Generic Employer Welding Fume Draft Exposure Control Plan

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EMPLOYER WELDING FUME EXPOSURE CONTROL PLAN

INTRODUCTION

1.0 Background

The welding shop at Employer Welding - Address British Columbia conducts carbon (mild) steel welding, grinding, plasma cutting and occasional aluminum, stainless and galvanized mild steel welding and fabrication of structural components for residential, commercial and industrial facilities. Employees of Employer Welding may also work at client sites as well as the welding shop. This exposure control plan outlines the safety measures implemented by Employer Welding to minimize worker exposure to toxic materials encountered during welding. This exposure control plan was developed in accordance with the requirements of Parts 5.54 and 5.57 of the BC Occupational Health & Safety Regulation (OHSR).

2.0 Priority Hazardous Materials

2(a) Manganese Welding Fume

Manganese is the metal fume component of primary health concern when welding carbon (mild) steels and many other welded alloys. Most all industrial steel formulations and welding consumables include manganese in sufficient concentrations to over-expose unprotected welders, even during short-term welding in well-ventilated work areas. The primary route of entry for manganese is inhalation of respirable particles (welding fume). Ingestion and intestinal absorption of larger particles of manganese is a secondary route of exposure.
Because of its high toxicity, manganese poses the most significant inhalation hazard to mild steel welders. Inhalation over-exposures to manganese can cause both temporary and permanent health problems depending on the amount inhaled.

Potential health effects of chronic (long-term) exposure to manganese above the exposure limit include damage to the central nervous system, decreased fertility in men, respiratory irritation and pneumonia. Symptoms of manganese poisoning include decreased fine motor control, increased reaction times, trembling (resembling Parkinson's Disease), loss of balance and short-term memory, infertility in men and respiratory irritation.

Manganese is a reproductive toxin and a designated (ALARA) substance under Part 5.57 of the BC Occupational Health & Safety Regulation. Employers in BC are required to reduce worker exposures to designated substances like manganese "as low as reasonably achievable" below applicable exposure limits. Manganese has not been classified as a human carcinogen. The WorkSafeBC 8-hour time weighted averaged exposure limit for manganese oxide welding fume was recently reduced from 0.2 to 0.02 milligrams per cubic meter (mg/m3). This exposure limit is intended to minimize the risk of pre-clinical (i.e. early warning) health effects in the lungs and central nervous system and any impairment of fertility in exposed male workers.

2(b) Iron Welding Fume

The current WorkSafeBC 8-hour time weighted averaged exposure limit for iron oxide (mild-steel) welding fume is 5.0 milligrams per cubic meter (mg/m3). This exposure limit is intended to minimize the potential for non-specific inflammatory responses and development of X-ray changes in the lung following long-term exposure. Iron oxide is unusually considered harmless and produces an apparently symptomless condition (pulmonary siderosis) that is characterized by an accumulation of iron oxide in the lungs. There is no evidence that iron oxide causes fibrotic changes or impairment of lung function beyond reversible mild inflammation in response to severe exposures.

2(c) Zinc Welding Fume

Zinc fume exposures can cause metal fume fever with symptoms including chills, muscular pain, nausea and vomiting. Recovery is usually complete in 24 to 48 hours. Metal fume fever does not result from occupational exposures to concentrations of zinc oxide fume below about 15 mg/m3. However, zinc chills can occur at levels around 5 mg/m3. Accordingly, 8-hour exposure limit of 2 mg/m3 for zinc oxide fume was adopted by the ACGIH in 2003. The WCB of BC automatically adopted this level under section 5.48 of the OHSR. When concentrations are kept below this level, the incidence of metal fume fever will be low and the cases that may occur will be mild. A STEL (15-minute exposure limit) of 10 mg/m3 has been in effect since 1976. Metal fume fever may also result from overexposure to copper, magnesium, and some other metals. Zinc oxide fume exposure is not associated with increased cancer risk in the current literature. Zinc alloys and galvanized metals both generate significant zinc metal fumes during welding and cutting.

2(d) Lead Oxide Fume and Lead Dust

In welding or other hot work, lead is normally encountered in paints or other coatings on base metals. When ingested as finely-divided dust or inhaled as respirable fume lead is extremely toxic to the blood-forming, reproductive and nervous systems. The reproductive toxicity of lead leads to its designation as an ALARA substance requiring exposure controls to levels “as low as reasonably achievable” below the current 8-hour exposure limit of 0.05 mg/m3. Part 12.115 of the B.C. Occupational Health & Safety Regulation requires that any coating containing lead is removed prior to hot work whenever practicable. When coatings are removed prior to hot work welding exposures are not significant. If workers may be exposed to lead during hot work on coated surfaces, designated “dirty” work areas must be established, a separate and separate lead exposure control plan must be developed and workers subjected to regular blood lead monitoring.

2(e) Nickel Oxide Fume

Nickel welding fume is generated by arc welding, cutting or grinding on stainless and specialty hardened steels. Nickel welding fume is a designated (ALARA) substance under the OHSR since nickel is a recognized nasal and respiratory carcinogen and respiratory and skin sensitizer. There

is some controversy regarding the role of nickel welding fume in carcinogenesis. The current WorkSafeBC averaged 8-hour exposure limit for nickel oxide fume is very low at 0.05 milligrams per cubic meter in air.

2(f) Chromium (6) Oxide Fume

The current WorkSafeBC 8-hour time weighted averaged exposure limit for chrome 6 welding fume is extremely low at 0.025 milligrams per cubic meter (mg/m3). Hexavalent chromium or chrome 6 is a carcinogenic, sensitizing and corrosive form of chromium that is generally man-made. Less toxic forms of chromium like chrome 3 are essential nutrients and necessary for maintaining blood glucose levels. Less toxic forms of chromium generate chrome 6 during hot processes like welding and cutting. Chrome 6 is generated when welding all stainless and specialty steels that contain significant amounts of chromium. This very low exposure limit is easily exceeded during hot work on stainless or hardened steel even in the absence of noticeable fume accumulations. Hexavalent chrome is a carcinogen and a sensitizer and therefore a "designated" or "ALARA" substance under Part 5.57 of the WorksafeBC Occupational Health & Safety Regulation. Worker exposure to chrome 6 must be minimized to levels "as low as reasonably achievable" below current exposure limits.

2(g) Titanium Dioxide

Titanium Dioxide is found in flux coatings of electrodes. Titanium Dioxide is a recognized respiratory tract carcinogen and respiratory irritant. Even though exposures to Titanium Dioxide during welding are low they must be controlled as low as reasonably achievable since TiO2 is a designated (ALARA) substance under Part 5.57 of the BC OHSR.

2(h) Carbon Monoxide

Carbon monoxide exposures during welding occur when carbon-containing materials are incompletely burned in the arc. The most severe CO exposures in hot work generally occur when gouging and burning coated metals but measureable CO exposures also commonly arise from oxidation of Calcium Carbonate in flux coatings. Carbon monoxide is a cellular asphyxiant that impairs the capacity of the blood to carry oxygen. Headache, nausea, vomiting and in serious cases, unconsciousness and death result from a lack of oxygen at the cellular/tissue level. Standard air-purifying respirators are not effective in filtering out carbon monoxide so local exhaust and general ventilation are the main control methods available unless catalytic or air-supplying respirators are used.

2(i) Shielding Gas – CO2 and Argon Mixtures

Shielding gases in Gas Metal Arc Welding procedures can pose asphyxiation hazards in confined spaces by displacing oxygen. No confined space welding is contemplated by this standard and a separate hazard assessment and safe work procedure would be required prior to confined space work.

In the normal shop environment shielding gas exposures are well controlled through local exhaust and general area ventilation. If CO2 rises to levels beyond 15,000 parts per million, workers experience rapid breathing and a general feeling of discomfort/stuffiness. Exposure to argon below asphyxiant levels does not result in symptoms. Either shielding gas can cause symptoms of asphyxiation in confined spaces. Those symptoms include dizziness, nausea, vomiting, collapse, coma and death.

3.0 WorkSafeBC Exposure Control Plan Requirements

3.1 Exposure Control Requirements for Common Air Contaminants

Where workers are, or may be, exposed to airborne concentrations of any air contaminants at levels exceeding 50% of the 8-hour Time-Weighted Average (TWA) exposure limit (0.05 mg/m^3), the WCB requires the employer to develop and implement a written Exposure Control Plan (ECP).

3.2 Exposure Control Requirements for Designated (ALARA) Substances

WorksafeBC requires that employers and workers pay attention to specially designated hazardous materials that do not have recognized safe exposure thresholds and that cause very serious health effects like cancer, reproductive toxicity and sensitization. Where workers are exposed to any significant amount of air contaminants meeting the criteria for "designated" or ALARA substances in Part 5.57 of the Occupational Health & Safety Regulation (OHSR), WorksafeBC requires employers to develop and implement a written Exposure Control Plan (ECP). Employers are required to reduce worker exposures to designated substances (ex. manganese, lead, chrome 6 and nickel welding fumes) to levels "as low as reasonably achievable" below current exposure limits.

The Exposure Control Plan must include written work procedures and must comply with the requirements OHSR.

3.3 Purpose of the ECP

The purpose of this Welding Exposure Control Plan (ECP) is to minimize the risk of exposure to hazardous materials generated during welding by establishing processes, practices and procedures that ensure that the hazards associated with assigned welding tasks are recognized, evaluated and controlled.

3.4 ADMINISTRATION

3.4.1 Review & Consultation

In accordance with Section 5.54(3) of the WCB OH&S Regulation, the ECP will be reviewed at least annually and updated as necessary in consultation the workers who carry out welding-related work.

3.4.2 Responsibilities

The Manager (Manager Name) is responsible for minimizing the risk of exposure to welding air contaminants by implementing the ECP, ensuring that workers comply with the requirements of the plan, and investigating incidents involving failure of the controls described in the plan.

Workers who carry out welding-related work are responsible for participating in the instruction/training provided, complying with the requirements of the ECP and reporting any problems or concerns to their supervisor or manager.

3.4.3 Documentation

Records will be kept of the activities pursuant to the ECP. The records may include:

- Any exposure monitoring results;
- Written work procedures for welding work;
- Medical monitoring results if required;
- Instruction and training;
- Annual review of the ECP;
- Investigations of incidents involving welding air contaminant exposure (if applicable).

4.0 RISK IDENTIFICATION, ASSESSMENT AND CONTROL

The routine and foreseeable welding activities at Employer Welding that may give rise to hazardous materials exposures are:

1. G.M.A.W., M.C.A.W. and F.C.A.W (wire) welding on carbon (mild) steel, and rarely galvanized mild steel
2. Oxy-Acetylene cutting on carbon (mild) steel and rarely galvanized mild steel.
3. Plasma Arc Cutting and Gouging on carbon steel.
4. Rarely, Carbon Arc Gouging conducted outdoors.

Due to the routine and repetitive nature of the work itemized in points 1-4 above a generic and conservative risk assessment has been carried out to establish exposure control procedures at Employer Welding.

5.0 GENERAL EXPOSURE CONTROLS

5.1 Access Control

To prevent exposure of unprotected workers to hazardous materials hazards during welding, access to the active hot work areas will be limited to authorized employees and escorted visitors.

5.2 Engineering & Administrative Controls

To reduce hazardous materials exposure levels welding will be carried out using standard safe work procedures and personal protective equipment summarized in section 5.5 of this document.

5.3 Personal Protective Equipment & Clothing

The minimum levels of respiratory protection required during hot work are as follows:

- Routine Work – Half face-piece respirator with P100 cartridges.
- Work on "Cleaned" Mild or hardened Steel after removal of coatings from the weld area – as above with combination P100/OV/AG cartridges.

The Employer Welding respiratory protection program will be followed, in accordance with the requirements of the OHSR.

5.4 Written Work Procedures

All routine welding work will be carried out in accordance with welding procedures and specifications authorized by a Peng. Work procedures will be reviewed at least annually and, if required, revised to reflect changes in work practices, processes and/or exposure assessment results.

5.5 Summary of Exposure Control Plan Requirements

For a summary of welding tasks, hazards and required controls see chart 5.5.

5.5 Welding ECP Summary Chart

Welding Task	Welding Process	Base Metal	Filler Metal	Hazardous Materials	Health Effects	Symptoms	Required Controls
Arc Welding on carbon (mild) steel, aluminum or galvanized carbon (mild) steel	**M.C.A.W. and G.M.A.W**	Carbon Steel in various forms including most commonly I-beams, Channel and HSS Tubing	Wire including: Fabco Edge, ESAB Spool Arc Dual Shield	Manganese welding fume	Neurological damage, decreased male fertility, respiratory irritation	Diminished fine motor control, infertility, coughing, and congestion.	NIOSH-approved half-face respirators with P100 cartridges and local exhaust ventilation whenever practicable.
				Iron welding fume	Respiratory irritation	Cough, congestion	As above
				Low concentrations of nickel and chromium may assumed to be present in some mild (carbon) steel wire	Nickel is an ACGIH A1 nasal and lung carcinogen, causing sensitizing dermatitis Chromium is an IARC Group 1 Lung carcinogen, respiratory and skin sensitizer, damage to nasal septum.	Nickel causes Respiratory tract irritation, shortness of breath, nosebleeds, skin irritation and itch. Chromium causes Respiratory tract irritation, shortness of breath, nosebleeds	As above.
				Zinc welding fume	Metal fume	Flu-like	As above.

				(galvanized only)	fever	symptoms improving when away from work	
				Titanium Dioxide from electrodes.	IARC 2B respiratory carcinogen	Cough, congestion	As above.
				Carbon Monoxide from CaCO3 decomposition	Cellular asphyxia	Headache, nausea, dizziness, vomiting	Local exhaust and general ventilation as above.
Welding Task	**Welding Process**	**Base Metal**	**Filler Metal**	**Hazardous Materials**	**Health Effects**	**Symptoms**	**Required Controls**
Welding on carbon (mild) plate, flat bar, tubing, channel, Quenched and Tempered Plate, rarely stainless and galvanized pieces	**F**.C.A.W. (wire)	Group 1,2 or 3 Steel as per CSA W59 (Table 11-1)	Flux-cored wire including Dual Shield	Manganese welding fume	Neurological damage, decreased male fertility, respiratory irritation	Diminished fine motor control, infertility, coughing, and congestion.	NIOSH-approved half-face respirators with P100 cartridges and local exhaust ventilation.
				Iron welding fume	Respiratory irritation	Cough, congestion	As above

				Low concentrations of nickel and chromium are assumed to be present in some steel components.	Nickel is an ACGIH A1 nasal and lung carcinogen, causing sensitizing dermatitis Chromium is an IARC Group 1 Lung carcinogen, respiratory and skin sensitizer, damage to nasal septum.	Nickel causes Respiratory tract irritation, shortness of breath, nosebleeds, skin irritation and itch. Chromium causes Respiratory tract irritation, shortness of breath, nosebleeds	As above
Welding Task	**Welding Process**	**Base Metal**	**Filler Metal**	**Hazardous Materials**	**Health Effects**	**Symptoms**	**Required Controls**

Oxy Acetylene Cutting and Plasma Arc Gouging	**Oxy Acetylene Cutting and Plasma Arc Gouging**	Coated and clean carbon (mild) steel, Galvanized mild steel and Aluminum	N/A	As above	As above	As above	As above. When coated steels are worked, NIOSH-approved half-face respirators with P100/OV/AG cartridges and local exhaust ventilation.
Welding Task	**Welding Process**	**Base Metal**	**Filler Metal**	**Hazardous Materials**	**Health Effects**	**Symptoms**	**Required Controls**

Carbon Arc Gouging	**Carbon Arc Gouging**	Carbon (Mild) Steel	N/A	Metal Fume as above Elevated Carbon Monoxide	Metal Fumes as above Carbon Monoxide as above	As above As above	As above for welding fume. For CO - Air-Arc Gouging to be conducted outdoors whenever practicable If conducted indoors, local exhaust ventilation will be used

5.6 Medical Monitoring

Medical monitoring of welders will not be required unless non-routine project work involves significant exposures to lead or other contaminants that can be effectively medically monitored to prevent or lessen the severity of occupational disease. Reports of symptoms consistent with over-exposure to welding fumes will be investigated and affected workers referred to their family physician to determine applicability of medical monitoring.

5.7 INSTRUCTION AND TRAINING

Workers who carry out work that exposes them to designated ALARA substances at any considerable concentration or other air contaminants exceeding 50% of the 8-hour TWA exposure limit will be given instruction in contaminant hazards, exposure awareness and avoidance and training in the following topics:

- The nature of the toxic materials and their toxic effects
- Signs and symptoms of overexposure
- Required respiratory protection and personal protective clothing/equipment;
- Written work and hazard control procedures;
- The importance of personal hygiene in reducing exposures; and
- The purpose of environmental and medical monitoring and the interpretation of the results.

Employer Welding Fume Exposure Control Plan Presentation – Participant's Notes

1. There is a regulatory requirement in Part 5 of the BC Occupational Safety & Health Regulation for employers to develop a written exposure control plan (ECP) when workers are exposed to hazardous materials that are either:
    a. Designated substances that are unusually toxic but cannot be replaced with less hazardous materials (ex. Manganese, Chromium and Nickel welding fume), or
    b. Likely to expose workers to airborne concentrations at or above 50% of their legal exposure limits (ex. Iron and Aluminum welding fume).
2. Manual welding generates both kinds of exposures so B.C. employers that conduct manual welding need a welding exposure control plan.
3. Workplace Exposure Limits (ELs) are established and enforced by WorksafeBC. ELs in B.C. are intended to prevent any adverse health effects after a lifetime of work exposure (40 hours/week over 40 years) when exposures remain below the EL.
4. There is a "double standard" in exposure control requirements in B.C. All hazardous materials must be kept below their legal ELs but designated substances must be removed wherever practicable and replaced by less hazardous materials. Where designated substances cannot be replaced exposures must be kept "as low as reasonably achievable" below the EL. Designated substances are also sometimes called "ALARA" substances.
5. Mild over-exposure beyond the EL is illegal but unlikely to be dangerous. There is a safety margin built into ELs.
6. The ECP must include some specific education and training in welding fume exposure health hazards and the specific exposure control measures required by the employer in the workplace,
7. Employer Welding requires that respirators be worn whenever welding and that local exhaust ventilation be used when welding indoors. When combined, these two control methods are effective in preventing over-exposures.
8. Priority welding exposures at Employer Welding are:
    a. Manganese fume (designated substance present in consumables and mild steel) – causes neurological and male reproductive toxicity at exposure levels close to the exposure limit. The current B.C. EL is now 0.02 mg/m3 which was recently reduced from 0.2 mg/m3. Recent studies have shown neurological effects at levels much lower than previously known.
    b. Nickel fume (designated substance generated when welding stainless and hardened steels) – causes nasal and respiratory system cancer. Current B.C. EL is very low 0.05 mg/m3.
    c. Chrome 6 fume (designated substance generated when welding stainless and hardened steels) causes lung cancer. Current B.C. EL is very low at 0.01 mg/m3.
    d. Titanium Dioxide (designated substance generated when welding with flux containing CaCO3) is suspected but not proven to cause lung cancer. Exposures are not generally considered at the same risk as proven carcinogens like Manganese, Nickel and Chrome 6. Current BC EL is very high at 10 mg/m3 but requires control to lower levels.
    e. Zinc fume arises when welding zinc alloys and galvanized materials. Exposure to zinc fume causes a short-term flu-like illness called metal fume fever at levels above 15 mg/m3. Current BC EL is 2 mg/m3.
    f. Aluminum fume causes lung irritation and has a current B.C. EL of 2.0 mg/m3.
    g. Iron fume causes mild irritation at very high levels and has a current B.C. EL of 5.0 mg/m3.

h. Carbon monoxide (CO) gas is generated from combustion of carbon-based materials in the welding arc (ex. arc gouging) and the breakdown of $CaCO_3$ in flux and CO_2 in shielding gases. CO inhibits oxygen uptake in the blood and causes headache, nausea, dizziness, vomiting, coma and death. The current B.C. EL is 25 ppm by volume in air.
i. Ozone (O_3) gas is generated by UV radiation from the arc and is a serious deep lung irritant. O_3 is generated at high levels when arc welding shiny surfaces like aluminum and stainless steel. Ozone can cause chemical pneumonitis by burning tissue deep in the respiratory tract and triggering accumulation of fluid in the lungs. The current B.C. EL for ozone depends on the level of exertion of the work task but varies between 0.05 and 0.1 parts per million.
j. CO_2 Shielding Gas – can accumulate in confined or enclosed spaces to cause rapid breathing (hyperventilation) above 1500 parts per million. CO_2 is not considered seriously toxic below very high levels (ex. 70,000 ppm) where it can displace oxygen and cause illness through oxygen deficiency.
k. Argon Shielding Gas - can accumulate in confined or enclosed spaces but generally causes no symptoms below very high levels (ex. 70,000 ppm) where it can displace oxygen and cause illness through oxygen deficiency. Oxygen deficiency is a severe hazard but only present in confined spaces.

9. The Employer Welding ECP will be reviewed annually and updated as required to reflect new work practices and materials.
10. Any questions regarding health and safety and welding fume exposure should be directed to your supervisor.