

- Cadmium is a soft and malleable metal which has several properties that allow it to be used in many ways.



Figure 1. Pure cadmium  
Source: <http://images-of-elements.com/cadmium.jpg>

## Occupational Uses

- Most commonly used for nickel-cadmium batteries
- Other uses:
  - Plating on steel
  - As pigment due to its ability to withstand high temperatures and pressure
  - As stabilizer to delay the degradation of polyvinylchloride (PVC)



Figure 2. Cadmium pigments  
Source: <http://www.sinopia.com/assets/images/products/cadcat.jpg>

## Occupational Exposure

- Approximately 30,000 workers are exposed to cadmium each year in the United States.
- Primary industries using cadmium: manufacturing industry and construction
- Other workers exposed:
  - Foundry workers re-melting metal ingots
  - Employees working in settings which use cadmium as coating for steel
  - Agricultural workers exposed to cadmium that is naturally occurring in the Earth's crust

## Toxicological Data

- Highly toxic and a known carcinogen
- 3 major routes of exposure: inhalation, ingestion, and dermal
- Health effects: cardiovascular, neurological, respiratory, reproductive, renal, and gastrointestinal problems.

## Epidemiological Studies

- Manufacturing workers who are exposed to cadmium have higher rates of lung and prostate cancers.
- There is a weak relationship between lung and prostate cancer the presence of cadmium.
- However, there is a relationship between cancer and cadmium exposure when workers are also exposed to arsenic.

## Sampling Methods

- Cadmium is collected using an air sampling pump connected to a 37-mm in diameter filter cassette containing mixed cellulose ester (MCE) membrane filter.
- The OSHA recommended air volume is 960 liters at a sampling rate of 2 liters per minute.



Figure 3. Sampling media for cadmium sampling.  
Source: [www.zefon.com](http://www.zefon.com)

## Analytical Methods

- Following collection, samples are taken to the laboratory for analysis.
- Samples are diluted with deionized water, after it is first digested by nitric acid and mixed with hydrochloric acid.
- Analysis is done using either flame atomic absorbent spectroscopy or flameless atomic absorbent spectroscopy.

## Occupational Exposure Limits (OELs)

- OSHA Permissible Exposure Limit (PEL)
  - 8-hr TWA - 5  $\mu\text{g}/\text{m}^3$
- OSHA Action Level
  - 8-hr TWA - 2.5  $\mu\text{g}/\text{m}^3$
- NIOSH Recommended Exposure Limit (REL)
  - Not established (lowest feasible concentration)
- ACGIH Threshold Limit Value (TLV)
  - 8-hr TWA - 0.01  $\text{mg}/\text{m}^3$  (total particulates)
  - 8-hr TWA - 0.002  $\text{mg}/\text{m}^3$  (respirable particulates)
- Industries such as shipyards, construction, and agriculture have separate standards from the general industry standards.

## Case Study

- OSHA finds that workers of the J. Walter Miller Co., foundry in Lancaster, PA were exposed to excessive levels of cadmium and lead.
- Workers exposed to cadmium: metal pourer working in the production, cut off, and finishing areas
- On March 11, 2016, the foundry was cited for violating the General Industry standards, and was fined \$42,700.
- Violations included deficiencies in engineering controls, written programs, exposure monitoring, decontamination, and several other violations.



Figure 4. Metal pourer in a foundry.  
Source: <http://careerthesaurus.com/Metal-Pourer-Caster>

## Control Measures

- Engineering controls - elimination or substitution of cadmium, increased ventilation, isolation from cadmium
- Administrative controls - worker rotation, employee training
- Personal protective equipment (PPE) - safety goggles, respirators

## References

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