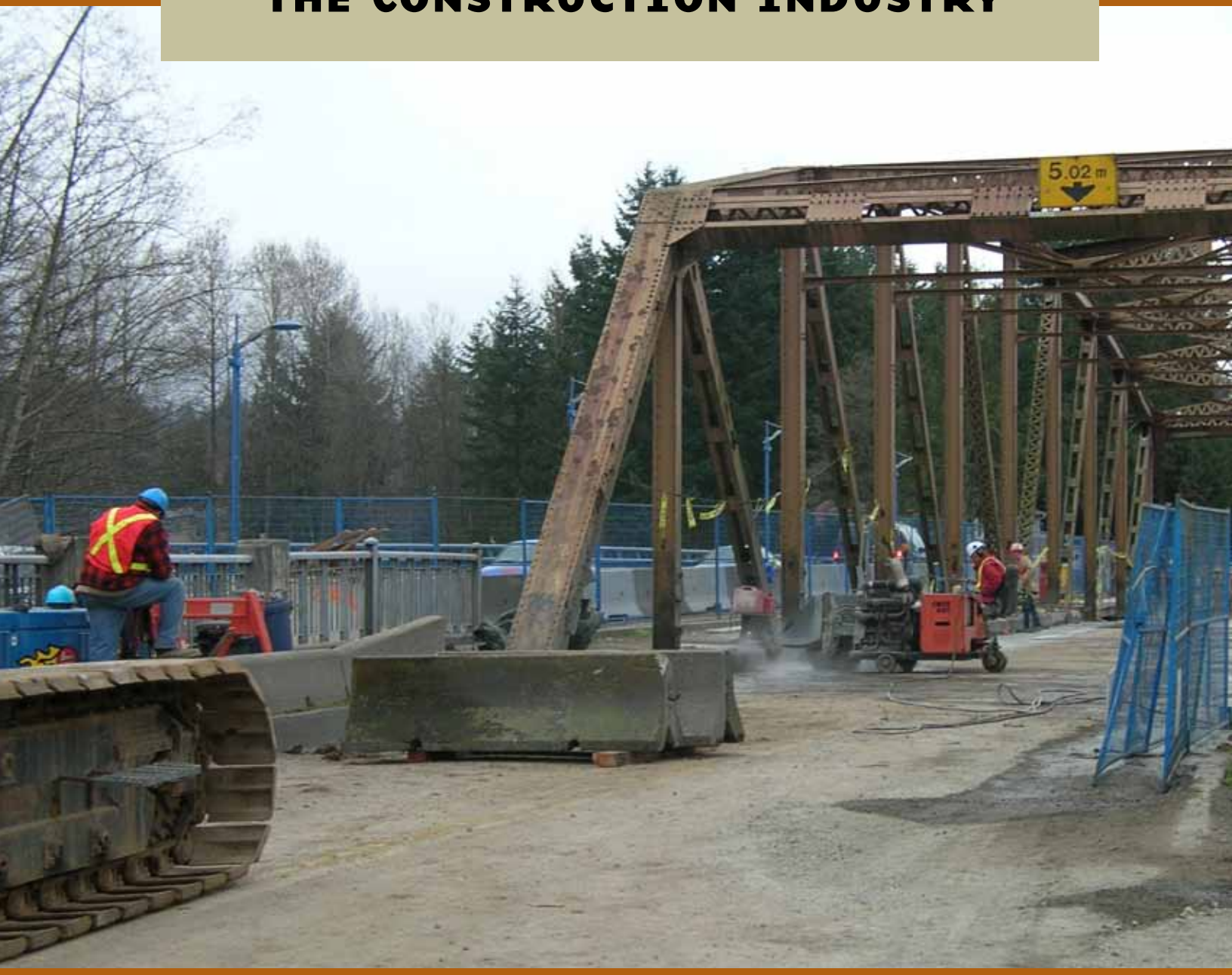
Lead-Containing Paints and Coatings

Preventing Exposure in the Construction Industry



WorkSafeBC
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WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act,* WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

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WorkSafeBC publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com

Some publications are also available for purchase in print:

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Introduction

Lead is a soft, bluish-grey metal that is pliable and corrosion-resistant. Until the 1980s, lead was used in paint because it increased durability, made colours more vibrant, and helped paint dry faster. Lead-containing paint is still used for the yellow lane dividers on roads and highways, and there is no restriction on lead in industrial coatings.

Lead-containing paints and coatings do not present a hazard if they are left intact. The health risk occurs when they chip, peel, or are otherwise damaged. When lead-containing materials are disturbed (e.g., scraped or sanded), lead dust can be released into the work environment and be inhaled or ingested by workers and other people, including children.

Who should read this manual?

This manual is for employers, supervisors, and workers who may come into contact with lead-containing paints and coatings in the construction industry. It provides information about lead and assists employers in developing suitable safe work procedures. If you are involved with lead-containing paint removal or other processes that could disturb lead-containing paints and coatings, you need to know how to work safely.

Workers who are most at risk of high lead exposure include those in workplaces where activities such as the following are carried out:

- Demolition or renovation of bridges, dams, structures, and buildings where lead-containing paints or coatings were used
- Lead abatement (removal of lead-containing paints and coatings)
- Dismantling or movement of abrasive blasting (and other) enclosures
- Welding, brazing, and soldering of products where lead is on or in the metal (such as on steel structures)
- Removal of lead debris and dust from a firing range
- Cleaning of power tools without (and even with) dust collection systems
- Cleaning of lead dust collection systems and filters
- Application of lead-containing paints or coatings

The Occupational Health and Safety Regulation (the Regulation) describes requirements for workplaces in which hazardous materials such as lead-containing paints and coatings are or may be present. This manual explains these requirements and describes how employers can meet their legal obligations to provide a safe working environment for workers.

In the Regulation

- Section 5.48, Exposure limits
- OHS Guideline G5.48-1, Table of exposure limits — background information
- Table of Exposure Limits for Chemical and Biological Substances
- Section 5.54, Exposure control plan
- Sections 6.59–6.69, Lead
- Section 5.57, Designated substances

What does ALARA mean?

ALARA means **a**s **l**ow **a**s **r**easonably **a**chievable. The ALARA principle applies to lead, which means that worker exposures to lead in paints and coatings must be kept as low as reasonably achievable. Although the Regulation specifies exposure limits for lead, employers must further reduce or eliminate worker exposure *if it can reasonably be done.*

Lead is an ALARA substance and is listed as a 2A and 2B carcinogen (probably and possibly, respectively, carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Lead also has an "R" designation in the WorkSafeBC "Table of Exposure Limits for Chemical and Biological Substances," meaning that the substance has an adverse reproductive effect.

Where possible, if damaged or during renovations, lead-containing materials should be replaced with products that do not contain lead. Improvements in technology as well as new work practices and procedures will help employers decrease worker exposures and move closer to the ultimate goal of zero exposure.

Use this manual as a starting point

This manual was developed to assist employers, general construction contractors, and trade contractors, who have a duty under the *Workers Compensation Act* and the Occupational Health and Safety Regulation to protect workers from exposure to lead. It was also developed to raise awareness within the construction industry about the hazards posed by lead in construction and to provide direction on methods that should be used to control exposure.

This document also provides basic information that employers can use to develop an exposure control plan and their own site-specific procedures. If a worker is or may be exposed to potentially harmful levels of lead, the employer must ensure that a risk assessment is conducted by a qualified person. The employer must also ensure that an exposure control plan (ECP) is developed and implemented. The ECP must meet the requirements of section 5.54 of the Regulation.

This manual can help determine how a risk assessment can be used to classify the risk level of the work and to select the controls required to protect the workers. Task-specific controls and personal protective equipment recommendations are included in the Appendix, along with a sample exposure control plan.

Must versus *should*

In this manual, the word *must* means that a particular safety step is required by the Regulation. The word *should* indicates that a particular action, although not specified in the Regulation, will improve safety in the workplace.

Refer to the Occupational Health and Safety Regulation

This manual is not a definitive guide and does not replace the Regulation. It complements the Regulation and is a tool to help industry work safely. You will still need to refer to the relevant sections of the Regulation (see page 11) to determine the exact requirements that apply to your operation.

containment

An isolation system designed to effectively contain lead dust and debris within a designated work area where lead-containing materials are handled, removed, encapsulated, or enclosed.

enclosure

A physical barrier made of materials such as gyproc (gypsum wallboard), plywood, metal, or polyethylene (poly) sheeting used to separate lead-containing materials from the habitable environment.

hazard identification/assessment

A comprehensive document that determines the conditions or changing set of circumstances in a workplace that present a potential for injury, illness, or property damage, including any activities that could produce harmful consequences.

HEPA filter

Defined in the Regulation as a high-efficiency particulate air filter that is at least 99.97% efficient in collecting an aerosol particle 0.3 micrometre in size. When used for respiratory protection, HEPA filters are now referred to as *NIOSH 100 series filters*, or "100" filters for short.

lead-containing surface coating materials

Defined by the federal Ministry of Health, under the *Hazardous Products Act*, as a paint or other similar material that dries to a solid film that contains over 90 mg/kg (0.009%) dry weight of lead.

negative air unit

A cabinet, usually portable, that contains a fan and one or more HEPA filters. Negative air units are used to exhaust air from an enclosure, reducing the risk of contaminated air escaping into the workplace through a leak in the enclosure. Negative air unit efficiency should be tested at least annually using a suitable indicator chemical, such as dioctyl phthalate (DOP) or polyalphaolefin (PAO) aerosols.

NIOSH 100 series filter

A high-efficiency particulate air (HEPA) filter used for respiratory protection. These HEPA filters, called "100" filters for short, are at least 99.97% efficient in collecting an aerosol particle 0.3 micrometre in size, and carry an N, R, or P designation that specifies where and for how long the filter can be used (see Table 1).

Table 1. NIOSH 100 series filter designations.

Filter designation	For use in...	Time-use limitations
N = No oil	Oil-free atmospheres only (atmospheres containing no oil mist)	May be reused only after considering cleanliness, filter damage, and increased breathing resistance
R = Oil-resistant	Oily atmospheres	A single shift only (or eight hours of continuous or intermittent use)
P = Oil-proof	Oily atmospheres	Check the manufacturer's specified time-use limitations for each P-type filter

practicable

Defined in the Regulation as "that which is reasonably capable of being done."

qualified person

An occupational health and safety professional with experience in the practice of occupational hygiene as it relates to lead management.

respirator

A device worn to prevent the inhalation of hazardous airborne substances. There are two basic types of respirators: air-purifying and air-supplying. So-called "single-use" or "disposable" respirators are not acceptable for working with lead-containing materials.

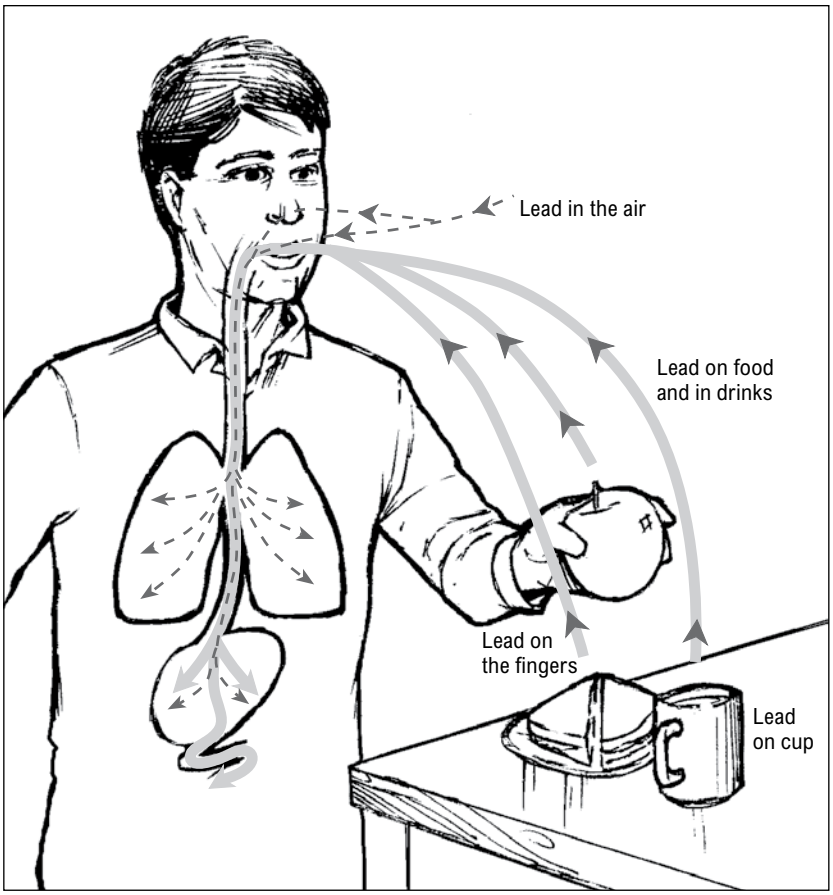
risk assessment

A comprehensive document, developed to select appropriate workplace controls, that evaluates the probability and degree of possible illness, injury, or death in a hazardous situation.

workers

Includes supervisors, managers, and workers.

Health effects of lead exposure



Lead gets into your body when you breathe in lead dust or fume or when you swallow lead.

Lead enters your body when you breathe it in (inhalation) or when you swallow it (ingestion). Lead can enter your body if you:

- Breathe in lead dust or fume
- Drink or eat food contaminated with lead
- Eat or drink from contaminated cups, plates, or bowls
- Bite your nails or smoke when your fingers are contaminated with lead
- Smoke or chew gum where there is lead dust or fume
- Put objects contaminated with lead in your mouth (such as pens and pencils from the work area)

Once lead is in your bloodstream, it is carried throughout the body and stored in various body tissues, mostly in the bones. The body can get rid of lead naturally over time, but lead may build up or accumulate in your body if it enters your body faster than you can get rid of it.

Common signs and symptoms

Early signs and symptoms of high lead levels may include:

- Tiredness and weakness
- Headaches
- Lack of appetite
- Metallic taste

Later signs and symptoms may include:

- Abdominal aches or pains
- Constipation
- Muscle and joint aches and pains
- Memory problems

Signs and symptoms of lead exposure may take a long time to develop.

Workers with similar exposures to lead may have different symptoms, which may also vary in severity. *All* workers need to prevent or minimize lead exposure.

Possible effects

Lead can affect the brain and nervous system, the reproductive system, the digestive system, the kidneys, and the body's ability to make blood. Lead is also a suspected human carcinogen and has been shown to cause cancer in laboratory animals. Possible effects of lead absorption are:

- Anemia
- Nerve damage causing muscle weakness
- Decrease in brain function
- Kidney damage
- High blood pressure
- Reproductive effects in both men and women

There may also be adverse effects for a developing fetus (for example, low birth weight and developmental delays) when the mother is exposed to even fairly low levels of lead. If a woman has been exposed to a significant amount of lead before pregnancy, then during pregnancy lead may come out of the body tissues where it is stored and may enter the blood and the fetus. Lead is also excreted in breast milk.

Children are generally considered at higher risk than adults for health problems from lead exposure. In addition to the health problems suffered by adults, children may also have problems with mental and physical development.

Measuring lead in the body

The amount of lead present in a person's body is measured using a blood test. The typical blood lead level for an adult is less than 0.1 micromoles per litre (µmol/L), or 2 micrograms per decilitre (µg/dL). Overt symptoms of lead poisoning in adults generally begin at blood levels between 3 and 6 µmol/L (60 to 120 µg/dL). If a worker's blood lead level exceeds 1 µmol/L (20 µg/dL), exposure should be minimized and protective measures improved.

Responsibilities

Everyone in the workplace has health and safety responsibilities—including owners, employers, prime contractors, supervisors, and workers.

Owners

Owners have the following responsibilities:

- Provide and maintain the land and premises that are being used as a workplace to ensure the health and safety of anyone at or near the workplace.
- Provide the employer or prime contractor at the workplace with information known to the owner that is necessary to identify the hazards, including lead.
- Comply with the relevant sections of the Regulation and the *Workers Compensation Act* (the Act), as well as any applicable orders.

Employers

Employers have the following responsibilities:

- Ensure the health and safety of all workers at the worksite.
- Identify workplace hazards and assess the risks of injury associated with those hazards.
- Conduct a risk assessment for lead exposure, develop an exposure control plan, write safe work procedures, and implement controls.
- Ensure that workers and supervisors are adequately instructed and trained.
- Keep written records of training (detailing who, what, and when).
- Establish and maintain an occupational health and safety program, including a written health and safety policy and a procedure for incident investigations.
- Support supervisors, safety coordinators, and workers in their health and safety activities.
- Take action immediately when a worker or supervisor tells you about a potentially hazardous situation.
- Initiate immediate investigations into incidents.
- Report exposure incidents to WorkSafeBC.
- Provide adequate first aid facilities and services.
- Provide and maintain personal protective equipment, clothing, and devices as required.
- Ensure that your workers follow the requirements of the Regulation and the Act. Ensure that workers have access to these documents.

Prime contractors

Prime contractors have the following responsibilities:

- Ensure the coordination of health and safety activities for employers, workers, and others at the workplace.
- Do everything that is reasonably practicable to establish and maintain a system or process that will ensure compliance with the relevant sections of the Regulation and the Act.

Each employer at a multiple-employer workplace must give the prime contractor the name of the person the employer has designated to supervise his or her workers.

What is a *prime contractor?*

In a workplace with multiple employers, the *prime contractor* is the directing contractor, employer, or other person who enters into a written agreement with the owner of that workplace to be the prime contractor. If there is no such agreement, then the prime contractor is the owner of the workplace.

Reference: Section 118(1) of the *Workers Compensation Act*

Supervisors

Supervisors have the following responsibilities:

- Instruct workers in safe work procedures.
- Ensure that workers are familiar with and follow the exposure control plan.
- Train workers for all tasks assigned to them, and regularly check that they are doing their work safely.
- Ensure that only authorized, adequately trained workers operate tools and equipment or use hazardous chemicals.
- Ensure that workers follow safe work procedures for handling, storing, and maintaining equipment and materials.
- Enforce health and safety requirements.
- Correct unsafe acts and conditions immediately.
- Identify workers with problems that could affect safety at the worksite, and follow up with interviews and referrals where necessary.
- Create health and safety rules, and inspect the workplace regularly for hazards.

Workers

Workers have the following responsibilities:

- Know and follow health and safety requirements that apply to your job.
- If you don't know how to do something safely, ask your supervisor for training before you begin work.
- Participate in all required health and safety education and training.
- Work safely, and encourage your co-workers to do the same.
- Use all required personal protective equipment and clothing.

- Correct any unsafe conditions or immediately report them to your supervisor.
- Immediately report any injury to a first aid attendant or supervisor.
- Inform your supervisor of any physical or mental impairments that may affect your ability to work safely.
- Make suggestions to improve health and safety.

Consultants

Consultants:

- Should be occupational health and safety professionals with experience in the practice of occupational hygiene as it relates to lead management.
- Must follow accepted occupational hygiene practices, including those related to:
  - The collection and identification of samples
  - Performance of risk assessments
  - Development of safe work procedures
  - Implementation of exposure control methods
- Should provide documentation in a reasonable timeframe and clearly explain any results, conclusions, and recommendations to their clients.

Regulation requirements

This section summarizes the key requirements in the Regulation that relate to lead exposure.

Section 5.2, General information requirement

This section describes the requirement to identify a chemical or biological agent, its possible effects on health, and precautions required to protect worker health and safety. This information must be clearly communicated to workers.

Guideline G5.3-5, Leaded surface coating materials

The purpose of this guideline is to clarify the application of supplier label and material safety data sheet (MSDS) requirements to lead-containing surface coating materials. It also defines a "surface coating material" and sets out requirements for coatings with a lead content that exceeds 90 mg/kg.

Sections 5.48–5.59, Controlling exposure

These sections describe general requirements for controlling exposure to various hazardous materials in the workplace. The sections include the following:

- Exposure limits
- Workplace monitoring to assess exposure levels
- Monitoring methods acceptable to WorkSafeBC
- Exposure control plans
- Types of risk controls
- Designated hazardous substances
- Investigating symptoms of overexposure

The current occupational exposure limit for lead (elemental and inorganic compounds, as lead) is 0.05 milligrams of lead per cubic metre of air (mg/m^3).

Guideline G5.53-4, Occupational hygiene methods acceptable to WorkSafeBC

The purpose of this guideline is to provide information on the publications that detail occupational hygiene methods (such as sampling and analytical methods) acceptable to WorkSafeBC.

Guideline G5.54-5, Health monitoring

WorkSafeBC may require health monitoring for workers exposed to lead (or other substances) as part of an exposure control plan. This guideline describes the purpose of a health monitoring program and how it should be carried out. Health monitoring should be considered when:

- There is reasonable likelihood of a workplace exposure.
- The exposure can potentially cause an occupational disease or adverse health effect.
- There is a means of detecting or measuring the disease, adverse health effect, or its precursor or biological indicator (such as lead in blood).

Sections 6.59–6.69, Lead

These sections describe specific requirements for workplace exposure to lead. Employers are responsible for the following:

- Develop and implement an exposure control plan (see "Exposure control plans," beginning on page 15) if workers are or may be exposed to lead.
- Conduct air monitoring if workers are at risk of overexposure to airborne lead in a construction project.
- Post warning signs at the boundary of work areas where hazardous lead exposures could occur.
- If lead might contaminate exposed skin or work clothing, meet the requirements for personal hygiene (see section 5.82).
- Keep work area surfaces free of lead dust as much as possible.
- When removing lead dust, use a method that avoids spreading it into other work areas.
- Instruct and train workers who are at risk of exposure to lead.
- Develop and implement a health protection program (see "Health monitoring" on page 20) if workers are exposed to potentially hazardous levels of lead.
- Maintain records of risk assessments, worker exposures, and worker training.

Section 12.115, Coatings on metals

According to this section, lead coatings must be removed from metal, whenever practicable, before welding or cutting begins.

Section 20.2, Notice of project

According to this section, if a construction project will significantly disturb coatings that contain lead (potentially producing concentrations of airborne lead in excess of 50% of the exposure limit), the owner or prime contractor must file a notice of project (NOP) with WorkSafeBC, in writing or by fax, at least 24 hours before starting the project. For more information or to file an NOP online, visit WorkSafeBC.com, and under "Quick Links," click "Notice of Project."

Section 20.112, Hazardous materials (Demolition)

This section describes the requirements that employers and owners are responsible for before beginning work on the demolition or salvage of machinery, equipment, buildings, or structures. The employer or owner must:

- Inspect the site to identify any lead that may be handled, disturbed, or removed.
- Have the inspection results available at the worksite.
- Ensure that lead is safely contained or removed.

Who is qualified to deal with lead?

According to the Regulation, qualified means "being knowledgeable of the work, the hazards involved and the means to control the hazards, by reason of education, training, experience or a combination thereof."

When lead-containing materials may be present, a qualified person should be an occupational health and safety professional with occupational hygiene experience related to lead. Examples include the following:

- Certified industrial hygienist (CIH)
- Registered occupational hygienist (ROH)
- Certified safety professional (CSP)
- Canadian registered safety professional (CRSP)
- Individuals with other acceptable education, training, and experience, including recognized courses in lead inspection, management, and abatement, as well as extensive experience within the lead abatement industry

These professionals should have education, training, and experience in recognizing, evaluating, and controlling lead hazards.

Exposure control plans

Employers are required to develop and implement an exposure control plan to minimize worker exposure to lead if:

- Workers are or may be exposed to airborne particulate that contains lead.
- Worker exposure through any route of entry could cause elevated blood levels.

Lead is an ALARA substance, and worker exposure must be kept as low as reasonably achievable.

In the Regulation

- For more information on exposure control plans and exposure limits, see sections 5.48–5.59.
- For more information on requirements for lead, see sections 6.59–6.69.

What is an exposure control plan?

Written exposure control plans explain the work procedures and other controls that will be used to reduce workers' risk of lead exposure. Exposure control plans must detail steps to eliminate risk or to control and reduce risk by either:

- Substituting with safer materials, where feasible, or
- Using engineering controls, administrative controls, or personal protective equipment (PPE)

Strict adherence to the ALARA principle (see page 2) as well as exposure limits and appropriate respiratory and skin protection are essential elements of exposure control plans. Employers must also ensure that qualified persons (see page 5) perform a formal risk assessment to determine which workers may be exposed to lead contaminants, and the extent of any exposure. Risk assessment applies not only to the lead itself but also to the methods used to remove or handle it.

Who needs an exposure control plan for lead?

Exposure control plans may be required by many employers, including the following:

- Construction and demolition contractors
- Lead abatement contractors
- Hazardous materials consultants
- School district maintenance facilities
- Commercial building management agencies
- Painters and welders
- Manufacturers of products containing lead (for example, paint, plastics, and ceramics)
- Recycling facilities (painted wood and scrap metal)

In the Regulation

For more information about the requirements for exposure control plans, see sections 5.54 and 6.34.

Elements of an exposure control plan

Every workplace is unique, so you need to develop an exposure control plan that is specific to your workplace. Exposure control plans should be developed only by a qualified person.

Your exposure control plan must include the following:

- Statement of purpose
- Responsibilities of employers, supervisors, and workers
- Risk identification and assessment
- Risk controls
- Written safe work procedures
- Worker education and training
- Written records
- Hygiene facilities and decontamination procedures
- Health monitoring

Statement of purpose

The purpose of an exposure control plan is to prevent harmful exposure of workers to chemicals (including lead) in the workplace. The following is an example of a typical statement of purpose:

> *[Name of employer] is committed to providing a safe and healthy workplace for all of our staff. A combination of measures will be used to achieve this objective, including the most effective control technologies available. Our work procedures will protect not only our workers but also any other workers who enter our workplace. All employees must follow the procedures described in this plan to prevent or reduce exposure to lead-containing materials.*

Responsibilities of employers, supervisors, and workers

Employers

Employers have the following responsibilities:

- Ensure that the resources (for example, safe work procedures, worker training, and PPE) required to implement and maintain the exposure control plan are readily available where and when they are required.
- Select, implement, and document the appropriate site-specific control measures.

- Ensure that supervisors and workers are educated and trained to an acceptable level of competency.
- Ensure that workers use appropriate PPE (for example, disposable coveralls, eye protection, and respirators).
- Conduct a periodic review of the plan's effectiveness. This includes a review of the available control technologies to ensure that these are selected and used when practical.
- Maintain records of training and inspections.
- Ensure that a copy of the exposure control plan is available to workers.

Supervisors

Supervisors have the following responsibilities:
- Ensure that workers are adequately instructed in the workplace controls.
- Ensure that workers use appropriate PPE.
- If workers require respirators, ensure that they have been fit-tested and that the results are recorded.
- Direct work in a manner that eliminates or minimizes the risk to workers.

Workers

Workers have the following responsibilities:
- Know the hazards of the workplace.
- Follow established safe work procedures as directed by the employer or supervisor.
- Use any required PPE as instructed.
- Report any unsafe conditions or acts to the supervisor.
- Know how and when to report exposure incidents.

Hazard identification and risk assessment

Employers must ensure that potential workplace hazards are identified and that the risks associated with those hazards are assessed. If there may be lead-containing paints or coatings at the worksite that will be disturbed (for example, by sanding or demolition), the employer will need to do the following before work begins:
- Conduct a lead survey to identify potential hazards.
- Assess the risks associated with those hazards.
- Control the risks by eliminating or minimizing them.

For more information, see "Hazard identification—Testing for lead," beginning on page 22, and "Risk assessment—Classifying abatement work," beginning on page 28.

Exposure limit

The occupational exposure limit for airborne lead is 0.05 mg/m^3. As lead is a suspected human carcinogen, the ALARA principle also applies, and workplace exposure must be reduced to levels ***a****s* ***l****ow* ***a****s* ***r****easonably* ***a****chievable.*

Risk controls

Risk controls are measures that are used to eliminate the risk to workers or, if elimination is not possible, minimize the risk.

Hierarchy of controls

Some types of controls are more effective than others, although it may not always be practicable to use the more effective solution. Whenever possible, however, controls must be implemented in the following order of preference:

1. Substitute less hazardous materials or processes (for example, replace lead-containing paints with paints that do not contain lead).
2. Use engineering controls, such as barriers, enclosures, and local exhaust ventilation.
3. Use administrative controls, such as work scheduling (limiting the shift time for workers exposed to lead), proper use of washing facilities, and setting up a blood monitoring program.
4. Use PPE. PPE is considered the last line of defence and should be used only when other controls are not practicable, or in addition to other controls. The proper use, fit, and disposal of PPE must also be considered.

Workplace controls should be based on a risk assessment conducted by a qualified person.

Written safe work procedures

Written safe work procedures describe how to carry out specific tasks safely and efficiently. In general, safe work procedures are written for:

- Hazardous tasks

- Complicated tasks, so that important steps don't get missed
- Frequently performed tasks
- Less routine tasks, to remind workers of the hazards and how to control the risks

Written safe work procedures should specify any required PPE, when it must be used, and where it can be found. Post the procedures where they will be available to workers. These procedures must be submitted to WorkSafeBC along with a notice of project (NOP) prior to the start of a lead abatement project.

How to develop a written safe work procedure

Follow these five steps when developing a written safe work procedure:

1. Determine the overall task for which the safe work procedure is needed.
2. Break down the task into its basic steps.
3. Identify the hazards associated with each step.
4. Identify the actions needed to minimize the risks to workers from these hazards.
5. Prepare a list of the actions that workers must do when performing the task.

Hygiene facilities and decontamination procedures

Employers must prepare safe work procedures and provide adequate wash facilities to help control lead exposure, including:

- Good housekeeping procedures, including end-of-workday procedures
- Washing facilities
- Shower facilities as required
- Separate "clean" and "dirty" changing areas
- Clean eating and drinking facilities

Worker education and training

Employers must ensure that workers are informed about the contents of the exposure control plan, and that they are educated and trained to work safely. Exposure control plans should describe worker education and training, and how they will be carried out. Education and training are particularly important for new workers.

Written records

The exposure control plan should be written down, and records should be kept for each component of the plan. For example, document education and training activities—keep track of who was trained, when the training took place, and what it included. Other documentation should include the following:

- Workplace inspections
- Health and safety meetings
- Accident investigations
- Health monitoring records

Health monitoring

An exposure control plan for lead should also include medical monitoring (for example, blood testing) of workers who will be working with or around lead-containing materials. For more information, see "Health monitoring" beginning on page 38 and "Guide to health monitoring" in the Appendix.

Reviewing the plan

Review the exposure control plan at least once a year, and update it as necessary. During this process, consult with the joint health and safety committee (or the worker health and safety representative, if applicable).

Respirator program

A respirator program is a formal plan for using respirators at a specific worksite. If respirators are required as part of an exposure control plan and used at a workplace, a respirator program must be in place. You cannot simply hand out respirators and expect workers to use them properly.

Ideally, one person in the organization should be designated as the program administrator and have overall responsibility for the program. Parts of the program can be delegated to others, but the final authority for running the program should rest with one administrator. It is important that whoever is assigned the responsibility for respirators has the knowledge to perform the job.

Elements of a respirator program

The Regulation lists six essential elements of a respirator program:

- Statement of purpose and responsibilities
- Written procedures for selection, use, inspection, cleaning, maintenance, and storage of respirators
- Instruction and training
- Medical assessment of respirator wearers, where required
- Documentation
- Program review

Hazard identification and risk assessment should be conducted only by a qualified person (see page 5). This person should be able to evaluate the lead hazard and classify the work activity as a low, moderate, or high risk.

Consider where and how lead is used in the workplace. For example:

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

When lead is present in a surface coating, consider the following:

- Information from the U.S. Occupational Safety and Health Administration (OSHA) suggests that the improper removal of lead paint containing 600 mg/kg lead results in airborne lead concentrations that exceed half of the exposure limit. This would trigger the requirement for an ECP and safe work procedures.
- Lead concentrations as low as 90 mg/kg may present a risk to pregnant women and children. Any risk assessment should include for the presence of high risk individuals within the workplace.

Follow these guidelines:

- Look at historical project records to see whether lead-containing paint was used in the workplace. For example, check project specifications, inspection reports, and material safety data sheets (MSDSs) from paint manufacturers.
- Conduct field tests. For example, use chemical spot tests or portable X-ray fluorescence analyzers to detect lead in paint.
- Conduct laboratory tests to confirm positive field tests, or in cases where lead-containing paint is suspected but the field test does not indicate the presence of lead.

Lead test kits

Lead test kits are available that are intended mainly for consumers to use to determine whether lead is present on surfaces. They are both easy to use and inexpensive. The kits use a colorimetric reaction with the lead (usually a pink colour change) that is immediately visible, but they do not give an actual number for the lead present — just a yes/no type of response.

OSHA has tested a number of these kits and posted its results at http://www.osha.gov/SLTC/leadtest/index.html.

Although these kits are useful as a quick screening tool to check for lead, a negative response does not prove that lead is not present. For a more thorough lead analysis, a bulk sample should be collected and sent to a laboratory.

Bulk paint sampling

Paint chips can be collected and submitted to a laboratory for lead analysis. The U.S. National Institute of Occupational Safety and Health (NIOSH) has developed a number of methods for analyzing lead in paint, including Methods 7082, 7105, and 7300. The paint sample collected should be about 2.5 centimetres (cm) by 2.5 cm in area. When collecting paint samples, you must make sure that all of the layers of paint or coating are collected, right down to the original surface. The results are usually reported by the laboratory in micrograms per gram (µg/g) or milligrams per kilogram (mg/kg). If the area sampled is included, the lab may also report results in milligrams per square centimetre (mg/cm^2).

Care must be taken not to contaminate adjacent areas while collecting samples. The damaged area should be encapsulated or repaired, and any dust or debris removed by wet-wiping or HEPA vacuuming.

X-ray fluorescence (XRF) analyzers

Portable X-ray fluorescence analyzers are available to measure the amount of lead in paint and other surface coatings. These units work by exposing a painted or coated surface to X-rays or gamma radiation, which causes any lead present to emit energy with a certain frequency. This energy is then measured by the instrument, and a lead concentration is displayed.

The major advantage of XRF analyzers over other methods are:

- They give an immediate reading of the amount of lead present, without damaging the paint.
- Numerous readings can be taken quickly.
- XRF analyzers can also measure lead in wipes, dust, soil, and air filters.

Disadvantages are that the thickness of the paint may influence the results and that the instrument reports results per unit area (rather than per unit weight). It may not be possible to correlate XRF data (in $\mu g/cm^2$ or mg/cm^2) with laboratory results reported by weight (in mg/kg or a percentage). Users (employers, consultants, or workers) should develop a comparison table that relates lead-containing paint samples analyzed by a laboratory to readings

from the XRF analyzer. Laboratories can report results by area (as well as by weight) if the area of the paint sample collected was also measured. The U.S. Environmental Protection Agency (EPA) has stated that the following values are "positive" for lead:

- 1 mg/cm^2
- 5,000 µg/g
- 5,000 mg/kg
- 5,000 parts per million (ppm), or
- 0.5% by weight

Recent data collected in B.C. suggest that 0.04 mg/cm^2 is equivalent to about 600 µg/g or 0.06% by weight; however, factors such as paint thickness may affect the results.

Portable XRF instruments emit X-rays or gamma radiation, and these instruments should be used only in accordance with a written radiation safety program. Operators of tube-based devices must have a valid X-ray Fluorescence Operator Certification from Natural Resources Canada. Units that utilize a radioactive source are licensed to employers by the Canadian Nuclear Safety Commission (CNSC).

All users of these devices must be properly trained both to handle the instrument and to protect themselves and other workers from radiation. For example, persons should not be near the opposite side of the area (wall, ceiling, or floor) being tested. It is also recommended that operators wear dosimeter badges to monitor exposure to radiation.

Lead in surface dust

Lead in surface dust can be collected by wipe-sampling or vacuum-sampling techniques. Wipe sampling requires completely wiping a measured surface area (usually 10 cm by 10 cm or 1 foot by 1 foot) with a pre-wetted wipe. Commercially available hand wipes are suitable, as are sterile cotton gauze and ashless filter paper material. These should be lead-free and easily processed by the laboratory. Wipe sampling can determine surface lead loading (usually in micrograms per unit area) as well as dermal exposures (for example, lead dust on hands). A standard laboratory method for lead in surface wipe samples is NIOSH Method 9100.

Vacuum sampling is particularly suitable for soft surfaces. The most common sampling device is a cassette attached to a personal sampling pump, but specialized high-flow vacuums are also available for sampling lead dust.

Regardless of the sampling device used, the area sampled should be recorded. Vacuum sampling can determine lead contamination by area and weight (if pre-weighed filters or cassettes are used). NIOSH Methods 7082 and 7105 are suitable for determining the amount of lead in vacuum sample cassettes.

Lead in air

To measure worker exposure to airborne lead, samples are collected from a worker's breathing zone by using a filter cassette connected to a personal sampling pump. The duration of the sample collection depends on the time required to perform the work and the amount of dust in the air. Ideally, the sample should be collected for a full work shift, but shorter periods may be required in order to prevent overloading of the cassette in dusty atmospheres. The cassettes are submitted to a laboratory for analysis. Lead content is reported in mg/m^3 or $\mu g/m^3$.

The number of samples required will depend on the nature of the work task and the amount of material affected. More air samples should be collected if the work activity generates significant amounts of lead-containing dust (for example, abrasive blasting) or if the affected work area is large. Samples should be collected:

- At the beginning of a project
- When establishing the effectiveness of workplace controls
- When there's a change in work crew

NIOSH analytical methods

The NIOSH analytical methods that have been referenced in this section can be downloaded from http://www.cdc.gov/niosh/docs/2003-154/.

Selecting a laboratory

Laboratory services are usually chosen based on sample cost, turnaround time, and convenience of location. You should, however, ask the following straightforward questions to find out whether the laboratory can provide the proper service:

- Is the laboratory accredited?
  A number of agencies, including the Canadian Association for Laboratory Accreditation (CALA) and the American Industrial Hygiene Association (AIHA), offer laboratory accreditation programs.

- Does the laboratory participate in a proficiency testing program?
  The AIHA administers an Environmental Lead Proficiency Analytical Testing (ELPAT) program, in which test samples are sent to participants four times a year. These test samples include paint chips, soil samples, dust wipes, and air filters.
- Does the laboratory have a quality control program?
- What analytical methods does the laboratory follow, and what are their detection limits (the detection limit is the level below which the laboratory cannot report an accurate amount of lead)?
- What is the turnaround time for sample analysis?
- What is the sample cost?
- Will the laboratory provide sampling materials?
  Many laboratories will provide wipes, gloves, templates, tubes, air sample cassettes, etc., for submitting samples.
- Will the laboratory accept composite samples (paint samples combined from several sources)?
- Will the laboratory complete all of the calculations?
  Some labs will report only the actual amount of lead found on the sampling media (such as wipes or filter cassettes) and leave it up to the sampler to convert the results to µg lead/gram of dust, $\mu g/cm^2$ of surface, or mg/m^3 of air.

Lead clearance levels for surfaces

Clearance levels can be used:

- As part of a risk assessment to establish the extent of contamination before a project begins
- To determine the effectiveness of workplace controls and the adequacy of housekeeping as lead is removed
- Along with a visual inspection, to help confirm that the lead hazard has been removed and the abatement project is complete

A number of agencies, including the U.S. Department of Housing and Urban Development (HUD) and the U.S. EPA, have established surface clearance criteria for lead abatement. These levels were originally intended for residential settings, public housing, and locations frequented by children. Many jurisdictions in the U.S. and Canada have adopted these values (or derivatives of them) to protect the health of workers (including pregnant workers) and the general public, as well as children. However, some commercial and industrial buildings may have little or no association with children, so clearance criteria could take this into account.

Table 2 lists recommended clearance criteria that should be applied to lead abatement projects.

Table 2. Recommended lead clearance criteria for surfaces.

	Floor	Sill/ledge	Trough
Residences, schools, daycare centres, and other public buildings	0.43 mg/m^2 (40 µg/ft^2)	2.7 mg/m^2 (250 µg/ft^2)	4.3 mg/m^2 (400 µg/ft^2)
Commercial buildings, including retail stores, offices (administrative), and laboratories (other than lead assay laboratories)	2.2 mg/m^2 (200 µg/ft^2)	5.4 mg/m^2 (500 µg/ft^2)	8.6 mg/m^2 (800 µg/ft^2)

Additional recommendations:

- Lead levels on clean surfaces in eating areas should not exceed 40 µg/ft^2.
- Lead residue on "cleaned" structural steel (from which a lead-containing coating has been removed) should not exceed 40 µg/ft^2 prior to welding, cutting, or burning.

Once you've identified hazards, the next step is to assess the risks associated with them. Work involving lead-containing paints or coatings can be classified as low, moderate, or high risk.

When assessing risks, consider the work methods or procedures that may result in exposure. The potential for exposure will vary from workplace to workplace, and will depend on work activities.

In addition, consider which workers have a higher risk of exposure. Appropriate protective measures will vary according to the kinds of activities workers perform. Workers who are at risk of exposure to lead-containing materials could be documented using information such as:

- The age of the building (the older the building, the more likely lead will be present in paint and accumulated dust)
- The location of the work (small confined area, large area, indoors, outdoors, etc.)
- The size of the area to be removed
- The amount of lead in the paint or coating
- The condition of the paint or coating (intact, deteriorated, flaking, etc.)
- The task or procedure (how will the lead-containing coating be removed?)
- Whether there are other workers who might be affected by the work
- The duration of the project
- The level of risk to workers (defined based on the above items):
  - Low
  - Low-moderate
  - Moderate
  - Moderate-high
  - High

These risk levels are based on the potential airborne lead concentration ranges in Table 3.

Table 3. Recommended lead risk level classifications.

Risk level	Potential airborne lead concentration (mg/m^3)
Low	<0.05
Low-moderate	0.05–0.50
Moderate	>0.50–1.25
Moderate-high	>1.25–2.50
High	>2.50

Please note that these risk levels are for airborne exposure only. Risk of ingestion must always be considered and accounted for.

Low-risk activities

Low-risk activities are those in which workers are exposed to lead but the airborne exposure is not likely to exceed the eight-hour exposure limit (0.05 mg/m^3). These include:

- Applying lead-containing paint with a brush or roller
- Installing or removing sheet metal that contains lead
- Operating an excavator (within the cab) during building demolition
- Transporting sealed containers of lead waste

Low–moderate risk activities

These include:

- Removing lead materials using a power tool with an effective dust collection system and HEPA filter
- Scraping or sanding (including wet sanding) of lead-containing coatings using non-powered hand tools
- Welding, burning, or cutting of surfaces from which lead-containing coatings have been removed

Moderate-risk activities

These include:

- Removing lead-containing coatings with a chemical gel or paste by hand
- Removing lead-containing coatings with a heat gun
- Scraping or sanding lead-containing materials using non-powered hand tools
- Manually demolishing lead-painted plaster walls or building components using a sledgehammer or similar tool
- Cleaning up and removing lead-containing dust and debris

Moderate–high risk activities

These include:

- Spraying on lead-containing coatings
- Using an electric or pneumatic cutting device for dry removal of mortar that contains lead
- Removing lead-containing materials using power tools without an effective dust collection system equipped with a HEPA filter
- Removing lead-containing surface coatings using a high-pressure water jet

- Removing or repairing ventilation systems used for controlling lead exposure
- Demolishing or cleaning up facilities where lead-containing products were manufactured

High-risk activities

These include:

- Abrasive blasting of lead-containing coatings (including wet, slurry, and dry abrasive blasting)
- Dry-ice blasting of lead-containing coatings
- Using an air mist extraction system to remove lead dust

Substitution

The most effective way to eliminate lead hazards is to replace lead-containing materials with safe alternatives that contain less lead or no lead at all. Because lead is designated as a substance that is a possible human carcinogen and a possible reproductive toxin, employers must replace lead-containing materials whenever practicable. For example, replace lead-containing paint with lead-free paint.

Before substituting materials, ensure that the new material does not contain another product that is just as hazardous or more hazardous than lead. Check the material safety data sheet (MSDS) to help identify potentially hazardous components.

Engineering controls are physical changes to the way site-specific tasks are done (for example, modifying equipment or machinery) in order to eliminate or minimize the amount of lead contaminant being released into the atmosphere. Common engineering control measures include:

- Enclosing specific tasks or work processes that produce lead contamination (e.g., a structure around a lead dust-generating demolition project)
- Installing local exhaust ventilation (e.g., for welding, burning, or cutting)
- Installing dust collection systems, equipped with HEPA filters, on machines or equipment
- Modifying the process to reduce the amount of lead fume or dust generated

Isolation (barriers and enclosures)

Barriers

Barriers and enclosures can be used to separate the work area from adjacent areas. A barrier can be simply a rope or other divider that restricts access to the work area. Barriers do not stop lead dust or other contaminants from leaving the work area. Enclosures are preferable to barriers because they contain lead dust within the work area. The isolation method used will depend upon the risk level (e.g., low, moderate, or high) and the scope and nature of the work.

If it's not practicable to use a partial or full enclosure, set up a barrier that leaves enough room for lead dust to settle before it drifts into adjacent work areas. Workers who enter an isolated area must wear appropriate respiratory protection and other protective equipment as required.

Enclosures

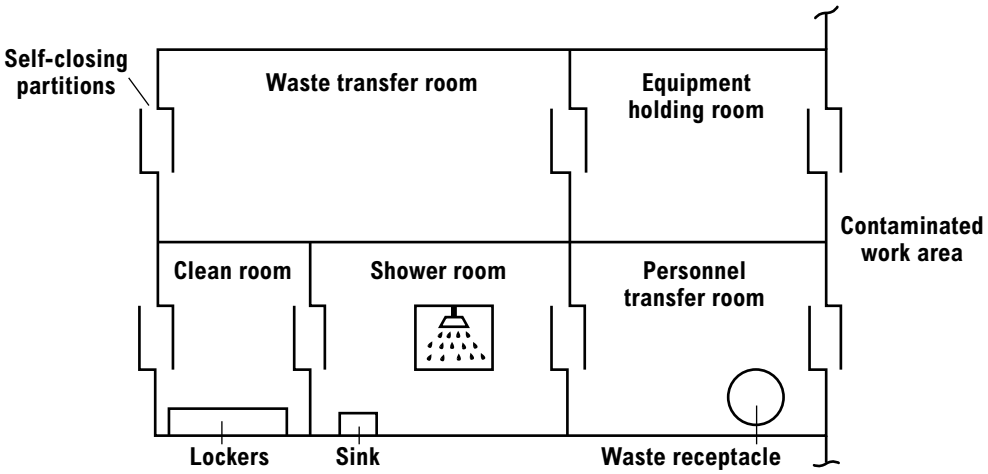
Partial enclosures are the next level of defence. They isolate an area but will allow some emissions to get outside of the enclosure. Full enclosures are the safest method of isolation. A full enclosure is a tight enclosure that allows few or no emissions to get out of the isolated area.

Follow these guidelines for full enclosures:

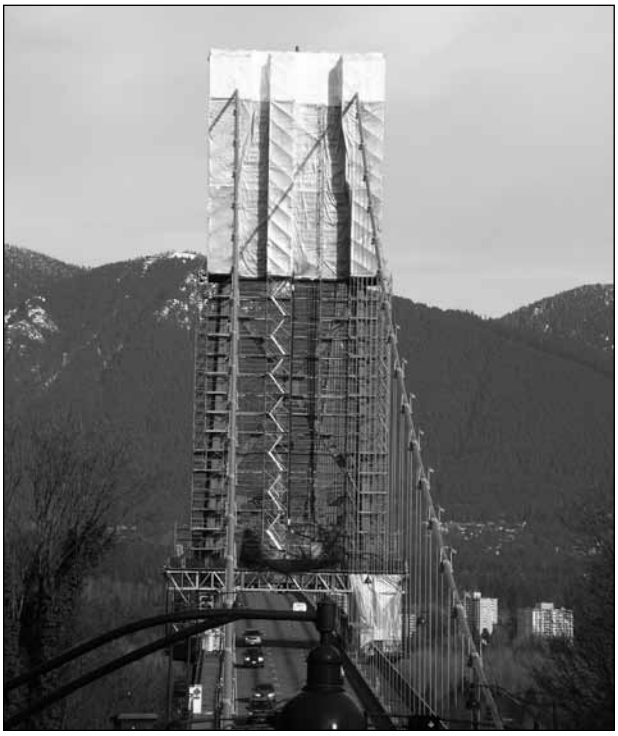
- Use windproof materials that are impermeable to dust.
- Support the enclosure with a secure structure.
- Seal all joints in the enclosure.
- Use overlapping tarps or air locks for entrances.
- Use baffles, louvers, flat seals, and filters to keep dust within the enclosure.

- Use general mechanical ventilation to remove contaminated air.
- Equip air vents with appropriate filters.

Pre-manufactured ("pop-up") enclosures are also available from several manufacturers.



A full enclosure containment facility consists of a shower room and a series of connected rooms separated by air locks. The configuration may be altered depending on the size and shape or configuration of the work area.



Enclosure containing a lead removal operation on a bridge



Entrance enclosure for lead removal

Work area containment ventilation

General mechanical ventilation is necessary for enclosed work areas. Ensure that exhaust air passes through a HEPA-filtered dust collector that is appropriate for lead dust as well as the volume and velocity of the air moving through the enclosure.

Local exhaust ventilation

Local exhaust ventilation is useful for removing lead dust during dust-generating operations. Use local exhaust ventilation for welding, burning,

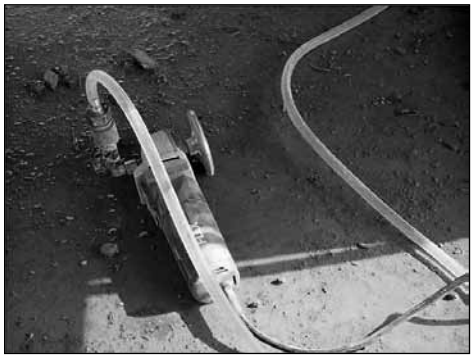
and high-temperature cutting of surfaces from which lead coatings have been removed (to control fumes from residual lead), and when using power tools to remove lead-containing coatings.

Follow these guidelines for local exhaust ventilation:

- Ensure that the air velocity in front of the extractor can overcome opposing air currents and capture contaminated air.
- Ensure that the air velocity at the source is at least 0.5 metres per second or 100 feet per minute. For some work activities (e.g., welding or grinding), the capture velocity may have to be at least 1 m/s (200 ft./min.).
- Ensure that air discharged from the system passes through a HEPA filter and is exhausted so that contaminants cannot re-enter the workplace (for example, through a nearby air intake).
- Place the extractor in front of the worker and below the work surface, to draw air down and away from the worker's breathing zone.

Wet methods

Wet methods can be effective techniques that literally put a damper on lead dust. Dust generation can be minimized by wetting surfaces, wet scraping, and wet shovelling. Water spray systems can be found on some common construction tools and equipment, including slurry or wet abrasive systems, hydro blast systems, and misting systems. Housekeeping and cleanup activities are critical when using wet methods and should be clearly described in the safe work procedures.



Grinder with a water attachment



Grinder with a HEPA exhaust attachment

Administrative controls

Administrative controls are changes to the way work is organized and performed, including the scheduling of resources and staffing. Administrative controls include:

- Good housekeeping
- Proper use of washing facilities
- Clean eating and drinking areas (separate from work areas)
- Worker education and training
- Safe work procedures
- Maintenance of equipment
- Work scheduling
- Implementation of a health protection program

Good housekeeping

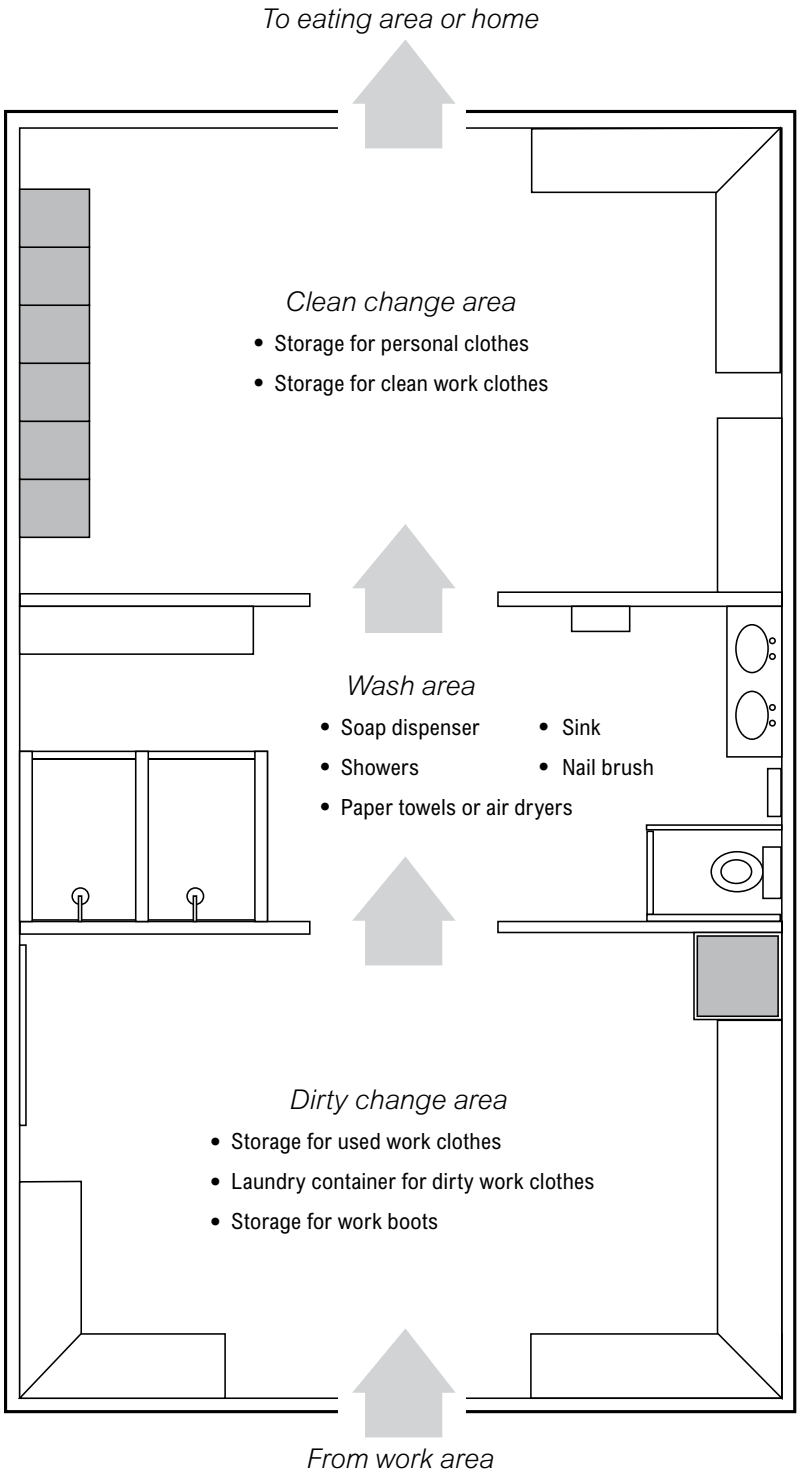


Warning sign on a lead removal site

- Use drop sheets below any lead operation that may produce lead dust or debris.
- Clean up lead dust and waste regularly, and seal it in a dust-tight container.
- Use a vacuum equipped with a HEPA filter to clean up dust and waste.
- Label or otherwise identify containers holding lead waste.
- Identify lead-containing materials or areas where lead is present with warning signs, labels, or other effective means.
- Before removing a container containing lead waste from the work area, clean it with a damp cloth or a vacuum equipped with a HEPA filter.
- Inspect the work area at least once a day to ensure that it is clean.
- Do not use compressed air or dry sweeping to clean up lead dust or waste.

Shower and change facilities

- Provide a room that workers can use to change into protective clothing and store contaminated protective clothing and equipment.
- Depending on the level of risk, provide a shower room (with warm water).
- Provide a room that workers can use to change into street clothes and store clean clothing and equipment.
- Provide washing facilities for workers to use before they eat, drink, smoke, or leave the worksite.



Properly designed change and wash areas ensure that lead contamination is removed before workers eat or go home.

Eating facilities

- Provide designated eating facilities that are free from lead contamination.
- Do not eat, drink, smoke, or chew gum in the work area.

Worker training

Employers must ensure that:

- Workers are informed of the health hazards associated with exposure to lead-containing paints and coatings present in the workplace.
- Workers are trained and instructed in the safe handling, use, and disposal of any substances used in working with lead-containing materials.
- Workers are provided with material safety data sheets (MSDSs) for these substances.
- Workers can demonstrate competency in doing their work according to the safe work procedures.

Health monitoring

Health monitoring can be used to evaluate the effectiveness of workplace controls. A health monitoring program may be required if:

- Recommended by a risk assessment
- The removal project has a long duration
- The lead concentration of the affected surface material is extremely high
- Ordered by a WorkSafeBC Occupational Hygiene Officer

The purpose of health monitoring is to determine whether a worker has absorbed significant amounts of lead, how or why the exposure took place, and what changes must be made to the work controls to reduce the exposure.

A typical lead health monitoring program consists of the following:

- Pre-project medical examination
- Periodic medical examinations conducted during the course of the project
- Clinical testing (usually the collection of blood samples)
- Worker education
- Recordkeeping

The concentration of lead in a worker's blood is a good indication of the amount of lead absorbed by the body during work activities. The results can be used to determine whether a worker should be removed from the lead exposure, or remain on the project with limitations. If workers show signs or symptoms of lead exposure, they should be removed immediately from the project and referred to a physician. The ultimate determination of a worker's fitness to remain on a lead project should be made only by a physician.

For more information on health monitoring, refer to the "Guide to health monitoring" in the Appendix.

All workers entering an area containing a lead hazard should wear the appropriate personal protective equipment (PPE). PPE should be the last line of defence in a health and safety program. It may be used as a control if other controls are not practicable, or in addition to other controls. Before considering PPE, first try to eliminate or minimize the risks using other means. Follow these guidelines when using PPE to prevent exposure to lead:

- Provide workers with appropriate respirators to remove contaminants from the air, and ensure that they use them according to their training.
- Ensure that workers use protective clothing to prevent skin contact with lead contaminant.

Protective work clothing

The use of disposable protective clothing is recommended. Workers should wear protective clothing that:

- Is made of a material that resists penetration by lead dust
- Covers the body and fits snugly at the neck, wrists, and ankles
- Covers the head
- Covers the feet
- Can be immediately repaired or replaced if torn

When working around lead, workers often have to wear protective clothing in confined spaces where there is not a lot of air movement. As a result, these workers may be at a higher risk of experiencing heat stress and resulting heat-related disorders. For more information, see the WorkSafeBC publication *Preventing Heat Stress at Work.*

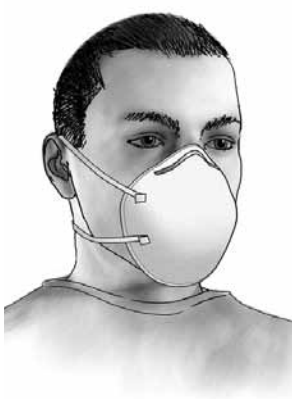
Respiratory protection

Employers must establish a respiratory protection standard for a specific job by selecting an appropriate respirator based on the anticipated work activity. Table 4 outlines appropriate respiratory protection choices based on risk level and work activity. The respiratory protection used should be based on the size of the work area, the amount of lead to be removed, and the duration of the work. More protection would be required if a greater amount of lead is potentially disturbed.

The respirator choices shown in Table 4 are determined by maximum use concentrations as detailed in section 8.34 of the Regulation. As the lead concentration approaches the maximum use concentration for the respirator being used, workers must switch to a respirator with a higher protection factor.

Table 4. Respiratory protection choices for different maximum use concentrations of lead.

Lead concentration	Air-purifying respirators	Air-supplying respirators
Up to 0.5 mg/m^3	Single-use half-face respirator (e.g., N95/N99)	—
Up to 0.5 mg/m^3	Half-facepiece respirator with P100 (HEPA) filters	—
Up to 1.25 mg/m^3	Loose-fitting hood/facepiece, powered respirator with P100 (HEPA) filters	—
Up to 2.5 mg/m^3	Full-facepiece respirator with P100 (HEPA) filters	—
Up to 50 mg/m^3	Powered full-facepiece respirator (PAPR) with P100 (HEPA) filters	—
Up to 2.5 mg/m^3	—	Airline: demand (negative pressure) full-facepiece respirator
Up to 50 mg/m^3	—	Airline: continuous-flow full-facepiece or helmet/hood respirator
Up to 50 mg/m^3	—	Airline: pressure-demand (positive pressure) full-facepiece respirator
Up to 500 mg/m^3	—	Self-contained breathing apparatus (SCBA): pressure-demand (positive pressure) respirator



Disposable N95 respirator



Half-facepiece elastomeric respirator with HEPA cartridges



Full-facepiece elastomeric respirator with HEPA cartridges

Checking for proper operation and fit of respirators

Fit testing is performed to make sure that respirators fit properly and that contaminants in the air cannot leak into the respirator. Testing must be done when a worker is first fitted with a respirator and once a year thereafter.

When fit tests are performed, workers must be clean-shaven and wear all other personal protective equipment that they might need (such as safety

glasses and hardhat). The earpieces of prescription eyeglasses must not interfere with the seal of full-face respirators (specialty lens holders are available from mask manufacturers).

Two types of fit testing may be performed: qualitative fit testing and quantitative fit testing.

In the Regulation

For more information about the requirements for fit testing, see sections 8.39–8.41.

Qualitative fit testing

In qualitative fit testing, a test agent is used to determine whether a worker has a properly sealing facepiece. The agent is introduced into a hood placed on the worker's head. If the worker can detect an irritant smell or taste (depending on the agent used) through the respirator, the respirator fails the fit test.



Qualitative fit testing for a disposable respirator using a special hood

Quantitative fit testing

In quantitative fit testing, specialized equipment is used to measure the actual amount of test agent, or ambient particulates, leaking into the facepiece. The concentration inside the facepiece is compared with the concentration outside the facepiece to determine the level of protection provided by the respirator.

Procedures for both qualitative and quantitative fit testing must be performed in accordance with *CSA Standard CAN/CSA-Z94.4-02.*

Seal checking

Seal checking is performed whenever a worker puts on a respirator. Before any seal check is done, the respirator should be inspected to ensure that the facepiece and straps are intact and that the inlet and exhaust valves are in good condition and lie flat.

Negative and positive seal checking are performed as follows:

1. Put on the respirator and tighten the straps until the respirator feels snug but comfortable.
2. To perform a negative seal check, close off the openings of the cartridges by covering them with the hands, then breathe in slightly to create a vacuum. Hold for about 10 seconds. If the seal is good, the facepiece should collapse slightly and stay collapsed. No air should leak in from around the seal.
3. To perform a positive seal check, close off the exhaust valve with a hand, then breathe out slightly to force air into the facepiece. Hold for about 10 seconds. If the seal is good, the facepiece should bulge and stay out. No air should leak out from around the seal.
4. If there is an air leak, check the inhalation and exhalation valves, reposition the respirator, and readjust the head straps. Repeat the seal checks until the respirator passes.



Negative seal check



Positive seal check

Dry abrasive blast cleaning and vacuum blast cleaning

Dry abrasive or vacuum blast cleaning with a medium such as steel shot, crushed glass, or sand is commonly used to remove lead-containing coatings from metal surfaces such as bridges, tanks, or pressure vessels. The abrasive medium strips paint off and conditions the surface underneath so that new paint will stick to it better. Enclosures such as tarps or rigid materials such as wood, metal, or plastic help prevent the spread of lead and debris into the surrounding environment, but they also increase the risk of worker exposure to the lead. Dry abrasive blast cleaning should be used only if less dusty methods such as wet abrasive blast cleaning or high-pressure water jetting are not practicable.

Abrasive blasting of a lead-containing coating is classified as a **high-risk** work activity.



In lead abatement projects, removal of lead-containing coatings exposes workers to lead dust.

Controls

- Enclose and ventilate the work area. Keep the work area under negative pressure to reduce the amount of lead released into the environment.

- Ensure that the ventilation in an enclosure maximizes the flow of fresh air past workers.
- Design and implement enclosures and ventilation systems that are specific to each work activity. For example, a series of mini-enclosures may be more effective at containing lead than one large enclosure.
- Ensure that contaminated dust is filtered before being released to the atmosphere.
- Avoid using silica sand as an abrasive. Instead, use alternatives such as steel grit, dry ice, crushed glass, or crushed walnut shells. Review the material safety data sheet (MSDS) before selecting an abrasive. If the abrasive will be recycled, the equipment must be regularly monitored to ensure that the lead is effectively removed from the abrasive.
- Develop and implement a respirator program.
- Provide workers with Type CE abrasive-blast respirators, and ensure that they use them for abrasive blast cleaning operations. The respirators should be a supplied-air type with a tight-fitting facepiece.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Wet abrasive blast cleaning

Wet abrasive blast cleaning also uses compressed air to propel an abrasive medium at the work surface. It is based on dry abrasive blast cleaning, but with water injected into the abrasive stream to reduce dust.

Abrasive blasting of a lead-containing coating is classified as a **high-risk** work activity.

Controls

- Controls recommended for dry abrasive and vacuum blast cleaning also apply to wet abrasive blast cleaning.
- Corrosion inhibitors such as nitrates, nitrites, and amines may be needed to prevent flash rusting. These chemicals may also affect worker health. Before using these additives, review the MSDS sheets to determine whether additional personal protective equipment and work procedures are required.
- The containment must be designed to capture the resulting water and debris. If practicable, the water should be filtered to remove debris, in order to reduce the amount of waste generated.

Dry-ice blasting

Dry-ice blasting is a less common removal system that directs dry-ice pellets through a blast hose and nozzle at high velocity. The pellets, which consist of frozen carbon dioxide (at -79°C), abrade the surface and then evaporate so that only the paint debris remains.

Dry-ice blasting is classified as a **high-risk** work activity.

Controls

- Enclosures should be constructed to contain the solid debris. They should not be airtight but should be ventilated (for example, using fans) with a continuous supply of fresh air passing by the workers.
- If the ventilation fails, an oxygen-deficient atmosphere high in carbon dioxide may develop. Workers should be supplied with personal gas monitors equipped with oxygen and carbon dioxide sensors. Alarms must be set to alert workers if the atmosphere in the enclosure or space changes.
- Develop and implement a respirator program.
- Provide workers with powered air-purifying respirators (PAPR) equipped with P100 HEPA cartridges, or full-face supplied-air respirators operated in continuous-flow or pressure-demand mode.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.
- Provide workers with protective clothing and heavy gloves to prevent frostbite when they handle dry ice.
- Workers should take care not to bend over into the hopper when filling it with dry ice.

High-pressure water jetting

In high-pressure water jetting, a pressure pump is used to direct water through a lance-and-nozzle assembly. The system does not generate much dust and is good for removing loose paint and rust. It is not very effective for removing tight paint, tight rust, or mill scale, although an abrasive can be added to the water stream to accomplish this.

High-pressure water jetting is classified as a **moderate–high risk** work activity.

Controls

- Enclose the work area to contain the water and lead debris.
- Design and implement enclosures that are specific to each work activity. For example, a series of mini-enclosures may be more effective at containing lead than one large enclosure.
- Corrosion inhibitors such as nitrates, nitrites, and amines may be needed to prevent flash rusting. These chemicals may also affect worker health. Before using these additives, review the MSDS sheets to determine whether additional personal protective equipment and work procedures are required.
- The containment must be designed to capture the resulting water and debris. If practicable, the water should be filtered to remove debris, in order to reduce the amount of waste generated.
- Develop and implement a respirator program.
- Provide workers with powered air-purifying respirators (PAPR) equipped with P100 HEPA cartridges, or full-face supplied-air respirators operated in continuous-flow or pressure-demand mode.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Manual scraping and sanding

Scraping using hand-held tools generates lead dust and paint chips, and sanding may produce a lot of dust.

Hand sanding (for example, using sandpaper or a sanding block) is classified as a **low–moderate risk** work activity; scraping and brushing using non-powered hand tools (for example, a scraper or wire brush) is classified as a **moderate-risk** work activity.

Controls

- The work area should be surrounded by a barrier or enclosed to warn unprotected workers.
- Disposable drop sheets should be used below all lead operations.
- Mist peeling paint with water before scraping it.
- When sanding, mist the debris before sweeping or vacuuming it.
- Use HEPA vacuuming or HEPA mechanical ventilation.
- Develop and implement a respirator program.

- Provide workers with half-face or full-face elastomeric respirators equipped with P100 HEPA cartridges.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.



Workers hand-brushing lead residue from a steel structure

Heat guns

Heat guns use a stream of hot air to separate the coating from the substrate so that it can be scraped off. Heat guns that operate above 370°C (700°F) can generate lead fume; scraping the residue from the surface can generate lead particulates.

Because of the potential for release of lead fume or particulates, the use of a heat gun is classified as a **moderate-risk** work activity.

Controls

- The work area should be surrounded by a barrier or enclosed to warn unprotected workers.
- Disposable drop sheets should be used below all lead operations.
- Use thermostatic control to keep heat gun operating temperatures as low as practicable.
- Use HEPA vacuuming or HEPA mechanical ventilation.
- Develop and implement a respirator program.
- Provide workers with half-face or full-face elastomeric respirators equipped with P100 HEPA cartridges.

- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Chemical removal

Solvent- or caustic-based paint strippers can be applied to surfaces by hand or spray gun. After a period of time, the coating can then be removed using a scraper, vacuum system, or pressurized water, followed by vacuuming to clean the surface.

Because of the potential for release of chemical vapours as well as lead, the use of solvent-based strippers would be classified as a **moderate-risk** work activity.

Controls

- The work area should be surrounded by a barrier or enclosed to warn unprotected workers.
- The work area should be ventilated (for example, using fans) with a continuous supply of fresh air passing by the workers.
- Disposable drop sheets should be used below all lead operations.
- Many chemical stripping products require additional controls because they are skin irritants or skin corrosives, and some are toxic when inhaled or absorbed through the skin. The MSDSs must be reviewed for recommendations regarding personal protective equipment.
  Note: Some chemicals (such as methylene chloride) should be replaced with less hazardous substitutes.
- Develop and implement a respirator program.
- Provide workers with half-face or full-face elastomeric respirators equipped with P100 HEPA cartridges for lead. A combination cartridge (for example, HEPA and organic vapour) may be required to protect workers from exposure to chemical vapours.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.
- Chemical stripping removes paint only. Rust and mill scale may require abrasive blasting afterwards.

Welding, burning, and torch cutting

Using an arc welder or oxyacetylene torch on steel that is coated with lead-containing paint can create hazardous lead fumes and is prohibited by section 12.115 of the Regulation. Coatings may consist of several layers of paint that could contain as much as 50% lead content. Lead should be removed (to below 0.43 mg/m^2 or 40 µg/ft^2) from the surface *before* welding, burning, or torch cutting takes place.

Welding, burning, and torch cutting of surfaces from which lead paint (or coating) has been removed are classified as **low–moderate risk** work activities.



Welding may be a source of lead exposure if lead is in the coating or in the metal being welded.

Controls

- The work area should be surrounded by a barrier or enclosed to warn unprotected workers.
- Use pneumatic air tools to remove rivets, instead of burning or torch cutting.
- Use hydraulic shears to cut steel.
- Use chemical stripping, vacuum-shrouded hand tools, or vacuum blasting to strip lead-containing coatings back at least 10 centimetres (4 inches) from both sides of the area where heat will be applied (or as determined by a risk assessment). Additional controls may be required, depending on the methods used to remove the paint.

- Use local exhaust ventilation with a flanged hood and HEPA filters. With flexible duct systems, the welder must keep the duct straight and close to the fume source. Make sure exhausted air does not create a hazard.
- Develop and implement a respirator program.
- Provide workers with half-face or full-face elastomeric respirators equipped with P100 HEPA cartridges, or powered air-purifying respirators (PAPR) equipped with P100 HEPA cartridges.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Manual demolition

Using hand tools such as sledgehammers to demolish walls or other building structures can generate high levels of lead dust from plaster or drywall walls with lead-containing coatings. Careful removal of components such as windows, cabinets, and trim generally presents a low risk of exposure, unless the components are deteriorating.

Manual demolition is classified as a **moderate-risk** work activity.

Controls

- Install partitions or other temporary barriers to contain dust.
- Moisten surfaces and debris to minimize dust generation.
- Cut wallboard into large pieces using a carpet knife or shrouded saw with HEPA filtration.
- Use HEPA vacuuming to remove dust and debris.
- Develop and implement a respirator program.
- Provide workers with half-face or full-face elastomeric respirators equipped with P100 HEPA cartridges.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Power tools

Impact, grinding, and brushing tools can generate lead dust and paint chips. Paint-removal tools include needle guns, disc sanders, grinders, power wire brushes, rotary hammers, rotary peeners, and scarifiers.

The risk classification for the use of power tools depends upon the presence or absence of local exhaust ventilation. If the tools are provided with HEPA vacuum attachments, the risk level is **low** (if air monitoring shows that airborne concentrations are below 0.05 mg/m^3). If the tools do not have an effective dust collection system (with a HEPA filter attachment), the risk level is considered **moderate-high**.

Controls

- The work area should be surrounded by a barrier or enclosed to warn unprotected workers.
- Enclose and ventilate the work area when using tools without an effective dust collection system. Keep the work area under negative pressure to reduce the amount of lead released into the environment.
- Disposable drop sheets should be used below all lead operations.
- Use shrouded tools with a vacuum attachment and appropriate HEPA filtration whenever practicable.
- Keep shrouds flush with the work surface.
- Use HEPA vacuuming to remove dust and debris.
- Develop and implement a respirator program.
- Provide workers with full-face elastomeric respirators equipped with P100 HEPA cartridges, or powered air-purifying respirators (PAPR) equipped with P100 HEPA cartridges.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Spraying lead-containing paint

Painting with lead-containing paint (mainly lead primers) is a primary source of lead exposure in the construction industry. The magnitude of exposure is based on the lead content of the product used and the amount of paint applied.

Spraying lead-containing paint is classified as a **moderate–high risk** activity.

Controls

- Enclose and ventilate the work area. Use local exhaust ventilation with proper filtration (such as HEPA filtration).
- Disposable drop sheets should be used below all lead operations.
- Develop and implement a respirator program.
- Provide workers with full-face elastomeric respirators equipped with P100 HEPA cartridges, or powered air-purifying respirators (PAPR) equipped with P100 HEPA cartridges. A combination cartridge (for example, HEPA and organic vapour) may be required to protect workers from exposure to chemicals in the paint.
- Follow good hygiene practices. Wash hands before breaks and meals and at the end of the day. Do not eat or smoke in the work area. Avoid touching the mouth with the hands.

Waste testing and disposal

When lead-containing materials (such as paints) are identified and require removal, the waste must be safely disposed of.

- Avoid carrying waste that contains lead through an occupied space. Lead waste must be removed using means that prevent the spread of lead dust. Place lead waste in properly marked, heavy-duty plastic bags or plastic or steel drums.
- If a dumpster is used, it must be covered at all times. If a chute is used, it should also be covered (or use a barrel chute).
- All waste should be stored in a secured container until disposal.
- Waste should not be transported in an open truck unless the container or truck bed is sealed.
- Water used for cleanup or for removal of lead-containing coatings (for example, through pressure washing or hydro blasting) should not be poured into a sink or tub, on the ground, or into a storm drain.

All lead-containing waste materials must be sampled and analyzed using the standard Toxicity Characteristic Leaching Procedure (TCLP). This procedure is designed to determine the "mobility" or "leachability" of lead in liquid and solid wastes.

A minimum of 50 g (100 g is preferred) of a representative lead-containing paint and associated substrate (concrete, plaster, etc.) should be collected and submitted to a certified laboratory for testing. Laboratory results are provided in milligrams per litre (mg/L) of leachable lead. The acceptable level for non-regulated disposal of lead-containing paint is less than 5 mg/L as determined through analytical TCLP. The disposal of lead-containing paint is regulated under the *Transportation of Dangerous Goods Act* and by the British Columbia Ministry of Environment.

Preparing for emergencies

If a risk assessment determines that there may be a need to rescue or evacuate workers, employers must prepare a written emergency plan for each individual worksite. This plan must include written procedures for evacuating workers from the contaminated work area in the event of a medical emergency. Employers must develop these procedures in consultation with emergency response agencies such as ambulance and fire departments. Employers must also assign a worker (such as an occupational first aid attendant) to coordinate the implementation of the procedures.

As soon as a written emergency plan is developed, the employer must do the following:

- Conduct emergency drills to determine whether the procedures work in practice and to thoroughly familiarize workers with their roles in an actual emergency.
- Keep records of emergency drills to monitor efficiency.
- Provide each worker with a copy of the plan, and provide enough training to ensure that workers clearly understand the procedures.
- Post the procedures and other relevant information (such as telephone numbers) in appropriate, conspicuous locations.

Medical emergency procedures

If a medical emergency occurs in a lead-containing work area as a result of an incident or collapse, standard protective measures may be temporarily ignored if they would otherwise cause an immediate threat to the worker's life or recovery. For example, a worker's respirator may be immediately removed so that mouth-to-mouth resuscitation can be performed, or a worker's contaminated clothing may be left on if a spinal injury is suspected.

If protective equipment and clothing can be left in place without interfering with the emergency care of the injured worker in a contaminated area, they should not be removed until the worker has been brought to an uncontaminated area. On-site decontamination procedures should be carried out only if they do not interfere with medical emergency procedures.

When first aid, ambulance, or other emergency personnel have to enter a contaminated area, they must be warned of the hazard and be provided with, and told how to use, respirators, coveralls, and head protection before entering the area. (In view of the hazard, some emergency responders may refuse to enter the contaminated area.)

Employers must ensure that emergency procedures and preparations provide emergency personnel with clear instructions, provisions, and the means to adequately decontaminate or clean up themselves and the injured worker before leaving the worksite. For example, first aid or ambulance personnel accompanying an injured worker can remove contaminated equipment and clothing in the equipment holding room to minimize the risk of contaminating other areas outside the containment area.

Injured workers who have not been decontaminated must be covered in such a way as to minimize contamination of clean areas. The cover should not hinder access to the worker by first aid or ambulance personnel. Someone familiar with the handling and disposal of lead-contaminated clothing should accompany the injured worker to the hospital. If the worker is still contaminated with lead upon arrival at the hospital, the employer must inform hospital staff of this and instruct them on the appropriate disposal of contaminated clothing. The employer's written emergency procedures must detail the collection and handling of contaminated materials in such a situation.

Appendices

Personal protective equipment and control measures for working with lead

Sample exposure control plan

Recommended practices when working with lead

Guide to health monitoring

Training courses

Table 5. Personal protective equipment and control measures for working with lead.

Table 5 summarizes the recommended personal protective equipment (PPE) and control measures for work activities at different levels of risk.

Work activities	Control measures	Recommended respiratory protection
LOW RISK • Applying lead-containing paint with a brush or roller • Installing or removing sheet metal that contains lead • Operating an excavator (within the cab) during building demolition • Transporting sealed containers of lead waste	• Washing facilities must be provided, including wash basins, tempered (warm) water, soap, and disposable towels. • Workers should not eat, drink, chew gum, smoke, or bite fingernails while in the work area. • Workers should wash their hands before eating, drinking, smoking, or leaving the work area. • Coffee and lunch breaks should be taken in a clean area separate from the work area. • Disposable drop sheets should be used below all lead operations. • Dust and waste should be cleaned up and placed in marked lead-waste containers that are dust-tight. • The work area should be kept clean, and compressed air or dry sweeping should not be used to remove dust. • Workers should remove all work clothes and shoes at the end of the work day and leave them at work.	• Respirators should not be required if safe work procedures and proper housekeeping protocols are followed. • Periodic air sampling should be conducted to ensure that the levels of lead in air are less than 0.05 mg/m^3.
LOW–MODERATE RISK • Removing lead materials using a power tool with a dust collection system and HEPA filter • Scraping or sanding of lead-containing coatings using non-powered hand tools • Welding, burning, or cutting of surfaces from which lead-containing coatings have been removed	The following should be adopted in addition to the low-risk procedures listed above: • Barriers should be erected to prevent access to the work area by unprotected workers. • Signs should be posted at every entrance to the work area; signs should include warnings of lead contamination and the requirement for respiratory protection. • Workers should wear disposable coveralls and other personal protective equipment (e.g., eye and hearing protection) that might be required at the jobsite. • The work area should be kept clean, and workers should use cleaning methods that minimize the generation of dust, such as wet dusting, wet sweeping, or vacuuming using a vacuum with a HEPA filter on the exhaust.	• NIOSH-approved single-use N95, N99, or P100 respirator, or • Half-face elastomeric respirator equipped with P100 HEPA cartridges • Periodic air sampling should be conducted to ensure that the levels of lead in air are within the protection factor of the respirator selected.

Work activities	Control measures	Recommended respiratory protection
MODERATE RISK • Removing lead-containing coatings with a chemical gel or paste by hand • Removing lead-containing coatings with a heat gun • Scraping or sanding lead-containing materials using non-powered hand tools • Manually demolishing lead-painted plaster walls or building components using a sledgehammer or similar tool • Cleaning up and removing lead-containing dust and debris	The following should be adopted in addition to the low–moderate risk procedures listed above: • Partial or full enclosures should be constructed around work areas where significant scraping, sanding, or demolition will take place. • Where full enclosures are required, they should be equipped with HEPA-filtered mechanical ventilation. • Separate changing areas and a shower (with warm water) should be provided.	• Half-face or full-face elastomeric respirator equipped with P100 HEPA cartridges, or • Powered air-purifying respirator (PAPR) equipped with P100 HEPA cartridges • The type of respirator chosen will depend on the amount of material removed and the duration of the work. • Periodic air sampling should be conducted to ensure that the levels of lead in air are within the protection factor of the respirator selected.
MODERATE–HIGH RISK • Spraying on lead-containing coatings • Using an electric or pneumatic cutting device for dry removal of mortar that contains lead • Removing lead-containing materials using power tools without an effective dust collection system equipped with a HEPA filter • Removing or repairing ventilation systems used for controlling lead exposure • Demolishing or cleaning up facilities where lead-containing products were manufactured • Removing lead-containing coatings using a high-pressure water jet	The following should be adopted in addition to the moderate-risk procedures listed above: • Full enclosures should be constructed and equipped with HEPA-filtered mechanical ventilation. • A decontamination facility should be constructed that has a dirty room for removing contaminated clothing, a shower room (with warm water), and a clean room for changing into street clothes. • Dust and waste should be cleaned up by wet sweeping, wet shovelling, or HEPA vacuuming. • Wherever possible, wet methods should be incorporated into the operation to reduce dust.	• Full-face elastomeric respirator equipped with P100 HEPA cartridges, or • Powered air-purifying respirator (PAPR) equipped with P100 HEPA cartridges, or • Full-face supplied-air respirator operated in continuous-flow or pressure-demand mode • The type of respirator chosen will depend on the amount of material removed and the duration of the work. • Periodic air sampling should be conducted to ensure that the levels of lead in air are within the protection factor of the respirator selected.
HIGH RISK • Abrasive blasting of lead-containing coatings • Using an air mist extraction system to remove lead dust • Dry-ice blasting of lead-containing coatings	The following should be adopted in addition to the moderate–high risk procedures listed above: • For dry abrasive blasting conducted outdoors, full enclosures equipped with HEPA-filtered mechanical ventilation should be constructed.	• Full-face abrasive-blast supplied-air respirator operated in pressure-demand or positive-pressure mode, for blasting operations. • Full-face supplied-air respirator operated in pressure-demand or positive pressure mode, when using an air mist extraction system. • Periodic air sampling should be conducted to ensure that the levels of lead in air are within the protection factor of the respirator selected.

Exposure Control Plan for the Removal of Lead-Containing Paint, Using Hand Tools

Removing lead-containing paint without proper controls can generate lead dust. Lead enters the body when the dust is inhaled or ingested (swallowed). Once it is in the bloodstream, lead can be carried throughout the body. Lead exposure can cause a number of health effects, including weakness, headaches, stomach cramps, muscle and joint pain, and memory problems.

Company information

- [Name]
- [Address]
- [Contact information—names and phone numbers]

Worksite information

- [Project name]
- [Address]

Health hazards from lead exposure

- Lead interferes with many body processes and is poisonous to most organs and tissues, including the bones, intestines, kidneys, nervous system, and reproductive organs.
- Acute lead poisoning (high exposure over a short period of time) can cause fatigue, anemia, constipation, and damage to the nervous system.
- Chronic lead poisoning (exposure over a longer period of time) can cause fatigue, joint pain, and weakness.
- Lead poisoning can damage the fetus in pregnant female workers, and impair fertility in male workers.
- Workers are exposed to lead when they inhale lead-containing dust or ingest lead residue from their hands (e.g., when eating, chewing gum, or smoking).
- Lead is a suspected human carcinogen and has been shown to cause cancer in laboratory animals.

Purpose and responsibilities

- [Company name] has a duty to protect our workers from lead exposure during the removal of lead-containing paints and coatings. Studies show that these operations generate airborne lead dust well in excess of safe levels. Effective controls are available to protect workers from harmful exposure.
- A combination of control measures will be required to achieve this objective. We commit to being diligent in our efforts to select the most effective control technologies available, and to ensure that the best practices, as described in this exposure control plan (ECP), are followed at our worksites.
- The work procedures we establish will protect not only our workers but also any other workers on-site who are not involved in these operations.

The employer is responsible for the following:

- Ensuring that the materials (for example, tools, equipment, personal protective equipment [PPE]), and other resources (for example, worker training) are readily available to fully implement and maintain this ECP.
- Ensuring that supervisors and workers are educated in the hazards of lead exposure, and trained to work safely during the removal of lead-containing paints and coatings.
- Ensuring that workers follow the requirements of the Occupational Health and Safety Regulation and the *Workers Compensation Act.*
- Maintaining written records of training (for example, proper use of respirators), fit-test results, crew talks, and inspections (for example, of equipment).
- Conducting an annual review (or more often if conditions change) of the effectiveness of the ECP. This includes a review of available control technologies to ensure that these are selected and used when practicable.
- Coordinating work with the prime contractor and other employers to ensure a safe work environment.
- Initiating immediate investigations into incidents/accidents and reporting these to WorkSafeBC.

Supervisors are responsible for the following:

- Providing adequate instruction to workers on the hazards of lead exposure.
- Selecting and implementing the appropriate control measures.
- Ensuring that workers using respirators have been properly trained and fit-tested, and that the results are recorded.
- Ensuring that work is conducted in a manner that minimizes and adequately controls the risk to workers and others. This includes ensuring that workers use appropriate engineering controls and wear the necessary PPE.
- Immediately correcting unsafe acts and conditions.

Workers are responsible for the following:

- Participating in all required health and safety education and training.
- Using the assigned protective equipment in an effective and safe manner.
- Following established work procedures as directed by the supervisor.
- Reporting any unsafe conditions or acts to the supervisor.
- Reporting to the employer any exposure incidents or any signs or symptoms of lead illness.

Hazard identification and risk assessment

- Lead-containing paints can contain anywhere from 0.009% to 50% lead by weight. Studies have shown that removal of paint with a lead content as low as 0.06% can generate airborne concentrations of lead that approach the occupational exposure limit.

- Removing lead-containing paint without the use of proper controls and PPE can expose workers to levels of airborne lead dust that are above the exposure limit listed in the Regulation.
- Unprotected workers or other persons may be exposed to the hazards of lead. All lead work locations will be enclosed by barriers or barrier tape and identified with signs or placards.

Exposure limit

- The occupational exposure limit (EL) for inorganic lead is 0.05 milligrams per cubic metre (mg/m^3).
- Because lead is a suspected human carcinogen and linked with cancer in animals, workplace exposures must be reduced to levels that are As Low As Reasonably Achievable (ALARA) below the EL.

Lead dust controls

- The Regulation requires employers to select lead dust controls based on the following hierarchy:
  - Engineering controls (for example, barriers, enclosures, general ventilation, local exhaust ventilation)
  - Administrative controls (e.g., wash stations, separate eating and changing areas, and limiting the time workers are exposed to lead)
  - Personal protective equipment (such as respirators and disposable coveralls)
- Respirators will be used in conjunction with other controls to reduce worker exposure to lead, unless air monitoring information suggests otherwise.
- A HEPA vacuum will be used for cleanup and decontamination.

Acceptable control methods for removing lead-containing paint

The work methods in the following table are acceptable, provided that the respirator selection, dust suppression, and other controls are adhered to.

The following control options will be used to eliminate or reduce the risk to workers from the hazards of lead dust exposure, unless air monitoring information suggests otherwise.

Work activity	Dust suppression	Other controls	Respirator type
Manual (hand) sanding/scraping	• Peeling paint will be misted with water before scraping. • Debris will be misted before sweeping or vacuuming. • A HEPA vacuum will be used to remove debris.	• Disposable drop sheets will be placed below the work area. • Barriers (for example, a tape barrier) will be installed to restrict access to the work area. • Signs will be posted at every entrance to the work area. • Workers will use disposable coveralls.	• NIOSH-approved single-use N95, N99, or P100 respirator • Half-face respirator with HEPA P100 series filters

Work activity	Dust suppression	Other controls	Respirator type
Manual scraping using heat guns	• The heat gun temperature must be kept as low as practicable. • Debris will be misted before sweeping or vacuuming. • A HEPA vacuum will be used to remove debris.	• Disposable drop sheets will be placed below the work area. • Barriers (for example, a tape barrier) will be installed to restrict access to the work area. • Partial or full enclosures will be constructed around work areas where significant removal will take place. • Where full enclosures are required, they will be equipped with HEPA-filtered mechanical ventilation. • Signs will be posted at every entrance to the work area. • Workers will use disposable coveralls.	• Half-face respirator with HEPA P100 series filters
Manual scraping using a chemical stripper	• Debris will be misted before sweeping or vacuuming. • A HEPA vacuum will be used to remove debris.	• Disposable drop sheets will be placed below the work area. • Barriers (for example, a tape barrier) will be installed to restrict access to the work area. • Signs will be posted at every entrance to the work area. • The work area will be ventilated with a continuous supply of fresh air for the workers. • Partial or full enclosures will be constructed around work areas where significant removal will take place. • Where full enclosures are required, they will be equipped with HEPA-filtered mechanical ventilation. • Workers will use disposable coveralls. • Methylene chloride products will not be used. • Additional PPE (e.g., gloves and goggles) may be required as recommended by the MSDS for the chemical stripper.	• Half-face respirator with HEPA P100 series/organic vapour cartridges • Additional respiratory protection may be required as recommended by the MSDS for the chemical stripper
Removing paint using powered hand tools	• **Tools equipped with a HEPA-filtered dust collection system will be used.** • Debris will be misted before sweeping or vacuuming. • A HEPA vacuum will be used to remove debris.	• Disposable drop sheets will be placed below the work area. • Barriers (for example, a tape barrier) will be installed to restrict access to the work area. • Signs will be posted at every entrance to the work area. • Workers will use disposable coveralls.	• NIOSH-approved single-use N95, N99, or P100 respirator • Half-face respirator with HEPA P100 series filters
	• **Tools without a dust suppression system will be used.** • Debris will be misted before sweeping or vacuuming. • A HEPA vacuum will be used to remove debris.	• Disposable drop sheets will be placed below the work area. • Partial or full enclosures should be constructed around work areas where removal will take place. • Where full enclosures are required, they should be equipped with HEPA-filtered mechanical ventilation. • Workers will use disposable coveralls.	• Full-face elastomeric respirator equipped with P100 HEPA cartridges, or • Powered air-purifying respirator (PAPR) equipped with P100 HEPA cartridges

Safe work planning

- Select one or more of the methods described in the table on pages 62 and 63.
- Establish a barrier or full enclosure around the work zone to restrict access by unprotected workers (full enclosures may require negative-pressure ventilation through a HEPA filter).
- Inspect all dust control equipment and tools to make sure they are in good working order.
- Use and maintain all tools and equipment as specified by the manufacturer. For example, test the effectiveness of HEPA filters using dioctyl phthalate (DOP) testing or similar means at least annually, and any time a HEPA filter is replaced in a vacuum cleaner or ventilation system.
- When working on a multiple-employer site, provide the general contractor with a copy of the lead exposure control plan and safe work procedures. Review the procedures and work schedule with the general contractor to determine whether additional measures are required to reduce worker exposure to lead.
- Ensure that workers inspect their respirators before start-up.

Respiratory protective equipment

- Each worker will be fit-tested if a respirator is required.
- If a worker is required to wear a respirator that requires an effective seal with the face for proper functioning, the worker must be clean-shaven where the respirator seals with the face.
- When the worker notices a notable resistance to breathing, the respirator filters must be replaced.
- Respirators will be used, cleaned, and stored in accordance with the respiratory protection program.

Other personal protective equipment and hygiene

- Workers should change from street clothes to work clothes (including footwear) at the beginning of their work shift.
- Street clothes should be kept separate from work clothes.
- Washing (and shower, if required) facilities should be located between “clean” changing areas and “dirty” work areas.
- Workers should remove contaminated outer work clothing and thoroughly wash their hands and faces before eating, drinking, or smoking.
- No eating, drinking, smoking, chewing gum, or nail biting should be allowed in the work area.
- No food, gum, cigarettes, or other personal items should be stored in the work area.
- Coffee and lunch breaks should be taken in a clean area separate from the work area.
- Workers should remove all work clothes and shoes at the end of the work day and leave them at work.
- Workers should wash (or shower) before leaving work to ensure that any potential contamination is removed before they go home.
- Workers should not take any contaminated items home, as this may expose family members to lead.

Housekeeping procedures

- Dry sweeping and the use of compressed air are **prohibited** for removing dust and debris containing lead. Work areas and equipment covered by dust will be cleaned at the end of every shift using a HEPA-filtered vacuum.
- Wet cleanup may also be used to remove dust.
- Waste material will be placed in a dumpster, and will be removed at least weekly. The location and method used to store waste will not allow lead-containing dust to re-enter the workplace.
- Supervisors are responsible for ensuring that work areas are free from dust at the end of each shift.

Worker training for lead exposure

- Training will be performed by the employer or the employer's designate.
- Records of attendance, dates of training, and training material will be documented and retained.
- Additional training or reference material on lead exposure will be made available to employees upon request.

  Training topics

  – Health hazards of lead exposure
  – Engineering controls and safe work practices used to protect workers
  – The importance of proper equipment control and maintenance
  – Housekeeping procedures
  – Proper use of respirators and the respirator program
  – Personal hygiene procedures to reduce exposures
  – The details of the exposure control program for lead

Health surveillance

A health monitoring program (including the collection and analysis of blood samples) will be implemented, under the supervision of an occupational physician, for projects more than one week in duration.

Annual review

This ECP will be reviewed at least annually and updated as necessary by the employer, in consultation with the workplace health and safety committee or the worker health and safety representative.

- Workers should change from street clothes to work clothes (including footwear) at the beginning of their work shift.
- Street clothes should be kept separate from work clothes.
- Where possible, washing and shower facilities should be located between the storage and changing areas for dirty protective clothing and footwear and the storage and changing areas for clean protective and personal clothing.
- Workers should remove contaminated outer work clothing and thoroughly wash their hands and faces before eating, drinking, or smoking.
- No eating, drinking, smoking, chewing gum, or nail biting should be allowed in the work area.
- No food, gum, cigarettes, or other personal items should be stored in the work area.
- Coffee and lunch breaks should be taken in a clean area separate from the work area.
- Workers should remove all work clothes and shoes at the end of the work day and leave them at work.
- Workers should wash or shower before leaving work to ensure that any potential contamination (e.g., on their hair) is removed before they go home.
- Workers should not take any contaminated items home, as this may expose family members to lead.
- Workers who launder contaminated work clothes should be educated about the potential health effects of lead, routes of exposure to lead, and control measures to reduce such exposure.
- The work area should be kept clean, and workers should use cleaning methods that minimize the generation of dust, such as wet dusting, wet sweeping, or vacuuming using a vacuum with a HEPA filter on the exhaust.

Guide to health monitoring

The purpose of health monitoring is to protect workers from developing occupational disease by detecting biological indicators or adverse health effects at an early stage to—in order of decreasing preference—prevent, reverse, reduce the severity of, or arrest the progression of the adverse health effects or disease.

Although health monitoring must not be used as a substitute for environmental monitoring, in some cases it provides the only method of control evaluation. In the case of substances absorbed by the skin or inadvertently ingested, air monitoring alone will not provide an accurate indication of exposure.

Inorganic lead exposure and toxicity

Inorganic lead is absorbed into the body either by inhalation of dust or fume into the lungs or by inadvertent ingestion, such as may occur through nail biting, eating, and drinking in contaminated areas, and smoking.

Blood lead concentration is the best available indicator of current inorganic lead absorption. It rises immediately after the first inhalation and reaches a steady state after weeks or months.

Urinary lead concentration is variable and does not reflect the amount of inorganic lead in the body. It is therefore not an effective tool for monitoring exposure to inorganic lead.

Overt symptoms of lead poisoning in adults are generally first seen at blood levels between 3.0 and 6.0 µmol/L (60–120 µg/dL). It is now known that mild effects can occur at lead levels lower than previously determined.

Acute lead poisoning follows high exposure over a short period of time. Signs and symptoms of acute lead poisoning include abdominal colic, constipation, fatigue, anemia, and peripheral neuropathy. The central nervous system may be affected, and sometimes the classic gingival (gum) blue line is seen. These effects do not occur until blood lead levels are over 3.5 µmol/L (70 µg/dL).

Chronic lead toxicity can result from significant absorption over a longer period of time. In cases of chronic absorption, the effects are more insidious, with symptoms such as headache, fatigue, joint pain, and weakness.

Reproductive toxicity

Woman and fetus

Neurological damage to the fetus can occur if blood lead levels in the mother exceed 0.75–1 µmol/L (15–20 µg/dL). Lead passes virtually unimpeded across the placenta, and the resulting neurological fetal impairment appears to be irreversible. It is possible that there is no threshold limit at which adverse effects could not occur in the course of development of the human fetus.

During a woman's pregnancy, blood lead levels rise and may double. This may be a result of hormonally induced mobilization of lead stored in bone. Fetal risk is therefore greater in women who have high lead stores due to past exposure.

Men

Reported effects of lead on the male reproductive system include lower sperm counts and a higher percentage of abnormally shaped sperm, although there is no strong evidence that these effects impair fertility. The maximum blood lead level that does not produce these changes appears to be 2.0 µmol/L (40 µg/dL).

Studies have suggested that duration of lead exposure, rather than actual concentration, is important, and that profound effects are seen in individuals with prolonged exposure even at relatively low blood lead levels.

Employers' guide to health monitoring

Program management

To run your health monitoring program, you will need the assistance of a physician or a nurse affiliated with a physician. This health care professional will set up the program and interpret results. He or she should assist you in determining the appropriate type of biological sample required and the time of day or week to collect it, depending on the nature of the exposure and the persistence of the substance in the body (the "half-life" of the substance).

The physician or nurse may be an occupational health specialist or may be a health care professional with an interest in occupational health.

Biological monitoring must not be used as a substitute for environmental (air) monitoring as, in some cases, air sampling may provide the only method of control evaluation. However, in the case of substances absorbed by the skin or inadvertently ingested (for example, lead), air monitoring alone may not be an accurate indicator of exposure.

Blood samples

If blood samples are required, collection of these samples must be authorized by a physician. Sample collection is usually carried out by a local laboratory. Sometimes arrangements can be made so that the laboratory or health care worker collects the samples on site. This not only minimizes disruption of work flow but also ensures that the samples arrive in one batch at the laboratory performing the analyses.

Samples collected for different analyses must be collected in different types of specimen containers. Storage and transport conditions will also vary with the nature of the specimen. The laboratory can provide you with the necessary information.

The collecting laboratory will charge you for the service.

Results

Results will be sent to the requesting physician. The actual numerical results of a worker's lab test cannot be given to the employer without the worker's signed, informed consent. The results must then be treated and stored like other confidential materials.

Participation

Whether health monitoring is voluntary or legally required, a worker cannot be forced to give a biological sample. If the worker's reluctance to participate makes the employer unable to comply with the Occupational Health and Safety Regulation, the worker may have to be restricted from work where the potential for significant exposure exists.

It is therefore important that:

- The worker's consent to participate be obtained
- The worker be told exactly what tests are to be carried out and that those are the only tests performed
- The worker's consent be informed; in other words, the worker understands what may happen if the test results suggest that exposure should be reduced (such as temporary removal from the job)

Main steps in a health monitoring program

1. Define the purpose of the program.
2. Appoint a competent person to manage the program.
3. Consult with employees or their representatives.
4. Get a physician to authorize requisitions for biological sampling and analysis.
5. Establish procedures for sample collection (including details of sampling media, timing, etc.), storage, transportation, analysis, and quality assurance.
6. Following the principles of confidentiality, establish procedures for interpretation and reporting of results.
7. Obtain workers' written, informed consent for biological sampling and analysis. Such consent is also required for actual individual results to be sent to the employer. Alternatively, ranges of results can be sent to the employer by the physician who requested the test.
8. Ensure that procedures are in place for storing results in an appropriate, confidential manner, acting on the results, and evaluating the effectiveness of the program.

Interpretation of blood lead results and recommended actions

In a steady-state situation, the measurement of blood lead levels is considered to be the best available indicator of current lead absorption. The blood lead level rises immediately after the first exposure and reaches a steady state in about a month. In cases of heavy exposure, it may rise after a few hours. The blood lead level decreases rapidly after exposure ceases, then more gradually thereafter. The average rate of decline is based on a half-life of about a month. (The half-life is the length of time required for the blood lead level to fall to half of its initial value.)

The following table shows the recommended actions for elevated blood lead levels.

Blood lead level	Retest recommendation	Recommended action
<1.0 μmol/L (<20 μg/dL)	None to annually	No specific actions necessary
1.0–1.74 μmol/L (20–34 μg/dL)	Every 6 months	CAUTION Minimize exposure by reviewing all sources of exposure and improving protective measures.
1.75–2.49 μmol/L (35–49 μg/dL)	Every 3 months	ALERT Minimize exposure by reviewing all sources of exposure and improving protective measures.
≥2.5 μmol/L (≥50 μg/dL)	Monthly until the level is acceptable to a physician	REMOVAL 1. Remove worker from further lead exposure. 2. Return worker to previous duties when: • Blood lead level is acceptable to a physician, and • Exposure is minimized by reviewing all sources of exposure and improving protective measures

Note: During pregnancy, blood lead levels should be less than 0.75 μmol/L (15 μg/dL).

Training courses

The U.S. Environmental Protection Agency has developed the following training courses for technicians, supervisors, contractors, abatement workers, and others who work with lead-containing paint:

- EPA/HUD Model Renovator Training Course
  http://www.epa.gov/lead/pubs/epahudrrmodel.htm
- EPA/HUD Model Lead Dust Sampling Technician Course
  http://www.epa.gov/lead/pubs/samplingmodel.htm
- EPA Model Lead-Based Paint Abatement Worker Training Course
  http://www.epa.gov/lead/pubs/abateworker.htm
- EPA Lead Abatement Training for Supervisors and Contractors
  http://www.ntis.gov/search/product.aspx?ABBR=AVA20595KK00
- EPA Lead Planner/Project Designer Training
  http://www.ntis.gov/search/product.aspx?abbr=AVA20817DK04

The EPA has also accredited a number of lead worker training providers. You can search, by state, for accredited renovation training programs at http://cfpub.epa.gov/flpp/searchrrp_training.htm.

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