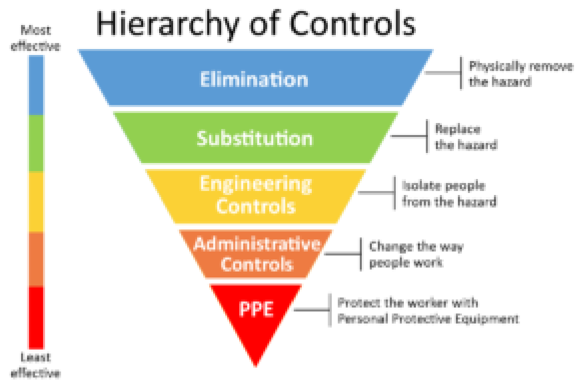
CONTROLLING OCCUPATIONAL EXPOSURE TO CARCINOGENS

Controlling occupational exposure to carcinogens is an important step towards reducing the burden of occupational cancer. The Hierarchy of Controls is often used as a guide for implementing exposure control strategies [1]. It ranks control strategies from most effective (elimination or substitution) to least effective (personal protective equipment). An effective control program uses multiple controls from across the Hierarchy, and often includes monitoring to evaluate the effectiveness of the control program.



The sections below lay out some of the control strategies available for key exposures that contribute the most to the burden of occupational cancer in Canada: asbestos, diesel engine exhaust, polycyclic aromatic hydrocarbons, radon, second-hand smoke, shiftwork, silica, solar UV radiation, and welding fumes.

For more information, read the Burden of Occupational Cancer in Ontario report.

Asbestos

The Canadian government banned asbestos in 2018 [2]. These changes at the federal level include prohibiting the import, sale, and use of asbestos and asbestos-containing products (with some exclusions). However, the ban does not address the issue of exposure to asbestos in existing materials, such as during the demolition, repair, or remediation of older buildings. Provincial regulations set out the proper procedures to control exposure during work with asbestos and asbestos-containing materials, but the possibility of exposure to workers and the public will continue to exist as long as asbestos is still present in older products and buildings.

There are a number of measures that can be adopted by workplaces to reduce occupational exposure to asbestos [3,4,5]. For example, asbestos-containing materials in buildings can be safely removed (following strictly regulated procedures) where the likelihood of exposure to workers is high. Handling or remediating asbestos is highly regulated and controlled. Only trained workers with appropriate personal protective equipment are allowed to perform these tasks. Engineering and administrative controls can be implemented for people who must work near or with asbestos. Engineering controls include using a vacuum equipped with a high-efficiency particulate air (HEPA) filter and brush attachment, and using wet processes. Administrative controls include prohibiting eating, drinking or smoking in areas where asbestos is present, and providing showers, lockers, change rooms and laundering facilities at the worksite, which can also help reduce para-occupational (take-home) exposures among family members of asbestos-exposed workers. It is important to recognize that these exposure reduction strategies do not completely eliminate occupational asbestos exposure, a goal that can only be achieved over time through a comprehensive asbestos ban and eventual removal from all building components in the long term.

Diesel Engine Exhaust

Diesel engine exhaust is poorly regulated in Canada. While some jurisdictions have occupational exposure limits for diesel engine exhaust in the mining industry [6], these limits are out of date and do not reflect the current evidence for diesel exhaust and cancer. As well, there are currently no limits anywhere in Canada that apply outside of mining, although in 2018 a proposal was made in Ontario for a limit of 160 $\mu g/m^3$ (measured as total carbon) for all industries [7].

Diesel engine exhaust is a complex mixture and elemental carbon has been identified as an appropriate surrogate for measuring exposure. OCRC recommends adopting occupational exposure limits of 20 $\mu g/m^3$ elemental carbon for the mining industry and 5 $\mu g/m^3$ elemental carbon for other workplaces, based on evidence of health effects at low levels [8,9] and feasibility considerations.

Diesel emissions can be reduced by substitution with diesel fuel alternatives, such as natural gas, electricity and propane; replacing old engines with low-emission diesel engines or rebuilding old engines and performing regular engine maintenance; or using cleaner-burning diesel fuel [10]. Engineering controls that can be implemented include installing pipe exhaust extenders and using enclosed pressurized cabs equipped with HEPA filters to better isolate the worker from the exhaust; implementing exhaust treatment systems (e.g., tailpipe filters, oxidation catalytic converters); and implementing technology to automatically turn off idling vehicles [10]. Indoor areas should be adequately ventilated and should use exhaust extraction devices to remove diesel engine exhaust from the indoor work environment where possible (e.g., tail pipe exhaust extraction systems used in fire halls) [10]. Finally, administrative controls include reducing engine idling, maintaining engines and vehicle bodies regularly; running engines outdoors; and scheduling work to minimize the number of workers near a diesel engine in operation [10]. Preventing and controlling occupational exposure to diesel engine exhaust can also contribute to reducing environmental emissions that affect the general population.

Polycyclic Aromatic Hydrocarbons (PAHs)

There are a number of engineering and administrative measures that can be used to control occupational exposure to PAHs. Engineering controls include implementing local exhaust ventilation systems [14], implementing systems to capture and remove PAHs from the air (e.g. fume scrubbing systems), and ensuring that workers are enclosed and separated from contaminated air (e.g. via cabs on vehicles, or enclosed rooms that are pressurized and supplied with filtered air) [15]. Examples of administrative controls are maintaining ventilation and other control systems, employing wet cleaning methods where appropriate, promoting good workplace hygiene practices, limiting exposure duration by adjusting workers’ schedules and limiting overtime hours [15].

Radon

Radon levels vary considerably based on a number of factors (e.g., geographical location, above or below ground, building age, foundation, ventilation). For these reasons, it is difficult to predict whether radon is present in the workplace. As a result, reducing radon begins with monitoring occupational radon levels as part of a workplace radon surveillance program. Personal monitors can be used when workplace levels are high. Long-term measurements should be conducted to account for seasonal variation in radon concentration.

The Federal Provincial Territorial Radiation Protection Committee has developed Naturally Occurring Radioactive Materials (NORM) Guidelines. These guidelines are applicable to workers engaging in NORM activities (e.g., mining, water treatment facilities, tunnelling and underground work), as well as any workplace where workers are incidentally exposed (i.e., as a result of the workplace being indoors) [16]. NORM emphasizes reducing radon levels to less than 200 Bq/m^3 in occupied areas. However, the World Health Organization recommends lowering levels in indoor residential spaces to less than an annual average concentration of 100 Bq/m^3 based on evidence of elevated lung cancer risks at very low levels of exposure [17]. Some Canadian workers, such as those working in uranium mines and mills, are monitored for their annual radon exposure through the National Dose Registry.

If radon levels are high, possible steps include installing radon gas mitigation systems (e.g., active soil depressurization) [17], installing or upgrading ventilation systems or changing ventilation patterns, and developing an exposure reduction program. In cases where radon is derived from NORM, such as materials processing, raw materials that are low in NORM can be selected [18].

Second-Hand Smoke (SHS)

Significant progress has been made over past decades to reduce exposure to SHS in workplaces through legislation, increased awareness of the health effects associated with SHS exposure, and population-wide changes in smoking behavior [11]. Smoking bans have been evaluated as the most effective measure for reducing SHS exposure [12]. Current occupational exposure to SHS is substantially less than in the past, and in the future, the burden of associated cancers is expected to be lower than the present cancer burden. However, according to the 2012 Canadian Tobacco Use Monitoring Survey, approximately 28 percent of workers in Ontario report occupational exposure to SHS, and some report a lack of smoke-free policies in their workplaces, despite current legislation (e.g., sales and service workers, trades and transportation workers) [13]. Further efforts must be taken to strengthen enforcement of smoke-free workplace legislation, especially in outdoor workplaces, and to promote smoking cessation programs to workers in all sectors.

Shiftwork

Shiftwork that includes night work (either rotating or night shift work) is associated with harmful health effects believed to be related to disruption of the body's natural circadian rhythm (the day-night cycle) [19]. Completing work during standard, daylight hours is the best way to limit circadian disruption. However, night work is necessary to maintain essential services, as well as continuous processes and services in varies industries. Eliminating it is often not practical. Workplaces that must use shiftwork can take initiative by promoting strategies to minimize the health effects, such as improved shift scheduling. The strongest evidence is for rotating schedules that move rapidly from morning-afternoon-evening shifts, which has been shown to improve sleep quality and quantity [20,21]. Flexible work schedules that allow workers to have input on their shift schedules resulted in workers reporting improved general health and reduced stress [22]. There is less evidence for other types of interventions, such as the use of controlled light exposure and behavioural strategies. Medications (other than melatonin) to improve sleep or wakefulness have been associated with adverse health effects in several studies [20].

Silica

Safer substitutes for silica-containing products should be considered to provide the highest level of protection against exposure. For example, silica in sand-blasting operations may be replaced by garnet, alumina, cereal husks and/or high pressure water [23]. Likewise, sandstone grinding wheels can be replaced with aluminum oxide wheels, and silica bricks in furnaces can be replaced with magnesite or aluminum oxide bricks [23]. Where materials cannot be eliminated, processes that generate respirable crystalline silica could be eliminated. For example, ensuring a smooth surface while pouring concrete eliminates the need to grind rough concrete.

Where substitutes or process changes are not available, engineering controls provide the next best level of protection. These controls include using local exhaust ventilation with dust collectors and filters [24], process enclosure to prevent the release of dusts into the workplace [25], mechanized processes [24] and placing workers in enclosed cabs with filtration systems [26]. Furthermore, workers should be trained to select processes and tools that are least likely to generate respirable dusts [23]. Administrative controls that can be employed include maintaining good housekeeping practices (e.g., using vacuums and wet sweeping methods instead of dry sweeping or cleaning with compressed air), maintaining dust control equipment, removing excess dust from clothing and skin, and removing work clothes at the work site [24].

Solar UV Radiation

All workplaces with workers that work outdoors for part or all of the day should develop a comprehensive, multi-component sun safety program. Sun safety programs include:

- A risk assessment to identify workers at high risk of exposure and scenarios where high exposure may occur

- Sun protection control measures
- Sun protection policies and training

Sun Safety at Work Canada provides resources on how workplaces can develop and implement sun safety programs.

The best way to protect outdoor workers from solar UV radiation is to provide shade. If no natural sources of shade are available, shade structures can be built. The design, placement and use of the shade structure should maximize protection [27-29]. The UV protection factor rating for shade materials should be at least 40 for maximum protection [27]. Other engineering controls include modifying reflective surfaces and tinting windows on vehicles [28,29]. Scheduling shifts and tasks to minimize time spent in the sun during peak UV hours (i.e. between 11 a.m. and 3 p.m.) can have a significant impact on individual workers' daily exposure [27].

Welding Fumes

Most jurisdictions in Canada do not have an occupational exposure limit for welding fumes and instead regulate the mixture as its constituent metals and particulates. Where a limit for welding fumes does exist, the fumes are treated as a nuisance dust, which does not adequately reflect the hazard [30]. As welding fumes are now a confirmed lung carcinogen [31], OCRC recommends reviewing and updating these regulations to include an appropriate limit for welding fumes in all Canadian jurisdictions.

The composition and amount of fume formed during welding depends on the welded material and the welding process, including the shielding gas, electrode size and type, manual or mechanized welding, current/voltage and arc time [32]. Choosing lower-fume welding techniques and welding rods with less hazardous fume composition can help reduce exposure [33].

Ventilation and isolation of workers are common engineering controls used to reduce worker exposure to welding fumes. Closed systems with properly maintained negative pressure relative to the surroundings may be used to isolate workers [34]. Local exhaust ventilation (e.g., fume hoods, fume extractor guns, and vacuum nozzles) is usually more effective than general ventilation, although a combination of local exhaust and general ventilation is ideal [32]. Other methods of reducing exposure include removing paint, coatings or residues from the weld area prior to welding [33], providing adjustable welding tables or positioning the body to avoid breathing the fumes [33,35], and scheduling operations that lead to the highest levels of exposure during times when the fewest employees are working [35].

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