

Workplace Health and Safety Bulletin



Lead at the Work Site

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 sulphide. 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 types of 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, radiator shops
- 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 occur in battery recycling facilities, firing ranges, radiation 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 legislation limited the level of lead in interior paint to 0.5 percent by weight. Exterior paint could still contain more lead. For example, 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 work site are inhalation of airborne 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.

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Most 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. The lead that remains in the body tends to accumulate 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 immediate health effects.

Nervous system effects

The nervous system is one of the main targets of lead. Early symptoms of lead exposure include headaches, irritability, memory problems and difficulty in 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 lead can cause local paralysis described as “wrist drop” or “foot drop”. Lead encephalopathy may also occur. This is a disorder of the brain that causes poor balance, confusion, dizziness, hallucinations, and speech and hearing problems. In severe cases, the result can be coma or death.

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

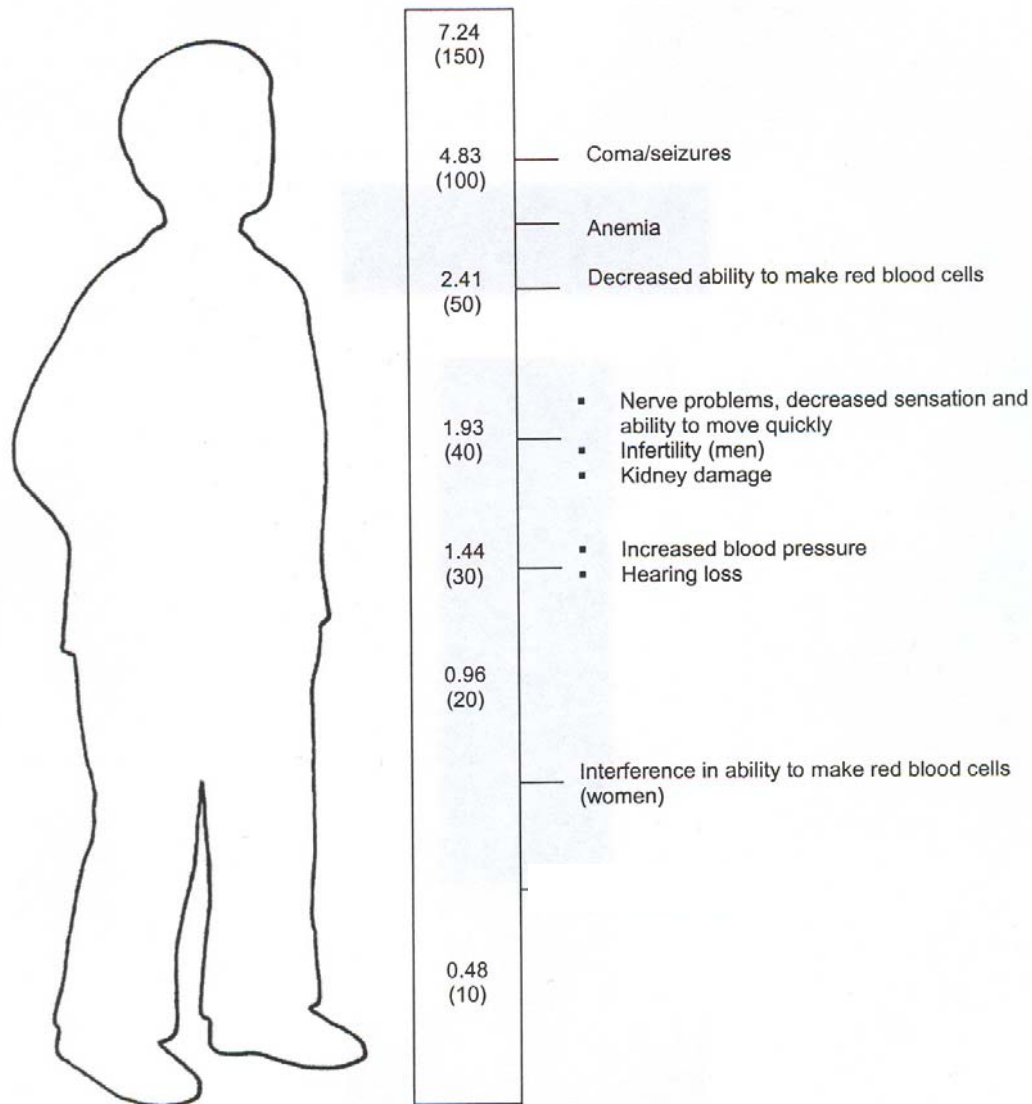
Reproductive and developmental effects

Lead can cause stillbirths and miscarriages in pregnant women exposed to it. Even low level exposure can effect 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.

Figure 1: Blood lead levels and physical symptoms



Blood level concentration - $\mu\text{mol/L}$
($\mu\text{g}/100 \text{ mL}$)

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.

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 to help determine if exposure is being effectively controlled. Together with hygiene monitoring, medical monitoring ensures worker health is not adversely affected. Note that since medical monitoring measures exposure after the fact, it is not a substitute for proper hygiene monitoring in the workplace.

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Where a worker may receive significant exposure to lead, the employer should routinely require workers to have a health assessment. Yearly testing is recommended. When hiring a worker, the employer should require the worker to have a health assessment. The purpose of this health assessment is to provide a baseline measure of the worker’s health. This provides a way of keeping track of 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.

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.

Health assessments should be offered to all workers involved in work that may result in elevated blood levels. Blood lead levels in workers exposed to lead should be less than 1.5 micromoles per litre ($\mu\text{mol/L}$).

In Alberta, blood lead results should be reported in the units of micromoles per litre of whole blood ($\mu\text{mol/L}$ 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 $2.5 \mu\text{mol/L}$, 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 $2.5 \mu\text{mol/L}$ or greater (see Table 1).

Blood lead levels on whole blood reported in micrograms per decilitre ($\mu\text{g/dL}$) can be converted to $\mu\text{mol/L}$ by multiplying the value by 0.0483. For example:

$$25 \mu\text{g/dL} \times 0.0483 = 1.21 \mu\text{mol/L}$$

Female workers of childbearing age who are pregnant or considering becoming pregnant should be monitored. Female workers need to have a health assessment at the same frequency as other workers. However, the blood lead level should be kept below $0.5 \mu\text{mol/L}$ (see Table 2).

Table 1: Blood lead levels for workers other than those covered in Table 2

Blood Lead Level (µmol/L)	Frequency of Follow-up	Required Actions
Less than 1.5	Annual blood testing for workers exposed to lead	<ul style="list-style-type: none"> Acceptable level – no action required
1.5 to 1.99	Blood testing every 6 months for workers exposed to lead	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 µmol/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

Blood Lead Level (µmol/L)	Frequency of Follow-up	Required Action
Less than 0.5	Annual blood testing for workers exposed to lead	<ul style="list-style-type: none"> Blood lead levels must be kept below the 0.5 limit
0.5 or more	To be determined by the treating physician based on blood lead level.	<ul style="list-style-type: none"> Worker to be removed from further exposure to lead

Managing lead in the workplace

To determine if lead poses a hazard 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

Air and surface testing

Air sampling and surface lead tests are an important part of assessing lead exposure and are part of an exposure control plan. Two types of sampling can be done — air sampling and collection of solid samples on surfaces 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/nmam

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, additional 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 is used for tetraethyl lead.

For 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 surface dust.

Portable x-ray fluorescence analyzers are available to measure the amount of lead in paint, without damaging the paint. 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.

There are a variety of lead test kits that are now available. These include kits for doing wipe samples on surfaces as well as for analyzing dust or paint chips. Some substances can interfere with the results from these test kits e.g. barium and chromate. The kits can also give false positive or false negative results, so should be used as screening tools. Analysis of the sample by a laboratory may still be needed to confirm the presence/absence of lead and lead concentrations. The US Occupational Safety and Health Administration (OSHA) has evaluated some test kits for lead. The results are available online at:

 www.osha.gov/SLTC/leadtest/index.html

OSHA also provides some guidance on lead surface sampling to evaluate skin exposure in the OSHA Technical Manual, available at:

 www.osha.gov/dts/osta/otm/otm_ii/otm_ii_2.html

Once samples have been collected and analyzed, the results must be compared to a standard to assess the potential hazard.

- For air samples, the results should be compared to the Occupational Exposure Limit (OEL) for lead in Alberta's occupational health and safety legislation.
- Paints containing less than 0.5 percent by weight of lead 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 developed dust-lead clearance standards of 40 µg/ft² for floors, 250 µg/ft² for interior window sills and 400 µg/ft² 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 surface 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

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 (administrative controls)
- 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.

Administrative controls

Work practices that can be implemented 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 must 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 and maintained properly.

The Ontario Ministry of Labour published the guideline “Lead on Construction Projects” in September 2004. This document provides guidance on work procedures where lead exposure is a potential hazard. It is available online at:


 www.labour.gov.on.ca/english/hs/guidelines/lead/index.html


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, or if they do not reduce the hazard sufficiently, protective equipment is needed. Respiratory protective equipment is used to remove contaminants from the air we breathe. Protective clothing is used to prevent skin contact with a contaminant or contaminated surfaces.

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

 http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe004.pdf
Guideline for the Development of a Code of Practice for Respiratory Protective Equipment

 http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe001.pdf
Respiratory Protective Equipment: An Employers' Guide

 http://employment.alberta.ca/documents/WHS/WHS-PUB_mg005.pdf
Medical Assessment of Fitness to Wear a Respirator

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, 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 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 potential 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 and the Centers for Disease Control and Prevention. The publication can be found online at:



www.hud.gov/offices/lead/library/LeadGuide_Eng.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. OELs are provided for lead compounds. 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 tasks or from substances such as lead paint.


Additional requirements include:

- Workers who are exposed to lead must be protected from further exposure.
 - Suitable showers, change rooms or other facilities must be provided to allow workers to remove contamination before leaving the work site.
 - No worker may eat, drink or smoke in an area of the workplace contaminated with lead.
 - Procedures must be established to minimize worker exposure to lead and workers must be trained in these procedures.
 - A lead exposure control plan must be developed if workers may be exposed to lead.
 - Medical monitoring (blood lead testing) must be made available to workers exposed to lead.
 - A Code of Practice must be developed if there is more than a small amount (10 kg) of lead at the work site.
 - Personal protective equipment must be properly selected, used and maintained.
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