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# **Colorado Mining Association**

## **2006**

**Reporting Under the  
Community Right-to-Know Program  
2005 Reports Filed July 1, 2006**

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## **What is TRI?**

The Toxics Release Inventory (TRI) was established as a part of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986. The initial purpose of the program was for chemical manufacturing facilities to report “releases” of certain listed substances to the air, land and/or water on an annual basis to the Environmental Protection Agency (EPA). The annual reporting of releases is accomplished with the submittal of Form R’s to the EPA by those facilities in the TRI program.

In 1997, the EPA expanded the TRI program to cover seven additional industries, including metal and certain coal mining operations. Beginning January 1, 1998, these additional industries started tracking releases of more than 600 designated chemicals and compounds. Releases were reported for calendar year 2005 by July 1, 2006. The information contained in the 2006 Form R reports is similar to that reported in previous years but overall the releases are higher due to improving economic conditions that translated into increased production. Information on prior TRI releases has been made available by the Colorado Mining Association (CMA) and member companies. CMA, along with the coal and metal mines reporting under TRI, have shared information with the public beyond what is provided by EPA because the industry believes communities should better understand the TRI program. As an example of that commitment, the mining industry works closely with local governments by providing them with site maps of facilities, encouraging local governments to visit the sites, and joining with nearby communities to coordinate activities of mutual interest.

Reportable materials from the Colorado mining industry include metals and compounds containing arsenic, barium, chromium, cobalt, copper, cyanide, dioxins, lead, manganese, mercury, lead, nickel, nitrate, selenium, zinc and vanadium. The vast majority (e.g., >99%) of the reported releases for the mining industry are naturally occurring metals in rock, with a minuscule percentage (e.g., dioxins, mercury, etc.) being associated with fuel combustion by-products, volatilization, or other authorized uses of materials containing TRI chemicals or compounds. The naturally occurring substances and the other chemical compounds that are manufactured, processed or otherwise used above established thresholds must be reported under TRI. Under the TRI program, it is assumed that all the naturally occurring chemicals and compounds in rock are released during the year of placement for simplicity. Observation and experience indicate that rock typically requires decades, centuries, or millennia to weather into the elemental constituents that TRI assumes occurs in only a year. The TRI program does not take into consideration the rigorous environmental permitting and management requirements for rock and coal ash. As such, TRI provides no meaningful indication of the risk to human health or environmental exposure to TRI chemicals in naturally occurring rock at mining operations.

**Should the information available in these reports be of concern to my community?**

No. TRI is merely a reporting program. It is not intended to assess risk of exposure. The EPA simply publishes the TRI data annually by state, company, facility, sector, and chemical without any explanation of risk or exposure. Based on these reports, industry sectors, companies and individual facilities are each ranked solely by the volume of materials reported and not on the risk of public exposure to these chemicals and compounds.

Furthermore, most of the reported materials never leave the controlled environment of the mine site and many of the reported materials remain contained in the minerals or rock matrix in which they occur in nature. EPA and the TRI program do not attempt to make any distinction between substances that are an integral component of the rock versus those that may be more mobile. Based on all of these factors, it is clear that the TRI program does not address the presence or absence of risk to the public for the vast majority of releases reported at mining operations for naturally occurring metals in rock.

## Implementing the Community Right-to-Know

### **Background:**

- As of January 1, 1998, metal and certain coal mining operations began tracking the chemicals and compounds to be reported to EPA on an annual basis under the TRI program. On July 1 of each year, the TRI reports are submitted to the EPA for those chemicals and compounds that exceeded established thresholds. The reported “releases” are categorized according to the receptor media – air, water or land.
- Reporting under the TRI program is triggered if more than 25,000 pounds of listed chemicals or compounds are manufactured or processed, with a lower threshold of 10,000 pounds for those that are otherwise used.
- Thresholds for certain persistent bioaccumulative toxic (PBT) chemicals were substantially lowered by EPA for reporting year 2000 and again in 2001. Dioxin was lowered to 0.1 gram, mercury to 10 pounds and lead to 100 pounds. Due to these changes to the reporting thresholds, the TRI releases reported by some facilities increased significantly in 2001.
- Nearly 650 chemicals/compounds are presently on the TRI list.
- Reported releases decreased dramatically for some hard rock mining operations in 2002 due to Federal District Court decisions clarifying the applicability of the program to naturally occurring TRI chemicals in excavated rock. Native rock moved by mining operations with TRI chemical concentrations less than 1% (excepting lead and mercury) are now eligible for the *de minimis* exemption previously established by EPA.
- The reporting is designed to provide local communities with information about the volume of materials being used and regulated at facilities near them. The reporting regulations now cover more than 23,000 industrial and federal facilities.
- The raw data neither identifies nor accounts for required environmental management controls designed and implemented to reduce health and environmental risks. These environmental management controls, applicable to mining operations through myriad environmental protection statutes, use criteria that are based on protecting the health of the environment and the public. The TRI reporting process does not provide public or environmental exposure information or risk assessments, which are essential in helping to inform and educate the public about health and/or environmental risks associated with these materials. The raw data reported to the EPA by the Colorado mining industry describes large volumes of material containing very low concentrations of naturally-occurring minerals that are listed “reportable chemicals” in the rock that is mined – they are often called “trace elements,” for good reason.

## **Implementing the Community Right-to-Know**

### **Colorado Mining Industry Positions:**

- The Colorado mining industry takes its many reporting responsibilities seriously. It believes that local residents have a right to know what materials are being managed on site. The industry has a long record of working openly and cooperatively with local communities on environmental issues.
- The Colorado mining industry is committed to safe work environments and safe communities, and has implemented modern, efficient and safe material management practices. The industry has a very good record for safety and compliance with environmental, health and safety requirements. Presidents and governors have acknowledged Colorado mines' environmental stewardship through numerous reclamation and environmental awards.
- The Colorado mining industry operates safe, environmentally responsible and community-oriented businesses, which are overseen and governed by local, state and federal regulations.
- The Colorado mining industry is fully committed to safe environmental practices. The industry routinely uses environmental protection measures such as sophisticated containment and monitoring systems; detailed engineering designs and controls; best management practices; and water conservation measures involving reuse and recycling.
- The Colorado mining industry manages operations to fully train and protect workers.
- CMA and the Colorado Mining Industry worked closely with the Colorado Department of Public Health and Environment (CDPHE) in developing a Pollution Prevention (P2) Program and acceptable Code of Practices (Code) for the mining industry. The P2 Code has been endorsed by the CDPHE and recognized by the EPA through a 2003 Friend of EPA Award. Several CMA member companies have certified under the P2 Code and received awards with special recognition from CMA along with an endorsement for consideration by the CDPHE in its Environmental Leadership Program.
- Reclamation and closure planning, design, implementation, reporting, and bonding are an integral part of modern mining in Colorado. The creation of stable land forms that are compatible with the surrounding land uses and environmental values are important objectives of the reclamation and closure activities.
- Responsible Colorado mining companies regularly reach out to local communities to address public concerns. The industry routinely provides information and education

about mining industry practices; the TRI reporting program is just another way the industry is able to do this.

- Responsible mining provides society with valuable metals and energy fuels necessary for everyday life. For example, coal is used to produce more than 72 per cent of the electricity generated in Colorado, and many precious metals are crucially important in the fields of medicine and health, electronics, communications equipment, safety devices, optics, aviation, security and other modern technologies.

**What will be reported?**

Colorado is home to mines producing coal, gold, silver and molybdenum. During the mining process, mining operations move hundreds of millions of pounds of rock to access the valuable mineral deposits. The industry must account for the reportable, naturally occurring metals found in the rock as well as other chemicals used in the process of removing the valuable minerals if certain thresholds are triggered.

The chemicals and compounds properly managed and reported by the Colorado mining industry include the following:

Arsenic	Lead
Barium	Manganese
Chromium	Mercury
Copper	Nickel
Cobalt	Nitrate
Cyanide Compounds	Vanadium
Dioxin	Selenium
Hydrogen Cyanide	Zinc

The materials containing these chemicals and compounds are all used, controlled and/or managed under federal, state and local permits and regulations designed to protect public health and the environment. Some of the chemicals and compounds occur in very small amounts and are totally (e.g., dioxin) or partially (e.g., mercury) attributable to the combustion of diesel fuel in various types of equipment (e.g., dump trucks, bulldozers, etc).

## **How are these materials managed?**

Reportable TRI “releases” represent emissions, discharges or transfers of materials containing listed chemicals and compounds to the land, water and/or air. It must be noted that while the Colorado mining industry will typically report large volumes, the materials and substances at mines are usually in very low concentrations. As such, there is minimal risk of exposure that would adversely affect human health or the environment. The following explains the ways in which the mining industry manages its reportable releases.

### **Air**

Trace amounts of TRI chemicals are created (e.g., dioxin) or liberated (e.g., mercury, lead, etc.) during the combustion of diesel or other fuel sources (e.g., used oil, propane, etc.). If the release exceeds 0.1 gram of dioxin, 10 pounds of mercury, or 100 pounds of lead on an annual basis, the respective thresholds are triggered and reporting is required under TRI. Heavy equipment, furnaces, heaters, boilers, generators and other stationary sources are also potential sources of combustion products that require reporting if TRI thresholds are exceeded. TRI chemicals or compounds in dust produced by a mining operation may also require reporting. The dust particles are controlled with suppressants and other effective measures to remain within safe limits and are monitored. Air emissions are monitored by the mine operators and regulated through permits issued by the Colorado Air Pollution Control Division to protect public health and the environment.

### **Water**

The mining industry must meet water quality standards established by the Colorado Water Quality Control Division before water can be released from a mining operation. These standards ensure that the water leaving the mine protects public health and the environment. Varying degrees of treatment and management practices are implemented to reduce constituent concentrations and assure that these levels are within prescribed limits. Many mining operations recycle water used in mineral preparation and processing and direct storm water around the active mine areas.

### **Land**

Most of the TRI chemicals and compounds reported by the mining industry originate from the movement of native rock or coal combustion products (coal ash) and remain on the mine site. These materials are safely managed, monitored and if necessary, treated. Carefully planned and executed engineering controls are implemented, including reclamation, to ensure that the public health and the environment are protected under permits issued by the Colorado Division of Minerals and Geology and, if on federal land, agencies such as the Bureau of Land Management and the U.S. Forest Service. Reclamation of disturbed lands is an integral component of modern mining operations.

**What purpose does the reporting serve?**

The reporting is designed to help communities identify the TRI chemicals and compounds “released” to air, water, and/or land at a regulated facility.

**What is a release?**

A “release” is any transfer, emission, or discharge of a listed chemical or compound to air, water, and/or land.

**What types of releases must be reported?**

Facilities are required to report all releases or transfers of listed materials and substances that exceed prescribed thresholds established by the EPA for air, water, and/or land. Under the reporting requirements, land releases include rock or other materials that are moved, deposited, or managed on site once thresholds are triggered.

**Why are there differences in the reported data from individual mines?**

As a result of the nature of mining, different mines will report different numbers. Whether a mining operation is being conducted on the surface or underground, the types of ore bodies being mined, and processing techniques being implemented are all factors that will result in different reported volumes.

**Are all mining operations required to report under the Program?**

No. Depending on the activity at the mine, some mines are not required to report. Inactive mines may not need to report because they do not trigger thresholds for the activities being conducted. Also, coal mines that use coal ash to enhance reclamation efforts are required to provide data on the reportable metals found in the coal ash, while coal mines not using coal ash have certain exemptions and are not required to report. Finally, the number of people employed at a mine, and the concentration levels of reportable substances affect whether or not a mine must report.

**What are the health risks posed to communities as a result of these releases?**

Mining operations are regulated so that both human health and the environment are protected. The reports on released substances do not address risk. Determination of risk depends on release and environmental conditions, which are monitored and managed by the mining industry. By and large, the Colorado mining industry reports large volumes of materials and substances, which are in very low concentrations with minimal, if any, risk to the public health or the environment.

**What does it mean to say that mines “manage” their releases?**

All of Colorado’s mines must obtain permits under federal, state and local laws and conduct their operations in compliance with these permits. Colorado’s mines apply technology effectively to protect human health and the environment and use monitoring systems to ensure that hydrologic and surface conditions are suitable for the safe and effective management of the materials and substances at the mines.

**What are waste rock and tailing?**

The bulk of materials reported are trace metals contained in the waste rock and tailing. Waste rock (also referred separately from the reporting program as “overburden”) is the unmineralized rock surrounding the ore body (which contains valuable minerals). During extraction of the ore body, waste rock is separated from the valuable ore material to be processed, and placed in engineered and managed areas that are reclaimed, often for continued wildlife use, after mining. During operations, tailing is comprised of a rock and water mixture that comes from the mining process that is placed in engineered containment facilities and which are designed and operated to be isolated from the surrounding environment. The tailing deposit is also reclaimed after cessation of mining.

**What are the mines doing with their used materials and substances?**

Colorado mines recycle their waste products to the greatest extent practicable. Materials like used oil and anti-freeze are recycled and most mines have implemented pollution prevention measures to reduce or eliminate hazardous wastes. Waste rock is moved so that the mineralized ore can be placed into engineered facilities that are graded concurrently with the on-going mining as a part of reclamation. Mill tailing is managed on site and monitored to ensure that reportable materials in the crushed rock are properly managed. More concentrated materials are stored in holding ponds, which are lined with clay or synthetic materials, and managed to prevent seepage into ground water. Still other materials used in the mining process are recycled until operations cease. The entire mine site is reclaimed and returned to a productive use after the mine closes.

**Does my community need to be concerned about used materials and substances?**

Everyone in their community should be interested in how used materials and substances are managed and the effective management practices in place at mine sites. All materials are subject to permit requirements set forth by the EPA, the Colorado Department of Public Health and Environment and the Colorado Division of Minerals and Geology. The mines welcome opportunities to answer any questions about their operations.

**Water is a big component of mining operations. Is there any chance that water can become contaminated by these materials?**

Mining operations are required under federal and state laws to obtain water quality permits for discharges. In Colorado, the water quality permit program is administered by the State's Water Quality Control Division and the Division of Minerals and Geology. Moreover, mines use monitoring wells to ensure compliance and recycling systems to capture, reuse and where necessary, treat water that may be impacted by their operations.

**How do used mining materials and substances affect Colorado wildlife?**

As required by state and federal laws, members of the Colorado mining industry are required to design and implement environmental protection measures that offer protection to fish and other wildlife. Many Colorado mines have returned previously mined land to prime wildlife habitat. Operating mine sites often become wildlife sanctuaries because of the excellent reclaimed habitats created and the protection afforded from hunting.

**Where can I find reliable sources of information on what is being reported?**

Ask the mining operations in your community. They fully disclose the metals and chemicals they report and are happy to answer any questions you may have. Additionally, the Colorado Department of Public Health and Environment and the Colorado Division of Minerals and Geology will also answer questions on reportable materials.

**Why is there such a large volume of materials being reported?**

Metal and specific coal mining operations are required to report the materials and substances used in the mining process, as well as, reporting the volume of metals that already exist naturally in rock if thresholds are triggered elsewhere in the operation. Again, the Colorado mining industry is expected to report large volumes of materials that are low in toxicity.

**Mining industry numbers are significant. Does this make the industry the worst “polluter” in the state?**

There is a misperception that those industries reporting the largest numbers are the top “polluters.” It is important to understand that mines move and handle massive volumes of rock and earth that have naturally occurring metal compounds. The materials present little health risk or potential impact on water, air or land.

**Can the mining industry reduce its releases?**

The mining industry has made significant environmental protection advancements over the years. However, advancements in mining technologies have not limited the amount of material that must be moved and handled to access the ore, or the fact that the mineral of value occurs as a very small fraction of the ore. Due to the nature of the mining process, there are fewer and fewer opportunities to reduce the volumes of rock moved by the mining industry. Mining companies have, since the enactment of the Emergency Planning and Community Right-to-Know Act, reduced the use of manufactured materials containing hazardous substances as part of their pollution prevention programs. Colorado’s mining companies will continue to develop and implement similar programs where feasible.

## **Industry Snapshot**

### **Production:**

**Coal** - Colorado coal is among the highest quality and cleanest burning in the country due to its low sulfur and high energy content. Given this low sulfur content, Colorado coal is preferred by utility companies because it helps them meet stringent air quality standards.

Coal is critical for generating electricity and is used to supply 72 percent of Colorado's electricity needs. Colorado's coal mines produced 36 million tons of clean burning coal in 2006.

**Gold** – Gold is used in dentistry, medicine and critical medical applications; jewelry and arts; in medallions and coins; sold as ingots for its value; for scientific, and electronic instruments, such as computers and as an electrolyte in the electroplating industry. Gold is also critical in the effective use of automotive airbags and as a radiation shield for the aerospace industry, to protect individuals, such as fire fighters, against heat, and in architecture. The major gold producer in Colorado is the Cripple Creek & Victor Gold Mining Company's Cresson Mine, which produces nearly 300,000 ounces of gold a year.

**Molybdenum** – Molybdenum is used in steel alloys; as a catalyst to remove sulfur from petroleum, a lubricant, as a corrosion inhibitor, as a pigment and as a flame and smoke suppressant. Molybdenum is also critical in the production of automotive airbags. The Henderson Mine near Empire, Colorado is the largest primary producer of molybdenum in the world, producing about 8.9 million tons of molybdenite in 2006.

**Copper** – Copper is used in electric cables and wires, switches, plumbing, heating, roofing and building construction; chemical and pharmaceutical machinery, alloys; alloy castings; and electroplated protective coatings and undercoats for nickel, chromium, etc. Copper is not produced in Colorado, but is found naturally in small amounts at many mine sites.

**Lead** – Lead is used in lead batteries, fuel tanks, solders, and bearings; electrical and electronic applications; TV tubes and glass, construction, communications and protective coatings; in soundproofing, and ammunition. The United States is the largest producer and consumer of lead metal. No lead mines are producing in Colorado today, but small amounts of lead are found naturally at most all mine sites.

**Zinc** – Zinc is used as a protective coating on steel, as a die casting, as an alloying metal with copper to make brass, and as chemical compounds in rubber and paints; as sheet zinc and for galvanizing iron; electroplating; metal spraying; automotive parts; electrical fuses; anodes; dry cell batteries; nutrition; chemicals; roof gutters; engravers' plates; cable wrappings; organ pipes, and pennies. No zinc is produced in Colorado today, but the metal is found naturally in many of Colorado's mineralized areas.

## **Industry Snapshot**

### **Economic Impacts:**

Colorado's modern mining industry extracts a wide variety of minerals from the earth, valued at more than \$2.5 billion. As an extension of the significant amount of minerals produced, Colorado also supports a thriving aggregates industry. In its 2006 report on the mineral resource industry, the Colorado Geological Survey reported that the mineral and mineral fuel industries produced materials valued at nearly \$3 billion.

When both the direct and indirect contributions of mining are considered, the value of mining's contribution climbs to nearly \$7.7 billion, according to a 1997 study conducted by the Western Economic Analysis Center. Additionally, the industry as a whole offers the highest paid positions of any industrial sector in rural areas.

### **Unique Facts About Colorado's Mining Industry:**

- Colorado is home to the largest molybdenum mine in the world, which produced 8.9 million tons molybdenite in 2006 with a direct value of more than \$900 million.
- Colorado coal producers mined 36 million tons of coal valued at \$884 million in 2006. Coal is the fuel used to generate 72 percent of the electricity consumed in Colorado.
- The most productive gold mine in Colorado's modern history produces nearly 300,000 ounces of gold annually.
- Colorado is home to the only commercial diamond mine to have been located in the United States since the turn of the century.
- The marble used in the construction of the Tomb of the Unknown Soldier came from a quarry in Colorado.
- Colorado's overall mineral production has a direct value of \$2.5 billion.

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## **Material Health Risk Profile**

The following Material Health Risk Profiles are compiled from EPA and industry studies, as well as, information available in EPA chemical databases.

### **BARIUM**

#### **What is barium?**

Barium is a silver-white metal that makes up 0.05% of the earth's crust. Small amounts of naturally occurring barium are present in food and drinking water.

#### **How is barium used?**

Barium is naturally present in coal that is mined and used to generate electricity. Trace amounts of barium compounds are present in the coal ash that results from this use. The coal ash is used to enhance reclamation at coal mines under the oversight of state and federal agencies. Barium compounds are also used in the manufacture of ceramics and as part of certain medical test procedures.

#### **Does the mining industry release barium into the environment?**

Very small amounts of barium remain in the coal ash generated from electricity production. The coal ash is used in managed and controlled environments to enhance reclamation efforts at coal mines.

#### **How could I be exposed to barium?**

Exposure to barium can occur in the following ways: food consumption, inhalation and direct skin contact (which is very rare). The amount of barium in food and water supplies poses little or no health concern. In fact, the human body requires a certain level of barium to maintain good health.

#### **What does the EPA say?**

Federal agencies regulate barium releases in order to protect the public health and the environment. The EPA has established a maximum level of 1.1 ppm of barium in drinking water. The EPA also has said that an average-sized adult exposed to 1.5 ppm of barium every day for 70 years will not experience adverse health effects.

## **Material Health Risk Profile**

### **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 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) and 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 and weathering processes.

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, and 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 the EPA say?**

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

## **Material Health Risk Profile**

### **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.

#### **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 weathering and natural erosion processes.

#### **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 sulfate, 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.

## Material Health Risk Profile

### 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. Cyanide occurs in at least 800 species of plants including apples, broccoli, brussels sprouts, cabbage, cauliflower, cherries, lima beans, radishes, almonds, and turnips. 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. Cyanide is used in the processing of pharmaceuticals, plastics, dyes, pigments, and in plating of various metals. It is also used to prevent caking and lumping of table salt and road salt.

The EPA reported in December 1985 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 wild 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 production of synthetics (e.g., nylon, pesticides, etc) and in other manufacturing processes (e.g., electroplating, pharmaceuticals, etc.).
- ◆ 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.

## Material Health Risk Profile

### CYANIDE (continued)

#### **How is cyanide used in other mining applications?**

Cyanide can also be used in ore-processing to suppress undesirable metals. Used in this way, a trace amount of cyanide is added to a large volume of crushed ore and water during ore-processing. In this type of application, the amount of cyanide solution added is small and reacts quickly so that it may not be detectable in the process after it has been added.

#### **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.

- ◆ 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 teratogenic.
- ◆ 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 on cyanide?**

- ◆ The Colorado Mining Association, 216 16th Street, Suite 1250, Denver, CO 80202
- ◆ 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
- ◆ *Cyanide Management Guideline*,  
1992, Western Australian Department of Minerals and Energy
- ◆ *Clinical and Experimental Toxicology of Cyanides*,  
B. Ballantyne and T. Marrs, 1987, Wright Publishers, Bristol, United Kingdom
- ◆ “Cyanide Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review”,

- R. Eisler, 1991, U.S. Fish and Wildlife Service, *Biological Reports* v. 85
- ◆ *Cyanide Management*, Environment Australia, 1998, a booklet in a series on Best Practice Environmental Management in Mining, Commonwealth of Australia
  - ◆ *Technical Guide for Environmental Management of Cyanide in Mining*, T.W. Higgs & Associates, 1992
  - ◆ *Mining Environmental Management Magazine*, June, 1995, Special Issue on Cyanide

## **Material Health Risk Profile**

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

#### **Where can lead be found?**

Automotive emissions produce lead that may settle 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.

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 and weathering processes. 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 humans' 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).

#### **What does the EPA say?**

The 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.

## **Material Health Risk Profile**

### **MANGANESE**

#### **What is manganese?**

Manganese is a silver-colored metal. In nature, it is combined 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 can be released into the environment as dust by moving these materials as well as by natural erosion and weathering processes.

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

#### **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 the body regulates most of it.

#### **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.

## **Material Health Risk Profile**

### **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 and 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 the EPA say?**

Based on the EPA's 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.

## **Material Health Risk Profile**

### **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
  
- ◆ 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 part of the rock “matrix” that is excavated, moved, and ultimately placed on the land during the mining process. It is this movement and placement of native rock that represents the majority of the reported zinc “releases” by the mining industry.

#### **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.

## **Material Health Risk Profile**

### **NITRATE (aqueous solution)**

#### **What is nitrate?**

Nitrate is a compound of nitrogen and oxygen, two of the most common elements in the earth's atmosphere and crust. It is produced as the end product of the oxidation of organic nitrogen, and to a lesser extent through the introduction of nitrogen fertilizer and the degradation of industrial chemicals. It is a common constituent in domestic sewage treatment systems, as well as of other biological decay processes. It is a component of fertilizer and it is used as a compound (*e.g.*, nitric acid) in many industries.

#### **How is nitrate formed in mining applications?**

Nitrate is a component of the fertilizer that may be mixed with diesel fuel and employed with a detonating device for blasting both ore and overburden at mines. However, very little of this nitrate is in the aqueous phase. It is more likely that the nitrate is formed from the dissociation of a chemical used in the beneficiation process, such as cyanide. This dissociation happens principally when the cyanide is being broken into its component parts through oxidation and biological action as part of reclamation. If fertilizers are used to assist in the regrowth of vegetation, small amounts of nitrate will be applied to the soils undergoing reclamation.

#### **How could nitrate affect me?**

Nitrate may be produced at mines in very low concentrations in water, typically less than 10 mg/l (as nitrogen), which is the drinking water criterion (a criterion designed especially to protect infants against the potential formation of methemoglobin). At higher concentrations, water with nitrate can be used for other purposes, such as supplemental irrigation, which makes use of the nitrate as a fertilizer.

Nitrate is a normal component of the human diet. Over 85% of the intake comes from the natural nitrate content of vegetables such as beets, celery, lettuce, and spinach.

Mines where nitrate can be produced in the aqueous environment will usually monitor water for this constituent.

# *toxics release inventory*

## **Chemical Profile**

*Environment*

*Science & Technology Development*

*Arsenic*

### **What is arsenic?**

Arsenic (As) is a gray, brittle, semi-metal that tarnishes in air. It is a natural component of the earth's crust and occurs in small amounts in bodies of water, underwater sediments, and soils. It is commonly found in combination with sulfur and iron in minerals such as pyrite. Arsenic is used mainly to preserve wood and to control insects and weeds.

### **How is arsenic released by electric utilities?**

Trace amounts of arsenic are present in coal and oil. When electric utilities burn these fuels at their power plants, arsenic is released in very small amounts. Calcium arsenate is likely to be the arsenic compound most frequently released. Most of this arsenic is carried by particles of ash. It is mainly on the surface of the particles. Coal-burning power plants are equipped with devices to capture ash particles before they reach the air. Particle control services typically capture more than 99% of the ash, so very little ash enters the air. Arsenic-carrying ash captured by these devices is usually sent to ash ponds or land disposal sites. Power plants reporting to the U.S. Environmental Protection Agency (EPA) released 3,440 tons of arsenic into the environment in 1998. This was about 1% of all the arsenic released by industries reporting to EPA that year.

### **Is arsenic also released by other sources?**

Natural arsenic occurs commonly and comes mainly from the soil. Estimates are that the amount of natural arsenic released into the air as dust from the soil is about equal to the amount of arsenic released by all human activities. An estimated 75% of all arsenic released by human activities comes from metal production, such as copper smelting. Industries reporting to EPA released 304,320 tons of arsenic into the environment in 1998. Most was released to the land.

### **What happens to arsenic after it is released by electric utilities?**

Ash particles carrying arsenic settle to the ground after they are released into the air from power plants. Arsenic compounds that dissolve in water are carried to the ground by rain and snow. Other arsenic compounds that don't dissolve reach the ground through gravity and air turbulence. Ash pond wastewater discharged into public waterways may contain small amounts of dissolved arsenic, but local permits regulate these amounts.

### **How might people be exposed to arsenic?**

Arsenic is common in the environment and people are exposed to small amounts of arsenic in their diet—for example, by eating shellfish. They may breathe smoke or particles from wood

containing arsenic preservatives, and workers may breathe airborne arsenic on the job if they fail to wear protective masks.

### **What are the potential effects of arsenic on human health?**

Very small amounts of arsenic in people's diets may be necessary for good health. But the kind of arsenic in the diet is important. Organic arsenic compounds (those containing carbon) are much less toxic than inorganic arsenic compounds (those containing no carbon). For example, eating organic arsenic compounds that accumulate in fish and shellfish is unlikely to harm human health. Eating or drinking large amounts of inorganic arsenic can be toxic, even fatal. Exposure to large amounts of inorganic arsenic can cause stillbirths and birth defects, and can damage blood vessels, skin, nerves, and the heart. According to EPA and the U.S. Department of Health and Human Services, inorganic arsenic—even in very small amounts—is a cancer-causing agent. For example, eating or drinking inorganic arsenic may increase the risk of skin cancer and tumors of the bladder, kidney, liver, and lung. Breathing inorganic arsenic may increase the risk of lung cancer, according to studies of workers exposed to dust from copper-smelter operations.

Copper-smelter dust may irritate the lungs. This irritation may be one of the critical reasons why copper-smelter workers appear to have an increased risk of lung cancer. Lung irritation appears less likely from breathing power plant ash because it contains a less-toxic form of inorganic arsenic.

### **How likely is it that utility releases pose a risk to human health?**

It is unlikely that arsenic from power plants poses a significant risk to human health. EPA has evaluated the potential health risks of breathing arsenic for people who live near power plants that burn coal and oil. EPA estimates that a person living all his life near one of these plants would have one chance in a million (or less) of developing cancer as a result of his exposure to power plant arsenic. According to EPA, only four plants out of nearly 600 in the United States posed cancer risks from arsenic exposure just slightly greater than these. Researchers are investigating several important issues about the possible health effects of arsenic in power plant ash. One issue is which form of inorganic arsenic to use in estimating health effects. Inorganic arsenic produced by copper smelting is about ten times more toxic than inorganic arsenic in power plant ash. By basing its current estimate of arsenic health effects on the more toxic form of inorganic arsenic in copper-smelter dust, EPA has set a standard that may be much more conservative than needed to protect human health in the community. Also, EPA may have substantially overestimated the ability of arsenic to cause cancer when people breathe it. Although research is underway on these issues, we don't have all the answers yet.

### **How is arsenic regulated?**

EPA regulates public exposure to arsenic in drinking water and has published an estimate of the cancer risks related to drinking different amounts of arsenic. EPA also has published water quality standards to protect freshwater life, such as fish, from exposure to inorganic arsenic. Under the National Pollutant Discharge Elimination System, federal and state regulators determine how much arsenic each power plant may release in wastewater discharges. The Occupational Safety and Health Administration has set limits on the amount of arsenic in workplace air.

**Where can I get more information about arsenic?**

The Agency for Toxic Substances and Disease Registry (ATSDR) has a fact sheet with answers to frequently asked health questions about arsenic. It is available through the ATSDR Information Center at 1-800-447-1544 or on the Internet-<http://www.atsdr.cdc.gov/tfacts2.html>. EPA also has a fact sheet that is available on the Internet at <http://www.epa.gov/ttnatw01/hlthef/arsenic.html>

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# *toxics release inventory*

## **Chemical Profile**

*Environment*

*Science & Technology Development*

*Cobalt*

### **What is cobalt?**

Cobalt (Co) is a shiny gray metal that is hard and magnetic. In nature, it usually combines with other elements to form cobalt compounds. Small amounts of these compounds are naturally present in soils, rocks, and water. Cobalt combines with other metals to form mixtures called alloys. Some of these are “superalloys” that maintain their strength at very high temperatures. For example, a superalloy of cobalt and steel is used in manufacturing jet engines. Cobalt is also used in paint and porcelain enamel finishes as a drying agent, in wear-resistant cutting and grinding tools, in electronic components that rely on its magnetic properties, and in formulating vitamin B12. Physicians implant artificial hip and knee joints made of cobalt alloys and use man-made isotopes of cobalt for radiation therapy.

### **How is cobalt released by electric utilities?**

Trace amounts of cobalt are present in coal and oil. When electric utilities burn these fuels at their power plants, cobalt is released. Most of this cobalt is carried by particles of ash. Coal-burning power plants are equipped with devices to capture ash particles before they reach the air. Particle control devices typically capture more than 99% of the ash, so very little ash enters the air. Cobalt-carrying ash captured by these devices is usually sent to ash ponds or land disposal sites.

Power plants reporting to the U.S. Environmental Protection Agency (EPA) released 2,096 tons of cobalt into the environment in 1998. This was about 29% of all the cobalt released by industries reporting to EPA that year.

### **Is cobalt also released by other sources?**

Cobalt is released into the air by soils as they erode in wind and rain, by volcanoes when they erupt, and by forest fires and seawater evaporation. Cobalt released by human activities comes mainly from nickel, copper, silver, lead, and iron mines and refineries; metal production facilities; industrial boilers that burn coal and oil; vehicles that burn gasoline; and incinerators that burn refuse and sewage sludge. Industries reporting to EPA released 7,336 tons of cobalt into the environment in 1998. Most was released to the land.

### **What happens to cobalt after it is released by electric utilities?**

Ash particles carrying cobalt settle to the ground after they are released into the air from power plants. Cobalt compounds that dissolve in water are carried to the ground by rain and snow. Other cobalt compounds that don't dissolve reach the ground through gravity and air turbulence.

Cobalt may stay in water and soil for years. Ash pond wastewater discharged into public waterways may contain small amounts of cobalt, but these amounts are regulated by local permits.

**How might people be exposed to cobalt?**

People are commonly exposed to small amounts of cobalt naturally present in the air they breathe, the water they drink, and the foods they eat. For example, leafy green vegetables are a natural source of cobalt in people's diets. Industrial workers may breathe cobalt dust or fumes, or touch substances that contain cobalt.

**What are the potential effects of cobalt on human health?**

Very small amounts of cobalt in people's diets are necessary for good health. These amounts can be supplied by vitamin B12, a compound that contains cobalt. Cobalt also benefits health when it is used to stimulate red blood cell production in the treatment of anemia. However, some people exposed to small amounts of cobalt for a long time develop an allergic reaction to it. The most common reaction is itching when cobalt contacts their skin. In less common, severe cases, people experience vomiting when they swallow cobalt or asthma attacks when they breathe it. People who are not allergic have health problems only when they are exposed to very large amounts of cobalt not normally found in the environment. For example, some breweries used to add cobalt to beer to stabilize the foam. Drinking large quantities of this beer caused serious heart problems, and the practice of adding cobalt has been discontinued. Breathing large amounts of cobalt for a long time may cause asthma, pneumonia, liver and kidney damage, and thyroid problems. Although research is ongoing, cobalt has not been found to cause cancer in people.

**How likely is it that utility releases pose a risk to human health?**

It is unlikely that cobalt from power plants poses a significant risk to human health. EPA has evaluated the potential health risks of breathing cobalt for people who live near power plants that burn coal or oil. In EPA's initial screening assessment, these risks were so low that the Agency eliminated utility cobalt from further analysis as an inhalation health hazard. Since airborne ash particles carrying cobalt are widely scattered before they settle to the ground, it is unlikely that ash from power plants significantly increases the amount of cobalt in soil, water, or food.

**How is cobalt regulated?**

EPA requires that 1000 pounds or more of cobalt be reported if it is spilled or released without a permit. Under the National Pollutant Discharge Elimination System, federal and state regulators determine how much cobalt each power plant may release in waste-water discharges. The Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health have set limits on the amount of cobalt in workplace air. The Nuclear Regulatory Commission regulates radioactive isotopes of cobalt.

**Where can I get more information about cobalt?**

The Agency for Toxic Substances and Disease Registry (ATSDR) has a fact sheet with answers to frequently asked health questions about cobalt. It is available through the ATSDR Information Center at 1-800-447-1544, or on the Internet at <http://www.atsdr.cdc.gov/tfacts33.html>. EPA

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# *toxics release inventory*

## **Chemical Profile**

*Environment*

*Science & Technology Development*

*Dioxins*

### **What are dioxins?**

Dioxins are colorless, odorless solids. They are part of a family of 210 organic compounds that contain carbon, oxygen, and hydrogen arranged in a unique chemical structure. Replacing hydrogen with chlorine in certain positions in that structure creates 17 compounds that the U.S. Environmental Protection Agency (EPA) considers harmful to human health. They include polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs). EPA calls this group dioxins or dioxin-like compounds. Dioxins are unwanted by-products of natural events and human activities. Very tiny amounts of dioxins are present in soils, plants, underwater sediments, water, and air. They have no useful commercial function.

### **How are dioxins released by electric utilities?**

Although no one knows exactly how dioxins form when power plants burn fuel, the following process seems most likely. Trace amounts of chlorine are present in coal and oil. When electric utilities burn these fuels in their power plants, chlorine is released. Some of this chlorine takes the place of hydrogen in specific organic compounds to create very small amounts of dioxin vapor. These amounts are so small that only highly specialized sampling and analysis can measure them. As dioxin vapor cools, it forms thin films on tiny ash particles. Coal-burning power plants are equipped with devices to capture ash particles before they reach the air. Particle control devices typically capture more than 99% of the ash, so very little ash enters the air. Ash captured by these devices is usually sent to ash ponds and land disposal sites. Dioxins from power plants were about 2-3% of all dioxins from human activities released into the air in the United States in 1995.

### **Are dioxins also released by other sources?**

Dioxins are released into the air by soils as they erode in wind and rain, by volcanoes when they erupt, and by forest fires. These natural releases are smaller than those from human activities. Dioxins released by human activities come mainly from incinerators that burn refuse, sewage sludge, and medical waste; backyard trash burners; landfills experiencing accidental fires; copper smelters; cement kilns; pulp and paper mills that use chlorine bleach; vehicle exhaust pipes; and wood-burning stoves and fireplaces. Dioxin releases from human activities in the United States peaked in the 1970s and have since declined about 80%. According to EPA, changes responsible for this decline include eliminating most open burning of solid wastes, installing particle control devices on combustion burners, phasing out leaded gasoline, and banning or restricting the use of chemicals that contain dioxins.

### **What happens to dioxins after they are released by electric utilities?**

Some ash particles carrying dioxins settle to the ground through gravity and air turbulence relatively near their source. Other particles travel further into the atmosphere, where they may remain for months. Eventually, these particles return to earth where they fall on soil and growing plants, and into bodies of water. Dioxins may remain in soil and underwater sediments for years. They build up in fish and in the fatty flesh of animals that eat plants, but not in the plants themselves. Ash pond wastewater discharged into public waterways may contain very tiny amounts of dioxins. Dioxins are noted on local discharge permits.

### **How might people be exposed to dioxins?**

People are commonly exposed to very tiny amounts of dioxins present in the air they breathe, the water they drink, and the foods they eat. For example, nursing infants are exposed to very tiny amounts of dioxins in their mothers' milk. However, people who eat large amounts of meat and dairy products that are high in fat, or large amounts of fish that have accumulated dioxins in their body fat, may have greater exposure. EPA estimates that 95% of exposure to dioxins comes from eating animal fats. Because fewer dioxins are being released into the environment and people are eating less animal fat, the amount of dioxin measured in their bodies is decreasing. Those who smoke may inhale dioxins found in tobacco, and industrial workers may breathe dioxins or touch substances that contain them. For example, an accidental explosion at a chemical plant in Seveso, Italy in 1976 contaminated the surrounding environment and exposed workers and local citizens to large amounts of dioxins. Military personnel in Vietnam were exposed to dioxins while using the herbicide, Agent Orange. Products known to contain dioxins, such as the pesticide 2,4,5-T and PCB dielectric fluids, are no longer sold.

### **What are the potential effects of dioxins on human health?**

Dioxins are considered to be very toxic substances. People exposed to large amounts of dioxins experience a skin disease called chloracne. Some studies have shown that high exposures also may contribute to the development of liver, kidney, heart, thyroid, and blood disorders, as well as adult onset diabetes and cancer. Eating the very tiny amounts of dioxins commonly present in food apparently does not make people sick. However, because dioxins build up in the human body, researchers are studying ways in which they might affect health over time—perhaps by altering normal reproduction, development, and immunity to disease. Laboratory animals develop liver cancer when they eat food containing 2,3,7,8-TCDD, the most toxic form of dioxin. Based on animal and human studies, EPA has classified 2,3,7,8-TCDD as a “human carcinogen” and other dioxins as “likely human carcinogens.”

### **How likely is it that utility releases pose a risk to human health?**

It is unlikely that dioxins from power plants pose a significant risk to human health. EPA has evaluated the potential cancer risk of exposure to dioxins from power plants. To do this, EPA modeled 16 different theoretical risk scenarios. In the highest risk scenario, adults lived near a large coal-fired power plant and relied on locally caught fish for much of their food. If 10,000 of these adults stayed in the same location and ate fish every day of their lives, 2 occurrences of cancer among them would be due to power plant dioxins. In the lowest risk scenario, children lived near a large oil-fired power plant and ate a typical American diet. If 1 billion of these children stayed in the same location all their lives, 1 occurrence of cancer among them would be due to power plant dioxins. EPA has not yet developed a method for evaluating non-cancer

health risks from exposure to dioxins. Since airborne ash particles carrying dioxins are widely scattered before they settle to the ground, it is unlikely that ash from power plants significantly increases the amount of dioxins in soil, water, or food.

**How are dioxins regulated?**

EPA has established limits for dioxins in drinking water. The Agency requires that 1 pound or more of 2,3,7,8-TCDD be reported if it is spilled or released without a permit. EPA regulates dioxins released into the air by waste incineration (including hazardous waste burning), dioxins released into wastewater from pulp and paper manufacturing, and dioxins applied to the land in wastes used as fertilizers or soil amendments. EPA also regulates the manufacture and use of products contaminated with dioxins. The Food and Drug Administration has set a “safe level” for dioxins in fish that will be eaten. The Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health recommend reducing workplace exposure to dioxins to the lowest feasible level.

**Where can I get more information about dioxins?**

Those interested in detailed information about dioxins from power plants may read EPA’s 1998 Final Report to Congress, Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units. This report is available on the Internet at <http://www.epa.gov/ttn/oarpg/t3rc.html>

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# *toxics release inventory*

## **Chemical Profile**

*Environment*

*Science & Technology Development*

*Mercury*

### **What is mercury?**

Mercury (Hg) is a silver-colored metal that is liquid at room temperature. It commonly occurs in water and soil. Mercury is the familiar silver column in thermometers. It is also used in fluorescent lights, some kinds of batteries, and dental fillings.

### **How is mercury released by electric utilities?**

Trace amounts of mercury are present in coal and oil. When electric utilities burn these fuels at their power plants, mercury is released. Most of this is mercury gas. Power plants pass stack gases through pollution control devices that may remove mercury before it enters the air. Wastes captured by these devices are usually sent to ash ponds or land disposal sites. Power plants reporting to the U.S. Environmental Protection Agency (EPA) released no mercury above the reporting threshold in 1998. After declaring mercury to be a “persistent bioaccumulative toxic” substance, EPA lowered its reporting threshold for 1999. According to this more sensitive measure, coal-burning power plants reporting to EPA released 45 tons of mercury into the air in 1999. Compared with the 52 tons EPA estimated in 1994, this shows that power plants are releasing less mercury into the air today. Mercury from U.S. power plants is about one-third of all the mercury released into the air by human activities in the United States, and is less than 1% of all the mercury released into the air each year around the globe.

### **Is mercury also released by other sources?**

Natural sources around the globe—such as ocean surfaces, mercury-rich soils, and volcanoes—release about 58% of all the mercury entering the air each year. In the past, people released large amounts of mercury by manufacturing pesticides and chlorine-based industrial products, and by mining. Today, people release mercury mainly by burning coal, and wastes from cities and hospitals. Mercury releases from human activities in the United States peaked about 1960 and are now declining. Industries reporting to EPA released 4,681 tons of mercury into the environment in 1998. Most was released to the land.

### **What happens to mercury after it is released by electric utilities?**

Mercury released by power plants becomes part of a global cycle. The behavior of mercury in this global cycle depends on its chemical form. Oxidized mercury easily washes out of the air and returns to earth relatively near its source. In contrast, elemental mercury usually travels further into the atmosphere, where it may remain for months. Eventually, this “background” mercury returns to earth and enters bodies of water and soils. Estimates are that about one-third of the mercury reaching the earth binds to the soil. As part of a broad investigation of how mercury behaves, researchers are studying how much mercury from power plants enters the

atmosphere and how much returns to earth close to the plants that release it. They estimate that about half the mercury from power plants is elemental mercury that enters the atmosphere and eventually settles to earth at points around the globe. Once mercury reaches the earth, it can enter natural ecosystems. For example, oxidized mercury can enter lakes and streams where bacteria may chemically change it to methylmercury, the organic form of mercury most easily taken up by fish and animals.

**How might people be exposed to mercury?**

People are most often exposed to methylmercury when they eat fish or shellfish. Because fish may accumulate methylmercury in their bodies, older predatory fish usually have the most methylmercury. People may also breathe elemental mercury from industrial sources or broken thermometers.

**What are the potential effects of mercury on human health?**

Because the body can naturally eliminate mercury, occasional exposure to relatively small amounts of mercury is believed to have no effect on human health. Exposure to large amounts of mercury—either from eating methylmercury or breathing elemental mercury—can cause kidney, brain, and nerve damage or even death. It can also affect the unborn babies of pregnant women. Our knowledge of how large amounts of methylmercury can affect people's health comes from two accidental poisoning incidents—one in Japan in the 1950s and another in Iraq in the 1970s—where people ate massive amounts of methylmercury. In Iraq, researchers observed that it took less methylmercury to affect babies developing in the womb than to affect adults. For this reason, it is a public health goal to limit methylmercury exposure especially for women of childbearing age. Methylmercury apparently does not cause cancer, based on long-term observations of the people exposed in Japan and Iraq.

**How likely is it that utility releases pose a risk to human health?**

Health risks from power plants depend largely on how much those plants influence the amount of methylmercury in fish that people eat. It is unlikely that U.S. power plants have a measurable effect on the amount of methylmercury in ocean fish living far from our shores. Nor do they impact fish raised on commercial diets at fish farms. These kinds of fish account for about 90% of the U.S. seafood diet. However, mercury releases from U.S. power plants may influence the amount of methylmercury in freshwater fish living in some U.S. lakes and streams. In several case studies sponsored by EPRI, independent researchers found that the amount of methylmercury in lake fish that might come from nearby power plants was well below the amount that EPA says people may take into their bodies without harming their health. For an average person who weighs about 150 pounds, the amount that EPA currently considers safe is up to 7 micrograms of methylmercury each day—about one fish meal a week, if the fish contain average amounts of methylmercury. In 1997, an office of the U.S. Public Health Service proposed that people could safely take in 5 times as much methylmercury, up to 35 micrograms each day—almost one fish meal every day. This government agency based its proposal on new studies of the way methylmercury affects children born to mothers who ate seafood containing it when they were pregnant. Although these levels are set by the government to protect the health of its most sensitive residents, average consumers in the United States need not be concerned with exposure to methylmercury.

### **How is mercury regulated?**

At freshwater lakes and rivers known to be contaminated with mercury, many states post “fish advisories” telling fishermen how many and which kinds of fish their families can safely eat. These advisories are aimed especially at protecting pregnant women and small children from harmful exposure to methylmercury, and are based on limits established by FDA or by the states. EPA regulates public exposure to mercury in drinking water and has published water quality standards to protect freshwater life, including fish, from exposure to mercury. EPA also requires that 1 pound or more of mercury be reported if it is spilled or released without a permit. The Occupational Safety and Health Administration has a limit for mercury in workplace air.

### **Where can I get more information about mercury?**

The Agency for Toxic Substances and Disease Registry (ATSDR) has a fact sheet with answers to frequently asked health questions about mercury. It is available through the ATSDR Information Center at 1-800-447-1544, or on the Internet <http://www.atsdr.cdc.gov/tfacts46.html>. EPA also has a fact sheet that is available on the Internet at <http://www.epa.gov/ttnatw01/hlthef/mercury.html>. Those interested in detailed information about mercury may read the *Mercury Study Report to Congress*, EPA-452/R-97-003, December 1997. This report, published by the EPA Office of Air Quality Planning and Standards and Office of Research and Development, is available on the Internet at <http://www.epa.gov/ttnatw01/112nmerc/mercury.html>

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## **Chemical Profile**

*Environment*

*Science & Technology Development*

*Vanadium*

### **What is vanadium?**

Vanadium (V) is a silvery-white metal that is easily molded. In nature, vanadium combines with other elements to form vanadium compounds. Small amounts of vanadium are naturally present in rocks, soils, water, and some deposits of iron ore and crude oil. Vanadium combines with other metals to form mixtures called alloys. For example, an alloy of vanadium and steel is unusually strong and resistant to heat and corrosion. Vanadium steel is used in engine and auto parts, springs, ball bearings, and high-speed tools. Vanadium compounds are used in ceramics, plastics, rubber, dyes, and as chemical catalysts.

### **How is vanadium released by electric utilities?**

Trace amounts of vanadium are present in oil and coal. When electric utilities burn these fuels at their power plants, vanadium is released. Most of this vanadium is carried by particles of ash. Coal-burning power plants are equipped with devices to capture ash particles before they reach the air. Particle control devices typically capture more than 99% of the ash, so very little ash enters the air. Vanadium-carrying ash captured by these devices is usually sent to ash ponds or land disposal sites. Power plants reporting to the U.S. Environmental Protection Agency (EPA) released 290 tons of vanadium into the environment in 1998. This was about 59% of all the vanadium released by industries reporting to EPA that year.

### **Is vanadium also released by other sources?**

Vanadium is released into the air by soils as they erode in wind and rain. It is released into water and soil by eroding rocks and ores. Vanadium released into the environment by human activities comes mainly from industrial boilers that burn oil or coal, chemical manufacturing plants, metal production facilities, and petroleum refineries. Industries reporting to EPA released 493 tons of vanadium into the environment in 1998. Most was released to the land.

### **What happens to vanadium after it is released by electric utilities?**

Ash particles carrying vanadium settle to the ground after they are released into the air from power plants. Most vanadium reaches the ground through gravity and air turbulence. Only small amounts of vanadium dissolve in water and it does not seem to build up in the flesh of fish.

### **How might people be exposed to vanadium?**

People are commonly exposed to small amounts of vanadium naturally present in the air they breathe, the water they drink, and the foods they eat. For example, cereals are a natural source of vanadium in people's diets. Industrial workers may breathe vanadium dust or fumes.

**What are the potential effects of vanadium on human health?**

Breathing large amounts of vanadium can irritate the throat, lungs, and eyes, and long-term exposure can cause bronchitis. The body does not absorb vanadium easily through the digestive tract or skin. Thus, eating, drinking, or touching vanadium is unlikely to cause health problems. There are no studies of cancer in people exposed to vanadium.

**How likely is it that utility releases pose a risk to human health?**

It is unlikely that vanadium from power plants poses a significant risk to human health. EPA has not evaluated the potential health risks of breathing vanadium for people who live near power plants that burn oil or coal. Preliminary estimates from plants preparing to report vanadium releases to EPA indicate amounts of vanadium that are unlikely to cause significant health effects.

Since airborne ash particles carrying vanadium are widely scattered before they settle to the ground, it is unlikely that ash from power plants significantly increases the amount of vanadium in soil, water, or food.

**How is vanadium regulated?**

EPA requires that 1000 pounds or more of vanadium be reported if it is spilled or released without a permit. The National Institute for Occupational Safety and Health has set limits on the amount of vanadium in workplace air. The Occupational Safety and Health Administration has set limits on the amount of vanadium pentoxide in workplace air.

**Where can I get more information about vanadium?**

The Agency for Toxic Substances and Disease Registry (ATSDR) has a fact sheet with answers to frequently asked health questions about vanadium. It is available through the ATSDR Information Center at 1-8000-447-1544 or on the Internet <http://www.atsdr.cdc.gov/tfacts58.html>

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