Health Consultation

Yankee Doodle Tailings Pond

Butte, MT

June 25, 2001

U. S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Background

The Montana Department of Environmental Quality asked the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate whether materials present at an inactive mineral processing facility pose an immediate public health threat.

The Montana Department of Environmental Quality has received a significant number of complaints since 5/5/01 about blowing tailings from Montana Resource's Yankee Doodle Tailings Pond. The department has documented violations of visible emission limits at the site and has determined that Montana Resources has been in violation of permit conditions and rule requirements pertaining to control of dust from the site.

Based on our answers to the following questions to our agency this report advises analysis of airborne silica within the next 4 months.

Question 1: Do airborne particulate metals present a health hazard for the community?
Question 2: Does airborne silica present a health hazard for the community?
Question 3: What additional precautions/sampling should be taken to protect public health?

Site History/Issues:

Montana Resources, a mining company, produces metal tailings as a by-product of its mining operations. The tailings are the finely ground waste rock from the ore concentration process. During normal operations, the tailings are pumped as a slurry up to the tailings impoundment area. The tailings slurry is discharged along the south end of the impoundment and flows north across the exposed tailings surface. The northern portion of the impoundment is a water surface. Historically, tailings have blown infrequently from the facility; however, persistent high winds and the lack of rainfall over the past few weeks have exacerbated the situation. The problem is worse while operations are curtailed and there are no new tailings and water being pumped to the impoundment.

The company did take an interim control measure of spreading lime over some of the surface prior to their curtailment in the summer of 2000. Following a significant wind erosion event in September 2000, the Montana Department of Environmental Quality issued a violation letter to Montana Resources for failure to maintain adequate dust control at the site. Subsequently, the company prepared a report detailing control measures and combinations of control measures which could be used to stabilize the surface. These include vegetative cover, water sprinkling, chemical stabilization, and covering the tailings with alluvium or rock. Some of these measures could require the use of helicopters or airplanes. The company started implementing a vegetative cover plan which includes seeding, fertilizing and installing a water sprinkler system on a portion

of the tailings surface. The sprinkler system was activated in the last week of May 2001. As an immediate short-term measure the company is also trying to pump more water to the tailings surface and is investigating the availability of aerial application of water or chemical stabilizers. The company also plans to cover selected tailings areas with alluvium.

The Montana Department of Environmental Quality plans to proceed with an enforcement action relative to the identified non-compliance situation. The purpose of the enforcement action is to continue to work with the company to resolve the dust problem, but to also have a mechanism in place to proceed with an order to the company to take corrective action if necessary and evaluate the need for non-compliance penalties. A state ambient monitoring site, which is operated by the Butte-Silver Bow Health Department, is located at the Greeley School. Particulate Matter (PM-10) less than 10 microns [μm] in diameter) is monitored continuously and PM-2.5 (less than 2.5 μm) is monitored at 3-day intervals (24 hour samples. The location of this site provides a good analysis of population exposure from the mine. The highest 24-hour PM-10 concentration recorded in May was 73 micrograms per cubic meter ($\mu g/m^3$) on May 20, 2001, which is well below the federal and state standard of 150 $\mu g/m^3$. The second highest was 43 $\mu g/m^3$ on May 5.

Peak 1-hr PM-10 concentrations were reported to be as high as 413 $\mu g/m^3$ on May 20. The second highest was 177 $\mu g/m^3$ was also on May 5, when the average 24-hr concentration was 73 $\mu g/m^3$.

The metals content of the airborne tailings material is a related concern not directly addressed through the PM-10 standard. Whole rock analyses of the tailings performed over the last several years has shown the following average values:

- Arsenic < 50 parts per million (ppm)
- Cadmium < 5 ppm
- Lead ~ 75 ppm
- Zinc ~ 200 ppm

There are no defined acceptable levels to compare these to as it relates to wind erosion, but in general these levels are elevated in comparison to particulate generated from "normal" surface materials but are relatively low compared to materials at other mining operations including the historic Berkeley Pit tailings.

Another related concern is the silica content in the tailings materials. Although actual silica (specifically, quartz) were not measured in the airborne dust, silica data was provided on the respirable fraction of the tailings. This data includes the percentage of the <5 μm and the <10 μm respirable fractions.

Size fraction of silica by weight	
<5 µm	<10 µm
0.050	0.099
0.005	0.016
0.082	**0.175**
0.046	0.123
0.076	0.154

The water sprinkler system previously mentioned consists of about 4,000 feet of mainline and 8,000 feet of lateral lines. Excessive emissions were observed from May 28 to May 31, 2001. On May 29, an additional 12,000 feet of laterals for the initial system and for a second system 4,000 feet of mainline are needed. An unspecified amount of lateral line were ordered. These additions should be operational in the first week of June.

On May 31, the company began applying Coherex™ (a petroleum resin based surface stabilizer) to tailings surfaces and spreading waste rock over the tailings along the embankment. Acreages of these cover applications will be compiled over time.

Discussion

1) Because the site is not accessible to local residents and the nearest homes are a ½ mile away, exposure to wind blown dusts from the tailings pond is generally low and sporadic (i.e., they will occur only when the wind is blowing in a certain direction).

2) According to the limited data available to the STRIKE team, the highest 24-hour average concentration of PM-10 recorded in May at Greeley School (73 µg/m^3) was well below the federal and state standard of 150 µg/m^3; the next highest (43 µg/m^3) was even below the 50 µg/m^3 standard for the *annual* arithmetic mean concentration. Peak 1-hour concentrations above 400 µg/m^3 are likely when the daily average is 73 µg/m^3. There is no health standard for peak 1-hour concentrations, but there is a 3000 µg/m^{3}standard to protect workers from 8-hour average exposures. ATSDR has used this worker standard to derive a value of 300 µg/m^3 which is protective of residents' 8-hour exposures. Since the two highest hours on record have concentrations that average 295 µg/m^3 (2-hour average), the likelihood that 8-hr concentrations exceed 300 µg/m^3 is remote. Based on these limited data, PM-10 levels are not a public health concern for healthy populations.

3) Assuming (a) the unlikely possibility that all of the dust included in the PM-10 measurements was from the tailings pond, and (b) the chemical composition of that dust is the same as that determined in whole rock analyses, a worst case scenario emerges. If these assumptions were true, a peak exposure to 73 µg/m^3 of PM-10 dust particles could result in exposure to <0.00365 µg/m^3 arsenic (CREG = 0.0002 µg/m^3), <0.000365 µg/m^3 cadmium (Cancer Risks Evaluation Guide (CREG)= 0.0006 µg/m^3), 0.005475 µg/m^3 lead (primary standard = 1.5 µg/m^3 quarterly average), and 0.0146 µg/m^3 zinc (RBC = 1100 µg/m^3). Based on these limited data, peak acute exposures to cadmium, lead, and zinc during the month of May were actually lower than standards and comparison values for chronic, long-term exposure, by 2-5 orders of magnitude in the cases of lead and zinc.

4) The maximum estimated 24-hour level of tailings-associated arsenic in air (<0.00365 $\mu g/m^3$) is at least 190 times lower than the lowest and most speculative inhalation Lowest Observed Adverse Effect Level (LOAEL [0.7 $\mu g/m^3$]) reported in ATSDR's Toxicological Profile for Arsenic (September 2000). The estimated peak exposure for arsenic exceeded ATSDR's CREG of 0.0002 $\mu g/m^3$. However, the CREG is an extrapolated value corresponding to a purely hypothetical, estimated cancer risk level of 1 in 1 million. The CREG is based on (a) studies involving relatively high, chronic exposure and (b) the assumption that no threshold other than zero exists for cancer effects. As stated earlier, exposures in Butte are generally low and sporadic, rather than high and chronic. Furthermore, arsenic does not cause point mutations, which represent the main rationale for applying the zero-threshold hypothesis to carcinogens. Arsenic related skin cancer is caused by soluble forms of arsenic and exhibits a threshold between 200 and 400 μg/day. In addition, an increased incidence of lung cancer has been consistently associated with prolonged, high occupational exposures to arsenic trioxide fumes from smelters. However, the much less bioavailable arsenic found in finely ground waste rock from the tailings pond is not comparable to either of these carcinogenic arsenic exposures. Therefore, based on the low concentrations of wind-blown tailings dust, the low bioavailability of arsenic in those ore tailings, and the threshold carcinogenicity of soluble arsenic compounds,(even the maximum estimated exposures), would not be associated with any cancerous or non-cancerous adverse health effects.

5) Assuming (a) the unlikely possibility that all of the dust included in the PM-10 measurements was from the tailings pond, and (b) the chemical composition of that dust is the same as the highest concentration of quartz found in PM-10 in the tailings analysis, another worst case scenario emerges. If these assumptions were true, a peak exposure to 73 $\mu g/m^3$ of PM-10 dust particles could result in exposure to <13 $\mu g/m^3$ quartz, this is higher than EPA's 5 $\mu g/m^3$ interim *annual* standard for silica exposure and gives cause to address the actual exposures of this community further. The 73 $\mu g/m^3$ level was the highest 24-hour PM-10 level and the EPA interim standard is for annual average concentration. Also, the EPA interim value is protective of healthy individuals. EPA concluded that, "... for healthy individuals not compromised by other respiratory aliments and for ambient environments expected to contain 10% or less crystalline silica fraction in PM10, maintenance of the 50 $\mu g/m^3$ annual NAAQS for PM-10 should be adequate to protect against the silicotic effects from ambient crystalline silica exposures." Since the EPA standard is based on silica levels less than 10%, a similar value may be derived to protect people from exposures to concentrations of silica greater than 10%. Should silica concentrations be as high as 17.5% of the PM-10 (the maximum value in the tailings), then an equivalent annual-average PM-10 value protective of silica exposures would be 28 $\mu g/m^3$. Therefore, average PM-10 levels below 28 $\mu g/m^3$ should limit silica exposures sufficiently. Although, this value may not be protective of all health-compromised individuals, it is very protective, as quartz tends to be larger than other particles (because quartz, which is harder than most minerals, resists being broken into fine particles). Persons with respiratory diseases should always consider limiting their exposure to fine particles.

CALCULATIONS:

Max PM-10 conc = 73 $\mu g/m^3 = 7.3 \times 10^{-8}$ kg/m^3.

7.3 × 10-8 kg/m^3 × < 50 mg **Arsenic**/kg = 365×10^{-8} $mg/m^3 = 0.00365$ $\mu g/m^3$
7.3 × 10-8 kg/m^3 × < 5 mg **Cadmium**/kg = 36.5×10^{-8} $mg/m^3 = 0.000365$ $\mu g/m^3$
7.3 × 10-8 kg/m^3 × ~75 mg **Lead**/kg = 547.5×10^{-8} $mg/m^3 = 0.005475$ $\mu g/m^3$
7.3 × 10-8 kg/m^3 × ~200 mg **Zinc**/kg = 1460×10^{-8} $mg/m^3 = 0.0146$ $\mu g/m^3$
73 $\mu g/m^3$ × 0.175 = 12.8 $\mu g/m^3$

Conclusions:

Do airborne particulate metals present health hazard for the community?

The data available provides dust levels as well as metal analysis of rock. No measurements of metals in the air have been made. However, the data provided indicates that site-derived dust exposure does not pose a public health hazard.

Does airborne silica present health hazard for the community?

Potential crystalline silica levels do not pose a health hazard to healthy individuals.

Potential annual concentrations may pose a health hazard to sensitive individuals compromised by other respiratory aliments.

Recommendations:

What additional precautions/sampling should be taken to protect public health?

The planned methods (rock covering, chemical stabilization, and watering) should provide additional protection against excessive exposures.

Analyze airborne particulates for silicates. Crystalline silica analysis in the PM-10 (air) samples will provide information to evaluate actual respiratory exposures to silica.

Metals analysis of the PM-10 samples could help determine if site dust is migrating into the community and will provide data on the level of metals that is in the ambient air.

If residents are concerned about dust concentrations aggravating asthma or other respiratory conditions, the Montana Department of Environmental Quality/Department of Health should consider requesting area specific information on hospital admissions/emergency room visits for asthma and other respiratory conditions –trends for asthma exacerbations in children may be compared to trends of high particulate concentrations in air in this community.

References

(1) American Conference of Governmental Industrial Hygienists; 1998, location Threshold Limit Values and Biological Exposure Indices.

(2) U. S. Environmental Protection Agency; Ambient levels and noncancer health effects of inhaled crystalline and amorphous silica; EPA/600/R-95/115; November 1996.

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