**Exposure Control Plan**

**Exposure to Carbon Monoxide during Greenhouse Operations**

**Employer company information**

|  |
| --- |
| Name: |
| Address: |
| Contact information (names and phone numbers) |
| Plan approved by: | Date: |

**Purpose**

We have a duty to protect our workers from exposure to carbon monoxide (CO) generated from internal combustion engines. Carbon monoxide can be fatal if the gas accumulates in confined spaces, greenhouses, garages and other poorly ventilated areas in agriculture facilities. Effective controls are available to protect workers from exposure to CO.

We know that 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 worksite.

The protective measures and work procedures we establish will protect not only our workers but also all other workers on our site

**Responsibilities**

*The employer is responsible for the following:*

* Ensure a safe work environment through the identification and assessment of work processes that might lead to worker exposure to CO during the operation of internal combustion engines (for example, gas, propane or diesel engines) within greenhouses
* Ensure that the materials (for example, tools, equipment, and personal protective equipment) and other resources (for example, worker training) required to fully implement and maintain this ECP are readily available where and when they are required
* Employers shall conduct a periodic review (at least annually) of the effectiveness of the ECP. This includes a review of available control technologies to ensure these are selected and used when practicable
* Ensure that all required tools, equipment, and personal protective equipment (PPE) are used as required by the ECP
* Ensure that supervisors and workers are educated and trained to an acceptable level of competency
* Maintain records of training, fit-test results, crew talks, and inspections (for example, for equipment, PPE, and work methods or practices)
* Maintain all First Aid services, equipment and supplies required at the greenhouse, in suitable condition
* Investigate all near misses and exposure incidents
* Coordinate work with other employers to ensure a safe work environment, including the following:
	+ Inform all subcontractors of the specific hazards on the worksites
	+ Ensure subcontractors have ECPs and written safe work procedures
	+ Ensure that all subcontractors have the proper personal gas monitors and other equipment

*Supervisors are responsible for the following:*

* Ensure that workers have received adequate instruction on the hazards associated with the use of internal combustion engines in greenhouses
* Select and implement the appropriate control measures
* Direct the work in a manner that ensures the risk to workers is minimized and adequately controlled
* Liaise with other employers to ensure a safe work environment
* Ensure that subcontractors are following the proper safe work procedures

*Workers are responsible for the following:*

* Attend educational sessions provided by the employer
* Use the assigned PPE in an effective and safe manner
* Follow established work procedures as directed by the supervisor
* Report any unsafe conditions or acts to the supervisor
* Refuse unsafe work
* Know how to report exposure incidents

**Risk identification and assessment**

Internal combustion engines can generate hazardous quantities of CO which can be fatal if the gas accumulates in confined or poorly ventilated areas. Carbon monoxide levels recorded from equipment commonly used in greenhouses can range from 200 to 600 parts per million (ppm), levels far higher than the current 8-hour exposure limit of 25 ppm.

Workers may be exposed to CO when using (or working in the vicinity of) internal combustion engine equipment in greenhouses, such as the following:

* Pressure washers, during greenhouse clean-up
* Grinding machines
* Propane powered Forklifts
* Water pumps
* Air compressors
* Portable generators
* Kilns, CO2 burners, furnaces and boilers

Carbon monoxide buildup is particularly dangerous during colder days in locations such as garages or greenhouses, where ventilation is further reduced as windows and doors are closed to conserve heat (or propane heaters are used).

Workers are potentially exposed to these sources of CO in our greenhouses:

The exposure risk is greater in these locations, within our greenhouses, where the area is confined, enclosed or ventilation is poor:

**Health Hazards**

Carbon monoxide is a toxic, odourless, invisible gas that comes from incomplete combustion of any carbon-containing material (for example, wood, coal, oil, kerosene, gasoline, diesel fuel, natural gas, or propane). Victims of CO poisoning cannot see or smell the gas, so they don’t realize they are in danger.

CO interferes with the ability of blood to carry oxygen to tissues, most importantly the brain. CO displaces oxygen from the blood, and then prevents further uptake of oxygen by the blood. As long as CO continues to be inhaled, it progressively reduces more and more of the blood’s oxygen-carrying capacity.

The effects of CO may vary from worker to worker depending on overall health status, muscular activity, time or duration of exposure and CO concentration. The following are symptoms of exposure to carbon monoxide:

* Dizziness
* Drowsiness
* Nausea
* Weakness
* Headache
* Confusion

Since CO may impact the cognitive abilities (e.g., a worker’s sense of judgement), some workers may find it difficult to escape from places where there is a significant amount of CO. This can lead to more severe health effects such as permanent damage to organs including the brain and heart and can result in coma or death. The Immediately Dangerous to Life and Health (IDLH) concentration for CO is 1200 ppm.

WorkSafeBC also designates CO as a reproductive toxin because of its effect on the developing fetus.

**Exposure limits**

The occupational exposure limit (EL) is a concentration to which nearly all workers could be exposed for eight hours a day, five days a week, without adverse health effects. We must ensure that workers are not exposed to CO levels above the EL.

The WorkSafeBC EL for CO is:

* 8-hour time weighted average (TWA) of 25 ppm
* 15-minute short-term exposure limit (STEL) of 100 ppm

The STEL must not be exceeded more than four times in an 8-hour work shift, with at least 1 hour between any two successive 15-minute periods.

CO is also an ALARA substance and exposure must be kept As Low As Reasonably Achievable.

**Exposure control**

The Occupational Health and Safety Regulation requires employers to select controls based on the following hierarchy:

1. Engineering controls (for example, emission control devices, mechanical ventilation, regular equipment maintenance, adjustment of controls on greenhouse vents, etc.)
2. Administrative controls (for example, post warning signage, limiting the number of internal combustion engines used, visually confirm that greenhouse vents are open, etc.)
3. Personal protective equipment (for example, protective clothing and CO gas monitors)

**List of internal combustion engine equipment used within this greenhouse (complete for your site)**

|  |  |  |
| --- | --- | --- |
| **Equipment** | **Used for** | **When the work will take place (date)** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Control methods for exposure to CO in greenhouse operations**

Certain engineering control options may not be practicable, for example:

* Emission control devices may not be available for some internal combustion engine equipment (for example, pressure washers) and the use of aftermarket equipment may void manufacturer warrantees
* Greenhouse electrical wiring may not accommodate the use of more than one or two pieces of electrical equipment (for example, electric pressure washers)
* The use of local exhaust ventilation hoses is impractical in a commercial greenhouse setting due to the number of machines that may be required (for example, pressure washers) and the length and amount of play needed for the exhaust hoses.

Before using internal combustion engines within greenhouses, the following will be determined:

* The number of engines (for example, pressure washers) that can be used without exceeding the CO exposure limit
* The length of time the work will take place during each shift
* Location of any “dead spots” in the greenhouse that may require supplementary ventilation (for example, by using fans).

**The following controls will be used during the operation of internal combustion engines in greenhouses:**

*Ventilation control:*

* Post signage on the greenhouse doors warning of possible CO exposure
* Override the automatic vent control system and manually set the vents open to the maximum extent required to ensure adequate airflow.
* Visually confirm that the vents are open. This must be done, frequently (at least every 20 minutes), while the machines are operating. A dedicated worker will perform this task (can be combined with monitoring CO levels – see below).
* Work will stop if it is determined that the vents need to close (for example, due to heavy rain or wind). Work will not resume until the vents are open.

*Equipment operation:*

* Shut down all internal combustion engines (for example, pressure washers) during refueling to ensure this is performed in a controlled manner.
* Internal combustion engines shall be maintained as per manufacturer’s instructions and inspected before use. Maintenance records must be available for inspection.
* Emission controls will be installed on internal combustion engines, where practicable, as per manufacturer’s instructions.

*Monitoring for CO levels:*

* Each machine operator will carry a personal monitoring device for CO
* CO monitors shall be used in accordance with manufacturers specifications and instructions including the frequency of instrument calibration and daily instrument “bump testing”
* Set the CO alarm to the 8-hour exposure limit (25 ppm)
* A dedicated trained worker will monitor and regularly record the CO levels (at least every 20 minutes) during the work.

*Stop work:*

* Work will be stopped if the CO levels exceed 25 ppm
* The following will be implemented until the CO levels drop:
	+ Reduce the number of machines used (for example, reduce the number of pressure washers)
	+ Reduce the length of time the equipment will be used during each shift
	+ Rotate the work staff
* The work area will not be re-entered until the CO levels drop below 13 ppm.

Safe work procedures for controlling the ventilation, properly operating the equipment, and monitoring CO levels, are included in the Appendix to this ECP.

**Personal protective equipment and hygiene**

* Workers will wear appropriate protective clothing (for example, rain gear, washable cotton or disposable Tyvek-type coveralls).
* Workers will wear other PPE (for example, protective eyewear, hearing protection, safety footwear, hard hats, or high-visibility vests) as required.

**Safe work planning**

* Work from the control methods included in this exposure control plan
* Make sure that warning signs identifying the presence of CO are posted outside the work area and are visible
* Inspect all equipment and tools to make sure they are in good working order
* Use and maintain all tools and equipment as specified by the manufacturer
* If the work involves a confined space (for example, a pump house or tank), then the confined space program must be followed.

**Worker training for CO 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 exposure to CO will be made available to employees upon request
* Training topics:
* Health hazards of exposure to CO
* Work activities that can produce CO
* Engineering controls and safe work practices used to protect workers during the operation of internal combustion engines
* Effective use of ventilation systems to control the accumulation of CO
* The importance of proper equipment control and maintenance
* Proper use of personal monitoring equipment, including bump testing
* Personal hygiene procedures to reduce exposures.
* The details of the exposure control plan.

**Health surveillance**

* Workers who may be exposed to carbon monoxide in the course of their duties should receive regular medical examinations from their family physicians.
* Workers will report any symptoms of exposure to the employer and WorkSafeBC for tracking and investigation.

**First aid**

In the event that workers demonstrate signs and symptoms of carbon monoxide exposure, the following guidelines shall be implemented:

* Remove the affected individual from the work area and take them to fresh air immediately
* Call the first aid attendant who will determine the appropriate course of action
* Keep the worker warm and at rest. Activity may worsen the effects of CO by increasing oxygen demand
* If the worker is not breathing, **call 9-1-1** and begin cardiopulmonary resuscitation (CPR).

**Annual review**

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

**Appendix: Safe Work Procedures Templates**

**Ventilation control – how this is controlled at the specific site**

**Safe operation of equipment – how utilizing pressure washer, how refueling, etc**

**Monitoring CO levels – how employer intends to monitor depends on the manufacturer’s instructions for the model selected for use. --- also include the number and location of monitors (teams vs individuals), record keeping**