Metal Working Fluids:
cutting the risks

Version 2

Kenneth Jimmerfield was just nine when he and his six brothers and sister lost their father, Ralph "Bud" Jimmerfield, to esophageal cancer in 1998. Jimmerfield, a long time member of Canadian Auto Workers (CAW) union, Local 89, and well-known health and safety activist, worked for an auto parts manufacturer for 31 years. As a tool and die maker, he ran a radial drill. He would drill 200 to 300 holes into a metal plate, flood the drill area with metalworking fluid, tap the holes and blow off the excess oil with an air gun. Of the working conditions Jimmerfield said, "My clothes were saturated 90 per cent of the time. You could taste the oil on your palate, and the air was a cloud of oil mist."

Metalworking fluids (MWFs) are water-based and/or oil-based fluids and additives used to cool and lubricate machinery, tools and metal workpieces in cutting, grinding and boring operations. These fluids also remove metal particles. New studies continue to add to the growing body of research showing MWFs can cause cancer at various sites along with respiratory health impacts and damage skin.

Around the same time as Jimmerfield's diagnosis, autoworkers in a St. Catharines, Ontario components plant, were diagnosed with hypersensitivity pneumonitis (HP), a lung disease related to chemical exposure at work. The Occupational Health Clinics for Ontario Workers confirmed a connection between the concentration of MWFs in the air and worker reports of a sore throat, dry cough, coughing up phlegm, shortness of breath and tightness in the chest.

MWFs continue to be a problem in many auto-manufacturing plants and for millions of workers engaged in manufacturing parts for farm equipment, aircraft, heavy machinery, rail, mining and other hardware.

Increasing health concerns have led many health, safety and environmental activists to seek alternatives to petroleum-based cutting fluids that are both healthier for workers and for the environment. It has also led them to press for reduction in exposure levels at work. Here in Ontario, **exposure to MWFs remains unregulated.** Bargaining gains made by UNIFOR (formerly CAW) at a General Motors components plant in St. Catharines, Ontario for example, have reduced the limit from 5 mg/m³ to 1.0 mg/m³ for existing equipment and 0.50 mg/m³ for new equipment. Their goal is to successfully negotiate a limit of 0.2 mg/m³, which is the level of exposure proposed by the American Conference of Governmental Industrial Hygienists (ACGIH) in the U.S.

What are MWF?

The term MWFs is a generic term, which encompasses coolants and lubricants used during the fabrication of products from metals and metal substitutes. MWFs are also known as cutting oils, and machining fluids. They are used during operations such as:

- metal grinding,
- cutting,
- boring,
- drilling,
- hobbing and
- turning.

What are the components of MWF?

MWFs are complex mixtures of oils, detergents, surfactants, biocides, lubricants, anti-corrosive agents, and other potentially toxic ingredients. They are applied to the cutting zone of the tool and the work or delivered as a mist in a high-velocity air stream. There are four main types of MWFs developed for use in the fabricating of metals. They are:

- straight oils;
- soluble oils;
- semisynthetic; and
- synthetic fluids.

Additives

Additives may be mixed with metal working fluids to enhance physical capabilities. They are added to increase lubricating and coolant effects, prevent bacterial growth, or to meet other technical or industrial requirements. For example, chlorine, sulphur or phosphorous additives, are frequently used to improve the lubricating properties of water-soluble oils for use in very heavy-duty machining operations. Biocides are added to MWFs containing water to prevent or suppress growth of microorganisms (e.g., fungi, mould and Legionella). Other ingredients and additives include anti-misting, anti-weld, anti-foaming and blending agents, corrosion and rust inhibitors, dyes, emulsifiers and surfactants (wetting agents to reduce surface tension).

Joint health and safety committee members, health and safety representatives and other workplace parties should review safety data sheets to determine the specific components of MWFs and offer recommendations to eliminate or limit exposure.

What are the health effects?

MWFs cause adverse health effects through skin contact with contaminated materials, spray, or mist and through inhalation from breathing MWF mist, or aerosol. The severity of health problems is dependent on a variety of factors such as:

- kind of fluid;
- degree and type ofcontamination; and
- level and duration of exposure.

Skin Disease

Two types of skin disease associated with MWF exposure are contact dermatitis and acne. Contact dermatitis is the most commonly reported skin disease associated with MWFs. Those working with water-based, synthetic and semisynthetic MWFs are most at risk. Workers with contact dermatitis have itchy skin and a rash, often with cracks, redness, blisters, or raised bumps. Left untreated this condition could become chronic and predispose workers to other related problems.

Respiratory Diseases

Inhalation of MWF mist or aerosol may cause irritation of the lungs, throat and nose. In general, respiratory irritation involves some type of chemical reaction between the MWF and the human respiratory system. Symptoms include:

- sore throat;
- red, watery, itchy eyes;
- runny nose;
- nosebleeds;
- cough, wheezing increased phlegm; and
- shortness of breath.

These symptoms may indicate a variety of respiratory conditions including asthma, chronic bronchitis, and hypersensitivity pneumonitis (HP).

HP is an allergic-type reaction that may be caused by exposure to microbial products or other materials found in water-based MWFs. The symptoms of HP are chills, fever, shortness of breath and a deep cough. HP is like a cold that does not go away. If left untreated HP can lead to irreversible lung damage.

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Cancer

MWFs contain a variety of known or suspected carcinogens. Some form in MWFs when specific chemical components interact or react. For example, nitrites or nitrates and amines are used as additives to inhibit corrosion and rust. The presence of these agents causes the formation of nitrosamines when MWFs are heated or under pressure from machinery. Certain nitrosamines, like N-Nitrosodiethanolamine (NDELA) detected in water-based MWFs, are cancer-causing agents.

Some biocides act by releasing formaldehyde, another suspected carcinogen. It can also speed up the formation of nitrosamines. Chlorinated paraffins are carcinogens and are used in processes where extreme pressure is applied. They form dioxins, which are also carcinogenic.

A growing body of research continues to link exposure to MWFs and the development of cancer at various sites including the rectum, pancreas, larynx, skin, scrotum, esophagus, bladder and kidney.

How do you control exposure?

Ontario health and safety law requires employers to take every precaution reasonable in the circumstances to protect workers. This protection should include steps to eliminate or control exposure at its source, along the path between the hazard and the worker, or at the worker.

Elimination/Substitution

The first priority is to eliminate the hazard altogether. This is achieved by substituting toxic MWFs with something less harmful. For example, vegetable oil-based fluids such as rapeseed, canola or soybean oils are less harmful to exposed workers and the environment than conventional mineral oil-based fluids. Auto workers in Windsor, Ontario have successfully replaced one third of the petroleumbased coolant that they routinely use in their engine plant with a canola-based oil. They discovered that canola-based oil has less of a negative impact on the environment both inside the plant and outside. It does not need to be replaced with fresh coolant as often as the previous coolant. Also, canola-based coolants do not have the long-term exposure health risks as petroleum products.

Biocides such as chlorine can be replaced using Ultraviolet light (UV) technology or the Zeta Rod which is the trade name for an electrode system that disinfects biofilm found in fluid storage tanks, filters and distribution pipes. Both these systems eliminate bad odours and reduce the amount of biocide needed. Care must also be taken with these alternatives to ensure they do not create their own hazards.

Design/Restructuring

Another way to control worker exposure to MWFs is to design the MWF delivery system to generate a minimum amount of fluid mist. Factors that can reduce misting include:

- low pressure delivery of MWF;
- minimizing the MWF flow rate;
- applying MWF as close to tool/workpiece as possible to avoid fluid contact with moving/rotating parts;
- covering fluid reservoirs and return systems where possible; and
- proper machine maintenance.

Isolation/Enclosure

Isolation of the worker through mechanical parts handling equipment and machine enclosures can minimize skin and inhalation exposure. Simple splash guarding may work for low production machines, but high production machines generally require complete enclosure with ventilation. Workers should be protected with isolation booths or air-curtain exhaust ventilation.

Machine Guarding

When full enclosure of machinery or process is not implemented, the next best thing is to use machine guarding. Machine guarding eliminates or controls worker exposure to moving parts. Machine guarding should be designed to capture flying metal chips, oil mist, and other airborne contaminants generated during metalworking processes. Closely-fitted baffles or splashguards control over-spray or splash exposure.

Local Exhaust Ventilation System

An effective local exhaust ventilation (LEV) system may remove some oil mist and other airborne contaminants before they enter a worker's breathing zone. Air is drawn into the hood and ducts by exhaust fans and taken away from the work environment. A source of clean make-up air replaces exhausted air. If air is re-circulated, an effective filtration system with properly maintained oil screens or filters is necessary. High efficiency particulate air (HEPA) filters can be used to capture small MWF particles.

General/Dilution Exhaust Ventilation System

General or dilution ventilation allows the contaminant to be emitted into the general workplace air and then dilutes the concentration of the contaminant by circulating large quantities of air into and out of work areas. Generally speaking, local exhaust ventilation is more effective than dilution ventilation in achieving contaminant control and worker protection.

Preventive Maintenance Programs

An effective preventive maintenance program can reduce worker exposure to the components and contaminants in MWFs. The program should include:

- thoroughly cleaning machinery and equipment whenever MWF is changed;
- eliminating old oil (to prevent bacterial contamination of new fluid);
- ensure tramp oil such as hydraulic oil does not leak into MWFs;
- general housekeeping (regular cleaning of equipment/machinery).

Caution: Compressed air should not be used to clean machinery, workstations, clothing, or to remove excess metal chips and other contaminants as it often creates additional airborne oil mist and is extremely hazardous. Oil-soaked rags should not be placed in the pockets of overalls or pants as oil can seep through the clothing onto the skin causing health problems.

Personal Protective Equipment (PPE)

As a last resort, exposure to MWFs can be reduced with the use of proper PPE (check safety data sheet for the MWF in use for appropriate protection) such as:

- impervious clothing (aprons, coveralls, pants, footwear, gloves);
- eye protection (splash goggles and face shields); and
- respirators (appropriate for specific substance with a HEPA filter).

MWF Health & Safety Awareness Training

General MWF health and safety awareness training is an important part of any exposure prevention program. For more detailed information and training on MWFs contact a Workers Health & Safety Centre training service representative.

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