

## Where does it come from? How is it present in mining?

Silver is a soft, bright, lustrous metal that can be associated with metal mining. The most important silver ores are argentite, chlorargyrite (cerargyrite, horn silver), proustite (ruby silver) and pyrargyrite (ruby silver), which are typically found in igneous rocks. Silver is often also found in gold, lead, copper and zinc ores. Silver may also be present at the mine as a component of explosives or in silver plating.

## What are the primary health effects from exposure to Silver?

The main hazard associated with silver over exposure is argyria. Argyria is a condition where an individual's skin, eyes, or mucous membranes turns slate to blue-gray in color. This can happen in a small area of the body or all over. Over exposure to silver can also result in pulmonary fibrosis, skin ulcers or other skin irritation, and gastrointestinal disturbances. Silver dust can be flammable so precautions should be taken.

## What are the occupational exposure limits for Silver?

Title 30 CFR §§ 57.5005 states that exposure shall not exceed the Threshold Limit Values Adopted by the American Conference of Governmental Industrial Hygienists in 1973. The Threshold Limit Values for silver are 0.01 mg/m<sup>3</sup> (10 µg/m<sup>3</sup>) and 0.03 mg/m<sup>3</sup> (30 µg/m<sup>3</sup>) averaged over 8 hours and 15 minutes, respectively.

## How often shall I complete exposure monitoring for Silver?

30 CFR Part 56.5002 requires that dust, mist, and fume surveys be conducted *as frequently as necessary* to determine the adequacy of control measures. It is standard practice to sample initially (called a baseline evaluation) to determine potential exposure concentrations. Routine or periodic monitoring (usually annually) is also recommended. Sampling may need to be done more often if the tasks change, if engineering controls change, or if sampling results are above the "action limit" which, for most chemicals, is defined as 50% (or half) of the TLV.

## How do I measure potential exposures to Silver?

To assess silver exposures you should conduct both air sampling and wipe sampling. Air sampling can be completed for the entire shift to compare with the 8-hr limit or for 15 minutes to compare with the short-term exposure limit. Consecutive short-term exposures could be completed to obtain the time-weighted full shift exposure.

According to NIOSH method 7300, a sampling pump is calibrated to 1.7 liters per minute. A 37 mm diameter mixed cellulose ester (MCE) filter with a 0.8 µm pore size is placed in a cassette and connected to the pump. The pump is placed on the worker with the cassette in their breathing zone for the appropriate duration. Upon completion the filter should be set to certified laboratory for analysis. At least one blank filter should also be sent. This filter should go through all the same processes except that the pump is not turned on. Sampling can also be conducted according to OSHA ID-121, where the pump is calibrated to 2.0 liters per minute.

Once the laboratory provides you with the mass of silver measured on the filter, you can calculate the air

concentration as: 
$$C = \frac{M}{Q \times T}$$

where C is the concentration of silver in mg/m<sup>3</sup>, M is the mass of silver measured on the filter in mg, Q is the pump flow rate in liters per minute and T is the total time of sampling in minutes. Note that many laboratories will loan you the necessary equipment to obtain the samples and provide you with the appropriate filters.

Wipe samples should be completed while wearing clean disposable gloves to avoid contamination. A piece of Whatman filter paper (41 or 42) or smear tabs moistened with distilled water is used to wipe a 10 cm x 10 cm area.

Then the paper is folded in half and transported in a plastic bag or jar to the laboratory for analysis. A clean piece of filter paper should also be submitted to the laboratory as a blank.

Some forms of silver are more toxic than others. You may want to discuss with the lab to distinguish soluble from insoluble silver in your samples.

Certified laboratories that can assist with measuring silver:

Galson <http://www.galsonlabs.com/>

Analytics Corporation <http://www.analyticscorp.com/>

**How do I control Silver exposures?**

Ventilation is recommended for controlling dust exposures including for silver. Appropriate administrative controls should also be used to ensure adequate maintenance for the ventilation system. Housekeeping policies should also be developed and used for further dust suppression and surface decontamination. With regard to silver metal overexposures between 0.01 mg/m<sup>3</sup> and 0.1 mg/m<sup>3</sup>, operators must use engineering controls to reduce exposure to the permissible limit and comply with the respiratory protection requirements of standard 56/57.5005. As silver can cause eye and skin irritation, it is recommended that workers also wear appropriate eye and skin protection compatible with the respirator.

Concentration (mg/m <sup>3</sup> )	APF	Respirator
0.25	25	supplied-air operated in continuous-flow mode or powered air-purifying with a HEPA filter
0.50	50	air-purifying full-facepiece with a HEPA filter, supplied-air with tight-fitting facepiece operated in continuous-flow mode, self-contained breathing apparatus with full facepiece, or supplied-air with full facepiece
10	2000	supplied-air operated in a pressure-demand or other positive-pressure mode

**References:**

MSHA. 2007. Metal Nonmetal Health Inspection Procedures Handbook. PH06-IV-1(1).

<http://www.msha.gov/readroom/handbook/PH09-IV-1.pdf>

MSHA Code of Federal Regulations (<http://www.msha.gov/30cfr/0.0.htm>).

Mineral Information Institute. Common Minerals and Their Uses. <http://www.mii.org/commonminerals.html>

Patnaik, P. 2007. A comprehensive guide to the hazardous properties of chemical substances. New Jersey: Wiley & Sons.

ATSDR. 1990. Toxicological Profile for Silver. <http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=539&tid=97>