Controlling Exposure Risks from Welding and Cutting Processes

WorkSafeBC

About WorkSafeBC

At WorkSafeBC, we're dedicated to promoting safe and healthy workplaces across B.C. We partner with workers and employers to save lives and prevent injury, disease, and disability. When work-related injuries or diseases occur, we provide compensation and support injured workers in their recovery, rehabilitation, and safe return to work. We also provide no-fault insurance and work diligently to sustain our workers' compensation system for today and future generations. We're honoured to serve the workers and employers in our province.

Prevention Information Line and contact information

We provide information and assistance with health and safety issues in the workplace.

Call the information line 24 hours a day, 7 days a week to report unsafe working conditions, a serious incident, or a major chemical release. Your call can be made anonymously. We can provide assistance in almost any language. You can also visit worksafebc.com to report an unsafe workplace.

If you have questions about workplace health and safety or the Occupational Health and Safety Regulation, call during our office hours (Monday to Friday, 8:05 a.m. to 4:30 p.m.) to speak to a WorkSafeBC officer.

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Health and safety resources

You can find our health and safety resources at worksafebc.com/forms-resources. Printed copies are available for some resources and can be ordered from worksafebcstore.com.

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ISBN 978-1-0399-0088-2

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Introduction

Welding and cutting processes generate fumes and gases that can be hazardous to welders and others working nearby, especially when welding indoors or in confined spaces. This book is for employers and workers in British Columbia who carry out welding work. It focuses on the main types of welding used in B.C. You'll find information on the health risks associated with welding fumes and gases, and how to reduce those risks.

Employer responsibilities

The Occupational Health and Safety Regulation requires employers to eliminate exposures to hazardous substances or otherwise control exposures below harmful levels. Welding fumes and gases often contain substances that are carcinogens, sensitizers, or reproductive toxins (i.e., designated substances, as specified in section 5.57). The International Agency for Research on Cancer classifies welding fumes and ultraviolet radiation from welding as human carcinogens.

For information on what might be in welding fumes, refer to the safety data sheets (SDSs) for the types of metal being welded, the consumables (e.g., welding rod or wire), and the shielding gases. An SDS will describe the composition of the products being used and any related hazards.

Employers are required to implement an exposure control plan (ECP) and follow the ALARA principle to control welding fume exposures.

What does ALARA mean?

The ALARA principle governs worker exposure to designated substances in welding fumes. It means that all exposures must be kept **a**s **l**ow **a**s **r**easonably **a**chievable below the exposure limits for the designated substances. The Regulation specifies exposure limits and action levels. Employers must take all reasonable measures to eliminate worker exposure or reduce it below these limits.

What this book covers

This book includes information on three basic types of risk controls for welding fumes and gases:

- Engineering controls, including local exhaust ventilation (LEV) and dilution ventilation
- Administrative controls
- Respiratory protection

These controls will help you manage the risks of exposure for your welding and cutting processes.

Although this book focuses on exposures to welding fumes and gases, many other hazards (such as noise, radiation, and fire) must be controlled during welding operations.

Managing risks

There are four steps to managing risks in the workplace:

1. Understand the risks by identifying hazards and assessing the risks associated with those hazards.
2. Implement measures to control the risks, following the hierarchy of controls.
3. Communicate your risk management program to managers, supervisors, and workers.
4. Monitor the effectiveness of your control measures and improve those that are not working as intended.

Involve your joint health and safety committee (or worker health and safety representative), as well as workers familiar with the work processes, at each step of the risk management process.

For more information, see the Managing risk webpage at worksafebc.com.

Health effects of welding fumes, gases, and vapours

Welding and cutting processes can produce:

- Fumes (e.g., manganese, chromium, nickel, beryllium, other toxic metals, and fluorides)
- Gaseous by-products (e.g., nitrogen oxides, carbon monoxide, carbon dioxide, and ozone), and shielding and fuel gases
- Other gases and vapours that are either by-products of the breakdown of solvents or coatings on the metal, or are formed as a result of interactions with chemicals in the air

Welders and others nearby who inhale welding fumes, gases, or vapours are at risk of developing occupational diseases and illnesses.

Exposure to welding fumes, gases, or vapours can have immediate health effects, such as metal fume fever (a flu-like condition) and irritation of the eyes, nose, and throat.

Potential health effects of long-term exposure to welding fumes include:

- Metal fume fever
- Neurotoxicity
- Occupational asthma
- Lung cancer
- Chronic obstructive pulmonary disorder (COPD)

On rare occasions, there have been fatalities when working with base metals or rods that contain very toxic metals, such as beryllium or cadmium.

Shielding gases used in welding processes can cause asphyxiation (suffocation from lack of oxygen). This usually occurs when the gases accumulate in confined spaces or when oxygen is displaced.

See the appendix on pages 22–25 for a detailed list of fumes, gases, and organic vapours that are produced during welding, and the health effects associated with each of them.

Exposure limits

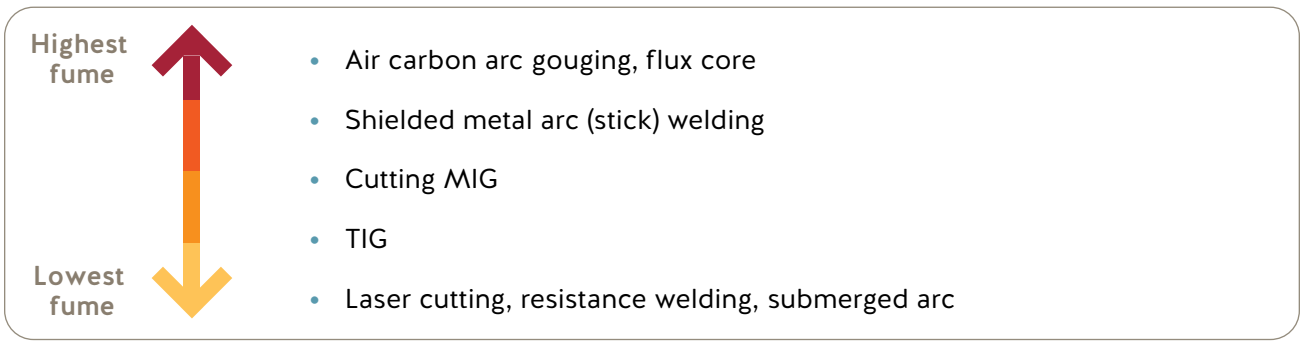
Without effective controls in place, airborne levels of welding fume and gas components can easily exceed exposure limits, which are set at levels to minimize adverse health effects. The exposure limits for some elements and chemical compounds are very low. Elevated exposures can occur when welding mild steel, stainless steel, and other alloys. Both indoor and outdoor welding can result in high exposure levels.

Understanding the risks

The first step when managing workplace risks is to understand the risks. Start by identifying potential hazards in your workplace, and then assess the risks associated with those hazards. A risk assessment will help you determine what sort of risk control measures you'll need to eliminate the hazards or reduce the risks.

When doing a risk assessment for welding, consider the following questions:

- What types of metal are being welded (e.g., mild steel, stainless steel, galvanized steel, or aluminum)?
- What welding processes are being used (e.g., tungsten inert gas [TIG], metal inert gas [MIG], air carbon arc gouging, or brazing)? Which ones create the most fumes?
- Are there welding processes that generate hazardous gases such as ozone, carbon monoxide, or oxides of nitrogen? Will potential exposures to these gases require additional controls?
- What consumables (e.g., welding rod or wire) and shielding gases are being used? Check safety data sheets (SDSs) for information on welding electrodes, rods, and shielding gases.
- What other factors might affect the amount of fumes generated (e.g., current and voltage, arc time, flux usage, electrode size and type)?
- What substances are likely to be in the fumes? What are the risks associated with them?
- Are welding surfaces coated or painted with lead-based paint, epoxy resins, degreasing agents, or rust inhibitors that must be removed before welding?
- What controls are currently in use (e.g., respirators, ventilation, welding booths)? Are they being used correctly and maintained?
- Where is the welding being done (e.g., outdoors, indoors, or in a confined space)? What is the degree of confinement?
- Who is exposed to the fumes and gases, how often (e.g., daily or sporadically), and for how long?
- Are exposure monitoring results available?



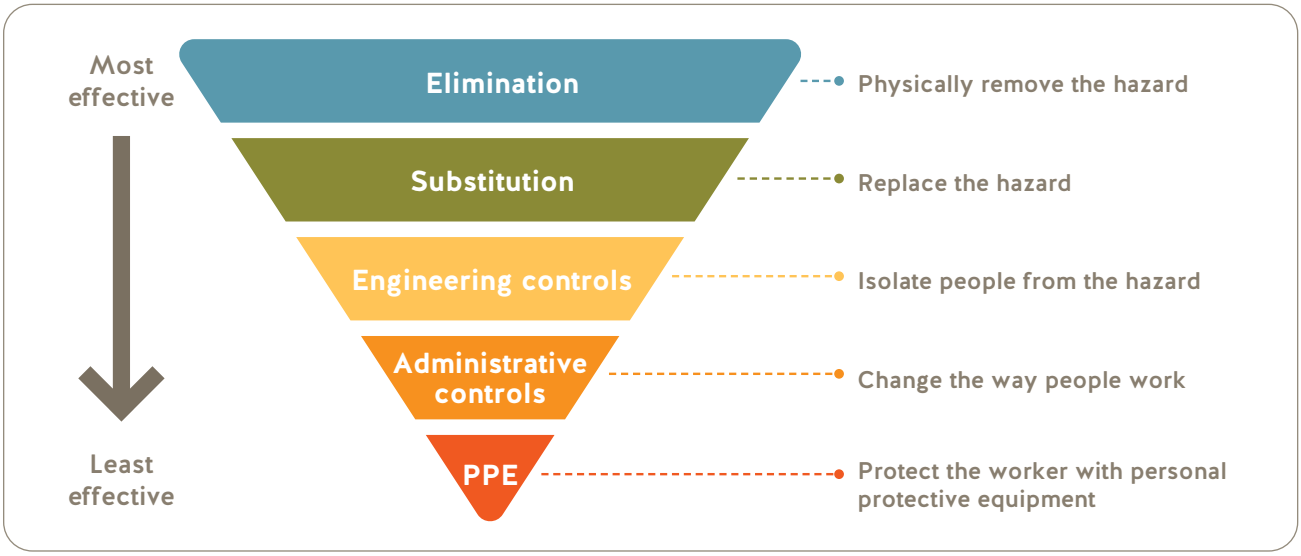
Amount of fume for different welding processes.

Implementing measures to control the risks

Once you understand the risks involved with the welding processes in your workplace, take steps to control those risks.

Hierarchy of controls

Some risk controls are more effective than others. You may not always be able to use the more effective solution, but whenever possible you must implement controls in the following order.



Even though the controls are listed in order of effectiveness, you should consider all types of controls. They often work best in combination — for example, using a respirator in addition to LEV.

Give priority to controls that protect several workers at a time. For example, LEV will protect everyone in the workplace, but a respirator only protects the person wearing it.

Elimination or substitution

Before considering risk controls that will help reduce the risk (e.g., LEV, dilution ventilation, administrative controls, respiratory protection), first try to eliminate the hazard or substitute a different process. Think about ways to modify the work process to eliminate or reduce the amount of hot work or fumes. Consider the following:

- Use cold-joining techniques such as mechanical fasteners or adhesives.
- Redesign the job to use thinner-gauge material.
- Remove grease and all surface coatings before welding. Paint and resin coatings may release toxic components when heated.
- Use a welding technique that creates less fumes and gases.

Controls for reducing risk

There are four basic risk controls for welding fumes and gases:

- Local exhaust ventilation (LEV) (see pages 8–11)
- Dilution ventilation (see page 12)
- Administrative controls (see page 14)
- Respiratory protection (see pages 15–16)

The following sections include suggested controls for indoor and outdoor welding. These controls apply to aluminum, mild steel, and stainless-steel base metals. For alloys that contain beryllium and other very toxic metals, consult a qualified person (as per section 1.1 of the Regulation).

Controls for common welding processes

Welding process	Type of control
Tungsten inert gas (TIG)	• Use LEV for higher-intensity activities. For lower-intensity activities, dilution ventilation may be adequate (see page 12).
Shielded metal arc (stick), metal inert gas (MIG), and flux-cored arc (FCA) welding	• Use a welding gun with on-torch extraction, if practicable. Otherwise, use one of the following: – An extracted welding booth. – An extracted workbench. – An LEV system with a movable capturing hood. • Make sure the work area has adequate clean makeup air to replace extracted air.
Oxy-fuel cutting and other processes	• Use a movable capturing hood. • Use dilution ventilation to minimize fumes in the area.
Plasma arc cutting (fixed equipment)	• Use a water table or downdraft table to capture fumes. • Use a good standard of dilution ventilation, such as the established engineering principles in the American Conference of Governmental Industrial Hygienists (ACGIH) publication *Industrial Ventilation: A Manual of Recommended Practice for Design*.
Air carbon arc gouging	• Work in an enclosed booth with an inward airflow, if practicable. • Keep fume extraction as close as possible to where the fumes are generated. • Provide suitable respiratory protection.

Welding in confined spaces

Before any welding processes take place in a confined space, a qualified person must conduct a hazard assessment and prepare written confined space entry procedures based on that assessment (see sections 9.9 to 9.11 of the Regulation).

What is a qualified person?

Section 1.1 of the Regulation defines *qualified* as "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."

For confined spaces, *qualified person* is further defined in section 9.11(1)(a) of the Regulation as someone "who has adequate training and experience in the recognition, evaluation and control of confined space hazards."

Local exhaust ventilation (LEV)

Local exhaust ventilation (LEV) is an engineering control that captures hazardous fumes and gases at the source and removes them from the workplace. LEV systems are effective for controlling exposure to welding fumes if the systems are:

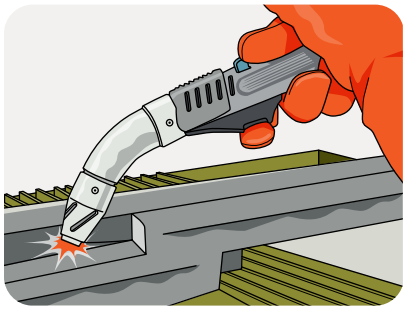
- Designed properly
- Appropriate for the situation
- Maintained regularly
- Monitored for performance

Workers should be trained in the use and maintenance of the LEV system. They should know how to use and position it, and understand its limitations and effectiveness.

LEV systems should be designed by a qualified person, such as an industrial ventilation engineer, who has assessed the ventilation needs of your workplace. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends minimum duct velocities of 12.5 to 17.5 m/s (2500 to 3500 fpm) for welding fumes and capture velocities of 0.5 to 0.85 m/s (100 to 170 fpm).

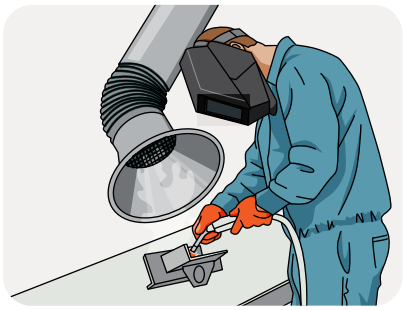
Capturing hoods

Capturing hoods are the most common type of LEV. With capturing hoods, the LEV system needs to generate enough airflow to draw in the fumes. The welding process happens outside the hood. There are several different types of capturing hoods for welding processes, such as on-torch capturing hoods, movable capturing hoods, and extracted workbenches. The shape of the hood and its distance from the welding operation influence the hood's ability to draw in enough air to control exposures effectively.



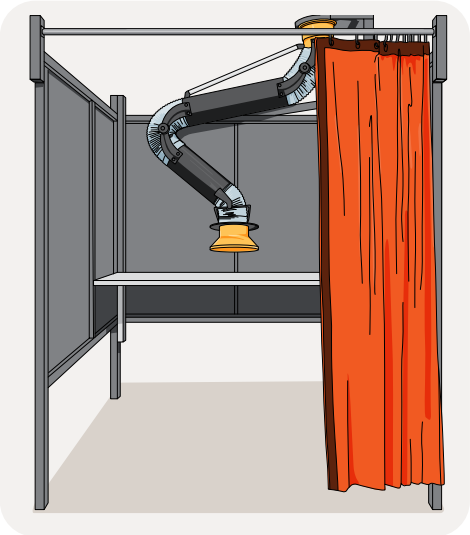
On-torch capturing hoods are useful when welding larger workpieces that are too big to transport to a workbench.

Extracted workbenches are ideal for workpieces that can be transported to the workshop.



Movable capturing hoods are another option when working on larger workpieces.

Welding benches and booths



Sometimes workpieces can be transported to a workshop and positioned on a welding bench or inside a booth. You can use an extracted bench or extracted booth that draws fumes away from the welder and toward the point of exhaust at the back of the bench or booth. The extraction hood doesn't need to be repositioned during welding to capture fumes.

Curtains on welding booths, shown here with a movable capturing hood, help protect nearby workers against exposure to UV light or flash burns.

Consider the following guidelines:

- Make sure the fumes are drawn away from the welder through a series of extraction holes or slots in the bench or booth.
- Enclose as much of the bench or booth as practicable to prevent cross-drafts and improve its ability to capture fumes. (In the Regulation, *practicable* means "that which is reasonably capable of being done.")
- Position the workpiece on the bench or booth to capture fumes effectively. For example, use a turntable or custom jig to ensure that fumes are moved away from the welder.
- Keep the work surface of the bench or booth free from clutter so air movement won't be restricted.
- Make sure the workpiece or the area to be welded is entirely within the booth.

On-torch LEV

Large and extra-large workpieces present different challenges because they are typically too big to transport to a workbench. For these workpieces, you can use on-torch extraction.

Welding torches with on-torch extraction come with an integrated vacuum hose. The hose diameter is normally about 25 mm (1 in.). When set up and used correctly, on-torch extraction is the most effective fume control (70 to 98% efficiency). The efficiency varies depending on the welding method, the type of shielding gas, the material, and the skill of the welder. If the required shielding gas makes on-torch extraction impractical, you can use LEV with a movable hood.

Advantages of on-torch extraction

- The extraction is integrated with the welding gun.
- The extraction moves with the weld and is always close to the source.
- It requires low air volume, which reduces the amount of tempered air extracted from the shop. This makes it cost effective.
- The welder doesn't need to reposition the extraction hood to maintain good fume capture.

Limitations of on-torch extraction

- The extraction unit can be bulky, so it's not always practical to have it close to the welding area when welding at heights.
- On-torch extraction is often effective for groove welding on a flat surface (e.g., downhand, horizontal, or vertical). But it's less effective for fillet welding or groove welding in the overhead position.

LEV with a movable capturing hood

Use a movable capturing hood on a flexible extraction arm when other, more-effective LEV designs are not practical for large to extra-large workpieces. It's important to set up the LEV correctly so it:

- Captures the fumes away from the welder's breathing zone
- Can be used without compromising the weld integrity

Consider the following guidelines for LEV systems with movable hoods:

- Select an appropriate hood design to maximize fume capture from your welding process. Consider the shape, size, and hood diameter, and whether you can use a flanged capture hood.
- Make sure ducting doesn't have any acute bends, kinks, holes, or cracks. Avoid long sections of flexible ducting.
- An optimal distance for capture is one duct diameter from the arc.
- Reposition the hood as often as necessary to maintain optimal fume capture.
- The recommended air volume is 600 to 1900 m^3/h (400 to 1200 cfm) depending on the type of extraction arm or hood.

Portable welding fume extractors with air cleaners

You can use portable welding fume extractors fitted with air cleaners for some welding tasks when exhausting outside is not practicable or it's not a fixed work station. These systems are acceptable if they effectively remove the fumes and filter the contaminants to minimize the effect of the exhausted air on the worker's overall exposure. The equipment should have a series of filters, including spark arrestors, pleated filters, activated carbon filters, and HEPA filters. It should be equipped to monitor the differential pressures across the filters.

When selecting a unit, consider the welding process, base metals, consumables, and other process-related factors. A recirculating system should not be used at fixed welding stations where it is practicable to have a system that exhausts outdoors.

A preventive maintenance program is required to ensure that the extractor continues to work effectively. The program must include inspections and regular replacement of filters as per the manufacturer's instructions. Workers must wear respirators when changing the filter media.

As part of the risk assessment, the employer must ensure that worker exposures are evaluated after the system has been installed and is in use.

Selection, installation, and maintenance

When selecting a ventilation system, make sure it's user friendly and appropriate for the welding processes and the workplace. Selecting and installing an LEV system can be complicated. Poor design or installation of any one component will reduce the system's ability to remove fumes. Hire a qualified person with experience designing systems to help you select the right system. A qualified person should also review any changes or additions to the system. For example, adding more hoods to a system can significantly impact its effectiveness.

LEV systems require regular checks and maintenance. Your LEV supplier should provide a user manual that describes how to use and maintain the system. As an employer, you should verify that the ventilation system is capable of working as intended. Follow the supplier's or installer's maintenance instructions and schedule.

The performance of any ventilation system will degrade over time. Establish ongoing degradation and trend monitoring for the ventilation system. There are various methods for checking the effectiveness of an LEV system, including:

- Dust lamps
- Static pressure readings
- Pressure differential readings on filters
- Duct-system measurements
- Airflow indicators
- Smoke tubes

Employers should make sure workers are trained to complete routine checks of LEV systems before starting work. Workers must report defects to supervisors. Fix faults immediately to ensure that the system continues to work effectively.

Considerations for LEV systems

- Conduct welding in a dedicated area away from drafts and other workers. This prevents fumes from blowing away from the hood and into other workplace areas.
- Ensure LEV systems exhaust directly to the outdoors unless it is not practicable and portable extractors are used (see page 10).
- Make sure the hood is the right design for the welding process and the types of fumes.
- Install an airflow indicator, such as a manometer, to check that the LEV is working properly.
- Make sure welders are not positioned between the fumes and the hood.

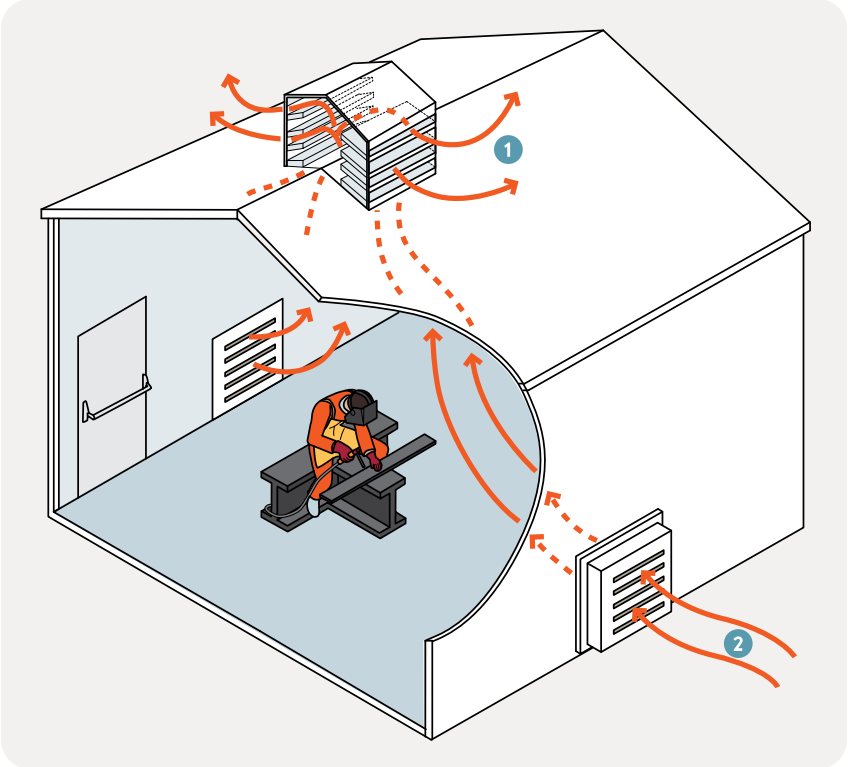
Dilution ventilation when welding indoors

Where LEV is not enough (or not practicable) to remove welding fumes completely, using dilution ventilation as an additional control can help prevent fume buildup. Natural dilution ventilation from open doors and windows is not reliable and generally doesn't provide enough air movement to disperse welding fumes.

Most welding workshops will need mechanical dilution ventilation, which uses fans mounted on the ceiling or high up on a wall. These fans extract the air from the room and draw in clean air to disperse airborne contaminants. The amount of airflow needed to dilute welding fumes is much higher than the airflow used in LEV. The airflow will also depend on the rod diameter, the amount used, and the characteristics of the space. For example, if the space is an open area, welding fumes can easily rise. In an enclosed area, they can't.

Mechanical dilution ventilation systems work well for processes that produce small amounts of fumes (e.g., low-intensity resistance spot welding and low-intensity TIG welding) in relatively large work areas with high ceilings. These systems also help control exposures for workers in adjacent areas.

Ventilation systems should be designed, installed, and maintained according to established engineering principles. A useful guide is the ACGIH publication *Industrial Ventilation: A Manual of Recommended Practice for Design.*



Dilution ventilation is an additional control that helps prevent buildup of welding fumes and protects workers in adjacent areas.

1. Fume and hot air out via exhaust fans
2. Cool air in

Welding outdoors

Welding outdoors is often done without controls due to a belief that natural ventilation will reduce fume levels sufficiently. However, outdoor welding is typically done with barriers in place or with the welder using their body to shield the weld. This reduces the effectiveness of natural ventilation and can lead to a buildup of fumes in the welder's breathing zone.

The current, low exposure limits, combined with the potentially serious health effects of exposure, mean that welding fumes and gases must be controlled to much lower levels than previously required. Except for infrequent and short-duration tasks, welding outdoors requires controls such as LEV and/or respiratory protection.

Similarly, when welding within enclosures such as pipelines, an adequate LEV system must be in place to control exposures and to prevent the accumulation of shielding gases. Respiratory protection may also be required.

Administrative controls

Administrative controls are changes to the way people work. They may include safe work procedures, programs and policies, training, and scheduling. For example, a common, required procedure is to clean welding surfaces of any coating (such as solvent residue or paint) that could create a toxic exposure.

It's also important to control the levels of hazardous substances that can accumulate in the air and on surfaces. Some welding substances can be absorbed through the skin (e.g., beryllium or chromium) or have direct effects on the skin because of irritation or sensitization (e.g., chromium). Hazardous substances can also enter the body through accidental ingestion (e.g., lead).

Employers must develop and implement decontamination procedures. This includes regularly cleaning of areas where food and beverages are consumed, as well as other surfaces where skin exposure may occur. Employers must provide workers with access to personal hygiene facilities that are appropriate for the exposure.

Respiratory protection

Welders will need to wear respirators if LEV and dilution ventilation aren't enough to keep exposure levels well below the exposure limits. In outdoor construction, for example, engineering controls such as dilution ventilation may not be practicable because of obstructions and wind direction. Respirator requirements are described in sections 8.32 and 12.124 of the Regulation.

Half-face respirators may be necessary in locations where LEV isn't practicable or is only partially effective.

Welders must wear respirators if both of the following are true:

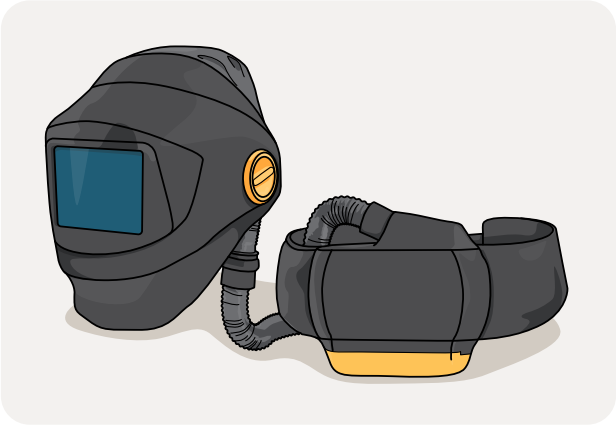
- The welding process generates a lot of fumes (e.g., air carbon arc gouging, plasma arc cutting, FCA welding, or MIG welding for a significant duration of the shift).
- The size or shape of the workpiece means that LEV won't be enough to control the fumes for all the welds.

Welders will also need respirators if the LEV system doesn't capture welding fumes consistently. For example, this can occur when using a movable capturing hood on a flexible arm for a large workpiece with long runs of welds.

Respirators may also be necessary for work in temporary work locations where the risk assessment indicates LEV is not reasonably practicable (e.g., work at heights).

In these situations, provide respirators to all workers in the area who are likely to be exposed to fumes. Also, make sure there is dilution ventilation to prevent fumes from lingering.

Powered air-purifying respirators (PAPRs) with integrated welding visors



PAPRs are available with an integrated welding visor to protect the skin and eyes from UV and to provide a clear viewing window. This device allows a welder to keep the respirator in place when checking a weld. If a welder has to lift the visor to check a weld, they should wait until visible fumes have disappeared before doing so.

PAPRs with welding visors let workers check welds without lifting the visor.

Respirator requirements

Most welding tasks will require the use of a respirator if engineering controls aren't enough to control exposures effectively. Follow these requirements:

- Implement a written respirator program if respirators are required to protect workers.
- Make sure workers are fit tested if they are using respirators with a tight-fitting face seal.
- Make sure workers with tight-fitting respirators are clean shaven where the respirator seals to the face.
- Train workers on how to use and maintain their respirators, and on the limitations of the respirators.

There may be some situations where, in addition to a P100 cartridge, the welder may need a gas and vapour cartridge that is appropriate for the hazard.

Where workers must perform welding tasks for more than one hour per day, consider providing PAPRs. Workers are more likely to use PAPRs consistently because they're more comfortable.

Communicating with workers

Employers are responsible for informing workers about the health hazards from welding fumes and gases. Provide orientation and training on the risks of welding fumes and gases and what to do to control those risks. Include managers and supervisors in health and safety training.

Education and training

Make sure workers receive education and training on the following:

- Responsibilities of employers, supervisors, and workers
- How to recognize welding fume hazards
- Health effects of welding fumes
- How to report welding fume hazards to a supervisor or the employer
- Safe work practices and procedures in place to minimize exposure to welding fumes
- How to use LEV, and how to make sure it's functioning properly
- How to position themselves and the workpiece
- When respirators are required and how to use them
- How to inspect, maintain, and store respirators
- What is included in the exposure control plan (ECP)

Safe work procedures

Written safe work procedures explain to workers in reasonable detail the steps they need to follow to perform their work safely. Employers must provide workers with instruction, training, and supervision to make sure they understand the procedures and are able to perform their tasks safely. Employers must also provide effective supervision to make sure that workers are following all safe work practices and procedures.

Documentation

It's important to document what you find from inspections, risk assessments, and air monitoring. You should also keep training records and have a written ECP. Your documentation doesn't need to be complicated, but it should have enough information to help you communicate and manage risks in your workplace.

These documents will help demonstrate how you are implementing your health and safety policies, procedures, and practices. They will also provide proof of any enforcement actions you have taken and demonstrate that appropriate checks and reviews are in place.

Monitoring and updating risk controls

Protecting workers from harm involves ongoing effort. Employers need to monitor the effectiveness of the risk controls they have in place and improve those that are inadequate to control the risk. Do the following:

- Conduct regular safety inspections so you can monitor the effectiveness of existing controls and identify new or changing hazards and risks.
- Consult with your joint health and safety committee or worker health and safety representative, as applicable.
- Review your ECP — in consultation with the joint committee or worker representative, as applicable — at least once a year and update it as necessary.
- Update your ECP and risk assessments whenever you introduce new equipment, materials, or work processes.
- Deal with health and safety concerns as soon as possible.

Exposure control plans (ECPs)

Most workplaces with welding activities will be required to develop and implement an exposure control plan (ECP) to deal with welding fumes and gases. An ECP is a written document that describes the control measures the employer will use to protect workers from harmful exposures to welding fumes and gases.

For each welding task, your ECP should identify:

- Which chemicals workers are exposed to
- The exposure levels (low, moderate, or high)
- The risk controls that will be used to minimize exposures

Employers must ensure that the controls described in the ECP are implemented and that workers are trained on the ECP and safe work procedures.

An ECP must include the following elements:

- A statement of purpose and responsibilities
- Risk identification, assessment, and control
- Education and training
- Written work procedures
- Hygiene facilities and decontamination procedures
- Health monitoring, when required
- Documentation

Evaluating exposures and monitoring health

As an employer, you might need to periodically evaluate worker exposures to welding fumes and gases. Evaluating exposures can help you determine how effective your risk controls are.

The exposure evaluation must be done by an occupational hygienist or another qualified person. The evaluation involves comparing the results with the relevant exposure limits for B.C. An exposure limit is an upper limit for the acceptable concentration of a hazardous substance in the air in a workplace. If the results show that your current controls are not working effectively, the qualified person can help identify appropriate controls for your workplace.

Employers must ensure that the results of the exposure evaluation are provided to workers.

Health monitoring

Health monitoring may be necessary for substances such as lead and cadmium, which are associated with some welding activities. Health monitoring helps protect workers from developing occupational disease by detecting biological indicators or adverse health effects early on.

Workers who are regularly exposed to welding or cutting fumes should tell their family doctors so records can be kept. As a worker, you may want to tell your doctor about the potential health effects of welding fume exposures. Some family doctors may not be trained in occupational diseases.

Workers should report any signs or symptoms of welding fume exposure to their employer for tracking and investigation purposes.

For more information

Regulatory references

In the Occupational Health and Safety Regulation, see the following sections:

- Section 5.48, Exposure limits
- Section 5.54, Exposure control plan
- Section 5.57(2), Designated substances
- Section 5.61, Engineering principles
- Section 5.64, Controlling air contaminants
- Section 5.65, Worker location
- Section 5.67, Effectiveness
- Section 5.69, Makeup air
- Section 5.70, Discharged air
- Section 8.32, When respirator required
- Section 12.114, Ventilation
- Section 12.124, Respiratory protection
- Guideline G5.48-5, Welding fumes
- Guideline G12.124, Respiratory protection during specific short duration welding, burning, or similar operations, and emergency work

Other resources

- Welding Gases & Fumes (WorkSafeBC)
- Welding Fume Exposure (WorkSafeBC)
- *Breathe Safer: How to Use Respirators Safely and Start a Respirator Program* (WorkSafeBC)
- Controlling the Risks from Welding (Health and Safety Executive)
- Welding and Local Exhaust Ventilation (WorkSafe New Zealand)
- Selecting Proper Welding Processes to Reduce Fume Exposure (The Center for Construction Research and Training)
- CSA Standard W117.2:19 Safety in Welding, Cutting, and Allied Processes (CSA Group)
- Welding — Overview of Types and Hazards (Canadian Centre for Occupational Health and Safety)

Appendix: Health effects of fumes, gases, and organic vapours produced during welding

Sources and health effects of welding fumes

Fume	Sources	Health effects	Regulation notation (section 5.57)
Aluminum	• Aluminum component of some alloys, such as Inconel, copper, zinc, steel, magnesium, brass, and filler materials	• Lower respiratory tract irritation, pneumoconiosis, neurotoxicity	—
Beryllium	• Hardening agent found in copper, magnesium, aluminum alloys, and electrical contacts	• Beryllium sensitization, chronic lung disease, cancer • Exposure may occur by skin route (see guideline G5.52, Skin notation)	• ACGIH A1/IARC 1 carcinogen • ACGIH sensitizer (respiratory, skin)
Cadmium oxides	• Stainless steel containing cadmium or plated materials, zinc alloy	• Lung cancer, metal fume fever, kidney damage	• ACGIH A2/IARC 1 carcinogen
Chromium	• Most stainless-steel and high-alloy materials, welding rods • Some electroplated metals • Hexavalent chromium is formed during welding	• Lung and sino-nasal cancer; asthma; respiratory tract and skin irritation and sensitization • Health effects vary with form of chromium • Exposure may occur by skin route (see guideline G5.52, Skin notation)	• ACGIH A1/IARC 1 carcinogen • ACGIH sensitizer (respiratory, skin)
Copper	• Alloys such as Monel, brass, bronze, some welding rods • Coating on filler fire, sheaths on air carbon arc gouging electrodes, non-ferrous alloys	• Eye, skin, nose, and throat irritation; metal fume fever; gastrointestinal distress	—

Fume	Sources	Health effects	Regulation notation (section 5.57)
Fluorides	• Common electrode coating and flux material for both low- and high-alloy steels	• Bone and joint damage, fluorosis • Eye, skin, and respiratory tract irritation • Chronic effects may include gastrointestinal symptoms, fluid in lungs, and kidney dysfunction	—
Iron oxides	• The major contaminant in all iron or steel welding processes	• Pulmonary siderosis (lung disease); nose and lung irritation	—
Lead	• Solder, brass, and bronze alloys • Primers and other coatings on base metals	• Blood effects; central and peripheral nervous system impairment; effects on kidneys and digestive system; adverse reproductive effects • May cause cancer • Health effects vary with form (see chromium for lead chromate)	• IARC 2A carcinogen • Reproductive toxin
Manganese	• Most welding processes, especially high-tensile steels	• Central nervous system impairment, metal fume fever, adverse reproductive effects, manganese poisoning	• Reproductive toxin
Molybdenum	• Steel alloys, iron, stainless steel, nickel alloys	• Respiratory tract irritation	—
Nickel	• Stainless steel, Inconel, Monel, Hastelloy and other high-alloy materials, welding rods, and plated steel	• Nasal and lung cancer, pneumoconiosis, dermatitis, asthma-like lung disease, renal dysfunction, respiratory tract irritation • Health effects vary with form of nickel	• ACGIH A1/IARC 1, 2B carcinogen
Vanadium	• Some steel alloys, iron, stainless steel, nickel alloys	• Upper and lower respiratory tract and eye irritation • May cause cancer	• IARC 2B carcinogen
Zinc	• Galvanized and painted metal	• Metal fume fever	—

Sources and health effects of welding gases

Gas	Sources	Health effects	Regulation notation (section 5.57)
Carbon monoxide	• Formed in the arc	• Adverse effects on neurobehavioural system, cardiovascular system, and exercise capability, as well as fetuses • Headache, dizziness, unconsciousness	• Reproductive toxin
Hydrogen fluoride	• Decomposition of rod coatings	• Pulmonary inflammation; lung damage; eye, skin, and respiratory tract irritation; fluorosis • Exposure may occur through skin	—
Nitrogen oxides	• Formed in the arc	• Lower and upper respiratory tract and eye irritation, cyanosis, hypoxia, pulmonary edema, lung disease (emphysema)	—
Oxygen deficiency	• Welding in confined spaces • Air displacement by shielding gas	• Dizziness, mental confusion, asphyxiation	—
Ozone	• Formed in the welding arc, especially during plasma arc, MIG, and TIG processes	• Lung function impairment, pulmonary edema, hemorrhaging • Headaches; dryness of mucous membranes and throat	—

Sources and health effects of organic vapours and other gases generated by welding

Gas/vapour	Sources	Health effects	Regulation notation (section 5.57)
Aldehydes (such as formaldehyde)	• Metal coatings with binders and pigments • Degreasing solvents	• With formaldehyde, irritation of eyes and respiratory tract; upper respiratory tract cancer, sensitization	• Formaldehyde: – ACGIH A1/ IARC 1 carcinogen – ACGIH sensitizer (respiratory, skin)
Diisocyanates	• Metal with polyurethane paint	• Lung function impairment; respiratory tract sensitization; skin sensitization; eye, nose, and throat irritation • Exposure may occur through skin • Health effects depend on type of diisocyanate	• IARC 2B carcinogen (some isocyanates) • ACGIH sensitizer (respiratory, skin)
Phosgene	• Metal with residual chlorinated degreasing solvents • Formed by reaction of the solvent and welding radiation	• Respiratory tract irritation, pulmonary edema, lung congestion, emphysema • Symptoms may be delayed	—
Phosphine	• Metal coated with rust inhibitors	• Respiratory tract irritation, pulmonary edema, kidney damage	—