



CRS Construction general superintendent Brian Bruinink (left), meets with welders Brodie Thom and Matt Hindmarsh to discuss source extraction ventilation and other fume and coordination controls for the planned work in this stairwell.

Effective controls for welding fumes require a unique approach

By Lucy Hyslop

The chemical reactions caused by welding and cutting metal can put workers on the front line for many chronic and irreversible health hazards, such as asthma, lung cancer, and neurological problems. The key is controlling a worker's exposure to gases and fumes.

With their bright lights and sparks flying, welders are everyday fixtures in just about every industry — seen daily working on pipelines, bridges and ships, and all over construction sites.

However, the complex chemical compounds they conjure up during these intense heating processes are anything but ordinary. Welders, burners, and workers in the plasma-cutting trade can be exposed to a slew of toxic fumes and gases when they melt, slice, and join metal. Depending on the material being worked on (such as high-alloy steel) or in the case of welders, the electrode being used, the danger is wide-ranging.

Serious health risks

The health risks from inhaling and being in contact with these types of chemical reactions can be equally wide-ranging: from the potentially short-term effects of nausea or irritations to the eyes, nose, and throat, to long-term asthma and lung cancer. More than eight out of ten welders — there are around 100,000 in Canada — are said to be exposed to lead, which can cause stomach, lung, kidney, and brain cancers, while five out of ten are exposed to nickel, which can lead to nasal and lung cancer, too, according to CAREX, a nationwide surveillance project that estimates the number of Canadians exposed to substances associated with cancer in workplace and community environments.

Many metal oxides, such as chrome, cadmium, nickel and lead are carcinogenic. Under particular spotlight is manganese, as its exposure limit was reduced in 2013. Manganese is found in all steel but exists in high amounts in high-impact resistant steels. While manganese is an essential nutrient in the body, it is dangerous when inhaled. Too much manganese in body tissue can lead to neurological and neurobehavioral disorders. According to the Centers for Disease Control and Prevention, inhaling manganese can cause Parkinson's-like neurological damage such as shakiness and blurred speech. According to the National Institute for Occupational

Safety and Health, inhaling manganese has been linked to a higher risk of fertility problems in men.

Getting the word out to workers about the dangers of toxic welding fumes is integral to safety, says WorkSafeBC occupational hygiene officer Anne Jopling. "Thousands of B.C. workers perform various welding and cutting-related tasks as part of their regular work," she says, adding it's one of industry's oldest trades. "It's important that these workers and their employers know the serious health outcomes that can result from exposure to harmful levels of welding fume and learn about and use effective controls appropriate to the welding tasks they perform."

The need for controls

Simply put, these "effective controls" centre on managing the levels of exposure. To do this, employers should run through the Hierarchy of Controls, an essential four-pronged checklist from the Occupational Health and Safety Regulations. It starts with employers asking the primary question of substitution: Is there any alternative way to do the task so that welding — and its fumes — are eliminated or a less hazardous material is used?

"Welding parameters and processes can drastically influence the fume and gas produced. This means that modifications to any aspect of the welding task can drastically alter the fume generated," says Jopling.

For example, the filler metal (electrode or wire) — which is used to make joints or solder metal parts together — can produce 90–95 percent of the fume.

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CRS welders Matt Hindmarsh and Brodie Thom work in pairs to complete a welding task requiring the use of fume extraction (local exhaust) ventilation.

“Substituting a lower alloy electrode or wire can make a significant reduction in fume generation,” says Jopling. “The selection of substitutes is complex as many variables and certifications need to be considered.”

If it can't be eliminated or substituted, there need to be engineering controls. Examples of engineering controls are local exhaust ventilation to remove the noxious air from the point of generation, or using fans (general ventilation) to move the smoke away from the worker to a fume collector or ventilated area.

Before you decide which engineering control to use, you should consider all the pros and cons of each option, notes Jopling. The aim is to make the atmosphere (which, of course, can also include grinding dust and other particulate that are unseen in the air) around the worker, and others present in the work area, safe and non-toxic. If you don't have all the answers yourself, consult a professional, adds Jopling: “Working with experts can save a lot of time and costly mistakes.”

The next stage is the administrative control, which is to make sure that your work practices and policies create awareness of the hazards and facilitate training. One example is to ensure that warning signs are installed to keep other workers away from the welding area. In conjunction with these other stages, personal protective equipment such as respiratory masks (which in turn need to be tested to ensure they are working well and are properly fitted), eyewear, and protective clothing should be supplied to the welders if needed. Many of the exposure limits for metal oxides are extremely low, and even with engineering and administrative controls, a worker's exposure can still be at or above the exposure limit. For this reason, a respirator will often be an important addition to a safety plan, but they must be used in conjunction with other safety measures.

“It typically only takes a fraction of a second for fumes and gases to be released into the air,” says Jopling. “Most fume components are microscopic — usually under 5 microns or smaller, invisible to the eye. The fume plume you see is a fraction of the particulate that is there.”

WorkSafeBC occupational hygiene officer Anne Jopling and Emily Ortis, the A.J. Forsyth regional health, safety, and quality manager, discuss the effectiveness of a submerged arc cutting process to eliminate airborne welding fume.



The Hierarchy of Controls is an essential part of an effective exposure control plan (ECP), but what does it mean to put all this in place in a real-world scenario? Welders can find themselves in a diverse set of scenarios, as varying as the work they carry out. For dynamic work environments, such as construction, the ECP is what provides guidance to field crews on the factors to be assessed when planning a welding task.

Ever-changing work environments

Take Lower Mainland-based CRS Construction, for example. Currently working on the new acute care centre at BC Children's Hospital and BC Women's Hospital in Vancouver, some 30 workers could be welding steel outside on rooftops one moment, and working indoors on stairwells and bridges connecting old and new passageways the next. According to Brian Bruinink, CRS general superintendent, that leaves its crews having to think on their feet when it comes to exposure control plans.

"Our first priority is the decision logic for risk assessment," he explains. The ECP needs to be read and adapted to the situation they face. "If you are outside and there's a breeze, for example, there can be

very little risk to anybody, but as you start to get inside you have to have other methods to protect your workers, other workers, and even the general public."

Indoor worksites or shops have the potential to be fume-filled without adequate ventilation. Protection in these cases, adds Bruinink, may come in the form of installing a fan to push the smoke away from the worker and hanging up tarps or blankets to protect others. Because taping off an area is often ignored by passersby, he says they may even employ someone to prevent the public from passing until it is safe to do so.

"It can be complicated to put a plan together," he says of working in more fluid situations and differing environments, "but we do it so often that you take pieces of the job and put a plan together to make it a safe environment." For Bruinink, it all comes down to taking the issue seriously. "Nobody wants their workers to retire with chronic health issues."

New techniques require new thinking

For those companies with workshops dedicated to welding, monitoring for noxious fumes and gases can be much easier. It's an approach taken by Richmond-

“Nobody wants their workers to retire with chronic health issues.”

—Brian Bruinink, CRS general superintendent

based company Menard Canada Inc. (formerly known as Geopac Inc.), a specialty contractor that uses a range of machinery to help stabilize the ground for building projects. They need welding expertise when it comes to a piece of equipment known as a cutter soil mixer.

The cutter soil mixer has giant rotating steel “teeth” that churn down into the ground, up to 45 metres deep, to cut shapes that will be filled with cement to create concrete panels that will be part of the foundation for construction. The welders need to protect the teeth from being worn down. As Drago Ranisavljevic, Menard’s corporate safety manager, explains, they use an electrode to coat the hardened steel of the teeth in chrome — a technique, however, that gives rise to chromium [VI] fume, which can cause such detrimental health effects as liver and kidney damage, and respiratory cancer when people are exposed to it.

“These fumes are harsh, so we knew we needed to fix it right off the bat,” says Ranisavljevic.

When it comes to the hierarchy of controls, it wasn’t possible to eliminate the process, says Ranisavljevic: “If there was another product apart from the one we use that is not as toxic, we’d be using it.” So, their next approach was to have a weld fume and chrome metal air sampling study, so the firm could monitor the toxicity levels.

That prompted a range of measures including a new ventilation system for their welding work stations to help remove the fumes. (Some are engineered directly above the welding table.) Significantly, the welders’ stations in the work area have an open wall to ensure they are not enclosed. “It’s totally open on one side to the outside so there is ventilation going through it, in addition to the fans to remove the fumes,” he adds. The worksite no longer registers harmful levels of chromium [VI].

Moving equipment may require new testing

Over at A.J. Forsyth, a division of Russel Metals Inc., there are regular tests of the air quality in its 24-hour

operation. A.J. Forsyth is a metal service centre that warehouses and processes a large range of products, such as sheet, plate, structural steel, tubing, pipe, and extrusions for various industries ranging from fabrication to forestry.

Looking for such chemicals as manganese, iron oxide, carbon monoxide, carbon dioxide, and ozone arising from their oxyfuel and plasma cutting tables, the firm monitors air quality to ensure operating levels are below exposure limits for chemical and biological substances at three points: at the machines, at stationary points within the worksite, and on workers wearing sampling tubes.

“Air sampling is taking a good pulse of the situation, and air quality testing goes hand-in-hand with risk assessment,” says Emily Ortis, A.J. Forsyth’s regional health, safety, and quality manager. As a baseline, she continues, the company can compare its levels year on year, and check that there is no negative change in the air quality.

Their century-old steel service centre in Delta is a fixed site, employing around 10 burners among

Other risks for welding

Occupational disease from fumes and gases is not the only risk that welders face. Welders are the largest occupational group exposed to artificial ultraviolet radiation (UVR), usually through electric welding arcs. According to CAREX Canada, exposure to UVR is associated with skin and ocular melanoma as well as short-term skin damage, and injury to the mucus membrane of the eye. Other risks for welders include explosion and fire risks from the use of oxy/fuel gas or from the welding of containers that contain flammable materials. It’s important that employers consider all the risks when developing their overall safety plan. For more information, search “welding” on worksafebc.com.



Steve Crone operates a plasma cutter on sheet metal using a down-draft local exhaust ventilation system at A.J. Forsyth.

87 employees, but they sometimes need to add new equipment or move or modify existing equipment. When that happens, the company will bring in a hygienist to sample the air again. “We want to test the overall ambient environment,” states Ortis.

“You need to know what hazards are present before you control them — it is difficult to control what you are unaware of.” Understanding the specific hazards at their worksite is how the company has known which air quality controls to put in place, such as a down-draft ventilation system that pulls the fumes from underneath the plates and out into a fume extractor outside, or whether to scrap a process completely.

In addition, she believes workers want to see this type of data. “They have a vested interest in going home safe,” says Ortis. “An air quality report that shows we are under the exposure limits not only keeps workers informed about our air quality performance, it also gives them peace of mind.”

The future

Ensuring welders know the importance of safety from the start of their careers is at the heart of British Columbia Institute of Technology’s teaching. Students — around 120 people study the trade through the Vancouver educational establishment per day — are given a welding fume exposure control guide that explains the health hazards for different metal fumes and welding process gases, the differences in the chemical compounds produced by welding, and the need for risk assessment and guidance for controlling exposure.

The teaching facility itself is also a testament to the necessity of good airflow. It has an on-demand ventilation unit that ramps up when anyone is welding (and producing fumes). There’s source capture of fumes, which means they shouldn’t be found outside of the welding area. “Of course this is the perfect world,” comments Mark Flynn, its chief welding instructor, who started welding in 1990. “We know

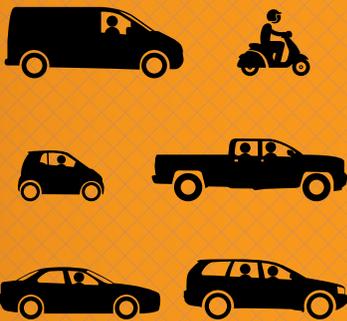
students will be going into the world where there might not be the same situation, so we tell them that just like smoking or anything else where there's fume and cancerous items, they should always wear respirators for any welding that they do so they are protecting themselves.”

The health issues associated with welders and metal cutters has prompted WorkSafeBC to include welding fume as a priority in their 2016/2017 Occupational Disease Strategic Plan. The focus is building greater awareness among employers and workers (especially within construction and metal manufacturing) and promoting safer work practices, according to Barry Nakahara, WorkSafeBC manager, Prevention Field Services for Prince George and Terrace regions.

“We are focusing on sectors where we know there are exposures and where the greatest number of workers have been exposed,” he says. While there are many positives in terms of myriad control options now available for welding and cutting, Nakahara concludes, “We believe we can still move the dial significantly.” ☺

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regional health, safety, and quality manager



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Hierarchy of Controls

The best way to reduce the risk of exposure to welding gases and fumes is to eliminate the source of exposure. If that's not possible, the Hierarchy of Controls is meant to provide a framework for creating a plan to eliminate the hazards.

- 1 Elimination or substitution:** Is there any alternative way to do the task so that welding — and its fumes — are eliminated? Can a less hazardous material (such as manganese-free welding rods) be used?
- 2 Engineering controls:** Making physical modifications to facilities, equipment, and processes can reduce exposure. This includes installing proper ventilation, using fans, and adjusting the workspace so that smoke isn't blowing into the worker's face.
- 3 Administrative controls:** Changing work practices and work policies, and using awareness tools and training can limit the risk

of exposure to welding gases and fumes. One example is to ensure that warning signals are installed in the welding area to keep other workers away from it. Your exposure control plan should address all of the issues that are unique to your situation.

- 4 Personal protective equipment (PPE):** In conjunction with these other stages, personal protective equipment such as respirators (which in turn need to be inspected to ensure they are working well and tested to ensure that they are properly fitted), eyewear, and protective clothing should be supplied to the welders if needed. PPE is only effective when used in conjunction with other protective controls.

Section 12.124 of the Occupational Health and Safety (OHS) Guidelines holds the key to developing fume protection. The tables provided there outline the necessary protections based on type of work and type of material used. Find them in the searchable OHS Regulation and related materials at worksafebc.com.

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