. Silver is commonly found in compounds or in conjunction with copper and lead ores, but also occurs occasionally in gold and zinc deposits. Approximately 80% of the silver produced is a by-product of the processing of other ores.

### **How Is Silver Used?**

Silver's unique properties have made it important in a number of products and applications, including:

- ◆ batteries
- ◆ brazing and soldering
- ◆ electrical circuitry
- ◆ electronics
- ◆ electroplating
- ◆ medical and dental applications
- ◆ mirrors and coatings
- ◆ photography
- ◆ water purification.
- ◆ coins
- ◆ jewelry and silverware

Use in industrial processes, photography, jewelry and silverware make up 95% of annual silver consumption.

### **Does The Mining Industry Release Silver Into The Environment?**

Although silver is found as a native element, it is a rare metal, making up less than a hundred-millionth of the earth's crust. More than two thirds of the silver produced, is obtained as a by-product from ores of other metals, primarily lead and copper ores, with small amounts from zinc and gold ores. Silver is "released" into the environment during the mining and processing of silver and other ores as these materials are removed from the earth, transported and processed.

### **How Could I Be Exposed To Silver And What Are The Health Risks?**

Silver is used in dental fillings, otherwise known as amalgams, which are actually an alloy of several metals (silver, zinc, tin etc.) and mercury. Reports have been generated about the possibility of mercury toxicity from silver fillings. The American Dental Association has conducted numerous studies which have found no proof that silver fillings pose any threat to the safety of the dental public.

The National Academy of Sciences' Laboratory Chemical Safety Summaries report that the acute toxicity of silver metal is low.

## Frequently Asked Questions & Answers about

### ZINC

#### **What Is Zinc?**

Zinc is a naturally occurring element and the third most used nonferrous metal (after aluminum and copper), of which the U.S. consumes more than one million metric tons annually.

#### **Where Does Zinc Come From?**

Zinc occurs naturally in the earth, in the air and in the foods you eat. Most rocks and many minerals contain zinc in varying amounts and zinc exists naturally in air, water and soil.

It is the second most common trace metal, after iron, naturally found in the body. Zinc is found in hundreds of products, including vitamins, cereals, cosmetics, pet foods, paints, fertilizers, tires, batteries, ointments, shampoos, soaps and pharmaceuticals.

#### **How Is Zinc Used?**

Zinc is primarily used as a coating on iron and steel to protect against corrosion but zinc has many other uses such as:

- ◆ in brass and other alloys (zinc combined with copper makes brass)
- ◆ in automotive equipment and batteries (zinc can store six times as much energy per pound as other battery systems)
- ◆ household appliances, fittings, tools, toys
- ◆ in building and construction (zinc sheets used in architecture, for roofs or facades, on counters and on bar tops, have a maintenance-free life of over 60 years)
- ◆ in pharmaceuticals, medical equipment and cosmetics
- ◆ in tires and all rubber goods
- ◆ in fertilizers and animal feed and...
- ◆ zinc is common “cents.” The U.S. penny is 98% zinc with a copper coating.

#### **Does The Mining Industry Release Zinc Into The Environment?**

Zinc is a naturally occurring element present in the earth’s crust. Due to natural erosion processes like the weathering and abrasion of rock, soils and sediments by wind and water, natural zinc is continuously being transported in the environment. Zinc is also “released” into the environment during the mining process as these materials are removed from the earth, transported and processed.

#### **How Could I Be Exposed To Zinc and What Are The Health Risks?**

Zinc is a natural element found in the earth's crust and is used in many consumer products, dietary supplements and in the food we eat and the water we drink.

Zinc is an essential nutrient required by the body and has a U.S. Government Recommended Daily Allowance of 15 milligrams for adults. Studies show that pregnant and lactating women need even more. Most adults, though, get only 9.9 milligrams a day, with women averaging 8.5.

Zinc is essential to your health, boosting the immune system, helping cells to grow, regulating appetite and healing wounds. Zinc lozenges can even cut short the common cold by four days. Zinc is a natural insect repellent and sun screen, protecting lips and skin. Zinc is not a carcinogen.

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### **Zinc (Zn) Chemical Backgrounder**

#### **Description:**

Zinc (C.A.S. 7440-66-6) is found naturally in the air, soil, and water, and is present in all foods. It is a soft white metal with a bluish tinge. It is an essential nutrient required by the body in low doses; an inadequate amount of zinc in the diet will lead to poor health. Too much zinc, however, can be harmful to human health.

Zinc can be found in pure form or mixed with other metals to form alloys such as brass for electrical apparatus, and in organic chemical extractions and reductions. It can also be found in compounds with other chemicals such as chlorine (zinc chloride) in the same way that sodium is found in table salt.

Zinc is used most commonly as a protective coating of other metals. Zinc chloride is a primary ingredient in smoke bombs used by the military for screening purposes, crowd dispersal, and fire-fighting exercises. In pharmaceuticals, salts of zinc are used as solubilizing agents in many drugs, including insulin. Zinc and copper alloys are used to make pennies.

#### **Chemical properties:**

Zinc is a combustible solid that is insoluble in water. It produces irritating and poisonous gas and fumes in a fire. Zinc dust forms an explosive mixture with air. Zinc must be stored to avoid contact with chromic anhydride, manganese chloride, chlorates, chlorine, and magnesium, since violent reactions occur with that contact. Flammable hydrogen gas is produced when zinc is exposed to water, acids, and alkali hydroxides. Cadmium, a cancer-causing agent, is released when zinc is refined.

Synonyms for zinc are zinc dust and zinc powder. Zinc compounds include zinc chloride ( $ZnCl_2$ ), zinc sulfate ( $ZnSO_4$ ), zinc sulfide - alpha (wurtzite) ( $ZnS$ ), zinc sulfide - beta (sphalerite) ( $ZnS$ ), and zinc oxide ( $ZnO$ ).

#### **Health effects:**

Inhalation of zinc oxide is common in occupational exposures and can produce serious injury to the respiratory system upon direct contact. Inhalation of zinc chloride, which is used in smoke bombs, can result in coughing, chest pain, and respiratory tract irritation. Death can result from acute high dose inhalation of zinc chloride smoke.

Zinc metal particles can irritate the eyes. High exposure to zinc dust can cause a cough with phlegm. When zinc is inhaled as zinc dust or fumes from smelting or welding, a short-lasting disease or syndrome called metal fume fever can occur. If too much zinc is digested even for a short time, stomach and digestion problems can occur. More serious damage to the digestive system, such as symptoms of gastrointestinal distress or lacerations in gastrointestinal tissues, can occur if too much zinc is taken for a longer period of time. Ingesting too much zinc may interfere with the body's ability to absorb and use other essential minerals such as copper and iron.

## **Zinc (Zn) Chemical Backgrounder (continued)**

### **Health effects: (continued)**

Too little zinc in the diet may result in a loss of appetite, a decreased sense of smell, failure to grow, impaired healing of wounds, and skin lesions. In severe cases, zinc deficiency can result in poorly developed sex organs and dwarfism.

Populations with potentially high exposure to zinc include those who intentionally consume large doses of zinc as a dietary supplement, and patients who receive chronic treatment with drugs containing zinc salts (such as injectable insulin).

### **Economics:**

The two most common zinc mining methods are underground and open pit. Production of zinc occurs in 19 states, with Tennessee, Mississippi, and New York contributing 50 percent. In 1987, approximately 240,000 metric tons were produced in the United States, with a value of approximately \$202 million. World production from zinc mines in 1987 was estimated at 7.1 million metric tons.

Zinc is available in many commercial forms, including ingots, lumps, sheets, wire, shot, strips, sticks, granules, powder, and granulated zinc obtained when molten metal is poured into cold water.

In 1987, approximately 740,000 metric tons of zinc were imported to the United States in slab form, and about 26,000 metric tons were imported as ores and concentrates. In the same year, an estimated 8,000 metric tons in ores and concentrates, and another 82,000 metric tons in slabs, scraps and compounds were exported from the United States to Canada, France, Germany, Israel, Italy, Japan, Mexico, Panama, and Taiwan.

### **Regulation:**

The Occupational Safety and Health Administration (OSHA) has established permissible exposure limits for zinc. The Food and Drug Administration (FDA) has issued permissible levels of zinc in bottled water. EPA offices issuing regulations for zinc are Drinking Water, Water Regulations and Standards, Emergency and Remedial Response, Solid Waste, and Toxic Substances.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of zinc fume or dust and zinc compounds into the air, water, or land must be reported annually and entered into the National Toxic Release Inventory (TRI).

Total emissions of zinc fume or dust into the air in 1987 were 2,938,830 pounds; 3,161,659 pounds of zinc compounds were emitted. Reported releases of zinc fume or dust were highest in Louisiana (373,409 pounds), Michigan (275,135 pounds), and Ohio (270,531 pounds). Highest in reported releases of zinc compounds were in Pennsylvania (530,370 pounds), Michigan (367,170 pounds), and Idaho (352,000 pounds).