Metal Working Fluids - Health Hazard Recognition, Control & Prevention

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Students' Manual

Education/Health & Safety Department

International Union, UAW

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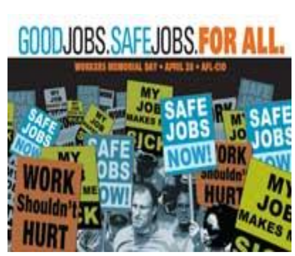

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What are metalworking fluids?

Metalworking fluid (MWF) is the name given to a range of oils and other liquids that are used to cool and/or lubricate metal when they are being machined, ground, milled, etc. MWFs reduce the heat and friction between the cutting tool and the metal, and help prevent burning and smoking. Applying MWFs also helps improve the quality of the metal by continuously removing the fines and chips from the tool being used.

Metalworking fluids (MWFs) are used to reduce heat and friction and to improve product quality in industrial machining and grinding operations. There are numerous formulations, ranging from straight oils (such as petroleum oils) to water-based fluids, which include soluble oils and semisynthetic/synthetic fluids. MWFs may be complex mixtures of oils, emulsifiers, anti-weld agents, corrosion inhibitors, extreme pressure additives, buffers (alkaline reserve), biocides, and other additives. In use, the fluid complexity is compounded by contamination with substances from the manufacturing process (such as tramp oils, hydraulic fluids, and particulate matter from grinding and machining operations). Furthermore, water-based metalworking fluids support microbial growth, which introduces biological contaminants (such as bacterial and fungal cells or cell components and their related biological byproducts such as endotoxins, exotoxins, and mycotoxins).

Some 1.2 million workers in machine finishing, machine tooling, and other metalworking and metal-forming operations are potentially exposed. Workers can be exposed to the fluids by breathing aerosols generated in the machining process, or through skin contact when they handle parts, tools, and equipment covered with the fluids. The National Institute for Occupational Safety and Health **(NIOSH) defines MWF aerosol as the mist and all contaminants in the mist generated** during grinding and machining operations involving products from metal and metal substitutes.

Occupational exposures to metalworking fluids may cause a variety of health effects. Respiratory conditions include **hypersensitivity pneumonitis (HP)**, chronic bronchitis, impaired lung function, and asthma. **Work-related asthma (WRA)** is one of today's most prevalent occupational disorders, imposing significant costs in healthcare and workers' compensation. Dermatologic exposures are most commonly associated with, but not limited to, allergic and irritant dermatitis (skin rash). In addition, substantial evidence shows that past exposures to some metalworking fluids were associated with increased risk of some types of cancer. Although actions taken in the last several decades have reduced that risk, it is not known if these actions have totally eliminated the risk.

NIOSH recommends that exposures to MWF aerosols be limited to 0.4 milligrams per cubic meter of air (thoracic particulate mass), as a time-weighted average concentration up to 10 hours per day during a 40-hour workweek. The **recommended exposure limit (REL)** is intended to prevent or greatly reduce respiratory disorders associated with MWF exposure. Some workers have developed WRA, HP, or other adverse respiratory effects when exposed to MWFs at lower concentrations. This REL is technologically feasible for most metalworking operations.

Several preventive measures are available to reduce MWF exposures and their effects. Formulations have been developed with safer, less irritating additives and MWF components. Machinery has been modified to limit the dispersal of MWF mists. In addition, the use of protective gloves, aprons, and clothing, the education of workers regarding the safe handling of MWFs, and the importance of workplace personal hygiene are all key to controlling the exposures to MWFs.

Types if MWF - four basic classes.

1. **Straight Oil**: Also called "cutting" or "neat" oils. This type is made up of mineral (petroleum), animal, marine, vegetable or synthetic oils. Today, the mineral oils are "severely solvent refined" or "severely hydrotreated". These terms refer to refining processes that help reduce the amount of polynuclear aromatic hydrocarbons (PAHs). Straight oils are not diluted with water but other additives may be present.

2. **Soluble Oil:** This category contains 30 to 85 percent severely refined petroleum oils, as well as emulsifiers to disperse the oil in water.

3. **Semi-synthetic fluids** contain 5 to 30 percent severely refined petroleum oils, 30 to 50 percent water and a number of additives.

4. **Synthetic fluids** do not contain petroleum oils. Instead, they use detergent-like components and other additives to help "wet" the metal.

Typical Additives Included in MWFs - The following tables show possible additives included in the various metal removal fluids.

Table 1: Straight Oil Additives

Additive	Purpose	Example
oiliness agent	increases film strength	vegetable oil, polyol ester
extreme pressure agent	to lubricate under high pressure	sulfurized fatty materials, chlorinated paraffins
antioxidant	to reduce oxidation of fluid	alkylated phenol
metal passivator	to protect newly exposed metal from corrosion	triazol
corrosion inhibitor	to protect part and machine	calcium sulfonate
anti-mist agent	to reduce aerosol formation	polyisobutylene polymer
dispersant	to suspend fluid contaminants	***
odorant	aesthetic	***
dye	aesthetic, identification	***

Table 2: Soluble Oil Additives

Additive	Purpose	Example
oiliness agent	increases film strength	polyol ester
emulsifier	to disperse oil in water, improve wetting of part	petroleum sulfonate, salts of fatty acids, nonionic surfactants
alkanolamine	to provide reserve alkalinity	monoethanolamine, triethaolamine
extreme pressure agent	to lubricate under high pressure	sulfurized fatty materials, chlorinated paraffins, phosphorus derivatives
biocide	to reduce microorganisms	triazine, oxazolidine
coupling agent	to improve the solubility of the various additives in the MWF	fatty alcohol
corrosion inhibitor	to prevent part or tool corrosion	sodium sulfonates, fatty acid soaps, amines
defoamer	to reduce foam production	long chain fatty alcohol
metal passivator	to protect newly exposed metal from corrosion	triazole
dye	aesthetic, identification	***

Table 3: Semisynthetic Additives

Additive	Purpose	Example
oilness agent	increases film strength	polyol ester
emulsifier (more complex)	to improve wetting of part, disperse oil in water	fatty amides, salts of fatty acids, nonionic surfactants
alkanolamine	to provide reserve alkalinity	monethanolamine, triethanolamine
extreme pressure agent	to lubricate under high pressure	sulfurized fatty materials, chlorinated paraffins, phosphorus derivatives
biocide	to reduce microorganisms	triazine, oxazolidine
coupling agent	to improve the solubility of the various additives in the MWF	fatty alcohol
defoamer	to reduce foam production	long chain fatty alcohol
corrosion inhibitor	to prevent part or tool corrosion	amine salt or boric acid
chelator	to reduce hard water effects	EDTA
metal passivator	to protect newly exposed metal from corrosion	triazole
dye	aesthetic, identification	***

Table 4: Synthetic Fluid Additives

Additive	Purpose	Example
synthetic lubricant	to improve lubricity of fluid	ethylene oxide-propylene oxide
alkanolamine	to provide reserve alkalinity	polymers, amides, organic esters monoethanolamine, triethanolamine
plasticizer	***	glycol ether
biocide	to reduce microorganisms	triazine, oxasolidine
defoamer	to reduce foam production	long chain fatty alcohol
corrosion inhibitor	to prevent part or tool corrosion	amine salt of carboxylic acids, amine salt of boric acid
chelator	to reduce hard water effects	EDTA
metal passivator	to protect machine components from corrosion	triazole
odorant	aesthetic	***
dye	aesthetic, identification	***

Health concerns - working with MWFs

MWFs have been associated with several health concerns. Contact dermatitis is the most common skin condition reported which can result in burning, itching, and blistery skin while breathing in the mists may cause asthma and lung irritation (hypersensitivity pneumonitis), chronic bronchitis, and impaired lung function.

There is also evidence that some MWFs are associated with an increase risk of certain cancers such as larynx, rectum, pancreas, skin, scrotum, and bladder. Since the ***time between exposure and the development of the disease is often more than 20 years***, most of this risk is thought to be from MWFs used in the mid 1970s or earlier. Substantial changes to the composition of MWFs and reductions in the contaminants have occurred in the past few decades and as a result, the risk of cancer from more recent exposures is not as clear.

Overall, the type and severity of the health problem depend on:

- What MWF is used,
- Degree and type of contamination to the MWF, and
- The level (how much), duration (how long), and frequency (how often) of exposure.

The three major areas of concern (**skin, respiratory and cancer**).

Skin

All types of MWFs can cause skin irritation. If you had severe eczema as a child, there is a high risk that you will suffer dermatitis when exposed to MWFs. Exposure occurs when hands are dipped into the fluid, or when a person handles the parts, tools and equipment covered in fluid. Splashing is a concern if guarding is absent or inadequate. Clothing contaminated with MWF, poor housekeeping, and poor personal hygiene can also contribute to skin exposure.

Irritant or allergic contact dermatitis is reported to occur from exposure to soluble, semisynthetic, and synthetic MWFs. Dermatitis can be caused by:

- bacteria and their by-products
- chemicals added to control bacteria (biocides)
- chemicals added to control rust and corrosion
- contact with metal contaminants such as nickel, cobalt and chromium, which are known sensitising agents.

Skin conditions associated with straight oils include:

- folliculitis (inflammation of hair roots or follicles) can be caused from prolonged and regular contact to straight oils.
- Oil acne can develop on the face, forearms, thighs, legs and other body parts in contact with oil soaked clothing and is marked by red bumps with yellow pustules (a blister filled with pus).

In addition, the small metal particles (fines and swarfs) generated while parts are machined can damage the skin and make existing irritations worse.

Skin conditions can become disabling if not treated or if the worker continues to work with condition.

Respiratory

An increase in work-related asthma, bronchitis, irritation of the respiratory tract and breathing difficulties is commonly reported by those exposed to metalworking fluids. Exposure to mist, aerosol, and vapor also aggravates existing respiratory conditions.

It is not clear whether respiratory problems are caused by specific fluid components, contaminants, products of microbial growth or degradation, or a combination of these factors. For example, metalworking fluid-induced asthma is reported more consistently with synthetic MWFs, but MWF-induced asthma can also occur with soluble and straight fluids.

Again, the severity of exposure depends on proximity to the machine, and if the operations involve high tool speeds and deep cuts, if the machine is enclosed, or if ventilation equipment is working properly. High pressure or excessive fluid application, contamination of fluid (with tramp oil), improper fluid selection, and poor maintenance will also result in higher exposures.

Bacteria contamination can cause irritation of respiratory tracts or flu-like symptoms, aggravate asthma, and irritate the eyes, nose and throat (causing a sore throat, red watery itchy eyes, runny nose, nose bleeds, coughing wheezing, or shortness of breath). For example, hypersensitivity pneumonitis (HP) is an allergic type reaction in the lungs that may be caused by exposure to microbial products. HP is marked by chills, fever, shortness of breath and a deep cough - similar to a cold that will not go away. If left untreated, it can lead to irreversible lung damage.

Cancer

Cancers often associated with exposure to metalworking fluids include rectum, pancreas, larynx, skin, scrotum, esophagus, and bladder. The National Institute for Occupational Safety and Health (NIOSH) in the USA reports that studies were not highly consistent regarding the specific types of cancer associated with MWFs. This uncertainty is likely due to the wide variation in the types of MWFs and contaminants and the lack of detailed exposure information.

Also, because the latency period (the time between first exposure and the discovery of disease) for cancer is often 20 years or more, it is likely that the diseases studied recently are associated with older formulations of MWFs (from the mid 1970s and earlier). For example, fluids used before 1985 may have contained nitrites, mildly refined petroleum oils and other chemicals which were removed because of health concerns. Cancer risks have likely been reduced but there is not enough data yet to prove this theory.

Areas of concern for risk of cancer currently include:

- Unrefined mineral oils and contact with exposed skin (including oil soaked clothing and especially oily rags kept in pockets, which caused cancer of scrotum).
- Nitrites or nitrates and amines that cause the formation of nitrosamines when MWFs are heated or under pressure. Certain nitrosamines, such as N-nitrosodiethanolamines (NDELA), are known to be cancer causing agents.
- Some biocides release formaldehyde, a suspected carcinogen. Formaldehyde can also speed up the formation of nitrosamines.
- Chlorinated paraffins are carcinogens (often used when extreme pressure is required). They also form dioxin, another carcinogen.

How MWFs enter the body

MWFs can enter the body when:

- The mist, aerosol, or vapor is inhaled. Exposure will depend on:
  - What kind of machining being done,
  - How the fluid is applied (e.g., manually with an oil can; flooded through a hose or pipe, or it can be atomized (aerosolized) and the mist directed where the tool contacts the metal), and
  - How or if the machine is enclosed and ventilated. Higher exposures happen when:
    - the operator works close to the metalworking machine,
    - the operations involve high-speed tools or deep cuts,
    - the machines do not have an enclosed process, or
    - there is poor ventilation.
- It comes into contact with the skin, especially if there are cuts, rashes, cracks, or other breaks in the skin. Hands and arms are most at risk if adequate precautions are not taken. Fluids can splash onto the skin during machining, and can also occur when preparing or draining the fluids, handling metal product, changing or setting tools, and during maintenance or cleaning operations. Rags or clothes soaked with MWF that are in constant contact with the skin are also a concern.
- Ingested if you eat, drink or smoke at the workstation or without washing your hands first.

What Training Is Necessary

Training of managers and employees in general is crucial to the proper management of metalworking fluids. Everyone in the workplace must understand why it is so important that certain procedures be followed. Then the likelihood increases that good practices will be carried out and health and safety risks will be greatly reduced.

The employer must provide information and training to employees working in the metalworking fluid environment so that they can perform their job safely. Managers should receive training as appropriate, including training in the employer's health and safety program for metalworking fluid processes and metalworking fluid management. Training should be well organized, integrated into the existing requirements of the OSHA Hazard Communication Standard, and be specific to the individual circumstances of each facility.

Requirements Under OSHA's Hazard Communication Standard

Under OSHA's Hazard Communication Standard (29 CFR 1910.1200), employers must train employees about the hazards of materials to which they are exposed. This standard requires employers to develop, implement and maintain at the workplace a written, comprehensive hazard communication program that includes provisions for labeling containers, collecting and making available MSDSs, and having in place an employee training and information program. The standard also requires employers to make a list of all the hazardous chemicals in the workplace as part of the written hazard communication program.

The following are a few of the major requirements of the hazard communication standard:

> *Labeling* Containers of MWFs and other chemicals must be labeled, tagged or marked with the identity of the material and must show appropriate hazard warnings as well as the name and address of the chemical manufacturer, importer, or other responsible party. The hazard warning can be any type of message - words, pictures or symbols - that conveys the hazards of the

chemical(s) in the container, including target organ effects. The labels must be legible, and prominently displayed. The label must be written in English and other languages if desired. Employees must be trained to read and understand labeling.

MSDSs - Employers must have a current MSDS for each hazardous chemical they use. The standard requires employers to make a list of all hazardous chemicals in the workplace, and the list should be checked to verify that MSDSs have been received for each chemical. If there are hazardous chemicals used which don't have MSDSs on file at the plant, the employer must contact the supplier, manufacturer or importer to get the missing MSDS. Each MSDS must be written in English, although the employer may maintain copies in other languages as well. The MSDS must include information regarding the specific chemical identity of the hazardous chemical and its common names. A description must also be included of the physical and chemical characteristics of the hazardous chemical, known acute and chronic health effects and related health information, primary route(s) of entry, exposure limits, precautions for safe handling and use, and any applicable control measures such as engineering controls, work practices, or personal protective equipment. In addition, the MSDS must include emergency and first aid procedures and the identification of the organization responsible for preparing the sheet, and the date of preparation or the last change to it. Copies of the MSDS for each hazardous chemical must be readily accessible during each work shift to employees when they are in their work areas.

When Training Should Be Conducted

Training should be conducted:

At the time of initial assignment to all affected employees and to the managers who must carry-out the employer's safety and health program;

To employees not previously trained;

Whenever a new and significantly different metalworking fluid or hazardous chemical is introduced into the workplace; and

Whenever a new way of protecting employees from hazards or new engineering controls is introduced into the plant.

Included in the Training Program

Employees should be informed about metalworking fluids and other hazardous chemicals in their work areas and the availability of information from MSDSs or other sources. Employees should be instructed about the adverse health effects associated with exposure to these chemicals. In addition, employees should be trained to detect and report hazardous situations (e.g., the appearance of bacterial overgrowth and degradation of MWFs).

Employees should be informed that exposures to MWFs during metalworking operations can occur through inhalation of MWF aerosols and through contamination of the skin by settled mists, splashes, dipping of hands and arms into MWFs, or handling of parts coated with MWF. Instruction should include information about how exposures can be controlled by a combination of proper MWF use and application, MWF system maintenance, isolation of the operation(s), ventilation, and other operational procedures.

Employees should be aware that dermal exposures may be reduced by the use of machine guarding and protective clothing and equipment such as gloves, face guards, aprons, or other protective work clothes. Employees should be encouraged to maintain good personal hygiene and housekeeping practices to prevent MWFs from contaminating the workplace.

The training program should be conducted in such a way that the employee is able to understand the information. The training program should provide answers to the following questions:

What is the employer's management program for metalworking fluids?

What is the nature of the hazards to which the employee is exposed? (When addressing this issue, employers should cover the adverse health effects associated with MWF exposures as well as other hazardous chemicals in the work area and explain the content of the Material Safety Data Sheets (MSDSs) and where employees can get them.)

How can employees recognize hazards?

What are the operations in the work area where metalworking fluids processes are used? What are the safe work practices that will limit exposure to metalworking fluids and contaminants?

What personal protective clothing and equipment do employees need to wear to limit their exposure to both the mist and the fluid itself? How should such clothing and equipment be used and what are their limitations?

What engineering and work practice controls are in place for employee protection? Why are they important? How should they be used and maintained? Is machine safety adequate?

How are spills handled? What are the cleanup procedures?

What emergency procedures are in place? What are the specific duties of each employee in case of an emergency?

What does the medical program consist of? What is its purpose? To answer these questions, you'll need to include information about the potential health hazards associated with exposure to metalworking fluids, the signs and symptoms of overexposure, the action an employee should take if he or she suspects the symptoms are related to exposure, and to whom they should report the symptoms.

Employers should provide the MWF-related information to their employees in written form by offering guides, brochures and manuals without cost to the employee. Employers should also tell employees to report illnesses, injuries, or hazards to an appropriate person; which, depending on the facility, could be the employee's supervisor, safety coordinator, or company or contract medical personnel.

***Hazard Communication* – 1910.1200 - "*Right to Know*"**

It's the law! Under federal and state Right to Know regulations employers must provide workers with basic information about the hazardous materials with which they work. When properly implemented, Right to Know can be a valuable tool to use in identifying workplace health and safety hazards. This section covers the strengths and shortcomings of the Right to Know, giving you what you need to get the most of it.

The federal standard is OSHA Hazard Communication Standard, 29CFR1910.1200.

Overview of the HazCom Provisions:

1. **Written Program (The Written Plan) 1910.1200 (e)**
    - Who is responsible for implementing the plan
    - How MSDS's will be secured for all materials before they enter the plant
    - Where MSDS are located and how they can be obtained
    - How workers can get a copy of the MSDS's
    - Who will design and conduct training and when it will be done

2. **Labeling 1910.1200 (f)**
    - Manufacturer (name and address)
    - Product (chemical or trade name)
    - Hazards (all health & safety warnings, including target organs)

3. **Material Safety Data Sheets (MSDS) 1910.1200 (g)**
    - Must accompany every hazardous chemical entering the workplace
    - Provides more detailed information on toxic ingredients, health effect and special precautions.
    - Applies to over-the-counter products used in the workplace that contain hazardous materials.

4. **Training 1910.1200 (h)**
    - To anyone that "has the potential to be exposed" to a hazardous chemical
    - Routes of entry
    - How to tell if you are being exposed
    - How to protect yourself from exposure
    - Prior to being exposed (new hire)
    - Anytime a new hazard is introduced or the existing hazard changes

Activity # 1

In your small groups, discuss the questions below. Write the answers your group decides on. Pick a recorder and a reporter to report out your groups' responses and be prepared to defend your answers.

1. **How do chemicals enter the body?**

    - ______________________________
    - ______________________________
    - ______________________________
    - ______________________________

2. **What are some symptoms that may indicate you are being over-exposed ?**

- **Dizzy/light-headedness**______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

3. **In your opinion, why do 50,000 people in the United States die an early death, each year, as a result of chemical exposure from the workplace? (NIOSH)**

- ❑ ____

4. **Why don't we take chemicals seriously?**

- ❑ ____
- ❑ ____
- ❑ ____
- ❑ ____
- ❑ ____

Activity # 2

Using your knowledge and your groups knowledge answer the following questions about the 1910.1200, HazCom Standard. Place an "X" in your groups' response (s). Note: In multiple choice questions, any number of answers might be correct. Pick a different recorder and reporter.

1. The OSHA HazCom Standard 1910.1200 (Right to Know) requires which groups to disclose information about hazardous chemicals?

- ❑ ______chemical manufacturers
- ❑ ______chemical distributors
- ❑ ______employers
- ❑ ______employees

2. Employers must have a written program on the HCS which is accessible to workers and the union. Which items have to be included in the program?

- ❑ _____a list of all hazardous chemicals at the worksite
- ❑ _____instructions on the hazards of non-routine tasks
- ❑ _____a list of all non-hazardous materials
- ❑ _____methods to inform the workers about the contents of piping

3. Which of these *containers* have to be labeled?

- ❑ _____pipes
- ❑ _____portable containers
- ❑ _____drums
- ❑ _____storage tanks
- ❑ _____boxes and bags

4. The HazCom standard requires what information to be on a "label"?

- ❑ _____manufacturer (name and address)
- ❑ _____product (chemical or trade name)
- ❑ _____hazards (all health and safety warnings)
- ❑ _____DOT and NFPA information

5. MSDS's are generally complete and accurate because they are approved by OSHA.

- ❑ _____True ______False

6. Which of the following items are MSDS's required to include?

- ______date MSDS was written
- ______all known health and safety hazards of ingredients
- ______name, address and phone number of responsible party
- ______identity of "hazardous ingredients"
- ______short and long term health effects

7. "Hazardous chemicals" might refer to which of the following under the HCS?

- ______coolants and cutting oils
- ______gasoline
- ______water-based cleaning agents
- ______contact cement
- ______steel, aluminum, wood or other solid material

8. Under OSHA, which of the following are workers' rights?

- ______review MSDS's during their shift
- ______review the MSDS for a chemical before working with it
- ______a copy of a MSDS for their own records

9. OSHA requires employers to train workers about chemical hazards after they have been on the job a few months.

- ______True ______False

10. OSHA only mandates training for workers who work *directly* with chemicals.

- ______True ______False

11. Once workers receive Right to Know training, they never have to be trained again.

- ______True ______False

12. What should be the end result of training in hazardous chemicals?

- ______Knowledge about the specific hazards of your job
- ______Ideas on how to protect yourself from exposure
- ______More responsibility put on workers, less on employers

13. Which agency or agencies enforce the Hazard Communication Standard?

- ______EPA (Environmental Protection Agency)
- ______CDC (Centers for Disease Control)
- ______OSHA (Occupational Safety and Health Administration)
- ______State Police

***Activity # 3**…. Getting familiar with MSDS*

Using the MSDS your instructor has given your group, pick a recorder and reporter, and answer the following questions. Be prepared to share the section and /or page number where your group found your answers.

1. **What are the hazardous ingredients for this chemical?**

2. **What are the possible health effects from exposure to this chemical?**

   - Short Term**:**

   - Long Term**:**

3. **What personal protective equipment is necessary? Why?**

4. **What specific precautions or procedures should be followed when using this product?**

5. **Is this product reactive? With what?**

6. **What happens when this product is heated, welded on or when used in a grinding or machining operation?** (Hint: Look for the hazardous decomposition products).

7. **What should be done in the event of a spill, leak or other incidents involving this product?**

8. Does this chemical have more than one name? What is it or them?

9. What is the most recent revision date? How can you find out if there is a more recent one? Does it really matter?

Activity # 4. How to identify health *hazards* at your worksite. Pick a recorder and reporter in your group.

First, discuss ***what is your groups' definition of a health hazard?***
____.

1. **What are the health hazards of your job (How could someone be exposed on your job)?**

2. **Can the hazards be eliminated? Why or Why not?**

3. **Can the hazards be controlled through engineering controls?**

4. **Will administrative controls, warnings or training help you stay safe? Why?**

5. **Does PPE do away with the hazard? How effective is PPE?**

The Hierarchy of Health & Safety Controls

A heated debate often occurs between labor and management in the health and safety arena that is sometimes referred to as the **"Do we fix the workplace or the worker?"** issue.

Management's tendency, given its focus on workers' behavior and short-term cost reduction, is to argue for 'fixing the worker' solutions: protective gear and discipline for failure to follow procedures. The Union considers this to be "blaming the victim" and advocates for solutions that 'fix the workplace.'

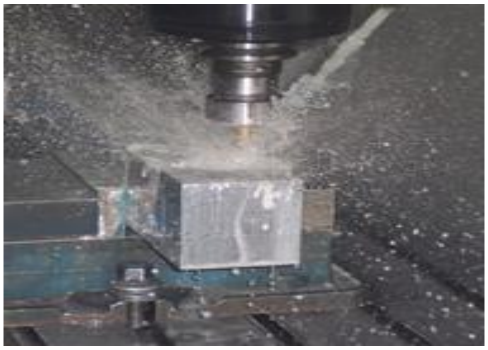
Research indicates that the latter approach is actually more effective and less expensive in the long run. One reason is that human behavior can never be completely regulated and controlled, so solutions based on compliance with procedures will always lead to mishaps. Machine controls and replacement of hazardous materials are much more capable of guaranteeing safety and health. The UAW's and OSHA's analysis of control effectiveness is captured in the chart below.

MOST EFFECTIVE	1. Elimination or Substitution **(ES)**	• substitute for hazardous material • change process to eliminate noise • perform task at ground level • automated material handling
↓	2. Engineering Controls **(EC)**	• ventilation systems • machine guarding • sound enclosures • circuit breakers • platforms and guard railing • interlocks • lift tables, conveyors, balancers
↓	3. Warnings **(W)**	• computer warnings • odor in natural gas • signs • back-up alarms • beepers • horns • labels
↓	4. Training & Procedures **(TP)**	• Safe job procedures • Safety equipment inspections • Hazard Communications Training • Safe Lifting Training • Lock-out • Confined Space Entry, etc…
LEAST EFFECTIVE	5. Personal Protective Equipment* **(PPE)**	• safety glasses • ear plugs • face shields • gloves • chemical protective clothing • respirator • safety harnesses and lanyards • knee pads

*Employees using PPE must be trained to follow all OSHA PPE requirements.

Options to control hazards from metalworking fluids (MWFs)

- Obtain Material Safety Data Sheets (MSDSs) from the supplier to know what precautions are recommended.
- Choose MWFs with the least toxic materials when possible.
- Maintain proper use of biocides.
- Keep machines clean and change MWFs as necessary.
- Use properly designed MWF delivery systems which minimize the amount of fluid mist generated.
- Some machines require a cooling system for the metalworking fluid. Use cutting machine coolant with a visual coolant filling point and level indicator. The coolant capacity should be suitable for the correct function of the machine tool.
- Use splashguards to prevent unnecessary spray and splashing.
- Minimize the number of pipe-work bends and kinks.
- Use nozzles that optimize coolant distribution.
- Use exhaust and local exhaust ventilation to prevent accumulation and recirculation of airborne contaminants.
- Use proper personal protective equipment (PPE).
- Ensure employees are aware of and promptly report skin or chest symptoms which may be related to MWFs.



Engineering controls

Proper design and operation of the MWF delivery system

- Use a system designed to generate a minimum amount of fluid mist. Fine mists are created when the MWF stream breaks up during use and becomes airborne, especially when the fluid is moved at a high speed or velocity. The small mist droplets are easily suspended in air and are hard to contain or collect.

Ways to reduce the amount of mist include low pressure delivery of MWF, mist suppressants, lower MWF flow rate, covering fluid reservoirs and return systems, proper machine maintenance (e.g., no leaks causing contamination), or interrupt (stop) the flow of MWF when a part is not being machined instead of the fluid running continuously.

- Do not use compressed air to blow clean parts covered with MWF as the air pressure causes the MWF to be airborne.

Isolation

- Install complete enclosures or splash guards, depending on the operation, to keep the metalworking fluids contained and away from the operator.

Effective ventilation

- Use exhaust ventilation to prevent accumulation and recirculation of airborne contaminants.
- Local exhaust (near the source) is most effective.
- Enclosed operations are easier to ventilate

Proper maintenance of equipment

- Reduce the amount of contamination into the MWFs, such as hydraulic oils and other "tramp" oils, by keeping equipment in good working order.
- Make sure that all systems (ventilation, guarding, etc.) are maintained properly.

Proper use of biocides

- Use biocides according to supplier or manufacturer's directions. Overuse of biocides can cause biocide-resistant strains to develop or another strain to overtake other strains.
- Biocides themselves can cause either allergic or contact dermatitis

Administrative Controls

Good work practices include the following:

- Stress the importance of personal hygiene. To maintain clean skin, be sure to wash with gentle soaps, use clean water and towels and wear clean work clothes (those that are not soaked in fluids).
- To prevent accidental ingestion do not eat, drink or smoke in the work area, and always wash your hands before eating, drinking or smoking. Observe good hygiene - wash your hands before and after you go to the bathroom.
- Barrier creams developed for specific hazards may offer a level of protection, but they should not be substituted for good personal hygiene and chemical protective gloves. The effectiveness of barrier creams has not been well documented. Some barrier creams can

actually make some skin conditions worse so they should only be applied to normal, healthy skin (that is, no cuts, rashes, scratches, etc.)

- Maintain good housekeeping. Keep floors, equipment and the general work environment clean. Use appropriate cleaning agents, work practices, and protective clothing. All workers should be trained in how to clean MWFs properly.
- Spills should be cleaned immediately. Wastes, including floor wash water, should not be dumped or swept into the MWF sumps or coolant return trenches. Solvent soaked rags should be deposited in airtight metal containers.
- All machines should be cleaned and MWF changed periodically. When changing the MWF, thoroughly clean the entire system to remove bacterial deposits.

Work Practice Controls

Work practices, as distinct from engineering controls, involve the way in which a task is performed. OSHA has found that appropriate work practices lower employee exposures to hazardous substances and reduce safety hazards. Some fundamental and easily implemented work practices are: (1) use of appropriate personal hygiene practices, (2) use of barrier and moisturizing creams, (3) good housekeeping, (4) periodic inspection and maintenance of process and control equipment, (5) use of proper procedures to perform a task, and (6) provision of supervision to ensure that proper procedures are followed.

Personal Protective Equipment and Clothing (PPE)

Engineering controls are preferred before using PPE, but in certain situations, PPE may be required. Employees should be trained to know when PPE are necessary, what PPE to wear, how to wear and remove it properly, the limitations of the PPE, and its proper care and maintenance.

PPE that may be required when working with metalworking machines and metalworking fluids include those that provide protection from:

- chemicals in the MWFs, cleaning fluids, etc.,
- flying metal particles (fines and swarfs),
- sharp edged parts,
- high temperatures / hot parts that could produce burns,
- falling objects, and
- machine noise.

For example, gloves, protective sleeves, aprons, eye protection (goggles and/or face shields), chemical-resistant clothing, and caps may be needed. **However**, in some situations, gloves may not be appropriate as they can get tangled in moving parts. A thorough hazard assessment of the task must be done.

Respiratory protection that is classified as "resistant to oil" or oil proof should be selected where appropriate. Depending on the level of airborne contaminants, an air-purifying, half mask respirator (with HEPA filter) including disposable (for oil mists less than 50 mg/m^3), or any powered, air-purifying respirator equipped with hood or helmet and HEPA filter (for oil mists less than 125 mg/m^3).

Remember that there may be other hazards associated with the MWF. For example, straight oil systems may also require fire protection. Read your MSDS so that you know and understand the hazards of the products that you are using, how to work safely with them, and what to do in case of spills or any emergency situations.

When Should Respirators Be Worn?

Before requiring the use of respiratory protection, the employer must institute effective engineering controls (such as machine enclosures and/or local exhaust ventilation), work practice controls, and/or administrative controls, as necessary, to reduce employee exposure to at or below the OSHA PELs of 5 mg/m^3 for mineral oil mist and 15 mg/m^3 for Particulates Not Otherwise Classified (PNOC) (applicable to all other metalworking fluids), expressed as 8-hour time-weighted averages. If these controls fail to reduce and maintain employee exposures, to or below the applicable PEL, then the employer must provide respiratory protection.

When respirators are required, a comprehensive respiratory protection program as outlined in the OSHA respiratory protection standard (29 CFR 1910.134) must be established. Important elements of the OSHA respiratory protection standard include:

Procedures for selecting respirators;

Medical evaluation of employees required to use respirators;

Fit testing procedures for tight-fitting respirators; and

Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing and otherwise maintaining respirators;

Training employees in the respiratory hazards to which they are potentially exposed;

Training employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and maintenance procedures; and

Procedures for regularly evaluating the effectiveness of the program.

When employees voluntarily use (not required, but provided by the employer or the employee and worn voluntarily by the employee) only "filtering facepieces" (formerly referred to as "dust masks" or "single use respirators"), the employer is **not** required to implement a respiratory protection program. Instead, employees must be provided annually basic information on respirators, contained in Appendix D of the standard. Furthermore, the employer needs to ensure that these respirators are not dirty or contaminated, and that their use does not interfere with the employee's ability to work safely.

When respirators other than filtering facepieces are being voluntarily worn by employees, the employer must:

Ensure that respiratory use will not in itself create a hazard;

Establish a limited written program:

Medically evaluate employees;

Ensure proper cleaning, maintenance, and storage of respirators.

Once the program is in place, make sure you evaluate it regularly. If you don't have a well-thought out, complete respiratory protection program, your employees may not be properly protected.

Respirator Selection

Respirators must be selected by correctly matching the respirator with the hazard, the degree of the hazard (airborne concentrations in the employee's breathing zone), and the user. Respirators should be selected by the person who is in charge of the program and knowledgeable about the workplace and the limitations associated with each type of respirator.

Particulate respirator filters are classified into three filter series, depending on the resistance of the filters to oil:

N (**N**ot resistant to oil)

R (**R**esistant to oil)

P (oil **P**roof)

These categories apply only to non-powered, air purifying, particulate-filter respirators. R- or P-series filters should be selected if there are oil (e.g., metalworking fluids, lubricants) or non-oil aerosols in the workplace. N-series filters should be used only for non-oil (i.e., solid and water-based) aerosols. According to NIOSH, the R-series should be used only for a single shift (or 8 hours of continuous or intermittent use) when oil is present. P-series filters can be worn for longer than eight hours. As with all filters, they should be replaced whenever they are damaged, soiled or causing noticeably increased breathing resistance (e.g., causing discomfort to the wearer).

The NIOSH recommended respiratory protection for employees exposed to metalworking fluid aerosol appears in Appendix 5 (NIOSH 1998a). The NIOSH REL is directed at reducing exposure to MWF aerosols - not to *vapors* from MWFs and its aerosols.

Personal Hygiene

Good personal hygiene is an important control measure in preventing occupational skin disorders. Employees should be encouraged to maintain good personal hygiene by cleaning MWF-contaminated skin periodically (especially before breaks and meals) with gentle soaps, clean water, and clean towels; and to minimize personal contact with MWF, metal debris, and other potentially harmful chemicals in the workplace. Employees should not place their unprotected hands and arms repeatedly into MWFs. Unwashed skin covered with unwashed and unchanged clothes prolongs contact with MWFs and other chemicals. In addition, rapid evaporation of water from the fabric leaves behind MWF at much higher than intended concentrations, which is a major cause of dermatitis.

Employees should change work clothing that becomes soaked with metalworking fluids and contaminants during the work shift, and should change from contaminated work clothes into street clothes before leaving work. Employees should wear clean work clothing at each shift.

Easy access to hand washing facilities must be provided if employees are to minimize contact with harmful chemical agents. Inconveniently located washing facilities invite undesirable practices such as washing at workstations with solvents, mineral oils, or industrial detergents, none of which is appropriate or intended for skin cleansing. Excessive skin cleansing with harsh agents can produce an irritant contact dermatitis or aggravate preexisting dermatitis.

In addition, employees should keep personal items such as food, drink, cosmetics, and tobacco separate from the work environment to prevent any unnecessary additional exposure to MWFs.

Barrier and Moisturizing Creams

Barrier creams may be useful for some employees (NIOSH 1998a). They may be applied to exposed skin areas to prevent contact with harmful agents. There are two main types of barrier creams: water-repellant and solvent-repellant. The primary application of water-repellant creams is in machine shop operations, where gloves cannot always be worn safely, and where water-based cutting fluids are used.

The use of good quality barrier creams on exposed skin areas can offer protection against the development of dermatitis if used consistently and re-applied as necessary throughout the shift. The use of moisturizing creams may also be protective. Although barrier creams and moisturizing creams protect the skin, they must be viewed as supplements only. They do not replace good personal hygiene or the use of chemical-protective gloves.

Moisturizing creams replenish the moisture in the hands; barrier creams prevent moisture in the hands from escaping and keep mild irritants from penetrating to the skin. Creams should be selected based on the characteristics of the fluids being used. Creams must also be used with care, as some operations may be contaminated by them. Barrier creams should be applied only to healthy skin and should not be used if the employee has dermatitis.

Housekeeping

Good housekeeping is an important control measure to prevent operator contact with MWFs and other potential hazards, and to prevent contamination of the MWFs by dirt and debris. Cleaning of floors, equipment, and the general work environment should be done by properly trained and equipped personnel working on a planned schedule. People assigned to cleaning should be supplied with proper equipment, materials, and protective clothing, and be trained in safe procedures.

On a day-to-day basis, spills should be cleaned up immediately. Wastes (including floor wash water) should not be dumped or swept into MWF sumps or coolant return trenches. Solvent-soaked rags should be deposited in airtight metal receptacles. All machines should be cleaned and have the MWF changed periodically.

Make-Up Air

Exhaust ventilation systems (whether they are local or dilution) require the replacement of exhausted air to ensure that they operate properly. Replacement air, also called make-up air, can be supplied naturally by atmospheric pressure through open doors, windows, wall louvers, and adjacent spaces as well as through cracks in walls and windows, and beneath doors; or by mechanical means such as a dedicated replacement air system.

Ideally, the make-up air should be provided, controlled, and conditioned by a mechanical system rather than relying on random infiltration. Mechanical air handling systems, which can range from simple to complex, all distribute air in a manner designed to meet the ventilation, temperature, humidity, and air quality requirements established by the user. Individual units may be installed in the space they serve, or central units can be installed to serve multiple areas.

A good make-up air system would have the following characteristics:

Adequate size to replace the amount of air exhausted from the building.

Supply registers positioned to avoid disruption of emission and exposure controls and to aid dilution efforts. The air supply and exhaust outlet should be so located that all the air employed in the ventilation passes through the zone of contamination.

Make-up air should be heated in cold weather and should be designed to provide some cooling in the summer in hot process areas.

Make-up air should be introduced into the "living zone" of the plant, generally 8-10 feet (2.4 to 3.0 meters) from the floor. This gives the workers the benefit of breathing fresh air and, if the air is tempered (heated or cooled), maximizes the comfort provided by the make-up air.

Make-up air inlets outside the building located so that no contaminated air from nearby exhaust stacks, chimneys, or parking lots is drawn into the make-up air system.

Factors When Exhaust Air is Recirculated

Air exhausted from machine tool enclosures and hoods is often cleaned and recirculated in the workplace. In a recirculation system, exhaust air that is removed from the process is cleaned and recycled back to the facility (the objective of recirculation of exhaust air is to return cleaned air to the facility in order to reduce the amount of energy required to heat or cool make-up air).

Though the benefits obtained by recirculating exhaust air can be great, the method is not a simple one, and it is not without problems. The air quality of the recirculated air should be such that the employee is not exposed to a potential health hazard. Before returning this air to the workplace, all contaminants should be removed. The ventilation system should be maintained and cleaned so that it does not itself become a source of air contamination.

The efficiency of any air cleaner in a recirculation system should be such that respirable particles or harmful gases and vapors are removed before the air re-enters the workroom. Commercially available mist collectors are typically multi-stage and should use a high-efficiency particulate air (HEPA) filter as a final stage. Air cleaners without a HEPA filter typically spew small particles out into the workplace.

In addition, air monitoring equipment should be installed and air sampling should occur on a real-time basis to ensure that the recirculated air is clean, since to determine that a harmful exposure has occurred after the fact does not provide adequate protection to the employee. Other adequate safety precautions should also be considered. These may include multiple air cleaning systems installed in series or automatic sensing devices to warn of air cleaner failure along with a means of diverting the recirculated air outdoors if the air cleaner fails. If unfiltered exhaust air is vented outside the work environment, local air pollution authorities should be contacted regarding the relevant regulations.

Function of a Mist Collector & How Should It Be Maintained

A mist collector is an air cleaning device used for removing MWF aerosol from an exhaust airstream before discharge into the ambient air. Factors which should be considered in the design and selection of a mist collector are collector efficiency, filter life, collector maintenance, and pressure drop.

Many commercial mist collection systems are available. In general, commercial collectors have multiple stages utilized in series. The purpose of the first stage(s) in a multi-stage collector is to remove swarf and to reduce the mist loading to the final stage, which is typically a 95% DOP filter or HEPA (high efficiency particulate air) filter. Often a three-stage collector, which includes a 95% DOP or HEPA filter is used for MWF operations:

> The first-stage is a prefilter, typically a metal-mesh. It removes swarf and reduces the mist loading on the second-stage and third (final) stage filters.
>
> The second-stage is more efficient than the first, and may use pocket or cartridge filters.
>
> The final-stage, using either a 95% DOP or HEPA filter, provides excellent efficiency when new, but are expensive to replace and have lifetimes determined by their cumulative mist load. Thus, selection of effective first and second stages, upstream of the final stage, is crucial (AAMA 1996).

Keep in mind that most filters work best when they are new, but they may lose their effectiveness quickly when they become loaded with liquid. For proper performance, it is crucial to inspect air cleaner filters and to clean them regularly or replace them, as appropriate. A poorly maintained mist collector can increase the mist loading in the discharged air. The aerosol captured by the mist collector can become rancid if left in the collector. Ideally, the collected aerosol should be removed continuously or at the end of each workday or shift. Collected aerosol should not be allowed to drain back into the fluid system. Microbial contamination will seriously degrade fluid life and can pose a serious health problem.

Exhaust Air of the Mist Collector

The discharged exhaust air of the mist collector can be directed back into the shop or it can be directed outdoors through the roof or wall of the building. A disadvantage of discharging the cleaned air back into the shop is that if the mist collector is operating improperly, mist will go back into the workplace. In addition, vapors or bio-aerosols that may contribute to respiratory problems and to odor problems are not removed by the filters.

Discharging the mist collector exhaust from the building eliminates the possibility of increasing the indoor mist level and gets rid of the moisture and vapors in the building. However, it can increase the need for building supply air. You may also need to get a permit from EPA, State or local authorities for venting the process air from the building.

In cases where exhaust air is discharged into the shop:

> Make sure you adequately filter the contaminants, both chemical and microbial, before you recirculate the air;

Use air pollution equipment that is capable of meeting rigorous collection standards and maintaining efficiency over time; and

Make sure you monitor the recirculated air as often as necessary to ensure that the contaminant levels do not exceed established limits.

Signs That a Fluid May No Longer Be Safe to Use

There are many signs that a fluid has undergone changes and is no longer safe to use because of emerging health hazards. If one or more of the following changes occur, the fluid should be evaluated to see if it is safe for continued use or if it should be replaced.

- *Low sump level.* Check the sump level at the start of the shift. A low sump level (30% below the full mark) shows metalworking fluid loss or water evaporation (increasing the concentration of chemicals present in the MWF). Check the concentration! If too strong, add water to reach the proper concentration. If the concentration is correct then fluid was lost due to dragout. You should add fluid at an appropriate dilution, or if prediluted fluid is not available, water and concentrate can be added. All systems should be monitored carefully and metalworking fluid additions should be made on a regular basis to maintain a constant working concentration. The correct concentration should be verified when finished.

- *Abnormal fluid appearance*. Determine if the fluid color looks normal. When in good condition many synthetic fluids are clear, semi-synthetics are often transparent to milky, and soluble oil usually looks milky white with no free oil layer. If the fluid turns gray or black, then bacteria are often present. If the fluid picks up a yellow or brown tint then tramp oil may be present. Dye fading may indicate that a fluid is aging.

- *Foul smell (rancidity).* When fluids smell bad, it usually means that there is uncontrolled microbial growth. Although it may be possible to cover up the odor, it's best to address the cause because microorganisms present in the fluid can be aerosolized into the air as part of the mist. Exposure to microorganisms in the air may cause adverse health effects to exposed employees. If the fluid has a strong and "locker room" odor, it likely has biological growth and should be treated with biocide and evaluated. If need be, the fluid should then be discarded, the sump properly cleaned, and the fluid replaced.

- *Floating matter on the fluid.* If the fluid has floating chips, swarf, or mold growth, this is not normal. Try to remove as much as possible with a skimmer or have it pumped off. The level of dirt (total suspended solids) in the fluid is a measure of the efficiency of the filtering system. Periodic checks and maintenance of the filtration system and oil skimmer are necessary to assure that they are functioning as designed.

- *Tramp oil floating on the surface.* With water-diluted fluids, if the sump is completely covered with oil and the machinist cannot swish the oil out of the way for more than 5 to 8 seconds before the sump is covered again, there is too much tramp oil present. Skim or pump the surface oil to remove it. Tramp oil is one of the main causes of dermatitis. These oils are not developed with repeated skin contact in mind, and some components of these machine lubricants are highly irritating to the skin. Unemulsified (tramp) oils can be a significant carrier of metallic fines, which can be deposited on the skin and cause mechanical irritation. These fines, suspended by tramp oil, are a major cause of dermatitis.

- *Excessive foam.* A lot of foam may be caused by soft water with some products. The fluid may also be too highly concentrated, or it may be contaminated by cleaners, or there may be an imbalance in the fluid surfactants. Another possibility is that you could have an undersized system, excessive flow rates, or the fluid may not be at rest long enough to allow air to escape. In addition, the level of cutting fluid in the reservoir may be low, causing air to be drawn into the pump.

- *Dirty machines or trenches.* This could mean that the emulsion is becoming unstable, the cleaners in the fluid have been depleted, the contaminants are being deposited from the fluid, there is filter failure, or there is poor housekeeping.

- *Employees have skin irritation.* If employees have skin irritation, it could mean that the fluid has one or more of the following properties: too high a concentration, high alkalinity, metal contamination, an unstable emulsion, or contamination from metal coatings. Of course, skin irritation can also be due to causes not directly related to metalworking fluids, such as changes in the weather, poor personal hygiene, poor work habits, the use of harsh hand soaps, wearing contaminated clothing, or prolonged exposure to the fluid.

- *Employees have respiratory irritation.* Exposure to MWF aerosols can lead to complaints of irritation and tightness in the chest. Factors that can contribute to irritation could be the improper delivery of fluid to the cutting zone; improper use of additives; a high coolant concentration; a heavy concentration of machines in a small area; inadequate or poorly designed enclosures and mist collectors; loss of microbial control; poor general ventilation of the shop; insufficient fresh air make-up rates; and high mist concentrations (even in the absence of machining operations) may be present in areas where coolant flumes make sharp turns.

Other problems that might be fluid-related and that should be investigated to see if the fluid is failing and may no longer be safe to use include:

- rust or corrosion of the machine tool or of the part produced;
- staining of the metal machined or machine tool;
- tool failure due to the loss of performance additives;
- growth of fungi that block fluid flow;
- change of fluid viscosity (thinner or thicker);
- accumulation of water at the bottom of the oil sump drain, in straight oils;
- dirt and grit suspended in the fluid; and
- failure at the metal-tool interface (for example, burning of a ground part due to excessive heat build-up).

Composition change of MWFs with storage or used

When stored, nitrosamines can form while the fluid is stored for long periods of time. Nitrosamines form slowly in the water-based MWFs and may be the result of interaction of nitrites in the fluid, lining of the cans used for storage, or from nitrogen oxides in air. Recycling MWFs can increase the problem if more reactants are added.

When MWFs are used, a primary concern is the presence of contaminants that encourage the growth of bacteria and fungi in water-based MWFs. The bacteria can degrade the emulsions and change the properties of the MWFs. While biocides are added to reduce the amount of microbial growth, the biocide products themselves have hazardous properties.

Other sources of contamination include "tramp" oils - oils used by the machines such as hydraulic oil, gear box oil, and lubricants. Tramp oils that leak into the metalworking fluids can also contribute to microbial growth.

MWFs are also contaminated by small particles of the metal or alloy objects (e.g., fines, chips, swarfs) that come off the parts while they are being machined. Common metals used include steel or alloys containing nickel, cobalt and chromium.

In addition, while the extent of the problem is not clear, there is the potential for straight oils to be heated during use (usually at the site where the cutting tool works on the metal) and the temperature may increase high enough to cause the formation of polynuclear hydrocarbons (or polyaromatic hydrocarbons, PAHs).

MWFs may also be contaminated by water, cleaning products used for routine housekeeping, or other products at the work site. Improper recycling of materials or the addition of unspecified fluids (such as old lubricating oils) to the MWF will also change the composition of fluid.

FLUID SELECTION

Safety & Health Information About a Fluid

The fluid supplier will normally be your best source of information about a fluid. The supplier should be familiar with the health effects associated with the fluid to be used and can provide you with up to date material safety data sheets.

Some suppliers go a step further and provide additional assistance such as providing a chemical or fluid management program, a customer support program, and a product stewardship program which includes health, safety, and environmental support. These programs can be especially helpful since they usually include current and comprehensive health and safety information required by OSHA's hazard communication standard, recommendations for effective fluid management, and information on the proper use and disposal of their products.

The supplier may also be able to assure you that its products comply with applicable governmental safety and environmental regulatory considerations; provide analysis of in-use fluids, including characterization of microbial content; and provide air sampling to measure employee exposure.

ESTABLISHING A METALWORKING FLUID MANAGEMENT PROGRAM

Metalworking Fluid Management Program

There are many factors that affect the generation of MWF mist, all interacting with each other, so an approach that takes the entire system into account will be the most effective. Addressing only one or a few of the issues will probably be ineffective, while dealing with all the issues in a systematic way will be beneficial.

MWF systems are complex, biologically active, and constantly changing in response to conditions of use. However, MWF systems can be maintained in a stable condition over relatively long periods of time. For that to happen, there should be a well thought-out and consistently enforced fluid management plan. The plan should identify key elements of the program and the individual(s) responsible for their implementation.

Elements of a Fluid Management Program

The main elements of the fluid management program include the following:

Designation of overall responsibility for performance of the system The designated person(s) coordinating the fluid management program should receive input from all available sources along with information on finished part quality, production quantity, and production cost data. Whoever is selected to track the system's performance should understand the chemistry involved in the metalworking processes.

Designation of responsibility for adding materials All system additions should be controlled and recorded by a designated person(s). Chemicals to be added may include fresh biocides, MWF fluid additives or concentrates, and waters or oils used to make up for fluid loss in the metalworking process.

A written standard operating procedure (SOP) for testing the fluid A procedure should be in place to test the fluids periodically to keep their performance in optimal shape. Such an SOP should include:

Where and when to collect the samples to be tested;

How they should be treated after collection;

Which tests should be performed;

A specific protocol for each test performed; and

The name of the person responsible for performing and recording the test results.

A data collection and tracking system To properly manage metalworking fluids, you also need to collect and track data about the operation. The data should include physical observations of the condition of the MWF and its supporting systems, laboratory analyses, and data on additions made to the system. The data should be tabulated so that relationships and trends in the data can be spotted which can be used to improve fluid management techniques. Production and quality data may also give you useful information on how the system is performing. The data collection and tracking system should be set up so that feedback on system condition allows corrective action to be taken before the system develops problems.

The metalworking fluid manager should decide which factors need to be recorded and tracked. These factors should be prioritized and customized for specific facility situations. For instance, in a facility using water-miscible MWFs with good microbiological control in a soft-water area, a manager's list of priorities may look like this:

1. concentration
2. pH
3. foaming tendency
4. water quality contamination
5. system stability
6. biological contamination
7. tramp oil and invert emulsions "cream"
8. biocide levels
9. corrosion resistance
10. emulsified oils

On the other hand, in a facility using water-miscible MWFs in older equipment with heavy leakage of tramp oil and poor microbiological control, a manager's list of priorities may look like this:

1. concentration levels
2. emulsified oils
3. tramp oil and invert emulsions "cream" contamination
4. corrosion resistance
5. biological contamination
6. biocide
7. pH

8. system stability
9. water quality
10. foaming tendency

Employee participation - Employees from the manufacturing, maintenance and technical support groups, and metalworking fluid lubricant and machine tool suppliers each have their own area of expertise, and together they can create the best fluid management program. Machine operators can be trained to look at the fluids and report anything unusual to those responsible for maintaining it. Employee observations should be documented and compared with the laboratory data and any chemical additions.

Training programs - Managers and employees should have training to understand the basic functioning of the fluid management system, including what can affect the proper functioning of a particular metalworking fluid system and prolong or shorten its useful life, and the warning signs of impending problems. Employees who work in the metalworking fluid environment should also receive training about the safety and health hazards of the chemicals to which they are exposed.

Ways to Minimize and Control Bacterial and/or Fungi Growth

Clean System Before Introducing Fresh Metalworking Fluid - It is important to clean the machine tool's MWF delivery system; otherwise, you are exposing the new fluid to the same conditions that forced you to change the fluid in the first place. This is particularly true in the case of bacteria and/or fungi contamination. By draining the sump only, you are disposing of the majority of the bacteria/fungi, but as long as there is some residual MWF in the system, there will be some residual bacteria/fungi. These bacteria/fungi consume the organic components (oil and other additives) present in the metalworking fluid. By allowing them to come into contact with fresh fluid, you are providing them a free food supply. Due to the abundance of food, they will rapidly multiply and within a short period of time, you will find yourself pumping out the machine tool sump again.

Existing bacteria and fungi should be killed by the proper addition of biocide, and then the coolant pumped out and discarded. Any accessible colonies should be physically removed, a suitable cleaner circulated through the system, the cleaner removed, and the system well rinsed before refilling with fresh MWF.

Operate System at Correct Concentration All water based metalworking fluids are designed to be operated at a given concentration dissolved or emulsified with water. The correct concentration is important to provide the cutting operation with optimal lubricity and cooling, corrosion protection, and resistance to bacteria and fungus. Operating a system at a low concentration may result in decreased tool life, bacteria and/or fungus problems, possible corrosion and eventual downtime. Operating a system at too high a concentration may result in dermatitis, foaming, and heavy residues.

Proper mixing procedures are critical to the attainment of long metal removal fluid life and economical use of metalworking fluid concentrate, as well as to the elimination of metalworking fluid concentration related problems. Premixing the MWF concentrate with pure water at the MWF manufacturer's recommended concentration is important for initial charge. Actual concentration in machines must be checked frequently and adjusted as needed with pure water, concentrate, or premixed fluid as appropriate to maintain the recommended range.

Ensure Makeup Water Is of Adequate Quality The quality of makeup water is very important. Water used for making MWF mixtures should be as pure as possible for the most economical and trouble-free use. Minerals in metal working fluid water can corrode machine tools and machined parts, can aggravate deposition of residues on machine tools, and can increase the rate at which bacteria and fungi grow in the metalworking fluid. It is also essential that the proper water miscible MWF be selected.

Water that contains certain dissolved ions such as calcium and magnesium is termed "hard" because they will form scale upon evaporation and will form insoluble soap scum when mixed with many MWFs. Other minerals such as sulfates are detrimental because they promote the growth of sulfate-reducing bacteria that produce a "rotten egg" odor. Some, including sulfates and chlorides, are corrosive to metal and contribute to rust. Minerals are thus very detrimental to the performance of MWF mixtures. The more concentrated these minerals are, the faster they build-up and cause adverse effects to appear. Therefore, the purer the water for making MWF mixtures is initially, the longer the fluid can be used before problems occur. One method of removing minerals is to run it through a zeolite softener followed by a reverse osmosis filter. Purified water can also be produced by deionization, which removes most of the dissolved minerals thus producing a high quality process water.

Incorporate Biocides The incorporation of effective biocides is also helpful in preventing or retarding degradation caused by bacterial action. These compounds may be incorporated as components in formulated MWFs or may be added to MWFs before and during use. Biocidal activity should be broad enough to suppress the growth of a highly diverse contaminant population. Over time, chemical and biological demands may consume the biocides and cause the concentrations to fall below those needed to inhibit microbial growth. Biocides should be added judiciously to prevent microbial growth or to arrest modest growth. Some biocides that function very well in clean products can actually serve as food for the various types of bacteria found in water miscible fluids that are so easily contaminated. Grossly contaminated fluids should be treated if necessary with biocide just prior to pumpout as part of the overall cleaning procedure, but this should be done after operators have ceased working with the fluid (i.e., offshift). Conscientious monitoring and prevention of microbial growth is the best approach for preventing the buildup of endotoxins and other hazardous biological substances and for preserving fluid quality and function.

Miscellaneous Factors To avoid problems related to bacteria and/or fungi growth a good filtration system should be in place. A metalworking fluid is subjected to the metal chips and fines of the process, airborne contamination from cascading fluid over a part and the machine, machine leakages, residues left on the part from previous operations, water, operators, and other factors. Whenever possible, these contaminants need to be removed (IAMS 1996).

The build-up of chips and metal fines in the metalworking delivery system provide an excellent "nesting" area for bacteria. In large systems, these chip beds many extend for many yards in sluices and pipes. The associated biomass will be too large for simple treatment with biocides to be effective. The periodic removal of this debris minimizes the potential for bacteria growth and extends MWF life.

Tramp oil is non-emulsified oil that is mechanically entrained in a MWF in large droplets. Tramp oil often results from machine tool hydraulic or way lube systems leaking oil into metalworking fluids. Tramp oil damages MWFs by extracting key components, by providing food for microbes, and by providing an area of reduced oxygen which promotes the growth of anaerobic bacteria. Consequently, all possible steps should be taken to reduce oil leakage.

In some cases it is not possible to avoid tramp oil. Oil is applied to the ways of machine tools to insure proper movement of the workpiece during the machining operation. As the MWF comes into contact with the ways or the oil drips off the way, tramp oil is introduced into the MWF. This should be minimized by applying the required amount of way lube and no more, and by making sure that way lubricators run only when the machine tool runs.

The amount of tramp oil in the system should be minimized through hand skimming or by the use of skimmers, separators, or other devices. Since tramp oil separates and floats when agitation ceases these devices are particularly effective when the system pumps are not running, as on weekends and off-shift. Using system quiet time to facilitate skimming will help prevent problems. In addition, finding a MWF and way oil that are compatible will also help.

It is important to maintain good housekeeping by teaching your company's employees not to use machine tool sumps as trash receptacles. Paper cups, uneaten food, cigarette butts, and other trash should not be seen floating in the MWF. These not only introduce bacteria into the sump but provide nutrients for bacteria. Trash should go in trash containers even if it means the employee has to walk away from the machine tool.

EXPOSURE MONITORING PROGRAM

Why Exposure Monitoring

Good management of the MWF environment includes assessing the level of employees' exposure to MWF. Exposure monitoring provides a means of determining the effectiveness of engineering controls and work practices, the overall performance of the metalworking system management program, and assists in the proper selection of personal protective equipment. Air sampling helps identify the high exposure jobs or tasks so that the employer can determine ways to reduce these exposures, for example, by improved ventilation to control MWF mist, and may also indicate the level of exposure associated with the presence or absence of health complaints.

Exposure to MWFs & Fluid Contaminants Assessments

There are two kinds of exposure assessments: qualitative and quantitative.

A qualitative assessment identifies the shop areas where exposure to MWFs is possible and estimates the level of airborne exposure and the extent of mist or dermal exposure hazards. Qualitative assessments are often performed to rule out the need for quantitative assessments. Such estimates may be based on expert industrial hygiene opinion, the presence of MWF-related adverse health effects, any past exposure measurements, and possibly the results of a direct-reading aerosol instrument. Objective data, discussed below, is also a good qualitative assessment tool. An employer should first conduct a qualitative assessment to characterize generally what the upper limits of exposure may be for each operation in the MWF environment. For example, in some MWF operations, such as automated transfer lines where machining takes place, operators do not routinely come into contact with MWF. In contrast, maintenance employees on such transfer lines may be required to change or adjust tools and be exposed to MWF for extended periods. Area and source sampling, discussed below, is considered a qualitative tool for estimating the airborne exposure of workers.

Quantitative assessment measures the amount of exposure to MWFs. Exposure monitoring is generally performed in response to employee concerns, complaints, symptoms or irritation or health effects, or where experience indicates that exposure to MWF aerosol may be relatively high. Exposure monitoring is generally not needed if the employer can show that a process, operation, or activity has low exposures If the qualitative assessment indicates that the exposure levels of MWF may exceed either of the current OSHA PELs you should conduct quantitative air monitoring (breathing zone air samples) for those employees whose exposure is at issue.

How Often

NIOSH recommends that surveys be repeated at least annually. For employees exposed to concentrations at or above one-half the NIOSH REL, NIOSH recommends that monitoring be undertaken at least every six months. If results show that aerosol levels are below the REL, you can just keep tabs on your system by completing the self-assessment metalworking fluid management checklist to ensure that the MWF is properly managed and aerosol mists controlled through the use of equipment.

In addition, employee exposures should be reevaluated whenever a significant change in production, equipment, process, product formulation, personnel, or control measures takes place, that might cause new or additional exposure to MWFs. If you get reports from employees complaining of conditions related to exposure to MWFs, (see discussion on medical monitoring in this guide), you should monitor workplace exposures of those employees as soon as possible.

Employers should notify the affected employee(s) of the results of the monitoring of metalworking fluid exposure. Notification should be in writing, either by distributing copies of the results to the employees or by posting the results.

MEDICAL MONITORING OF EXPOSED EMPLOYEES

Importance of Medical Monitoring

Whatever the exposure in a shop, control of MWF exposures by engineering and work practice controls and implementation of a MWF management program may not eliminate all possibility of illness or injury due to exposure to MWFs. Medical monitoring of employees will help identify those experiencing early evidence of respiratory impairment or skin disease due to failure of control systems or inadequate hygiene and respirator programs.

Taking corrective action will reduce the incidence and severity of lung and skin disease in people working with MWFs.

Medical Monitoring Process

Medical monitoring should be directed and supervised by a qualified and licensed physician or health care professional who periodically reviews an employee's health status by collecting health information from the employee and/or conducting a physical examination and appropriate medical tests. An adequate program includes:

1. Review of an employee-completed health questionnaire;
2. Limited examination of the areas of the body at risk (lungs and skin); and
3. Measurement of lung function (pulmonary function test).

Health problems as a result of exposure to MWFs should be followed by referral to a qualified and licensed physician or health care professional.

Who Should Be Included

All exposed employees will benefit from participating in a medical monitoring program. Newly hired or transferred employees should undergo a pre-placement evaluation to determine a baseline status. All employees should have periodic exams following job placement. People working in high exposure areas or working in areas where one or more co-workers have developed lung disease (asthma, bronchitis, HP, etc.) or skin disease should be evaluated more frequently.

Symptoms or Conditions Are Considered Most Important in the Medical Monitoring of MWF Employees?

Symptoms or conditions important in the medical monitoring process can be identified by the use of OSHA's Respirator Medical Evaluation Questionnaire, or a comparable questionnaire, and a skin history. A few examples include:

1. Treatment by a physician for a respiratory illness;
2. Onset of chest tightness, shortness of breath, or wheezing, especially if it occurs at work and improves when away from work;
3. Onset of cough that produces phlegm;
4. Tightness in the chest;
5. Chills, fever, and unusual weight loss;
6. Unusual fatigue;
7. Skin rash, sores, or pimples; and
8. Eyes burning or nasal congestion while at work.

What Follow-Up Examinations Should Be Conducted?

All employees included in the medical monitoring program should be provided with periodic health exams. Medical monitoring and follow-up medical evaluations should be provided at a reasonable time and place and without cost to the participating employees.

Periodic health evaluations should include a medical exam of the lungs and the skin, spirometric testing, as well as a brief questionnaire to determine if the person is experiencing any respiratory symptoms (such as shortness of breath, wheezing, chest tightness, or cough) and/or skin disorders. The questionnaire should also include a question on whether the person is taking any medications for these conditions.

The frequency of periodic exams depends on the frequency or severity of health effects in the employee population for a given worksite. If there is no evidence of any person contracting a disease associated with metal working fluids or MWF aerosols at a particular facility, then testing once a year would be reasonable. Employees in facilities where there has been an increase in the frequency and severity of MWF health related illnesses or symptoms should be tested more frequently, such as twice a year.

Medical Management

Medical management is the process of using medical information to help reduce health risks in the workplace. Management decisions may address broad issues, such as selecting a less irritating MWF or hand cleaner, or the decisions may apply only to specific employees. Job reassignment to an area where no skin exposure to MWF exists coupled with proper medical treatment for an individual who has a serious case of dermatitis is an example of a medical management decision that addresses a specific individual and enhances that person's recovery by eliminating subsequent occupational exposure.

Employee – Self reporting of Symptoms

Employees should be strongly encouraged to report any medical condition that they feel may be related to their work with MWFs to the appropriate plant personnel. It is important for employers to recognize that workers may put off self-referral or even deny exposure-related symptoms on periodic questionnaires for fear that reporting of symptoms will lead to involuntary transfers or loss of income. That's why it's crucial for employers to encourage employees to promptly report any exposure-related symptoms and to let employees know that accurate reporting of symptoms is important to the program's success. The necessity of reporting medical symptoms should be part of the employee's training and should be reemphasized during periodic retraining.

Confidentiality

The relationship between the employee and the health practitioner must remain confidential. The physician's report to the employer should only reveal specific findings or diagnoses related to occupational exposure to MWFs.

MWF – "A Little History"

1993 – The International Union, United Automobile Aerospace and Agricultural Implement Workers of America (UAW), petitioned OSHA to take emergency regulatory action to protect workers from risks of occupational cancers and respiratory illnesses due to exposure to MWF's.

1997 – OSHA convened and chartered the **Metal Working Fluids Standard Advisory Committee (MWFSAC)** "to recommend to OSHA an occupational safety and health standard, or other appropriate response to mitigate the adverse health effects associated with occupational exposure" to metal working fluids (MWF).

1998 -- The National Institute for Occupational Safety and Health (NIOSH) recommended actions to reduce workplace exposures to MWFs. The recommended measures are intended to lower substantially the risks of serious respiratory disorders, including occupational asthma, associated with job-related exposure to widely used MWFs. In 1998, NIOSH recommended a limit of 0.5 mg/m3, as a time-weighted average up to 10 hrs. per day during a 40-hr. work week, for exposures to MWF aerosols. The current NIOSH Web page on MWFs recommends that the exposure be limited to 0.4 mg/m3 under the same conditions.

NIOSH also recommends that exposures be controlled through comprehensive workplace programs of safety and health training, worksite analysis, hazard prevention and control, and medical monitoring of exposed workers. The recommendations are documented in "Criteria for a Recommended Standard: Occupational Exposure to Metalworking Fluids."

1999 -- OSHA MWFSAC Recommends Regulatory Action After almost two years of deliberations, the **majority** of the MWFSAC officially voted to recommend that the Occupational Safety and Health Administration promulgate a health standard under section 6(b)(5) of the Occupational Safety and Health Act, which would include a permissible exposure limit of 0.5 mg/m3, exposure assessment, medical surveillance, and training.

A **minority** recommendation was prepared and submitted which supports a non-regulatory approach and proposes agency publication of guidelines for management of the metal removal fluid environment, coupled with a cooperative program (with industry and academia) of outreach and education.

The Secretary of Labor signed a charter establishing a Standards Advisory Committee (SAC) to address the issues on August 28, 1997, four years after the UAW petition. The SAC submitted its final report in 1999. Currently (2010), **there are no OSHA standards specific to MWFs**.

They are regulated under General Industry:

CFR **1910.1000 Table Z-1**-

- Oil Mist, mineral: 5 mg/m^3.
- Particulates not otherwise regulated, total: 15 mg/m^3.
- Particulates not otherwise regulated, respirable: 5 mg/m^3.

<u>2001</u> – OSHA released an 89 page health and safety guide for \metal working fluids. "**Metalworking Fluids and Health Best Practices Manual"**. It drew upon recommendations from the Agency's MWF Standards Advisory Committee (SAC), NIOSH Criteria Document on Occupational Exposures to MWF and the Organization Resource Counselors' (ORC) "Management of the Metal Removal Fluid Environment: A Guide to the Safe and Efficient Use of Metal Removal Fluids".

<u>2003</u> -- The **United Auto Workers (UAW)** and the **United Steelworkers of America** (USWA) filed suit today against U.S. Secretary of Labor Elaine Chao, seeking to compel the U.S. Occupational Safety and Health Administration (OSHA) to set clean air standards in U.S. factories. The suit asks the court to order OSHA to issue standards reducing the permissible exposure to metalworking fluids in U.S. workplaces.

<u>Late 2003</u> -- <u>The decision</u> - The Court has denied the unions' petition for review. The Court's analysis contains three parts: 1) the statutes to be reviewed; 2) whether OSHA had a statutory duty to regulate MWFs; and 3) whether OSHA's refusal to regulate MWFs was arbitrary and capricious. The statutes reviewed by the Court were the Occupational Safety and Health Act (specifically section 655)(OSH Act) and the Administrative Procedures Act (APA). All of the parties to the litigation told the Court that these were the two relevant statutes. The Court dispatched the unions' argument that OSHA had a mandatory duty to act within 60 days of receiving a recommendation from an advisory committee. The Court stated that there is nothing in the OSH Act that requires the OSHA Administrator to cede his discretionary authority to an advisory committee. The Court agreed that the statute confirms the Administrator's discretion.

The Court said, "OSHA never decided to regulate MWFs, much less, formally initiated rulemaking proceedings with the publication of a proposed rule." Accordingly, the Court found that OSHA was not under a mandatory duty to regulate MWFs.

The Court also agreed with OSHA's assessment that a MWF rulemaking would be time consuming and difficult because "MWFs come in a variety of types, numerous combinations, and many forms." Further, the Court said that "Exposure to one likely has different hazardous effects than to another." While the Court said it is sympathetic to the workers, the Secretary has broad discretion to set the regulatory agenda of the agency, and the decision to direct OSHA's scant resources elsewhere was neither arbitrary nor capricious.

Respiratory Disease…Is it due to my occupation?

Occupational diseases are by their very definition, caused by an exposure that occurs as a result of work. In the case of the lung cancer, emphysema, and the dust diseases, the role of smoking, chemicals, and mineral dusts is well known. These diseases are insidious, usually developing after years of repeated exposures that produce no immediate effect. Unfortunately, when symptoms develop, it is often too late to reverse the disease process. The key to these diseases is prevention: eliminating the use of hazardous materials where possible, minimizing exposure through containment and ventilation where safe substitutes are unavailable, and quitting smoking.

For other conditions, the role of the workplace and the lung disease is less clear. For example, asthma is a common disease: the Centers for Disease Control states that it affects about 50 individuals out of 1000. Occupational asthma represents an estimated 15 percent of the cases of adult asthma. To determine if asthma has an occupational cause, your physician will need to obtain a careful, detailed history to relate the occurrence of symptoms to work exposure. A physical examination of the chest is often normal if done several hours after exposure has taken place but is useful in ruling out other causes of shortness of breath. Pulmonary function tests given before and after the work shift may detect narrowing of the airways. Special studies can sometimes confirm the diagnosis but inhalation of the suspected agent (challenge test) may be necessary. A chest x-ray is essential to exclude other lung disorders, but has no direct role in the diagnosis of occupational asthma.

We have all experienced mild respiratory infections or allergies at sometime in our lives. These illnesses are caused by viruses and microorganisms communicated to us by the people in our environment. Microbes present in the work environment can also produce respiratory illnesses (both infections and allergies). Two outbreaks of microbially related respiratory illness occurred in 2001 in automotive plants:

Two cases of hypersensitivity pneumonitis were diagnosed in January 2001 at an Ohio manufacturer of brake parts. A third suspected case and complaints of respiratory problems among the membership led to a request for a health and safety department site visit. At the time of the visit, mist levels were above 0.5 mg/m^3 (the UAW recommended maximum) and unusual bacteria (*Mycobacteria*) were present in the metalworking fluid. Blood samples from the HP cases were found to show antibodies to used cutting fluids and to organisms present in the fluids, including *Mycobacteria.* Based on successes in previous outbreaks of HP, the UAW health and safety department recommended that the coolant systems be immediately dumped and cleaned, additional fresh air be supplied, and that the machines be enclosed and vented. An occupational physician hired by the employer countered that these recommendations were not a medical necessity, which led to needless delay in their implementation. Fortunately, the company also hired a local clinic to screen workers for respiratory symptoms.

The clinic continued to diagnose new cases. In addition, other workers without HP developed symptoms requiring medical removal. The local union and the company issued a joint request for a health hazard evaluation by the National Institute for Occupational Safety and Health. After the case toll reached sixteen workers NIOSH issued a letter recommending an "immediate" cleanup of the metalworking fluid systems. Subsequently, all of the systems were aggressively cleaned, a biocide that is effective against *Mycobacteria* was adopted, and other improvements made. An order was placed for air conditioning units for the machining areas of the plant and plans are underway for improved mist control. Subsequent tests of the fluids for *Mycobacteria* have been negative. At least one of the workers (not an HP case) symptoms have resolved allowing a return to work. NIOSH continues to monitor the progress of the cleanup. This is the fifteenth known outbreak of HP in a machining plant since 1995.

Dave P., a machine operator and member of UAW Local 1739 at TRW in Mount Vernon, OH, initially reported respiratory symptoms to his physician in October, 2000. He was eventually diagnosed with Hypersensitivity Pneumonitis (HP). Another machine operator, John J., and set-up man John G. were diagnosed with HP in January. Blood samples from these members were found to show antibodies to used cutting fluids and to Mycobacteria and Pseudomonas. Chris B., an assembler who also worked in the machining area, was diagnosed with HP in February, 2001. Three of the four cases known at that time required hospitalization, and these members are currently on long-term disability. A NIOSH Health Hazard Evaluation was launched, jointly requested by the UAW and TRW management.

NIOSH concluded that approximately 300 UAW members work at this facility. This is the fifteenth known outbreak of HP in a machining plant since 1995.

For the HP problem caused by metal working fluids, the UAW petitioned OSHA for a new standard for metalworking fluids, in 1993. NIOSH issued a criteria document in 1996, recommending a new standard and other protective measures. The OSHA Metalworking Fluids Standards Advisory recommended a similar new exposure limit, medical surveillance and coolant maintenance.

The National Institute for Occupational Safety and Health (NIOSH) has published criteria recommending that exposure to MWFs be limited to 0.4 mg/m^3, on a full-shift basis as thoracic mass. The NIOSH limit is roughly equivalent to 0.5 mg/m^3 measured as total particulate. NIOSH also noted that "concentrations of MWF aerosols should be kept below the REL where possible because some workers have developed work-related asthma, hypersensitivity pneumonitis, or other adverse respiratory effects when exposed to MWFs at lower concentrations". Experiences with metalworking fluids since the 1999 agreement shows that the guidelines permitting exposures up to 1.0 mg/m^3 allows UAW members to suffer respiratory illnesses and incur needless other risks. Dangers persist in operations which are in compliance with the new equipment guideline of 0.5 mg/m^3, so that limit is not the last word. We have also learned enough about measurement and control of exposure to move forward with confidence.

DaimlerChrysler machining facilities have experienced two major respiratory disease incidents (New Venture and KTP) and one outbreak of multiple cases of hypersensitivity pneumonitis (at ITP). These incidents were a direct result of not fully implementing available engineering controls, not maintaining ventilation, inadequate fresh air, not implementing the agreed upon medical surveillance program, and a failure to maintain the metalworking fluids and equipment in a sanitary condition.

General Motors experienced a confirmed hypersensitivity pneumonitis in the Toledo plant, as well as inability to control abnormal microbial contaminants in the MWF. Medical surveillance was ineffective.

Additional HP incidents were observed in UAW supplier facilities. Exposure levels in these facilities were typically 1 mg/m^3 and below, some below 0.5 mg/m^3, because mist control is generally easier in smaller, lower production operations. The same constellation of poor mist control, inability to stabilize MWF, and sub standard ventilation amplified these situations. This experience is directly relevant to auto facilities.

Adding to this, more scientific data emerged. An update of the mortality study for cancer, at GM, reinforced previous findings of increased cancer among workers exposed to MWF, with increased risk also found among more recently hired workers. Increased cancer was confirmed among Ford workers in engine and transmission operations. Increased cancer was observed in a Delphi Saginaw machining facility, and a Ford transmission facility. Additional toxicity and carcinogenicity data on MWF ingredients emerged. A microbial study funded by Chrysler but performed on samples from a GM facility, demonstrated that measurement methods for contaminants in MWF are inadequate to monitor control. The study also showed that abnormal microorganisms reappeared within hours of a dump and clean, demonstrating that a standard control measure is ineffective.

I. Introduction

This document focuses on that group of metalworking fluids known as *metal removal fluids.* Metalworking fluids/metal removal fluids are also called machining fluids, cutting fluids, and cutting oils. These fluids are those used in grinding, cutting, boring, drilling, and turning metal. Although metal removal fluids is a more specific term, these fluids are most often referred to by the generic term metalworking fluids. It is believed that management and employees are more likely to associate this document with their work environment if the term they commonly use is in the title and text. Consequently, the more common term, metalworking fluids, will be used throughout the document.

These requirements apply to all metal metalworking fluid (MWF) systems. Small systems (less than 500 gallons) *may* be exempt from some of the testing requirements if the system is on a regular cleaning and change-out schedule, is not more than one year old, and it is observed for odor, discoloration, irritation and build up of slime or fungi. Concentration of metalworking fluids in small systems shall be tested and recorded on a schedule determined by the plant.

II. Metalworking Fluid Handling System

Systems handling MWFs should be designed (or modified) to minimize factors which will contaminate or adversely alter the MWFs or needlessly expose the worker to the fluid.

Reduction of Employee Exposure to Mists and Vapors. Mist and vapor control requires that minimizing the generation of mist, containing generated mist by means of physical enclosures and local exhaust ventilation, and dilution of any escaping mist and vapor by fresh air ventilation.

1. Mist minimization: The quantity of mist generated during the machining process should be minimized by the following practices:

The minimum adequate fluid pressure should be used. For most applications, a high volume, low-pressure coolant flood delivered to the cutting zone is recommended.

Whenever feasible, fluid flow should be interrupted during the transfer cycle.

Skilled trade and other non-production workers should turn off the MWF during maintenance or set-up work where feasible and ventilation should remain in operation where available. Respirators should be used where MWF cannot be turned off and mist is excessive.

Consider the use of mist suppressants. (A test protocol needs to be developed to evaluate the effectiveness of these additives.)

Local exhaust ventilation: Enclosures or splash guarding should be provided to contain mist and to control splashing. When containment measures do not control mist to acceptable levels (less than 0.5 mg/m^3) exhaust ventilation at the site of mist generation should be incorporated. A minimum total plant exhaust rate of 3 cfm per sq ft of floor area is needed in machining plants. Exhaust stacks should be of adequate height and velocity to avoid re-entrainment of exhaust. Adequate height and velocity are defined as stacks designed using the methods outlined in the ASHRAE Handbooks, current edition.

Flume systems should be covered and should be ventilated where needed. Covers and ventilation should be provided at 90-degree bends, and where the flume drops into the central system. Cover sumps with solid covers control mist released from bursting bubbles of entrained air in the MRF.

Recirculation of air from mist collection units and general ventilation should be discouraged or eliminated. Even properly functioning units with HEPA or other good filters do not remove oil vapor, other volatiles, heat, moisture, and odors from the exhaust stream. In air-conditioned plants, the heat and moisture negate any money saving.

3. Fresh air ventilation. Ventilation systems must be upgraded and maintained to provide a minimum supply air rate (outside air) of 100% of the actual exhaust rate; all supply air should be heated to a minimum temperature of 65^{o}F. The supply air should be introduced into the "living zone" of the plant, generally 8-10 feet (2.4 to 3.0 meters) from the floor. The supply should be distributed so that all the air employed in the ventilation passes through the zone of contamination. In areas of potentially high exposure or heat stress (e.g., machine shops and foundries), fresh air outlets should be located directly above/behind workstations.

Where supply air units employ air recirculated from the building (return air), filtration/air cleaning shall be employed appropriate to the contaminants present in the return air. The concentration of contaminants in the supply air should not exceed 10% of the applicable standard or negotiated limit, whichever is lower

Air houses, ductwork, and outlet louvers will be kept in a clean and sanitary condition. Clean and sanitary is defined to mean free of standing water, debris that would hinder airflow, or deposits that would render means of equipment entry hazardous.

Testing and Maintenance of ventilation systems

Initially and when modifications are made, identify and map all major air house units and exhaust systems, the area served, the location and height of the exhaust stack (Verify that it meets minimum height requirements), the responsible party for maintenance and service records, and the results of acceptance testing.

Air Supply Houses

Annually, identify the cfm capacity of the fan in each unit; measure total airflow and the fresh airflow (when outside air dampers are in minimum position). Check operation of filter pressure loss gauge.

Quarterly, check filter maintenance records; are the correct filters installed and inspected or replaced at the required intervals? Use Dustrak or similar device in air plenum (clean side of filters) to verify that the concentration of contaminants in the supply air does not exceed 10% of the applicable standard or negotiated limit, whichever is lower. Check air house and outlet louvers for accumulated moisture and visible microbial growth.

Local exhaust systems

Existing ventilation systems must be maintained to provide adequate mist control. Volumetric tested of exhaust systems shall be performed *annually*. Volumetric testing to consist of a pitot tube traverse at the fan or static pressure measurement at each hood. An acceptable alternate would be installation of a continuous flow monitor with warning devices and/or recorder. The performance criteria and the final testing protocol will be determined jointly.

Quarterly, the following items should be visually inspected:

Check supply air ductwork and outlet louvers for signs of damage, modification, or gross contamination.

Exhaust Hoods: Verify that hood is physically intact; measure hood static pressure and compare to specification; ask operator if hood appears to be functioning properly.

Exhaust ducts: Inspect ducts for openings, crushed, or bowed sections. Tap on ductwork and listen for signs of plugging.

Exhaust fans: Inspect flexible duct connections for visible tears or leaks; perform pitot tube traverse and compare results to specified CFM.

Air cleaner: Verify that pressure gauge upper and lower limits are clearly marked and unit is operating within those limits.

The performance of air cleaners that recirculate process air back into the workplace must be closely monitored. *Quarterly*, verify the performance of recirculating collectors. The limit on concentration of recirculating air cleaners is no more than 10% of the applicable air standard. (This guideline would impose a 0.05 mg/m^3 limit on MWF in the recirculated air.) Where elimination of recirculated air from mist collectors is not possible, the final filtration stage shall be HEPA filters.

Exposure Monitoring. Exposure measurement serves as a means to monitor mthe performance of existing control measures as well as identify and prioritize areas needing improvement.

Traditional industrial hygiene monitoring of exposures (personal sampling pump with closed-face filters, analyzed gravimetrically for total particulate) will continue to be the standard method. An air sampling plan for each facility will be developed, and results summarized for the UAW-DCX NJC once per year.

Aerosol mapping of all machining facilities should be performed on an annual basis, using a common computer-based plotting software (software to be selected by the corporation); Individual problem areas/departments within the plant should be mapped on an ongoing basis to identify major mist sources and to document the success of corrective actions.

3) A centralized air sampling data storage and analysis system should be developed, with access by plant and local union health and safety staff. Provide the NJC an annual report describing the industrial hygiene activities. As a minimum the report will contain the computer generated mist concentration maps overlayed onto plant layout drawings, comparisons to the previous year's maps, and summary statistics (number, mean and ranges) of other industrial hygiene air sampling.

4) A program of assessment of intermittent exposures in maintenance and service activities needs to be developed. The local health and safety committee needs to create a list of high priority intermittent jobs with potential high exposure to metalworking fluid mist. A sampling plan for these high priority jobs should be developed, based on the use of real-time aerosol measuring devices, such as the DustTrak.

C. Reduction of Contamination and Degradation of the Fluid

1. The system must have provisions to maintain fluid cleanliness. Large systems should have their own clarification equipment. Small systems should have portable equipment available to them. Particulate matter can be removed by straining, settling, centrifugation, filtration, floatation, or other effective means. Tramp oil can be removed by several methods including skimming and centrifugation.

2. Optimal system performance requires proper maintenance of the filtration and fluid delivery systems and any other settling, skimming or centrifuging systems involved in the process.

3. Coolant systems should be circulated when not in use to avoid stagnation.

4. To keep chips and swarf from accumulating in flumes and trenches:

(a) Sufficient grade should be established to keep good flow and sharp curves and corners should be avoided.
(b) Infloor trenches should have a hyperbolic shaped cross section to maintain good flows at low volumes.
(c) Dead spots, which allow swarf to accumulate, retard fluid circulation and allow microbe growth, should be avoided. Where dead spots are identified, they should be closed-off.
(d) Flumes and trenches should be covered to avoid contamination with excess dirt and large objects that could physically block the flow of MWF.

5. To avoid contaminating the MWF:

Seals, greases, and paints should be compatible with the fluid, so as not to degrade and contaminate the fluid.
Seals that fit properly and do not fail are important to reduce contamination with hydraulic fluid; similarly, repairing leaks in hydraulic systems is imperative.

III. Control and Maintenance of Metalworking Fluids

An individual employed by the plant shall be assigned the responsibility for MWF maintenance. A management plan must be written to define coolant management requirements, responsibilities, testing protocols and rules concerning additions and system maintenance. The plan should incorporate the following:

- Statement of Requirements
- Designation of Responsibilities
- Written Testing Protocols
- Standard Operating Procedures
- Data Collection and Tracking
- Employee Participation
- Service Life Planning

Testing for the correct concentration and for microbial growth is important to maintain performance and to avoid health issues, such as irritation. Concentration can be measured by:
splitting the emulsion with acid (for soluble and semi-synthetic fluids) and centrifuging the fluid to separate the oil component; by titration with the appropriate chemical reagents; by using a refractometer and comparing to calibrated standards. Concentration should not be estimated by sense of touch.

Because water-based MWF's support microbial growth, periodic measurements of microorganisms are important. It is important to note that the microorganisms found in metalworking fluids are also found in the air, soil, and on the human body.

Once in use, MWF's should be maintained and kept in good condition. Factors that must be controlled include coolant concentrations, pH, suspended particulate matter, tramp oil, microbe levels, and biocide concentrations.

Evaluation and Maintenance of the Fluid.

Evaluation and maintenance of the fluid are to be incorporated into MQAS documentation.

The following measurements shall be performed:

-Daily, pH, alkalinity, and coolant concentration shall be measured and recorded, unless conditions require more frequent testing.

-On a weekly basis, microbial activity shall be measured using dip slides (or using a dissolved oxygen meter, as frequently as on a daily basis), unless conditions require more frequent testing. Biocide levels should be measured where possible to determine consumption rates and MWF compatibility.

-Suspended particulate matter (dirt) and tramp oil shall be measured weekly.

-Fluids that consistently show very low biological activity (less than 10^4 total bacteria) shall be tested for contamination by Mycobacteria by pellet testing using an acid fast bacteria stain (AFB Pellet Test), on a semiannual schedule.

All MWFs shall be tested for contamination by Mycobacteria by AFB Pellet testing no less than every year. MWFs with a positive test within 1 year should be tested semiannually. MWFs with AFB Pellet results of “moderate to high”, “high” or “very high” will be tested monthly. In addition these systems should be evaluated by a total plate counts for Mycobacteria (CFU/cc counts) and treated to reduce Mycobacterial contamination. MWFs with AFB Pellet results of “moderate” or “low to moderate ”, will be tested quarterly and treated to reduce Mycobacterial contamination. MWFs with AFB Pellet test of, “low”, “very low” or “negative” will be tested on a six-month basis.

The following levels shall be maintained:

- The pH should be kept between 8.5 and 9.5. or at the manufacturer’s recommended level.
- Coolant concentrations should not exceed the manufacturer's recommended levels.
- Suspended particulate matter should be kept below 50 mg./l.
- Tramp oil should be kept at no more than one percent.
- Total bacteria should be kept preferably below 1 million colonies/cc (10^6 colonies/cc).
- Mycobacteria should be kept below 1 colony/cc (as determined by plate count).
- AFB Pellet tests should be "low", "very low" or "negative".
- Yeast and fungus should be absent but must not exceed 10 CFU/cc.
- Biocide levels should not exceed the manufacturer's recommended level.

Biocide Use.

Triazine and oxazolidine biocides (e.g. Grotan, B1 Conditioner) may be used sparingly for tank-side addition, only as an alternate biocide. Coolants containing triazine or oxazolidine compounds in the formula may not be used in MWF systems.

The compatibility and effectiveness of any biocide should be evaluated to ensure optimal performance.

Biocide additions shall be carefully controlled. Biocides and other maintenance chemicals shall be added in a manner that minimizes exposure to machine operators. Personal protective equipment must be used according to the plant's safety procedures. To maintain microbe control, biocides may need to be changed occasionally.

Only biocides registered with the EPA and approved by facility shall be used. Where possible, biocide additions should be based on known concentrations (i.e. measured) of existing biocide and microbes.

It is recommended that dissolved oxygen be measured daily as a rapid indication of biological activity.

The following measurements should be considered to optimize fluid maintenance depending on fluid type and use:

- On a daily basis, a mechanical check of equipment, visual inspection of the MWF and observation of odor should be performed.
- On a Twice weekly basis emulsion stability, total oil, and percent free oil, cream and free water should be measured.
- On a weekly basis rust, conductivity, flash point and viscosity should be measured.
- Hardness should be evaluated every other week, total metals monthly and foaming as needed.

Any additions or changes to a MWF shall be controlled through a single functional responsibility. Although others may do the actual additions, only one person should have the authority to approve additions.

- All additions and changes shall be recorded on a central log sheet. Records must be kept for at least two years.

- All materials added to a system must have a valid NPM number including vendor-added materials (even if DAIMLERCHRYSLER Corporation does not pay for the material(s).

- The use of reodorants or masking agents to cover up "spoiled" systems is prohibited.

- Production changes, unusual events, accidents, actual or alleged adverse health effects and miscellaneous observations on the system are to be recorded on a log sheet. Records should be kept for at least two years.

- Stand-alone machining systems feature smaller volumes that can normally be monitored and maintained by area personnel on a less formal basis. Due to their small volume, frequent observations should be performed for coolant concentration, chip removal, proper filtration, odor or build-up of swarf, chips or stagnant coolant. Recurring problems should be addressed as issues occur.

IV. CHANGING METALWORKING FLUIDS

Procedures for dumping and cleaning MWFs are to be incorporated into the plant's documentation.

When it becomes necessary to change MWFs:

- The preferred method is to dispose of ("dump") the original fluid, thoroughly clean and disinfect the system, then recharge with a clean coolant.

The following general procedure is to be followed:

- Lubrication systems should be filled prior to draining
- Fluid should be drained to waste treatment
- Fill with a system cleaner (in conjunction with a biocide were practicable), circulate for an appropriate length of time and drain.
- Chips and swarf should be removed as completely as possible, using power-washing or comparable means, shoveling, etc.
- Screens and other removable materials should be removed and cleaned separately if possible.
- A solution of biocide and water should be circulated through the system for an appropriate length of time, if bacterial contamination was present before being drained. The recommendations of the biocide manufacturer should be closely followed.
- The cleaning solution should be drained and rinsed. The use of an inhibitor or coolant as part of the rinse can avoid rusting.
- Filter media should be replaced
- The system should be recharged with fresh coolant

V. Compatibility

A. Evaluating the Compatibility of Materials

Compatible materials are products that will not react with each other in an undesirable manner that could change, neutralize or alter desired chemicals or create unwanted chemicals (such as nitrosamines).

All chemicals which are likely to be added to the MWF intentionally or otherwise, should be screened for compatibility.

1. All possible combinations of coolants, biocides, additives, machine cleaners, flo or soaps, hydraulic oils, way lubricants, seals, greases, machine paint, rustproofing agents, carry over materials, and etc., should be evaluated.

VI. Cleanliness

The overall MWF system should be maintained in as clean as is reasonably practical. This is to be accomplished by appropriate predictive and preventive maintenance along with periodic system cleaning. Cleaning should include power-washing or steam cleaning, flushing with a system cleaner, removing accessible swarf and debris and rinsing with a water-biocide mixture, similar to the process in IV.A.2.

VII. Parts Washers

Legionella bacteria have been identified in the water-based solutions used in parts washers. This is important, as *Legionella* have been identified as the cause of *Legionnaire 's Disease*. A milder form of *Legionella* infection, with flu-like symptoms, is called *Pontiac Fever*. Some authorities state that the strain of *Legionella* which causes the severe pneumonia will only infect about 5% of the persons exposed, while the strain which causes Pontiac Fever will infect many more.

Parts washers should be exhausted outside the plant. Washers equipped with mist arrestors won't remove small droplets, which may harbor microorganisms. Venting parts washers outdoors provides the additional benefits of both reduced humidity and lower noise levels inside the plant. Volumetric testing of parts washer exhaust systems shall be performed annually. Volumetric testing should consist of a pitot tube traverse at the fan. An acceptable alternate would be installation of a continuous flow monitor with warning devices and/or recorder. The performance criteria and the final testing protocol will be determined jointly.

Legionella grow in warm stagnant water with temperatures between 68° and 122°F. Ideal growth occurs at temperatures of 77°-108°F (25°-42°C) and a pH between 5.0 and 8.5.

Algae and other microorganisms can provide habitat and nutrients for the protozoa and bacteria that promote *Legionella* growth. Washers should be kept clean and checked for microbiological activity, especially fungi. Bacteriacides and fungicides should be used as needed and appropriate records of measurements and additions kept for two years.

To prevent exposure during cleaning and maintenance, OSHA recommends that you wear proper personal protective equipment: a Tyvek-type suit with a hood, protective gloves, and a properly fitted respirator with a high-efficiency particulate (HEPA) filter.

Specific guidelines to control growth and spread of *Legionella* are contained in the OSHA Technical Manual Section III: Chapter 7 and in the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Guideline 12-2000, Minimizing the Risk of Legionellosis Associated with Building Water Systems, 2000. In general the guidelines focus on eliminating the conditions that allow bacteria to thrive.

SUGGESTED CONTINGENCY PLAN FOR FACILITIES THAT ARE EXPERIENCING A HP OUTBREAK

This protocol describes actions required to minimize the potential for further development of disease in a plant in which an outbreak of Hypersensitivity Pneumonitis (HP) has occurred. For purposes of this document, an "outbreak of HP" may be said to exist when a case or cases of HP are diagnosed by a physician using criteria consistent with those recognized by the National Institute for Occupational Safety and Health, and the case(s) are epidemiologically associated with a Metal Removal Fluid (MRF) system.

Employee Medical Issues:

1. If an employee or a Medical professional suspects that a case of HP exists, the Corporate Occupational Safety and Health, Corporate Medical, and UAW-DCX National Joint Committee on Safety and Health are to be contacted immediately. Employees suspected of having HP are to be sent to a medical specialist to confirm or deny the suspected diagnosis.

2. The Medical Department will evaluate employees with potential respiratory diseases to determine if other cases of HP exist in the plant. Additional cases that are work related will be treated as above.

3. Employees should be educated on HP, including what HP is, what is being done to eliminate it, how it is contracted, and how to minimize exposure through work practices and respiratory protection. Respirators should be made available to employees on request.

4. It will be necessary, following confirmation of an outbreak, to isolate individuals with HP from all potential sources of exposure. Individuals with HP must avoid exposure to contaminated MWF by physical isolation by working in areas where the contaminated MWF exposure is minimal or non-existent, as determined by aerosol mapping, or by otherwise keeping them out of areas with exposure to contaminated MWF. Alternatively, employees may be able to be protected by the use of respirators. The plant and Corporate Medical Departments will determine appropriate placement of ill individuals, in consultation with the employee's treating physician.

MRF System Management:

1. Review the logs of systems associated with HP cases. Systems treated with triazine biocides, systems with low total bacteria counts, systems with high Mycobacteria counts and systems and washers with high fungus levels are potential sources of HP.

2. Systems and associated washers suspected of being the source of HP should be evaluated for treatment and cleaning. Before flushing or disinfecting the MWF systems, take samples for analysis of:

- the Acid Fast Bacteria (AFB) Pellet
- the predominant bacteria
- the presence of Mycobacteria, and
- the number of colony forming units CFU) of fungus, total bacteria and Mycobacteria per milliliter of MWF.

3. Additionally, biocide levels should be determined. This information will be helpful in identifying the potential sources of the disease. Because of the two-week delay in obtaining some of the test results due to culturing the bacteria, corrective action should begin immediately.

4. Samples for biological analysis should be taken.

5. Based on the suspicion of high Mycobacteria levels being a source of HP, a MWF system or washer should be treated with an appropriate biocide, usually "*Kathon*" or "*Preventol CMK*" (but ***not*** a triazine derivative) and/or fungicide.

Further action on the suspect systems will be determined by the test results.

Based on "very high", "high" or "moderate to high" AFB Pellet results or on Mycobacterial levels greater than 1CFU / ml, the MWF systems will continue to be treated with the appropriate biocide.
At the first opportunity, (but no later than 30 days after the receipt of test results showing "very high", "high" or "moderate to high" AFB Pellet results) the system will be dumped, the machines and system powerwashed, a system cleaner circulated, visible sludge and debris removed, the system rinsed with a water-biocide mixture and the system recharged with clean MWF. The replacement MWF selection basis should include its lack of ability to support Mycobacterial growth.
Biocide treatment should continue. AFB Pellet tests and Mycobacterial CFU counts should be taken periodically to document the progress of the reduction of Mycobacteria levels.
Systems that initially have AFB Pellet results of "moderate to high", "high" or "very high" will be tested weekly until it is established that the levels are dropping. AFB Pellet results of "moderate" or "low to moderate" will be tested quarterly; AFB Pellet test of "low", "very low" or "negative" will be repeated on a six-month basis.
The results of other tests (total bacteria, fungi, etc.) may determine other courses of action such as biocide or fungicide additions.

SUGGESTED CONTINGENCY PLAN FOR FACILITIES THAT ARE EXPERIENCING A SUDDEN INCREASE IN RESPIRATORY SYMPTOMS

This protocol describes actions required to minimize the potential for further development of breathing difficulties in a plant in which a sudden increase in respiratory symptoms has occurred. For purposes of this document, a sudden increase is respiratory symptoms may be said to exist when three or more Metal Removal Fluid (MRF) exposed workers seek medical care in a twenty-four hour period.

<u>Employee Medical Issues</u>:

1. The Medical Department will canvas employees to determine the extent of the problem. The canvassing will be conducted for the dual purposes of identifying workers who may need medical care and establishing the department, MRF system, or area in the plant which may be the source of the illness. The local Joint Committee on Safety and Health will be notified of the incident as soon as practical.

2. If the cause of the respiratory symptom outbreak cannot be identified, the Corporate Occupational Safety and Health, Corporate Medical, and UAW-DCX National Joint Committee on Safety and Health are to be contacted immediately. Employees experiencing these symptoms are to be sent to a medical specialist to assist in the diagnosis.

3. Employees should be educated on the health effects of exposure to MRF, and be encouraged to participate in the MRF medical surveillance program. Respirators should be made available to employees on request.

<u>MRF System Management:</u>

Review the logs of systems associated with respiratory symptoms, paying particular attention to recent chemical additions to the system. Recheck the coolant concentration, pH, and measure dissolved oxygen (as a surrogate for bacteria level). If the concentration or pH are out of spec, adjust the system chemistry as needed to bring to within specifications.
If the dissolved oxygen is low, review the logs of bacterial testing results, and visibly inspect for gross microbial contamination; if significant contamination is present, the metalworking fluid systems and associated washers should be drained, cleaned, and recharged. Before flushing or disinfecting the MWF systems, take samples for analysis of: the Acid Fast Bacteria (AFB) Pellet, the predominant bacteria, the presence of Mycobacteria, and the number of colony forming units CFU) of fungus, total bacteria and Mycobacteria per milliliter of MWF.
If the records review and the visible inspection are both negative, and if new cases of respiratory symptoms continue unabated for 5 days, drain, clean, and recharge the system. As above, before flushing or disinfecting the MWF systems, take samples for analysis of: the Acid Fast Bacteria (AFB) Pellet, the predominant bacteria, the presence of Mycobacteria, and the number of colony forming units CFU) of fungus, total bacteria and Mycobacteria per milliliter of MWF.
If the records review and the visible inspection are both negative, and if <u>no</u> new cases of respiratory symptoms develop, take samples for analysis of: the Acid Fast Bacteria (AFB) Pellet, the predominant bacteria, the presence of Mycobacteria, and the number of colony forming units CFU) of fungus, total bacteria and Mycobacteria per

milliliter of MWF. The results of these tests (total bacteria, fungi, etc.) may determine other courses of action such as biocide or fungicide additions.

Industrial Hygiene/Ventilation:

The industrial hygienist should conduct a walk through survey of the affected area using a direct reading aerosol instrument such as the DustTrak, and observe any modifications/damage to the ventilation system. Results of the mist measurements should be compared to historical aerosol levels in the plant. Measurements should be made near the workstations of symptomatic workers. Additional mist measurements should be collected near the discharge of any mist collectors. (Mist levels at collector discharge should be less than 0.05 mg/m^3).

Sentinel Events

It is likely that there have been HP outbreaks in recent years of which we are not aware. Abnormal and work-related incidents involving HP, Legionnaire's disease and possibly other chemical or biological effects are likely to be blown off as "flu season," and not investigated. Workers in metalworking fluid or foundry environments routinely experience respiratory symptoms of asthma and bronchitis in the absence of a special situation, and so special situations may not be recognized. Among UAW members at an auto company, about 1% receive sick pay benefits for respiratory illnesses with at least 7 days time off the job or hospitalization each year. This would appear to be high for a working age population, but in any event multiple cases in a work area are statistically unlikely even in this increased population.

The pneumonia-influenza hospitalization rate for working age populations is about 3 per 1,000 per year. Thus, a situation where more than one and certainly more than 2 employees in a plant, and particularly an area within a plant were hospitalized at the same time for pneumonia would be statistically quite improbable. Certainly such incidents may be sporadic cases which coincide, or transmission of a sporadic infection.

Because common sources of infection are plausible in the industrial environment, therefore, prompt investigation of such sentinel events is warranted. Additional employees may be at risk because of an environmental condition, especially for an HP situation in a metalworking fluid environment. Investigation would provide potential for future prevention, even if an outbreak has taken its course and ended.

Sentinel Events for Work Related Pneumonia and Pneumonitis in an Industrial Environment

- ***More than one person hospitalized for respiratory illness of any kind within the same month.***
- ***More than two people on sick leave for respiratory illness with fever at the same time.***
- ***A recurring case of respiratory illness with fever in an individual within the same season.***
- ***Any respiratory illness in a worker exposed to metalworking fluids or in a foundry.***

Actions:

1. Workers in general should be informed of what is considered a sentinel event and the appropriate actions for the union and management. .

2. In many instances the data sources available to management and the union may significantly lag behind a developing problem. Informal "word of mouth" reporting of

illnesses (more readily available to the union) may be the most reliable early warning. As a health and safety representative it should be your responsibility to investigate suspect events.

3. Management should establish a reporting system that can detect sentinel events. Key data sources would be requests for sick leaves stating a respiratory cause to personnel departments, requests for disability benefits for respiratory causes to benefits departments, closed claim examinations for return to work to medical departments. These measures by their very nature will examine a disease outbreak after the fact

4. Individuals exhibiting these sentinel signs and symptoms should be encouraged to see a respiratory disease specialist (pulmonologist), an infectious disease specialist, or both, immediately.

5. Individuals should inform union representatives and management of the occurrence of a suspected sentinel event.

6. When a suspected sentinel event is identified, prompt efforts to confirm diagnosis should be launched.

7. In Michigan, cases of suspected occupational illness are required by law to be reported to Michigan Department of Consumer and Industry Services (MIOSHA).

8. Where diagnoses supporting the suspected sentinel event are confirmed, union and management should begin identification of other hidden cases. Management and union representatives should request employees to report respiratory illnesses to their personal physicians, to plant medical, or both.

Fluids in the environment should be sampled for microbial content according to established protocol.

Class Vocabulary		*Definitions*
acne		A skin condition that causes pimples or pustules. MWF skin contact can often lead to acne.
aerosol		A gaseous suspension of fine solid or liquid particles. Employees are often exposed to MWFs through aerosol devices that spray MWFs.
allergic contact dermatitis		A form of dermatitis that appears over time as a result of prolonged exposure.
animal oil		A natural oil derived from the fat of animals. Straight oil often contains animal oil or marine oil to increase lubricity.
asthma		A chronic lung disease characterized by fits of obstructed breathing or coughing. Studies have shown that long-term exposure to MWFs can lead to or worsen the effects of asthma.
bacteria		Microorganisms that may be harmful to inhale. Bacteria growth in MWFs is a sign of contamination and must be controlled.
barrier cream		Cream that is rubbed on the skin to provide a barrier and help reduce the effects of skin contact with a harmful substance. While barrier creams can be effective, they must not be used as a substitute if an application requires gloves.
biocide		A substance added to MWFs that is used to curb the growth of microorganisms.
biocide-resistant microorganism		A type of microorganism present in MWFs that cannot be killed with biocide alone because it has built up a resistance to it.
cancer		Any type of the various malignant cells that surround and invade nearby tissue. Carcinogens in MWFs have been greatly reduced.
carcinogen		A cancer-causing substance.

chemical protective clothing		Specialized clothing such as aprons, pants, or sleeves designed to provide a protective barrier between the skin and harmful chemicals.
chronic bronchitis		An inflammation of the bronchial mucous membrane characterized by coughing and increased mucous production over a long period of time. Studies have shown that long-term exposure to MWFs can lead to or worsen the effects of asthma.
CNC machine		A sophisticated machine tool run by a computer that can perform multiple machining operations in the same setup with a variety of tools. Most CNC machines are completely enclosed to minimize MWF exposure.
cold forming		The shaping of metal at room temperature.
concentrate		A substance that has a reduced volume by the removal of liquid. Many coolants are delivered as a concentrate of the coolant/lubricant substance and require the machinist to add water.
contaminant		Any substance that is harmful and poses a safety risk. MWFs require special safety precautions to eliminate and/or reduce exposure to contaminants.
coolant		A substance that reduces high temperatures. Metalworking processes yield high temperatures and subsequently require coolants to prevent burning or smoking.
crude oil		A type of petroleum oil that is unrefined. Crude oil contains carcinogens.
dedicated exhaust system		A type of exhaust system that uses a suction force to capture the contaminated air at the source of contamination. Dedicated exhaust systems either remove contamination from the airstream or re-circulate clean air.
dermatitis		A skin condition that causes a red itchy rash. MWF skin contact can often lead to dermatitis.
detergent		A substance with chemical components that acts as a cleaning agent.
emulsifiable oil		A class of metalworking fluid that is composed of lubricant base oil, emulsifiers, and other additives. Also called soluble oil, emulsifiable oil is obtained as a concentrate and is then mixed with water.

detergent		A substance with chemical components that acts as a cleaning agent.
emulsifiable oil		A class of metalworking fluid that is composed of lubricant base oil, emulsifiers, and other additives. Also called soluble oil, emulsifiable oil is obtained as a concentrate and is then mixed with water.
emulsifier		A substance that is added to oil to help the oil mix with water.
engineering control		A step taken by an administrator to reduce hazards and safety risks before they can reach the employees. Choosing quality chemicals, installing exhaust systems, and maintaining machines and coolant are examples of engineering controls.
exhaust system		The collection of various devices used to remove harmful fumes at the source of contamination.
eye contact		To be absorbed or contacted by the eye. MWFs may come into eye contact if you are not wearing adequate eye protection, and they are absorbed by tears.
eye protection		Any type of eyewear with face shields that protect the eyes in a work area. Goggles and safety glasses are examples of approved protective eyewear.
face shield		A rigid, transparent plastic sheet that covers the worker's entire face to protect against dust or splashes. Because face shields do not protect against impacts, they are often worn with goggles.
facemask		A breathing device worn to prevent the inhalation of fumes or dust.
flammable		A material that can easily ignite and start a fire.
fluid management occupational safety and health program		A NIOSH-recommended program followed by employers to ensure the safety of personnel exposed to MWFs. The fluid management occupation safety and health program includes safety and health training, worksite analysis, hazard prevention and control, and medical monitoring of exposed workers.

fungi		Any of numerous types of growing organisms that range from single-cell to larger and include yeasts, molds, and mushrooms. Fungi growth in MWFs is harmful if inhaled and must be controlled.
goggles		A type of tight-fitting eye protection that completely covers the eyes, the sockets, and the surrounding facial area. Goggles offer protection from impact, dust, chips, and splashes.
Hazard Communication Standard		An established OSHA policy that sets guidelines for hazard communication. The HCS emphasizes labeling, MSDS, and training.
hydrogen sulfide		A colorless, flammable poisonous gas that has a characteristic rotten-egg odor. Many microorganisms give off hydrogen sulfide, their presence is often detected by their smell.
hypersensitivity pneumonitis		An inflammation of the lung caused by bacterial or fungal exposure. HP can cause cold and flu-like symptoms. Studies have shown that exposure to MWFs can lead to or worsen the effects of HP.
ingestion		To take into the body by means of swallowing or absorption. It is possible to ingest MWFs if you eat in an area where MWF misting is present.
inhalation		Breathing in a substance. The two main types of MWF exposure occur through inhalation and skin contact.
irritant contact dermatitis		A form of dermatitis that appears only in the area of contact.
local exhaust system		A type of exhaust system that ventilates a specific area of production and may replace the total air volume several times an hour.
lubricant		A substance that reduces friction. Metalworking fluids are used to lubricate the metalworking process.

lung disease		A chronic disease of the lungs such as emphysema or asthma that makes breathing difficult. Studies have shown that long-term exposure to MWFs can lead to or worsen the effects of lung disease.
marine oil		A natural oil derived from the fat of marine animals. Straight oil often contains marine oil or animal oil to increase lubricity.
material safety data sheet		Mandatory information that must accompany almost every chemical in the workplace except for items like cleaning supplies. An MSDS includes details such as the risks, precautions, and first aid procedures associated with the chemical.
metal cutting		A metalworking process that uses a tool to create chips and remove metal from a workpiece.
metalworking		A material manufacturing process that produces parts by mechanically deforming or shaping metal into parts. Metal cutting and molding are two examples of metalworking processes.
metalworking fluid		A fluid used to decrease friction and reduce the temperature of the metalworking process. Metalworking fluids are abbreviated as MWFs.
microorganism		A tiny, microscopic organism. Many microorganisms emit harmful fumes and their presence can be detected by a rancid smell.
mineral oil		Any one of the various light hydrocarbon oils that are derived from natural petroleum. Mineral oils may be used in straight oil combinations to lubricate a metalworking process.
mist		A suspension of liquid droplets in the air. Employees are often exposed to MWFs through devices that mist MWFs.
moisturizing cream		Hydrating cream that is rubbed on the skin to reduce the effects of skin contact with a harmful substance. While moisturizing creams can be effective, they must not be used as a substitute if an application requires gloves.
mold		Any type of the various fungi that cause the disintegration of organic matter. Molds are often present on the surface of MWFs.

molding		A metalworking process in which heated liquid metal is poured into a mold to form a shape and then released once it cools and solidifies.
MSDS		Material safety data sheets. Mandatory information that must accompany almost every chemical in the workplace except for items like cleaning supplies. An MSDS includes details such as the risks, precautions, and first aid procedures associated with the chemical.
National Institute for Occupational Safety and Health		The federal agency that is responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control and Prevention.
Occupational Safety and Health Administration		The United States government agency that regulates the conditions in working environments to ensure the health and safety of employees. The Occupational Safety and Health Administration is abbreviated as OSHA.
permissible exposure limits		The amount of time, based on a time-weighted average for an eight-hour shift, that someone can be exposed to a harmful substance.
personal protective equipment		Any example of various safety equipment that workers wear or use to prevent injury in the workplace. Safety glasses are common personal protective equipment (PPE).
petroleum oil		A thick mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the earth's surface. Refined petroleum oil can be used in the metalworking process as a lubricant.
respirator		A breathing device worn to prevent inhalation of hazardous substances.
respiratory disease		Any of various diseases that affect the human respiratory system including chronic bronchitis and lung cancer. Long-term inhalation of MWFs has shown to cause respiratory disease.

semi-synthetic fluid		A class of metalworking fluid that is composed of lubricant-based oil and water. Semi-synthetic oil is mixed with a range from 10 to 40 parts water.
short-term exposure limit		The amount of time, based on a time-weighted average for a short shift, that someone can be exposed to a harmful substance.
skin contact		Touching a substance without any other barrier protection. The two main types of MWF exposure occur through inhalation and skin contact.
soluble oil		A class of metalworking fluid that is composed of lubricant based oil, emulsifiers, and other additives. Soluble oil is obtained as a concentrate and is then mixed with water.
straight oil		A class of metalworking fluid that is composed of mineral oil or vegetable oil and is mainly used as a lubricant. Straight oil is not intended to be mixed with water.
sump		A low-lying resevoir in a machining center where MWF is stored. Regulating the MWF in the sump is crucial to MWF safety.
sump level		The ratio of liquid to concentrate in the sump. Sump level must be monitored because a low level of water yields increased exposure to harmful substances in MWFs.
sump life		The amount of time an MWF maintains its water-to-concentrate characteristics. It is important to maintain sump life to reduce harmful MWF exposure.
swarf		Metal filings or chips extruded during certain metalworking processes. Swarf must be skimmed off of coolant before it may be used safely.
synthetic fluid		A class of metalworking fluid that does not contain petroleum oil. Synthetic fluids contain detergent-like components.

time-weighted average		A measure of noise exposure that is an average of varying levels of noise experienced in a given eight-hour workday.

tool life		The length of time that a cutting tool can function properly before it begins to fail.
tramp oil		Oil present in a MWF mix that is not from the intended coolant mixture. Tramp oil is usually a result of machine tool lubrication systems and leaks.
ulceration		A raised lesion on the skin. Workers are more suceptible to MWF exposure if they have ulcerations on the skin.
vegetable oil		Any one of the various oils obtained from plants. Vegetable oils may be used in straight oil combinations to lubricate a metalworking process.
ventilation		A means of providing fresh air. For the safety of the shop floor personnel, the use of MWFs requires proper ventilation.
ventilation system		A means of cleaning or re-circulating contaminated air. Ventilation systems are necessary at certain MWF worksites to prevent MWF inhalation.
viscosity		The resistance of fluid to flow. A change in MWF viscosity may indicate the fluid is no longer safe to use.
work-piece / tool interface		The point of contact between the work-piece and the tool used to machine it. Failure at the work-piece / tool interface may indicate that a fluid is no longer safe to use.