Lead in the Workplace

Lead is a bluish-grey metal that has been used since ancient times. It has a low melting point, is pliable and corrosion resistant. Lead is naturally present in the earth, usually combined with other elements such as zinc, silver and copper. The most common lead ore is galena or lead sulfide. Since lead is easily re-melted and refined, it has the highest recycling rate of all metals in the world.

Uses of lead

In ancient times, lead was used to construct water pipes and storage vessels and white lead was used as a coating. Lead has continued to be used in many ways. Until the 1980s, the main sources of lead exposure for Canadians were lead paint and emissions from cars using leaded gasoline. The use of lead in gasoline was stopped in Canada in 1990, except for some specific vehicles like race cars and farming equipment.

Today, lead is used in many of the following products:

- batteries
- lead shielding for x-rays
- crystal
- ceramics and pottery glazes
- stained glass
- lead solder — used in water pipes in older homes, electronics
- cosmetics — many of the pigments and other substances used in cosmetics contain lead
- pesticides (lead arsenate)
- ammunition
- lead weights and tools

Exposure to lead can also occur in battery recycling facilities, firing ranges, radiator shops (lead contamination in the radiator fluid) and during welding activities (due to lead paint on the metals being welded). Wood products such as furniture that have been chemically stripped of lead paint can continue to contain lead in the pores of the wood. Even though the wood looks uncoated, airborne lead dust can be released when surfaces are cut or sanded. Lead may also be produced as a by-product in metal smelting operations and at brass or copper foundries.

Some paints used before 1950 contained as much as 50 percent lead by weight. Lead was often used as a pigment in white and pastel shades. Lead made paint dry faster, last longer and gave the colours a more vibrant look. In the 1950s the amount of lead used in paint decreased as other pigments were substituted. In 1976, federal regulations limited the level of lead in interior paint to 0.5 percent by weight. Exterior paints could still contain more lead. The yellow markings found on highways still use lead-based paint.

Health effects

The most common ways that workers are exposed to lead at the workplace are inhalation of lead dust or fumes and accidental ingestion. Workers ingest lead by handling cigarettes or food when their hands are contaminated with lead. About 5 to 15 percent of the lead an adult ingests is absorbed into their body. Lead is not normally absorbed through the skin unless there is a break in the skin such as a cut or scrape.

A good proportion of the lead entering the body will leave the body in the urine, feces, sweat and as dead skin cells slough off. Lead may also be found in breast milk. Most of the lead that remains in the body accumulates in bone where it can be stored for decades. Lead in bones can be released back into the blood long after the original exposure.

Lead does not have a known function in the human body. It disrupts the function of enzyme systems that use other metals such as calcium, zinc and iron.
Many of the health effects from lead take a long time to develop. Workers with lead in their bodies may not notice any immediate health effects

Symptoms of lead poisoning affecting the nervous system

The nervous system is one of the main targets of lead. Early symptoms of lead exposure include headaches, irritability, memory problems and problems sleeping. Over time, the nerve-muscle system can be damaged, leading to muscle weakness, decreased feeling in the hands and feet and a metallic taste in the mouth.
Long-term exposure to high lead levels can lead to local paralysis described as “wrist drop” or “foot drop”. Lead encephalopathy may also occur. This is a disorder of the brain that is characterized by poor balance, confusion, dizziness, hallucinations, and speech and hearing problems. In severe cases, the result can be coma or death.

Long term exposures to high lead levels are linked to high blood pressure and cardiovascular disease. However, these effects are rarely seen at the lead exposures usual today. See Figure 1 for a summary of the physical symptoms associated with blood lead levels.

**Reproductive and developmental effects**

Lead can cause stillbirths and miscarriages in pregnant women exposed to lead. Even low level exposure can affect a pregnancy by shortening the term or affecting the mental development of the fetus. In men, sperm can be affected which may result in lowered fertility.

**Effects involving the stomach and intestine**

Lead can affect the digestive system. This can cause lack of appetite, nausea, vomiting, constipation, diarrhea and abdominal pain.

**Other health effects**

Lead affects the formation of blood cells and causes anemia. Lead can damage the kidneys and, in extreme cases, can cause kidney failure.
Figure 1  Blood lead levels and physical symptoms

<table>
<thead>
<tr>
<th>Blood lead concentration - µmol/L (µg/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.24 (150)</td>
</tr>
<tr>
<td>4.83 (100)</td>
</tr>
<tr>
<td>2.41 (50)</td>
</tr>
<tr>
<td>1.93 (40)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1.44 (30)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0.96 (20)</td>
</tr>
<tr>
<td>0.48 (10)</td>
</tr>
</tbody>
</table>
Cancer

Lead has been found to cause cancer in animals. The International Agency for Research on Cancer (IARC) has classified lead and inorganic forms of lead as being “possibly carcinogenic to humans”. Organic lead compounds are not known to cause cancer.

Medical monitoring

Medical monitoring provides valuable information that can help determine if control measures are effectively controlling exposure. Together with hygiene monitoring, medical monitoring ensures worker health is not adversely affected.

Where there is a potential for a worker to receive significant exposure to lead, the employer should routinely require workers to have a health assessment. Yearly testing is recommended. When hiring a worker, it is the employer’s responsibility to require the worker to have a health assessment. The purpose of the health assessment is to provide a baseline measure of the worker’s health. This provides a way of keeping track of any changes to a worker’s health that may occur over time. The health assessment should include a health history, physical examination, and blood lead testing.

It is the employer’s responsibility to ensure that blood lead tests are made available to workers if the workers are likely to be exposed to significant amounts of lead. The employer is responsible for paying the cost of the health assessment if one is required.

Health assessments should be offered to all workers involved in work that may result in elevated blood leads. Blood lead levels should be less than 1.5 micromoles per litre (µmol/L).

Measuring the concentration of lead in the blood is one way of measuring the amount of lead in the body from all exposures. It is the best available measure of recent lead absorption. Repeating the test and monitoring the worker’s symptoms should confirm abnormal blood results. The frequency of testing is included in Table 1.

In Alberta, blood lead results should be reported in the units of micromoles per litre of whole blood (µmol/L whole blood). The physician performing the testing should explain the results of blood lead testing to the worker. A worker with a blood lead level greater than 2.5 µmol/L, or symptoms diagnosed as a result of lead exposure, is considered to have lead poisoning. The Director of Medical Services must be notified if a worker has a blood lead level of 2.5 µmol/L or greater (see Table 1).

Female workers of childbearing age who are considering becoming pregnant should be monitored to safeguard the fetus from harmful effects of lead. Female workers need to have a health assessment at the same frequency as other workers. However, the blood lead level should be kept below 0.5 µmol/L (see Table 2).
Managing lead in the workplace

To determine if lead poses a health risk in the workplace, it is important to find out where and how lead is used. Lead may be found in places that are not immediately obvious. Tools, weights, solder and old paint may contain lead. Ask the following questions:

- Where is lead present in this workplace?
- What tasks or products involve the use of lead?
- How do workers come into contact with lead?

Once these questions are answered, an exposure control plan can be developed. The purpose of the plan is to make sure that a program is developed to minimize worker exposure to lead. This plan must have the following elements:

- statement of purpose and responsibilities
- worker education about the hazards of lead and safe work procedures
- written safe work procedures to control the hazard
- procedures for worker decontamination
- health monitoring
- documentation and record-keeping
- follow-up to evaluate how well the program is working and determine if changes are needed
## Table 1  Blood lead levels for workers other than those covered in Table 2

<table>
<thead>
<tr>
<th>Blood lead level (umol/L)</th>
<th>Frequency of follow-up</th>
<th>Required actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1.5</td>
<td>Annual blood testing for workers exposed to lead</td>
<td>▪ Acceptable level – no action required</td>
</tr>
</tbody>
</table>
| 1.5 to 1.99               | Blood testing every 6 months for workers exposed to lead | ▪ Worker must be informed of blood lead level.  
                                      ▪ Hazard of worker exposure to lead must be assessed and effectiveness of worksite controls evaluated.  
                                      ▪ Controls must be implemented to reduce exposure. |
| 2.0 to 2.4                | Blood testing every 2 months for workers exposed to lead | ▪ Worker must be informed of blood lead level.  
                                      ▪ Hazard of worker exposure to lead must be assessed and effectiveness of worksite controls evaluated.  
                                      ▪ Controls must be implemented to reduce exposure. |
| 2.5 or greater            | Blood testing every month | ▪ Worker must be informed of blood lead level.  
                                      ▪ Worker must be removed from the lead-containing workplace until his or her blood lead level returns to acceptable levels – less than 2.0 umol/L.  
                                      ▪ Notify the Director of Medical Services, Alberta Human Resources & Employment.  
                                      ▪ Source of exposure must be identified and corrective actions taken to reduce or eliminate exposure potential.  
                                      ▪ Hazard of worker exposure to lead must be assessed and effectiveness of worksite controls evaluated.  
                                      ▪ Controls must be implemented to reduce exposure. |
Table 2  
Blood lead levels for pregnant workers and female workers of childbearing age considering becoming pregnant

<table>
<thead>
<tr>
<th>Blood lead level (umol/L)</th>
<th>Frequency of follow-up</th>
<th>Required actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.5</td>
<td>Annual blood testing for workers exposed to lead</td>
<td>• Blood lead levels must be kept below the 0.5 limit</td>
</tr>
<tr>
<td>0.5 or more</td>
<td></td>
<td>• Worker to be removed from further exposure to lead</td>
</tr>
</tbody>
</table>

Air and surface testing

Air and surface lead tests and sampling are important to assessing lead exposure and as part of an exposure control plan. Testing and sampling help ensure that lead is properly removed. Two types of sampling may be done — air sampling and collection of solid samples e.g. paint, dust or soil.

When doing air testing to evaluate worker exposure to airborne lead, methods developed by the National Institute of Occupational Safety and Health (NIOSH) must be used. These methods are provided in the NIOSH Manual of Analytical Methods. The methods can be downloaded from the NIOSH Web site www.cdc.gov/niosh.

Methods 7082 (Lead by Flame AAS), 7105 (Lead by GFAAS), 7701 (Lead by Ultrasound/ASV), 7300 (Elements by ICP) involve the collection of an air sample using a small filter and pump. The samples are then analyzed in a laboratory using the appropriate method. The method chosen depends on the range of concentration and accuracy needed. Two additional methods, 7700 (Lead in Air by Chemical Spot Test) and 7702 (Lead by Field Portable XRF), can be done in the workplace. However, some samples should also be analyzed by a laboratory to confirm the results.

Where lead is present in an organic form, tetraethyl lead for example, air samples must be collected and analyzed using different methods. In this case, the NIOSH Manual of Analytical Methods should be consulted for the specific chemical involved. For the above example, method 2533 (tetraethyl lead) is used.

Regarding solid samples, NIOSH methods 7082, 7300 and 7105 provide variations for analyzing paint chips. Method 9100, Lead in Surface Wipe Samples, can be used to sample and analyze dust and assess if lead has been properly cleaned from a surface.

Portable x-ray fluorescence analyzers are also available that can be used to measure the amount of lead in paint, without damaging the paint. However, the readings from some of these instruments are affected by the base material
under the paint (wood, plaster, metal, etc.). For curved surfaces or for paint that is in poor condition, these instruments may not read accurately. In these cases, a paint chip sample may be needed.

Once samples have been collected and analyzed, the results must be compared to a standard to determine if lead poses a potential hazard.

- For air samples, the results should be compared to the Occupational Exposure Limits for lead that are provided in Alberta’s occupational health and safety legislation.
- Paints containing lead at less than 0.5 percent by weight are not considered to be lead-containing paints (federal Hazardous Products Act).
- The U.S. Environmental Protection Agency and U.S. Department of Housing and Urban Development have set dust-lead clearance standards of 40 \( \mu g/ft^2 \) for floors, 250 \( \mu g/ft^2 \) for interior window sills and 400 \( \mu g/ft^2 \) for window troughs. These values are based on a weighted average of all wipe samples. These, or an equivalent standard developed by a reputable and credible organization, are considered acceptable clearance criteria in Alberta.
- For lead contamination of soil, the Canadian standard used is Recommended Canadian Soil Quality Guidelines published by the Canadian Council of Ministers of the Environment (CCME). A copy can be ordered from the CCME Web site: www.ccme.ca

General preventative measures

The health of a worker’s family may be at risk if lead dust is taken home on clothes, boots or in the hair. Children are much more susceptible to lead exposure than adults.

Preventing exposure to lead is the best way to protect health. Options that should be considered include the following, listed in order of preference:

- use of less hazardous substitutes
- use of engineering controls
- changes in work practices to reduce exposure
- use of personal protective equipment

Use of less hazardous substitutes

Where possible, less hazardous substances should be substituted for lead. This can be done with paints and glazes, batteries and solder materials.

Engineering controls

Engineering controls are mechanical processes used to eliminate exposure to a contaminant. Engineering controls remove the contaminant from the air or provide a barrier between the worker and the contaminant. Examples of engineering controls that can be used to prevent exposure to lead include:
- installation of local ventilation hoods
- installation of dust collection systems onto machines or equipment
- enclosures around the work process.

If working properly, engineering controls will eliminate or greatly reduce the potential hazard. They only need to be installed once and unlike personal protective equipment, do not place a physical burden on workers. However, an initial investment is required and the systems must be properly operated and maintained once installed.

Work practices

Work practices that can be implemented in the workplace to reduce potential exposure to lead include:

- Educating workers so that they understand the hazards associated with lead. Workers should be encouraged to participate in training and monitoring programs in the workplace.
- Using good hygiene practices. Workers must not eat, drink or use tobacco products in areas contaminated by lead. The hands and face need to be washed before eating, drinking or smoking. Since ingestion is one of the main exposure routes for lead, the importance of good personal hygiene needs to be emphasized in the workplace.
- Ensuring that engineering controls and other equipment used to reduce exposure are used properly.

Implementing work practices to reduce exposure is often less expensive than other control measures. However, workers must be properly trained, they must use the practices appropriately and the employer must make sure that the practices are followed.

Personal protective equipment

If it is not practicable or feasible to use substitutes, engineering controls, or change work practices to reduce the potential for exposure, protective equipment is needed. Respiratory protective equipment is used to remove contaminants from the air we breath. Protective clothing is used to prevent skin contact with lead or lead contaminated surfaces.

There are many types of respirators available and it is important to select the correct one(s) for the work being done. For further guidance, Alberta Human Resources and Employment has three specific publications available:

  Guideline for the Development of a Code of Practice for Respiratory Protective Equipment

  Respiratory Protective Equipment: An Employers' Guide
The type of protective clothing chosen depends on the type of work being done, work conditions, and the presence of other contaminants in the workplace. Protective clothing used in a lead contaminated environment must be removed before the worker leaves the workplace. Otherwise, there is the risk that the worker may take the lead contamination home resulting in family members being exposed. This is one of the most common ways that children are exposed to lead. Lead contaminated clothes should not be laundered at home.

Although the use of personal protective equipment may initially seem less costly, workers need to be trained about the protective equipment they are using. Employers need to monitor how the protective equipment is used and ensure that it is properly maintained. In some cases, personal protective equipment can create a hazard to workers such as heat stress, limited vision, allergic reactions to the equipment material. These issues need to be evaluated when personal protective equipment is selected.

Lead paint

Lead-based paint does not normally pose a health hazard if it remains in good condition. The hazard usually begins after the paint starts to chip or peel or if paint is damaged during renovation activities. If the flakes turn into dust, anything the dust contacts will be contaminated.

Removing lead paint can sometimes create a greater hazard than just leaving it as is. For example, sanding will greatly increase lead dust levels in the air and this should be avoided. Heat guns, blow lamps or flame torches should not be used as they will produce lead fume. If proper precautions are taken, lead paint can be more safely removed using a chemical stripper. Be aware that paint stripping introduces a second hazard — chemical solvents — that must be controlled by using proper ventilation equipment and proper procedures.

During renovations, a number of strategies can be used to reduce the risk of exposure to lead. These include replacing structures that have lead painted surfaces, encapsulating painted surfaces, or paint removal. There are advantages and disadvantages to each strategy. The chosen method depends on factors such as the condition of the existing paint, location and size of the surface.

During renovations, consideration should be given to controlling lead dust and other debris. Approaches include using local HEPA filtered exhaust ventilation and vacuum systems, containing the dust by enclosing the work area, using wet work procedures, properly packaging wastes and following good housekeeping practices. A good reference for dealing with lead paint is Lead Paint Safety, A Field Guide for Painting, Home Maintenance and Renovation Work, produced by the U.S. Department of Housing and Urban Development in cooperation with the U.S. Environmental Protection Agency.
Development in cooperation with the U.S. Environmental Protection Agency and the Centers for Disease Control and Prevention. The publication can be found on line at:

www.hud.gov/offices/lead/training/leadsafetybk.pdf

Lead Paint Safety, A Field Guide for Painting, Home Maintenance and Renovation Work

Legislation

Legislation under Alberta’s Occupational Health and Safety Act have general and specific requirements related to lead. Occupational Exposure Limits for lead are provided. These limits apply to workers directly involved with tasks using lead, and also to workers in the workplace who may be exposed to lead indirectly from these operations or from substances such as lead paint. Additional requirements include:

- ensuring that workers who are exposed to lead are protected from further exposure
- the need for suitable showers, change rooms or other means to allow workers to remove contamination before leaving work
- ensuring that no worker eats, drinks or smokes in an area of the workplace contaminated with lead
- establishing procedures in the workplace to minimize worker exposure to lead and training workers in these procedures
- requirements for the use of personal protective equipment.
How to contact us:

Province-Wide Call Centre

📞 1- 866-415-8690

Deaf or hearing impaired
- Edmonton (780) 427-9999
- Other locations 1-800-232-7215

Internet Web Site

🌐 www.whs.gov.ab.ca

Getting copies of regulations:

Queen’s Printer

🌐 www.qp.gov.ab.ca

.libs
Edmonton (780) 427-4952
Calgary (403) 297-6251

Workplace Health and Safety

🌐 www.whs.gov.ab.ca/law/index.html

Call any Government of Alberta office toll-free
Dial 310-0000, then the telephone number you want to reach

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