

Occupational Health Guideline for Cobalt Metal Fume and Dust

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formulas of example compounds: $\text{Co}/\text{CoO}/\text{Co}_2\text{O}_3/\text{Co}_2\text{O}_4$
- Synonyms: None
- Appearance and odor: Odorless black solid or finely divided particulate dispersed in air.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for cobalt metal fume and dust is 0.1 milligram of cobalt metal fume and dust per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for cobalt metal fume and dust a Threshold Limit Value of $0.05 \text{ mg}/\text{m}^3$.

HEALTH HAZARD INFORMATION

• Routes of exposure

Cobalt metal fume and dust can affect the body if they are inhaled or if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

• Effects of overexposure

Cobalt metal fume and dust cause irritation of the nose and throat. They have also been reported to cause respiratory disease with symptoms ranging from cough and shortness of breath to permanent disability and death. The symptoms frequently go away when expo-

sure is stopped, but sometimes the symptoms progress after exposure has ceased. Exposure to cobalt may cause an allergic skin rash.

• Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to cobalt metal fume and dust.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to cobalt metal fume and dust at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Cobalt may cause human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Cobalt is reported to decrease pulmonary function. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

• Summary of toxicology

Cobalt metal fume and dust cause upper respiratory tract irritation, chronic interstitial pneumonitis, and skin sensitization. Rhabdomyosarcomata developed in rats injected intramuscularly with the powder of either pure cobalt metal or cobalt oxide. Animals were exposed to the repeated inhalation of the cobalt metal blend used by the cemented carbide industry: a concentration of $20 \text{ mg}/\text{m}^3$ of cobalt for 3 years produced hyperplasia of the bronchial epithelium and focal fibrotic lesions of the lungs with developing granulomata; daily inhalation of cobalt metal fume composed of approximately equal parts of cobalt, cobalt oxide, and cobaltic-cobaltous

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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oxide did not elicit these reactions. Guinea pigs developed acute pneumonitis, often rapidly fatal, from the intratracheal injection of cobalt metal or repeated inhalation of a mixture of 75% tungsten carbide and 25% cobalt. Chronic interstitial pneumonitis has been reported in workers in the cemented carbide industry, and cobalt has been conditionally implicated as the etiologic agent by a process of elimination of the other materials used in the industry. Symptoms range from shortness of breath, cough, and dyspnea on exertion to permanent disability or death in some cases. Among 12 workers exposed to cobalt engaged in manufacture of, or grinding with, tungsten carbide tools, who developed interstitial lung disease, there were 8 fatalities; serial chest roentgenograms over a period of 3 to 12 years revealed gradually progressive densities of a linear and nodular nature which gradually involved major portions of both lungs; cough, dyspnea on exertion, and reduced pulmonary function occurred early in the course of the disease. The disease has features of hypersensitivity; only a small percentage of people exposed are affected and with little evidence of dose-response relationship. Cobalt and its compounds produce an allergic dermatitis of an erythematous papular type, which usually occurs in skin areas subjected to friction, such as the ankles, elbow flexures, and sides of the neck.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 58.93 to 181.9
2. Boiling point (760 mm Hg): 3100 C (5612 F)
3. Specific gravity (water = 1): 8.8
4. Vapor density (air = 1 at boiling point of cobalt metal fume and dust): Not applicable
5. Melting point: 1491 C (2715 F)
6. Vapor pressure at 20 C (68 F): 0 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F):

Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact of dust with strong oxidizers may cause fire and explosions.
3. Hazardous decomposition products: None
4. Special precautions: None

• Flammability

1. Flash point: Not applicable
2. Autoignition temperature: Specially prepared (the form prepared by reducing the oxides in hydrogen) very fine cobalt dust will catch fire at room temperature in air.
3. Flammable limits in air, % by volume: Not applicable
4. Extinguishant: Dry sand, dry dolomite, dry graphite powder

• Warning properties

The AIHA *Hygienic Guide* states that "cobalt appears to

be an eye irritant. One of the findings in the study of the tungsten carbide industry was a significant amount of conjunctivitis, presumably caused by the cobalt used as 'cement'." Contact with industry has indicated that workers in the cobalt-cemented tungsten industry have not experienced eye irritation to cobalt below 1 mg/m³.

MONITORING AND MEASUREMENT PROCEDURES

• General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Method

Sampling and analyses may be performed by collection of cobalt metal fume and dust on a cellulose membrane filter, followed by treatment with nitric acid, solution in acid, and analysis with an atomic absorption spectrophotometer. An analytical method for cobalt metal fume and dust is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact

with cobalt dust.

- If employees' clothing may have become contaminated with cobalt dust, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing contaminated with cobalt dust should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of cobalt dust from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the cobalt dust, the person performing the operation should be informed of cobalt dust's hazardous properties.

- Non-impervious clothing which becomes contaminated with cobalt dust should be removed promptly and not reworn until the cobalt dust is removed from the clothing.

SANITATION

- Skin that becomes contaminated with cobalt dust should be promptly washed or showered with soap or mild detergent and water to remove any cobalt dust.

- Eating and smoking should not be permitted in areas where cobalt metal fume or dust are generated, handled, processed, or stored.

- Employees who handle cobalt metal fume or dust should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to cobalt metal fume and dust may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during use as a binder in manufacture of cemented carbide items; during refining and concentration of ores; during preparation of alloys	Local exhaust ventilation; personal protective equipment
Liberation during manufacture of metal items from magnetic alloy; during manufacture of metal items from super- and high-temperature alloys	Local exhaust ventilation; personal protective equipment

Operation

Liberation during grinding and sharpening of cemented carbide and steel tools; during synthesis of cobalt compounds for use as pigments and as catalysts and driers; during refining and concentrations of ores

Liberation during manufacture of metal items from cutting tool and tool steels; during manufacture of metal items from hard-facing alloys; during manufacture of items containing low-expansion alloys; during manufacture of metal items containing constant-modulus alloys; metal to glass seals in electric lamps, vacuum tubes, and x-ray tubes

Liberation during manufacture of dental prosthetic and osteosynthetic items; during asbestos fiber processing

Controls

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EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If cobalt metal dust gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If cobalt metal fume or dust get on the skin, wash the contaminated skin using soap or mild detergent and water. If cobalt metal dust penetrates through the clothing, remove the clothing and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of cobalt metal fume or dust, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respi-

ration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When cobalt metal dust has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or releases until cleanup has been completed.

- If cobalt dust is spilled or if potentially hazardous amounts of cobalt metal fume are inadvertently released, the following steps should be taken:

1. Ventilate area of spill.

2. Collect released material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill.

- **Waste disposal method:**

Cobalt dust may be placed in sealed containers and disposed of in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR COBALT METAL FUME AND DUST

Condition	Minimum Respiratory Protection* Required Above 0.1 mg/m ³
Particulate Concentration	
0.5 mg/m ³ or less	Any dust and mist respirator, except single-use.
1.0 mg/m ³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator. Any fume respirator or high efficiency particulate filter respirator.
5 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
20 mg/m ³ or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter. A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 20 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator with a full facepiece. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

