**Metalworking Fluids
Best Practices Manual**

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**A. INTRODUCTION**

**What Does This Manual Address?**

**T**his document provides general information about the metalworking fluid environment and the health hazards of occupational exposure to MWFs. This Manual recommends occupational health guidelines to mitigate the adverse health effects associated with occupational exposure to MWFs. It covers major topics such as a systems management approach, exposure assessment, medical surveillance, and training. Systems management includes a comprehensive programmatic approach including such things as machine enclosure, ventilation, fluid management, and other actions to control exposure and minimize contact with the fluid. The material in this Manual will help safety and health professionals apply their resources to the industrial hygiene problems associated with the metalworking environment. Engineering, work practice, and administrative controls that help reduce workplace exposures are identified and appropriate methods are described that limit exposures.

**Additional Health and Safety Hazards**

**O**ther potential safety and health hazards associated with the metalworking fluid environment but not addressed in this Manual include,

* Noise
* Vibration
* Ergonomic stresses
* Machine guarding and interlocks
* Electrical hazards
* Flying objects
* Wet and slippery work surfaces
* Sources of high temperature

**B. THE BASICS OF METALWORKING FLUIDS**

**I**ndustrial operations requiring the grinding, cutting, or boring of metal parts also require the use of metalworking fluids to meet productivity and quality requirements. Metalworking fluids (MWFs) have two primary functions: to cool and to lubricate.

All metal removal processes generate a tremendous amount of heat. This heat must be reduced in order to achieve productivity and part quality. The cooling effect provided by a metalworking fluid gives the cutting tool or grinding wheel a longer life and helps to prevent burning and smoking. At the point where the tool is in contact with the part, lubrication is necessary to reduce friction between the tool and the part, resulting in improved tool life and better finishes on the metal cut.

Metalworking fluids also provide corrosion protection for the newly machined part and machine tool. Water-miscible metalworking fluid formulations (those fluids that are meant to be diluted with water) include components that slow or prevent such corrosion. MWFs also help remove chips or swarf (an accumulation of fine metal and abrasive particles) from the cutting zone.

**What Are the Different Types of Metalworking Fluids?**

**T**here are four major classes of metal-working fluids widely available: straight oil, soluable oil, semisynthetic, and synthetic. Many metalworking fluids, except the straight oils, are mixed with water for use. Each has additives such as surfactants, biocides, extreme pressure agents, anti-oxidants, and corrosion inhibitors to improve performance and increase fluid life (refer to Appendix 2 for a listing of typical additives).

**Straight Oil**: This type of metalworking fluid is made up mostly of mineral (petroleum) or vegetable oils. Petroleum oils used for these fluids today tend to be "severely solvent refined" or "severely hydrotreated" (refining processes which reduce cancer-causing substances called polynuclear aromatic hydrocarbons [PAHs] present in crude oil). Other oils of animal, marine or synthetic origin can also be used singly or in combination with straight oils to increase the wetting action and lubricity.

Straight oils can be recognized by an oily appearance and viscous feel. These materials may contain chlorinated and sulfur additives. This product is not diluted with water before use.

Straight-oil metalworking fluids are generally used for processes that require lubrication rather than cooling. They perform best when used at slow cut speeds, high metal-to-metal contact or with older machines made specifically for use with straight oils. Straight-oil MWF systems may require fire protection.

**Soluble Oil**: Soluble oil is also called emulsifiable oil. It is made up of from 30 to 85 percent of severely refined lubricant base oil and emulsifiers to help disperse the oil in water. The fluid concentrate usually includes other additives to improve performance and lengthen the life of the fluid. Soluble oil products are supplied as concentrates that are diluted with water to obtain the working fluid. They may have colorants added.

Soluble oils in general provide good lubrication and are better at cooling than straight oils. Drawbacks in using soluble oils, however, are that they sometimes have poor corrosion control, are sometimes "dirty" (i.e., machine tool surfaces and nearby areas become covered with oil or difficult-to-remove product residues), may smoke (they may not cool as well as semisynthetics and synthetics), and may have poor mix stability or short sump life.

**Semisynthetic:** This type of metalworking fluid contains a lower amount of severely refined base oil, for example, 5-30 percent in the concentrate. Semisynthetics offer good lubrication, good heat reduction, good rust control, and have longer sump life and are cleaner than soluble oils. They are comprised of many of the same ingredients as soluble oils and contain a more complex emulsifier package.

**Synthetic:** These metalworking fluid formulations do not contain any petroleum oil. They contain detergent-like components to help "wet" the part and other additives to improve performance. Like the other classes of water-miscible fluids, synthetics are designed to be diluted with water.

Among the four types of fluids, synthetic metalworking fluids generally are the cleanest, offer the best heat reduction, have excellent rust control, and offer longer sump life. In addition, this type of metalworking fluid is transparent (allowing the operator to see the work) and are largely unaffected by hard water.

**What Are the Signs That a Fluid May No Longer Be Safe to Use?**

**T**here 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 workpiece 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 ma chine 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 workpiece-tool interface (for example, burning of a ground part due to excessive heat build-up).

**C. PRINCIPLES OF FLUID SELECTION**

**How Can You Obtain Safety and Health Information About a Fluid?**

**T**he 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.

**What Are the Health, Safety, and Environmental Concerns That Should Be Considered When Selecting a Fluid?**

**W**hen selecting a fluid, consider the following:

* *Toxicity of the fluid components*

The MWFs selected should be as non-irritating and non-sensitizing as possible. Avoid potentially carcinogenic components such as oils containing PAH's, chlorinated paraffins, alkanolamines, nitrites, and formaldehyde release biocides. The base oil used in petroleum-containing MWFs should be evaluated for potential carcinogenicity using ASTM Standard E 1687-98, *Determining Carcinogenic Potential of Virgin Base Oils in Metalworking Fluids.* Acute toxicity characteristics of metalworking fluids can be evaluated using information contained in ASTM Standard E 1302-00, *Standard Guide for Acute Animal Toxicity Testing of Water-Miscible Metalworking Fluids*. To minimize the potential for nitrosamine formation, nitrite-containing materials should not be added to MWFs containing ethanolamines (NIOSH 1998b).

If soluble oils or synthetic fluids are used, ASTM Standard E 1497-00, *Standard Practice for Safe Use of Water-Miscible Metalworking Fluids* should be consulted for safe-use guidelines, including product selection, storage, dispensing, and maintenance.

Most water-miscible metalworking fluids contain a chemical biocide that kills various microscopic organisms and protects the fluids from microbial degradation. To protect workers, make sure that the biocides used in your fluids and as sump-side additives are registered by the U.S. Environmental Protection Agency for use as additives to metalworking fluids and are used in accordance with the conditions of registration. Biocide concentration should not exceed that needed to meet fluid specifications, since an excessive amount may cause employees to experience skin or respiratory irritation or sensitization.

* *Flammability of the fluid*.

This is an important consideration for straight oils. You should consult OSHA standards, U.S. Department of Transportation (DOT) regulations, local codes, the National Fire Protection Association (NFPA), SDS's, and specific handbooks for detailed information about flammability hazards.

* *Fluid Disposal*

In order to protect your employees, as well as the public, from the potential safety and health problems that can occur during disposal operations, you should follow the manufacturer's instructions for disposal as well as relevant government regulations. Government regulations dictate where and how to dispose of metalworking fluids. Disposal requirements vary by the type of fluid. The Environmental Protection Agency (EPA), for instance, regulates emissions and disposal of substances under the Clean Air Act, the Clean Water Act and the Resource Conservation and Recovery Act. In addition, some states may have disposal requirements that are stricter than the federal government requirements. Local publicly owned treatment works (POTWs) are likely to have their own discharge regulations which significantly affect what can be disposed of through a POTW.

The National Center for Manufacturing Sciences' *Metalworking Fluids Optimization Guide (NCMS Guide)* describes the important factors to consider when selecting metal removal fluids. The NCMS Guide also includes an example of a MWF selection process to assist you in making an appropriate selection.

**D. REQUIRED AND RECOMMENDED EXPOSURE LIMITS**

**C**urrently two OSHA air contaminant permissible exposure limits apply to MWFs. They are 5 mg/m3 for an 8-hour time weighted average (TWA) for mineral oil mist, and 15 mg/m3 (8-hour TWA) for Particulates Not Otherwise Classified (PNOC) [applicable to all other metalworking fluids], 29 CFR 1910.1000. No other requirements exist.

In addition, there are other recommended exposure limits. In 1998, the National Institute for Occupational Safety and Health (NIOSH) published a criteria document which recommended an exposure limit (REL) for MWF aerosols of 0.4 mg/m3 for thoracic particulate mass as a time-weighted average (TWA) concentration for up to 10 hours per day during a 40-hour work week. Because of the limited availability of thoracic samplers, measurement of total particulate mass is an acceptable substitute. The 0.4 mg/m3 concentration of thoracic particulate mass approximately corresponds to 0.5 mg/m3 for total particulate mass. The NIOSH REL is intended to prevent or greatly reduce respiratory disorders causally associated with MWF exposure. It is NIOSH's belief, that in most metal removal operations, it is technologically feasible to limit MWF aerosol exposures to 0.4 mg/m3 or less (NIOSH 1998b).

The American Conference of Governmental Hygienists (ACGIH) threshold limit value (TLV) for mineral oils is 5 mg/m3 for an 8-hour TWA, and 10 mg/m3 for a 15-minute short-term exposure limit (STEL).

In 1999, the OSHA Metalworking Fluids Standards Advisory Committee also recommended a new 8-hour time-weighted average permissible exposure limit (PEL) of 0.4 mg/m3 thoracic particulate (0.5 mg/m3 total particulate). The committee based the recommended PEL on studies of asthma and diminished lung function.

**E. HEALTH EFFECTS**

**General**

**M**etalworking fluids (MWFs) can cause adverse health effects through skin contact with contaminated materials, spray, or mist and through inhalation from breathing MWF mist or aerosol.

Skin and airborne exposures to MWFs have been implicated in health problems including irritation of the skin, lungs, eyes, nose and throat. Conditions such as dermatitis, acne, asthma, hypersensitivity pneumonitis, irritation of the upper respiratory tract, and a variety of cancers have been associated with exposure to MWFs (NIOSH 1998a). The severity of health problems is dependent on a variety of factors such as the kind of fluid, the degree and type of contamination, and the level and duration of the exposure.

**Skin Disorders**

**S**kin contact occurs when the worker dips his/her hands into the fluid or handles parts, tools, and equipment covered with fluid without the use of personal protective equipment, such as gloves and aprons. Skin contact may also result from fluid splashing onto the employee from the machine if guarding is absent or inadequate.

Two types of skin disease associated with MWF exposure are contact dermatitis and acne.

Contact dermatitis is the most commonly reported skin disease associated with MWFs. People with contact dermatitis have itchy skin and a rash, often with cracks, redness, blisters, or raised bumps. The two kinds of contact dermatitis are irritant contact dermatitis and allergic contact dermatitis. In irritant contact dermatitis the rash is confined to the area in contact with the irritating substance. In allergic contact dermatitis the rash can spread beyond the area directly in contact with the irritant. Fourteen to 67 percent of workers exposed to MWFs are at risk for developing dermatitis (NIOSH 1998a). This high rate of dermatitis indicates susceptibility of many employees to the irritating or sensitizing nature of MWFs and their contaminants or additives. Once the skin is compromised, very small exposures, which previously did not have any effect, can cause an episode of dermatitis. It is important to try to prevent skin disease from developing and to treat it early because untreated dermatitis can lead to more serious complications (NIOSH 1998a).

In metalworking operations contact dermatitis may be caused by any of the following factors: clothing contaminated with MWF; poor personal hygiene (e.g., allowing MWF to remain in contact with skin by not washing after exposure); poor housekeeping practices; higher than recommended metalworking fluid concentrations; high alkalinity of in-use fluid which can remove natural skin oils; metal processing aids such as degreasers, cleaners, or rust inhibitors; metal shavings contained in the fluid which may abrade the skin; prolonged contact with the MWF; tramp oils (e.g., hydraulic fluids, gear or spindle oils, way lubes, grease); hand washing with abrasive soaps or with water that is excessively hot or cold; seasonal conditions (e.g., winter dryness); other contaminants (e.g., water in an oil based system).

People working with water based, synthetic, and semi synthetic MWFs are most at risk for developing contact dermatitis.

Straight oils are often associated with acne-like disorders characterized by pimples in areas of contact with the MWFs. Red bumps with yellow pustules may develop on the face, forearms, thighs, legs, and other body parts contacting oil-soaked clothing.

**Respiratory Diseases**

**I**nhalation of MWF mist or aerosol may cause irritation of the lungs, throat, and nose. In general, respiratory irritation involves some type of chemical interaction between the MWF and the human respiratory system. Irritation may affect one or more the following areas: nose, throat (pharynx, larynx), the various conducting airways or tubes of the lungs (trachea, bronchi, bronchioles), and the lung air sacks (alveoli) where the air passes from the lungs into the body. Exposure to MWF mist or aerosol may also aggravate the effects of existing lung disease.

Some of the symptoms reported include sore throat, red, watery, itchy eyes, runny nose, nosebleeds, cough, wheezing, increased phlegm production, shortness of breath, and other cold like symptoms. These symptoms may indicate a variety of respiratory conditions, including acute airway irritation, asthma (reversible airway obstruction), chronic bronchitis, chronically impaired lung function, and hypersensitivity pneumonitis (HP). When symptoms of respiratory irritation occur, in many cases it is unclear whether the disease was caused by specific fluid components, contamination of the in-use fluid, products of microbial growth or degradation, or a combination of factors.

Exposure to MWFs has been associated with asthma. In asthma, airways of the lung become inflamed, causing a reduction of the flow of air into and out of the lungs. During an asthmatic attack, the airways become swollen, go into spasms and fill with mucous, reducing airflow and producing shortness of breath and a wheezing sound. A variety of components, additives, and contaminants of MWFs can induce new-onset asthma, aggravate pre-existing asthma, and irritate the airways of non-asthmatic employees.

Chronic bronchitis is a condition involving inflammation of the main airways of the lungs that occurs over a long period of time. Chronic bronchitis is characterized by a chronic cough and by coughing up phlegm. The phlegm can interfere with air passage into and out of the lungs. This condition may also cause accelerated decline in lung function, which can ultimately result in heart and lung function damage.

Hypersensitivity pneumonitis (HP) is a serious lung disease. Recent outbreaks of HP have been associated with exposure to aerosols of synthetic, semi synthetic, and soluble oil MWFs. In particular, contaminants and additives in MWFs have been associated with outbreaks of HP (NIOSH 1998a). In the short term, HP is characterized by coughing, shortness of breath, and flu-like symptoms (fevers, chills, muscle aches, and fatigue). The chronic phase (following repeated exposures) is characterized by lung scarring associated with permanent lung disease.

Other factors, such as smoking, increase the possibility of respiratory diseases. Cigarette smoke may worsen the respiratory effects of MWF aerosols for all employees.

**Cancer**

**A** number of studies have found an association between working with MWF and a variety of cancers, including cancer of the rectum, pancreas, larynx, skin, scrotum, and bladder (NIOSH 1998a). Studies of MWF and cancer have relied on the health experiences of workers exposed decades earlier. This is because the effects of cancers associated with MWF may not become evident until many years after the exposure. Airborne concentrations of MWF were known to be much higher in the 1970s - 80s than those today. The composition of MWFs has also changed dramatically over the years. The fluids in use prior to 1985 may have contained nitrite, mildly refined petroleum oils, and other chemicals that were removed after 1985 for health concerns. Based on the substantial changes that have been made in the metalworking industry over the last decades, the cancer risks have likely been reduced, but there is not enough data to prove this.

**F. ENGINEERING AND WORK PRACTICE CONTROLS**

**How Can Occupational Exposures Be Controlled?**

**O**ccupational exposures can be controlled by the application of a number of well-known principles including engineering and work practice controls, administrative controls, and use of personal protective equipment. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occupational exposure to individuals. Engineering and work practice controls, applied at the source of the hazard, are generally the preferred and most effective means of control. In machine shops where workers are at risk of exposure to metalworking fluids, exposure may be controlled by some or all of the following: (1) proper design and operation of the MWF delivery system; (2) isolation; (3) effective local exhaust ventilation (see Appendices 3 and 4); (4) effective general or dilution ventilation; (5) good work practices on the part of the machinists, including the proper use of controls; and (6) proper maintenance of equipment;

**What Design Considerations and Operational Procedures Can Be Used to Control Misting?**

**M**any factors influence the generation of MWF mists, which can be minimized through the proper design and operation of the MWF delivery system (Figure 1). ANSI Technical Report B11 TR 2-1997 (*Mist Control Considerations for the Design, Installation and Use of Machine Tools Using Metalworking Fluids*) [ANSI 1997] provides guidelines for minimizing mist and vapor generation. Another useful document is ASTM E 1972-98, *Standard Practice for Minimizing Effects of Aerosols in the Wet Metal Removal Environment*.

Fine mists are produced when MWF streams break up during use. This occurs when the fluid is applied and interacts with the spinning tools or parts, and when fluid is moved at high velocity in open conduits. Small mist droplets are easily suspended in air and can escape containment or collection.

The MWF delivery system should be designed to generate a minimum amount of fluid mist. Factors that can reduce misting include low-pressure delivery of MWF, matching the fluid to the application, using MWF formulations with low oil concentrations, using mist suppressants, avoiding contamination with tramp oils, minimizing the MWF flow rate, covering fluid reservoirs and return systems where possible, maintaining control of MWF chemistry, and proper machine maintenance.

An adequate, low-pressure flow of MWF delivered directly to the cutting zone, where it floods and cools the workpiece and cutting tool, is usually most effective in reducing misting. A high-pressure delivery of MWF, on the other hand, may create mists, may not supply adequate cooling or lubrication, and may not have sufficient flow to properly remove swarf or chips from the cutting area.

The use of mist suppressants should also be considered. Mist suppressants work at the source, enlarging the size of the mist droplets so that they don't stay suspended in air as long. The use of mist suppressants may also reduce fluid loss and vapor generation.



**Figure 1.** Metalworking Fluid Delivery System Schematic. (Reproduced by permission of American National Standards Institute, New York, New York.)

Another basic step that can be taken to reduce employee exposure to mist is to interrupt or reduce the flow of MWF when practical. As an example, the flow of MWF should be interrupted when machining is not occurring. This not only reduces mechanically generated mist, it also reduces degradation of the MWF and oxidation of the biocides. Quiet time also allows tramp oil to float and solids to settle so that they can be removed more easily. An intermittent flow (or change in pressure) of the MWF (e.g., 30 seconds on, then 2 minutes off) may often be more effective at moving chips than a continuous flow. Extended periods of fluid inactivity (more than 8-10 hours) should be avoided as this promotes the growth of anaerobic bacteria in those fluids that are heavily contaminated and/or do not contain the correct concentration of the right biocide.

Proper equipment maintenance is also important. Leaking seal packing, leaking mechanical seals, and leaking ports in delivery pumps allow air into the metalworking fluid, increasing the amount of mist produced. Filtration and delivery systems that are properly maintained also reduce misting and minimize splashing.

Metalworking fluids should not be allowed to flow over the unprotected hands of employees loading or unloading parts. Use of compressed air blow-offs to dry parts of excess fluid should be avoided, unless adequate ventilation controls are provided to capture the airborne mist created by the compressed air.

**How Can Isolation Be Used to Control Exposures?**

**I**solation of the employee through mechanical parts handling equipment and machine enclosures can minimize skin and inhalation exposure. Simple splash guarding may suffice for low production machines, while high production machines generally require complete enclosure with ventilation. In addition, transfer machines should be located away from other operations and workers should be protected with isolation booths or air curtain-exhaust ventilation (NIOSH 1998b).

**Should an Exhaust Ventilation System Be Installed to Control Mist?**

**O**ne way to reduce employee exposure to MWF aerosols is to install an exhaust ventilation system to prevent the accumulation or recirculation of airborne contaminants in the workplace. A local exhaust ventilation system is the primary means for controlling employee exposure to air contaminants. This exhaust system is termed "local" because the source of exhaust or suction is located adjacent to the source of contamination. If properly designed, such an arrangement removes a contaminant directly from its source before it has an opportunity to escape into the workplace environment where it could be inhaled by an employee. Capturing and removing a contaminant at its source is the principle objective of local exhaust ventilation.

You are much more likely to successfully ventilate operations that produce MWF aerosols if the machine tool and machining operations are enclosed as much as possible. Where an exhaust hood (i.e., enclosing hood) is used that completely or partially encloses the process or contaminant generation point, it essentially surrounds the contaminant source, thereby isolating the process from the employee and the workplace. Thus, when the MWF aerosol is emitted from the machining operation, it is already either totally or at least partially inside the hood. The aerosol is contained inside the enclosure by an inward flow of air through the hood opening(s) and is prevented from escaping into the workplace air.

Also effective is locating an exhaust hood (i.e., an exterior hood) in close proximity to an emission source without enclosing it. Then, the movement of air flowing into the hood captures contaminants at their source and induces the contaminants to flow into the hood along with the moving air. Since this hood does not completely or partially enclose the process, the MWF aerosol is released outside rather than inside the physical confines of the hood. The capture velocity for this type of hood should be designed to overcome the velocity with which the generated aerosol is released from the process, and the motion of the air (in front of the hood) into which the aerosol is released.

Local exhaust ventilation of machining operations is not the only strategy for reducing employee exposures to aerosols, vapors, mists, and dust. General or dilution ventilation systems rely on the supply and exhaust of air with respect to an area, room, or building rather than on a localized exhaust source to control airborne contaminant concentrations.

Dilution ventilation is different from local exhaust ventilation because, instead of capturing emissions at their source and removing them from the air, dilution ventilation allows the contaminant to be emitted into the general workplace air and then dilutes the concentration of the contaminant by circulating large quantities of air into and out of the work area(s). Generally speaking, local exhaust ventilation is more effective than dilution ventilation in achieving contaminant control and employee protection.

**What Are the Types of Exhaust Hoods?**

**M**any types of exhaust hoods are available. Some designs are more effective than others. ANSI Technical Report B11 TR 2-1997 contains guidelines for exhaust ventilation of machining and grinding operations and recommends only enclosure type exhaust hoods for MWF mist control. Enclosures are classified by ANSI according to the extent of enclosure: close capture (partial enclosure at the point of operation), total enclosure (enclosure of the entire machine), or tunnel enclosure (continuous enclosure over several machines).

Types of exhaust hoods:

* Close capture enclosure;
* Total enclosure;
* Tunnel enclosure;
* Push-pull ventilation;
* Side-draft hood;
* Canopy hood; and
* Down-draft hood.

A brief description of the kinds of exhaust hoods and their pros and cons follow:

*A close captureenclosure* (Figure 2) is a contaminant-capturing hood that is mounted very close to the point of mist generation. By nature, it has a high entrainment velocity and lower air volume requirements. The problem with this device, though, is there may be significant loss of the MWF into the exhaust system, requiring excessive make-up fluid to be added.

*Total or complete enclosure* (Figures 3 and 4) is defined as a box or housing around the machine or process. The housing is not intended to be airtight. The openings are normally limited to the minimum required to allow for part entry/egress, maintenance, or utility access. The enclosure is provided with exhaust ventilation with the replacement air entering through the openings designed into the enclosure. Total enclosures will have low air volume requirements.

*A tunnel enclosure* encompasses two or more connected workstations or machining processes.

*Push-pull ventilation* consists of a jet of air blown across the process emission source (i.e., work piece/cutting tool) toward an exhaust hood. The push-pull hood is generally used on open surface tanks and is not recommended for effective capture of contaminants generated by machine tools. Generally, it is not used unless close capture or total enclosure is not possible.

The *side-draft hood* (capture exhaust hood) is located behind or to the side of the worker and tends to pull the contaminants away from the breathing zone of the operator. Large volumes of air are usually required for this type of hood design.

The *canopy hood* (receiving hood) is located above the machine operator's breathing zone. Large volumes of air are required for this type of hood design. In addition, if the hood is not properly designed, contaminated air can pass through the employee's breathing zone.

The *downdraft hood* is a device located in the floor or at the base of the machine. It pulls contaminants vertically down below the breathing zone of the operator. It requires large volumes of exhaust air.

**Why Are Machine Tool Enclosures Necessary?**

**S**tudies show that aerosol mists may have an adverse effect on exposed workers. That's why mist generating operations should be enclosed and ventilated. Enclosures and appropriate exhaust ventilation minimize the release of MWF aerosols into the workplace. When you put in place well-designed enclosures and splashguards you prevent metalworking fluids from spilling on the ground and improve the general cleanliness of the operation. Consequently, existing enclosures and splashguards should be maintained. Missing equipment and enclosures should be restored. If guarding has been removed or the enclosure not maintained, MWF may escape through openings in the enclosure.



**Figure 2.** Close capture enclosure of a surface grinder. ("From American Conference of Governmental Industrial Hygienists: *Industrial Ventilation (*ACGIH*): A Manual of Recommended Practice, 23rd Ed.* Copyright 1998. Cincinnati, OH. Reprinted with permission.")



**Figure 3.** Total enclosure (at point of operation) of a lathe. ("From American Conference of Governmental Industrial Hygienists: *Industrial Ventilation (*ACGIH*): A Manual of Recommended Practice, 23rd Ed.* Copyright 1998. Cincinnati, OH. Reprinted with permission.")



**Figure 4.** Total enclosure of a milling machine. ("From American Conference of Governmental Industrial Hygienists: *Industrial Ventilation (*ACGIH*): A Manual of Recommended Practice, 23rd Ed.* Copyright 1998. Cincinnati, OH. Reprinted with permission.")

**What If Existing Equipment Lacks an Enclosure?**

**R**etrofitting existing equipment should be considered if other control measures (previously mentioned) have been tried and were unsuccessful in reducing airborne mist concentrations to acceptable levels. ANSI Technical Report B11 TR 2-1997 should be used as a guide. However, unless exhaust hood retrofits are properly designed and constructed, retrofits may not effectively capture metalworking fluid aerosols. With some equipment, retrofitting may not be possible or even economically feasible (ORC 1999), in which case modifying MWF handling to reduce or eliminate mist generation is crucial. When ever possible, ventilated enclosures should be phased in with new machinery or machinery rebuilds.

**Is it Necessary to Provide Make-Up Air?**

**E**xhaust 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.

**What Factors Need to Be Considered When Exhaust Air is Recirculated?**

**A**ir exhausted from machine tool enclosures and hoods is often cleaned and recirculated in the workplace (NIOSH 1998a). 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). Criteria to ensure the safe recirculation of exhaust air are discussed in, *TheRecirculation of Industrial Exhaust Air* (NIOSH 1978), and general guidelines for recirculating exhaust air are presented in *Industrial Ventilation: A Manual of Recommended Practice* (ACGIH 1998).

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.

**What Is the Function of a Mist Collector and 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. Guidance for design and maintenance is contained in ANSI Technical Report B11 TR 2-1997. 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.

**Where Can the Exhaust Air of the Mist Collector Be Discharged?**

**T**he 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 (ORC 1999). 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 bioaerosols 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.

**What Work Practice Controls Can Be Implemented to Reduce Employee Exposures?**

**W**ork 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 Hygiene**

**G**ood 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**

**B**arrier 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 (SACMA 1990).

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**

**G**ood 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.

**Periodic Inspection and Maintenance**

**P**eriodic inspection and maintenance of process equipment (e.g., fluid filtration and delivery systems) and control equipment, such as ventilation systems, is another important work practice control. Equipment that is in disrepair will not perform as intended. The failure of the ventilation system, for example, can result in elevated exposures of MWF to machine workers. Maintenance of the fluid chemistry as well as properly maintained filtration and delivery systems provide cleaner MWFs, reduce mist, and minimize splashing and emissions.

Regular inspections can detect abnormal conditions so that timely maintenance can be performed. If process and control equipment is routinely inspected, maintained, and repaired, or is replaced before failure occurs, there is less chance that hazardous employee exposures will occur.

**Use of Proper Procedures**

**O**ne important element of this program is training employees to follow the proper work practices and operational procedures for their jobs. Employees must know the proper way to perform job tasks to minimize their exposure to MWF and other hazardous chemicals. For example, machine operators should thoroughly understand the proper addition and dilution of fluids and components. How to recognize if a ventilation system is not working properly is important. Procedures for getting something fixed should be known by machine operators. Employees can be informed of proper operating procedures through fact sheets, discussions at safety meetings, and other educational means.

**Supervision**

**G**ood supervision is another important work practice. It provides needed support for ensuring that proper work practices are followed by employees. By stressing proper work procedures and ensuring that employees wear the necessary protective clothing and equipment, a supervisor can do much to minimize unnecessary employee exposure to safety hazards and airborne contaminants.

**G. PERSONAL PROTECTIVE EQUIPMENT**

**When Should Employees Use Personal Protective Equipment (PPE)?**

**E**ngineering controls, work practice controls, and a MWF management program are the preferred methods for reducing employee exposure to metalworking fluid. However, in some situations, personal protective clothing and/or respirators should be used to prevent dermal contact with the MWFs or unhealthy airborne exposures.

**What OSHA Standards Govern the Use of Personal Protective Equipment?**

**O**SHA's Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to evaluate the need for personal protective equipment in their workplaces, to provide the proper equipment, and ensure it is properly used and maintained (even when it is employee owned). The standard has an employee training provision that requires that each affected employee demonstrate an understanding of the training before being allowed to use PPE.

Other standards, 29 CFR 1910.133 through 1910.138, clarify and expand the requirements for specific areas such as hand protection, eye and face protection, and protective footwear. These standards are intended to make sure that the employee is protected and that PPE doesn't create any new hazards of itself.

**What Are Some of the Specific Requirements of the Personal Protective Equipment Standard (29 CFR 1910.132)?**

**T**he standard requires that the employer conduct a workplace review for hazards that require PPE to be used. This can be done by surveying each work task, looking for potential injury and illness sources, and then organizing and analyzing the resulting data. An assessment may then be made of the potential for injuries and illnesses, the type and level of risk, and the seriousness of the hazard. Material safety data sheets, operating manuals for machines, and any warnings of the companies that made the machines, tools, and chemicals used in the shop should all be considered in the final assessment. From this survey, PPE can be selected.

Training is necessary for each employee who is required to use PPE. Each employee must be trained to know when PPE is necessary; what PPE is necessary; how to properly put on, take off, adjust, and wear it; the limitations of the PPE; and the proper care, maintenance, useful life, and disposal of the PPE. For example, for chemical splash goggles the employer should point out to the employees what the goggles protect against, how to wear them, how to adjust them, what they won't protect against (UV radiation, welding arcs, intense light, etc.), how to clean and store them safely, and finally how to know when its time to get a new pair. This can be done easily and effectively with short commercially produced training videos. Some makers of equipment have inexpensive (or even free) videos that are adequate.

In addition, each affected employee must demonstrate an understanding of the training, and be able to use PPE properly, before being allowed to do work requiring the use of PPE. If the employer has reason to believe that an employee does not have the understanding and skill required to safely use the assigned PPE, then the employer must retrain that employee. It may also be necessary for the employer to re-evaluate the training program.

**How Can the Employer Tell If MWF Hazards Warrant Employees WearingPersonal Protective Equipment?**

**T**he employer should conduct a survey to identify all potential safety and health hazards from machining operations using MWF. They may include:

* Chemical exposure - splash or spray from MWFs, cleaning compounds such as parts cleaning liquids, etc.;
* Projectiles - flying metal chips;
* Punctures - sharp edged parts;
* High temperatures - hot parts that could result in burns;
* Falling objects - heavy parts that pose a risk to feet if dropped; and
* Machine noise.

**What Type of Personal Protective Equipment Should Be Worn?**

**P**rotective equipment for employees exposed to metalworking fluids should protect wearers from chemicals as well as punctures, cuts and abrasions. Employees should wear gloves, protective sleeves, aprons, trousers, and caps as needed and appropriate to protect their skin from contact with MWFs. Eye protection such as goggles and face shields should be worn to guard against chemical splash when handling the neat chemicals, and safety glasses with side shields can be worn for most other machining operations to prevent eye contact with MWFs.

Since excellent manual dexterity is often required of machine operators, some personal protective equipment, such as gloves, may not be appropriate for some operations and may even be a serious safety hazard from possible entanglement in moving tools or workpiece parts. Consequently, if gloves are required, special attention should be given to guarding the equipment. In any event, the employer should specify the operations for which gloves are permitted. Gloves and other protective equipment, where used to prevent dermatitis, must be chemical-resistant or impervious to the chemicals contacted.

Eye and face protection must also be worn to protect employees from hazards of flying particles. Such protection may be required for employees working at or near operating metalworking processes or transferring as-received MWFs and other materials, such as additives, to the machine tool or fluid sump or reservoir. Foot protection is needed against hazards such as falling objects, and objects that may penetrate the feet. When floors of the work area are oily, safety shoes with slip-resistant soles should be provided.

**When Should Respirators Be Worn?**

**B**efore 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/m3 for mineral oil mist and 15 mg/m3 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**

**R**espirators 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. Guidance on the selection of appropriate respirator filters is presented in the *NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR 84* (NIOSH 1996).

**H. ESTABLISHING A METALWORKING FLUID MANAGEMENT PROGRAM**

**Why Is Establishing a Metalworking Fluid Management Program Important?**

**T**here 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.

**What Elements Should a Fluid Management Program Include?**

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.

**What Are Some of the Ways to Minimize and Control Bacterial and/or Fungi Growth?**

***C****l*e*an 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.

**What Should Be Done After MWFs Reach the End of Their Service Life?**

**A**ll fluids, even those used with well-managed systems, eventually reach the end of their useful life. When testing shows that the fluid in a system has reached the point where making additions to the fluid is no longer effective, or when the level of bacteria or mold has become unmanageable, the system must be properly drained, cleaned and recharged (see Appendix 6). Periodic checks of the system on a regular basis are strongly recommended. The size of the system will indicate the frequency and type of testing.

**How Does a Facility Determine If It Has Good MWF Management?**

**A** self-assessment should be done to determine good MWF management. The procedure outlined in Appendix 7 (developed by the Organization Resources Counselors) is recommended. It involves the use of a checklist and covers the features of the management plan that are common to all shop MWF systems. It also covers individual processes, locations, or MWF systems within the shop. The purpose of the self-assessment metric is not to grade a shop's performance, but rather to provide information for improvements in the MWF management program. Regardless of the outcome, the assessment information should be used to improve the MWF management program. Other checklists may also be effective in evaluating the fluid management program.

**I. INSTITUTING AN EXPOSURE MONITORING PROGRAM**

**Why Should Exposure Monitoring (Air Sampling) Be Conducted?**

**G**ood 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.

**How Is Employees' Exposure to MWFs and Fluid Contaminants Assessed?**

**T**here are two kinds of exposure assessment: 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.

**What Is Objective Data and How Can It Be Used in Qualitative Assessments?**

**O**bjective data is used in qualitative assessments to show that a process, operation, or activity is highly unlikely to result in significant exposures under all foreseeable conditions. For example, many small, low volume, or ventilated machining operations just do not create exposures above an appropriate exposure limit. The kind of objective data that employers would use to demonstrate this may include information from industry studies, laboratory product test results, insurance companies, or trade associations. You should make sure that the data are obtained under workplace conditions closely resembling the processes, types of materials, control methods, work practices and environmental conditions in your current operations or under conditions that would results in even higher exposures that the conditions in your workplace.

**How Is Air Sampling to Be Conducted?**

**I**f a qualitative assessment shows that air sampling should be done, a strategy for sampling should be developed.

Personal samples give the best estimate of an employee's exposure level since they represent the actual airborne contaminant concentration in the employee's breathing zone during the sampling period, and is the preferred method for determining a employee's time-weighted average (TWA) exposure. Where several employees perform the same job, on the same shift, and in the same work area, and the length, duration, and the level of MWF aerosol are similar, an employer may sample a representative fraction of the employees instead of all employees. Personal sampling can also be used to assess work practice controls.

Source and area samples are useful supplements to personal monitoring. However they cannot substitute for taking personal breathing zone samples. Area sampling is useful for evaluating overall air contaminant levels in a work area and for investigating cross-contamination with other areas in the facility. Area sampling may help to determine the source of MWF aerosol exposures. Source sampling can be used to assess the effectiveness of engineering controls. It is also useful to take a sample when the target equipment is not running. Exposure at a work station when the target equipment is not running will tell how much of the exposure is due to adjacent sources, and how much comes from the target machine.

**What Are the Sampling and Analytical Methods That Can Be Used?**

**T**he OSHA Chemical Sampling Information file contains current sampling technology for mineral oil mist and other metalworking fluids (Particulates Not Otherwise Classified). The OSHA sampling procedure for mineral oil mist is listed under IMIS: 5010; and for other metalworking fluids, under IMIS: 9135 (Appendix 8).

The current OSHA recommended media sampling for mineral oil mist requires a pre-weighed, 5-micron low-ash polyvinyl chloride (LAPVC) filter. The sample can be taken at a flow rate of 2.0 L/min. Total sample volumes not exceeding 960 liters are recommended. The current recommended media sampling for all other metalworking fluids also requires a pre-weighed, 5-micron low-ash polyvinyl chloride filter. The recommended sampling flow rate and total sample volume is also the same as for mineral oil mist. The filter media captures total aerosol, and the gross weight measured does not require laboratory analysis. A cyclone should not be used with this method.

NIOSH recommends thoracic sampling and gravimetric measurement of MWF aerosol using NIOSH Method 0500 (see Appendix 9) with a sampling device that collects the thoracic fraction. If a thoracic sampling device is not available, a total dust sampler can be used and the result can be divided by 1.25 to estimate the thoracic fraction. NIOSH Method 0500 can be used to measure the total material collected.

When there are simultaneous exposures to nontoxic particulate materials, ASTM PS 42-97 Provisional Standard Test Method for Metal Removal Fluid Aerosol in Workplace Atmospheres, may be useful to estimate the soluble component of the workplace aerosol. This method improves the specificity (ability to measure only MWF) of the analytical method by removing non-MWF materials from the analysis. In ASTM PS 42-97, a sample of MWF mist is collected on a PTFE membrane filter and then a combination of standardized gravimetric and solvent extraction techniques are used. The extraction solvent removes the fluid components and leaves the insoluble particulate on the filter, regardless of MWF formulation. The resulting extract can be subjected to various analytical techniques to determine the total or specific components of the extracted MWF. In this method, both total particulate matter and extractible mass MWF aerosol concentrations in a range of 0.05 to 5 mg/m3 in workplace atmospheres can be quantified.

A direct reading instrument (real-time aerosol monitor) can be used in some cases as an alternative to conventional sampling and analysis that uses pumps and filters with subsequent gravimetric analysis. Aerosol monitors (photometers) can be used for screening operations for further evaluation or determining locally high concentrations of aerosol. Aerosol monitors are also useful in identifying mist or particulate sources and can be useful in determining time-dependent fluctuations in mist or particulate levels. They sample the workplace air and instantaneously measure the concentration of airborne dusts and mists by measuring the amount of light scattered by these materials.

Because these monitors cannot differentiate between MWF mist and dust, care must be used when evaluating areas near dry machining operations or other sources of particulate. Although the results of these measurements are typically displayed with the units mg/m3, these numbers should be considered as estimates of the true concentration, since the amount of light scattered depends on the characteristics of the aerosol in addition to its concentration. Consequently, these instruments should be calibrated by comparing them with gravimetric techniques for each combination of aerosol size and fluid type.

**How Often Should Monitoring Be Done?**

**N**IOSH 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.

**How Can a Small Company Get Industrial Hygiene Assistance in Obtaining Monitoring Services?**

**S**ome of the ways to reduce sampling costs for small business can be achieved through the use of insurance carriers, fluid supplier product stewardship, the OSHA Consultation Program (Appendix 10), NIOSH Health Hazard Evaluations, and through union and association efforts.

Data may be available to you from previous exposure measurements. For example, studies may have been conducted in your industry. Your trade association may have data, or manufacturers of the MWF fluids used in your workplace may have conducted laboratory tests that provide employee exposure data. To generalize from data obtained from these sources or an industry-wide survey, however, you must show that the conditions that existed in the survey, such as the operations, MWF fluids, control methods, work practices, and environmental conditions, are similar to those in your own workplace.

**J. MEDICAL MONITORING OF EXPOSED EMPLOYEES**

**What Is Medical Monitoring?**

**M**edical monitoring is a process of periodic medical screenings aimed at early diagnosis and treatment of disease in employees exposed to a hazardous substance.

**Why Is Medical Monitoring Important?**

**W**hatever 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.

**What Is the Medical Monitoring Process?**

**M**edical 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 in the Medical Monitoring Program?**

**A**ll 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.

**What Does Medical Monitoring Consist Of?**

**A**t a minimum, medical examinations should consist of an examination of the lungs and a standardized respiratory symptom questionnaire that addresses all of the potential respiratory conditions that have been associated with MWF exposure. OSHA has a respiratory symptom questionnaire associated with the Respiratory Protection Standard, Appendix C to 29 CFR 1910.134.  The respiratory protection questionnaire contains appropriate questions about respiratory conditions. However, questions about other conditions relating to MWF exposure should be added when questionnaires are used for medical monitoring for MWFs.

NIOSH recommends that if an employer's resources permit, routine periodic examinations should include baseline spirometric (lung function) testing for comparison with future tests. NIOSH recommends that anyone who administers a spirometric test as part of an occupational medical monitoring program should have completed a NIOSH-approved training course in spirometry. Spirometry equipment and procedures should comply with American Thoracic Society guidelines.

The initial medical examination should also consist of a skin examination and history of skin problems.

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

**S**ymptoms 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?**

**A**ll 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.

**What If the Questionnaire, the Skin Examination, Pulmonary Function (Spirometric) Testing or Other Medical Tests Reveal Problems That Might Arise from Working with MWF?**

**E**mployees who develop new abnormal respiratory or skin symptoms or signs and workers with worsening pre-existing disease should be referred to a health practitioner for evaluation.

**What Is Medical Management?**

**M**edical 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.

**What About Employee Self-reporting of Symptoms or Medical Problems?**

**E**mployees 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**

**T**he 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.

**K. TRAINING**

**What Training Is Necessary?**

**T**raining 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 (ORC 1999).

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.

**What Are Some of the Requirements Under OSHA's Hazard Communication Standard?**

**U**nder 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 SDSs, 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.
* *SDSs* - Employers must have a current SDS 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 SDSs have been received for each chemical. If there are hazardous chemicals used which don't have SDSs on file at the plant, the employer must contact the supplier, manufacturer or importer to get the missing SDS.Each SDS must be written in English, although the employer may maintain copies in other languages as well. The SDS 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 SDS 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 SDS for each hazardous chemical must be readily accessible during each work shift to employees when they are in their work areas.

**When Should Training Be Conducted?**

**T**raining 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.

**What Should Be Included in the Training Program and How Should It Be Conducted?**

**E**mployees should be informed about metalworking fluids and other hazardous chemicals in their work areas and the availability of information from SDSs 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 Safety Data Sheets (SDSs) 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.

Each program should be custom designed to consider the individual circumstances of each facility, and it has to be geared to a specific audience. In particular, the name and title of the person(s) responsible for aspects of the MWF management program should be included in the training. For guidance in developing a training program, one can refer to the outline (Appendix 11) developed by the OSHA Metalworking Fluids Standards Advisory Committee.

**J. Appendices**

**Appendix 1. Glossary**

**Bag Filter** - a pressure filter where fabric bags are installed inside a cylindrical housing (pressure vessel) and the filtered liquid is pumped through the bag walls. Liquid flow is from the inside to the outside of the bag - dirt is trapped inside the bag.

**Biocide** - a chemical agent used to kill microbiological organisms (bacteria or fungi) in MWFs. Biocides are registered by the EPA under Federal Insecticide Fungicide and Rodenticide Act (FIFRA) and are known officially as antimicrobial pesticides.

**Boring** - an operation designed to machine internal work such as cylinders, holes in castings, and dies.

**Cartridge Filter** - a pressure filter where paper or fabric cartridges are installed inside a cylindrical housing (pressure vessel) and the filtered liquid is pumped through the cartridge walls. Liquid flow is usually from the outside of the cartridge wall through to the inside core. Dirt is deposited on the OD of the cartridge.

**Clarifier** - equipment used to remove contaminant from MWFs.

**Close Capture Enclosure** - a device mounted near a contaminant source for the purpose of containing or removing air contaminants. By design it will have a high entrainment velocity and lower air volume requirement.

**Compatibility** - "compatibility" of MWF means that the fluid does not chemically or physically react with other materials in the metalworking process.

**Contaminants** - substances contained in in-use metalworking fluids that are not part of the original fluid formulation. These can include abrasive particles, tramp oils, cleaners, dirt, metal particles, dissolved metals, hard water salts, bacteria, fungi, and microbiological byproducts.

**Cutting** - a machining operation that removes material from the workpiece by the use of a cutting medium (e.g., saw blade).

**Decant System** - system to separate light floating liquid (tramp oil) from a heavier liquid (water-soluble MWF).

**DOP Filter** - a high efficiency air filter that has been tested using the dioctylphthalate (DOP) challenge test.

**Drilling** - a machining operation where short holes can be made using a radial drill and the tool rotates in the operation. Drilling deep holes may require a gun drill and the workpiece may rotate in this operation.

**Electrostatic Separator** - an air cleaner that charges aerosol particles and then removes them from the airstream by passing the charged particles between high voltage plates to cause electrical migration to the surface.

**Emulsion** - a mixture of liquids that do not dissolve in each other to form a true solution, by have droplets of one liquid dispersed throughout the other. For MWF it is generally an oil and water mix.

**Emulsifier** - a substance added to soluble oil MWF to aid in forming an emulsion in the fluid (see above.)

**Enclosure** - a mechanical device that creates a separation or barrier between the process and the worker's environment. Enclosures may be designed as close capture, total enclosure or tunnel enclosures.

**Endotoxin** - a component of the cell wall of gram-negative bacteria.

**Filter** - a porous medium (disposable media, wedge-wire or mesh screen) through which liquid is passed to separate and trap particles held in suspension.

**Grinding** - a machining operation that is done with an abrasive wheel. The workpiece may be stationary, may rotate or move in a plane.

**HEPA Filter** - High efficiency particulate air filter. Available in different performance classifications ranging from 95 to 99.99% efficiency for 0.3 um DOP aerosol.

**Hood** - a hood is a generic term for a device designed to capture contaminated air and conduct it into an exhaust duct system. The term may include enclosures, canopy hoods, push-pull hoods, down draft hoods, side draft hoods or others.

**In-Use MWF** - metalworking fluid that is being used and continually recycled for lubrication, cooling, chip transport, and corrosion protection of a metal removal operation. These fluids are distinguished from "as received" metalworking fluids by the presence of contaminants from the metal removal process, the machine tool, and biological growth in water based fluids.

**Media (Filter)** - that part of the filter upon which the contaminant is actually trapped as the fluid passes through. Usually disposable media, permanent belt, and wedge-wire are used.

**Medical Management -** the use of medical information to help control the health risk posed by a contaminant in the workplace. The risk management decisions may be directed toward the entire workforce or they may be made for a single worker who is not able to safely work in an area due to a temporary or permanent medical condition.

**Medical Monitoring -** the collection of medical information to screen for health problems that may be related to work in a specific work environment. The focus is on early detection of health problems for the individual employee.

**Medical Surveillance** - is the systematic examination of medical monitoring data to determine if there are unusual patterns of health problems in the workplace. Statistical techniques may be used in larger workplaces to improve this analysis.

**Metal Removal Process -** a manufacturing process that removes metal to produce a finished part.

**Metal Working Fluids -** a generic term to describe four categories of fluids (straight oils, soluble oils, semi-synthetic and synthetic) that facilitate a wide variety of operations involving the working or modification of metals. Metal removal fluids are used in machining, grinding, and honing operations. Metal forming fluids are used in stamping, forging, drawing, coining, rolling, piercing, cold heading and wire/bar/rod drawing operations. Metal protecting fluids are used primarily for fingerprint displacing and indoor/outdoor storage. Metal treating fluids are used primarily for metal quenching operations. Drawing and forming fluids are similar or identical in composition to MRF's but are used in an entirely different way.

**Mist -** fine liquid droplets suspended in or falling through a moving or stationary gas atmosphere.

**MWF System -** removes particles from the fluid. The system must deal with the chips and swarf generated by the metal working process as well. It usually includes a clarifier, electrical controls, pumps and a trench return for chips and spent MWF. May also include water make-up, chiller for temperature control, tramp oil skimmer, variable speed pump control, etc.

**Neat Oil** - as it comes from the drum; not diluted. Usually refers to soluble oil before mixing with water to form soluble oil and water MWF mixtures. Sometimes used to describe straight mineral oil.

**Occupational Exposure Guideline** - a guide for use in evaluating worker exposures to particular workplace contaminants, especially where there is a lack of definitive data to establish a safe exposure level.

**Particulate Matter** - small dirt particles suspended in MWF or microscopic particles suspended in air.

**Pressure Filter** - a filter where the filtered liquid is pumped under pressure through the media. Examples are automatic flat bed filters, cartridge and bag filters.

**Semi-Synthetic MWF -** a water-based (reducible) MWF composed of both water-soluble components and emulsifiable components. It may or may not include performance-enhancing additives, and generally contains 5 to 30% (by volume) of oil. In mixed form semi-synthetic MWF may contain 5% or less of oil.

**Soluble Oil MWF -** a water-based (reducible) MWF composed of an emulsion of oil (or oil-like material) in water. It may or may not include performance-enhancing additives.

**Straight Oil -** usually refers to oil used as an MWF. Could be a mineral seal oil (40 to 50 SSU) used for honing, a light oil (90 to 100 SSU) used for aluminum machining (valve bodies) or a heavy oil with high-pressure additives used for broaching (250-450 SSU). Contains no water and is not mixed with water in normal conditions.

**Surfactant -** surface-active agent such as an emulsifier or detergent that lowers the surface tension of water.

**Swarf -** fine particles of metal, graphite and carbide that result from grinding operations.

**Synthetic MWF** - a water-based (reducible) MWF composed of a true solution of water-soluble organic and/or inorganic components. It may or may not include performance-enhancing additives.

**Thoracic Particulate Mass** - the portion of the MWF aerosol that penetrates beyond the larynx in the respiratory system.

**Total Enclosure** - a box or housing around the machine or process. The housing is not intended to be air tight. Openings are limited to the minimum required to allow for part entry/egress, maintenance or utility access.

**Total Particulate Mass** - the portion of the aerosol spectrum that would be sampled by a 37-mm, closed-face filter cassette that is worn by a worker and connected to a portable sampling pump operated at 2.0 liters/min.

**Tramp Oil** - petroleum contaminants of metalworking fluid that come from hydraulic oil, gear oil, way oil, and other lubricants.

**Tramp Oil Skimmer -** device for removing floating tramp oil. Common types are endless tube, disc, belt, and decant systems, All tramp oil removal systems require regular maintenance-systems remove fines as well as floating tramp oil and tend to plug up. Must be installed in a still or quiescent part of the filter dirty tank.

**Tunnel Enclosure -** a continuous total enclosure over two or more connected work stations or machining processes. The design principles are similar to those applied for total enclosure.

**Turning** - a machining operation that uses a single point tool that is fed into a rotating workpiece.

**Vacuum Filter** - a filter where a vacuum is created on one side of the media, usually by means of the pump suction. Atmosphere pressure then pushes the dirty liquid through the media.

**Water-miscible -** designed to be diluted with water.

**Wet Metalworking Fluid Environment** - the workplace environment in which wet metalworking operations occur.

**Worker Exposure** - the exposure of a worker to metalworking fluids and contaminants that would occur without regard to the use of respirators.

**Appendix 2. 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 | \*\*\* |

**Appendix 3. References for the Proper Design and Operation of Ventilation Systems**

Principles for the proper design and operation of ventilation systems can be found in the following publications:

* American Conference of Governmental Industrial Hygienists (ACGIH), *Industrial Ventilation: A Manual of Recommended Practice,* 23rd edition, 1998.
* American National Standard Institute (ANSI) Z9.2- 1979 (1991), *Fundamentals Governing the Design
and Operation of Local Exhaust Systems.*
* National Institute for Occupational Safety and Health (NIOSH). 1978. *The Recirculation of Industrial Exhaust Air.* DHEW (NIOSH) Publication No. 78-141, NIOSH, Cincinnati, OH.
* Hagopian, J.H., and Bastress, E.K. 1976. *Recommended Industrial Ventilation Guidelines*. DHEW(NIOSH) Publication No. 76-162, NIOSH, Cincinnati, OH.

**Appendix 4. General Considerations for Enclosure/Exhaust Hood Design**

Enclosures/exhaust hoods should be designed for efficiency, safety, accessibility, and compatibility with the metalworking fluid being used. Some general considerations, which are taken from ORC's Document *Management of the Metal Removal Fluid Environment*, include:

* Materials of construction should be of sufficient structural strength, and known to effectively resist degradation by the MWFs used;

* Enclosure/exhaust hood design should avoid sharp corners or extensions that may be a hazard to the operator or maintenance personnel. The top of the enclosure should be slightly pitched to control internal MWF drippage from its roof. Any access doors should be designed with a drip edge incorporated to prevent MWF from dripping out of the enclosure;

* Allow for reasonable access to operate and maintain the machine and to provide tool changes;

* Safety of the operator during normal operation of the machine should be provided. Safety lock-out capability should be available to prevent machine operations where doors (to access openings) need to be opened and/or where operators or repair personnel may be required to enter an enclosure;

* Some enclosures may need to be fitted with permanent lighting for operating and maintenance purposes. Design the light system consistent with NEC and NFPA as well as applicable local or plant-specific codes;

* Enclosure design should allow for effective removal of chips and swarf;

* Enclosure openings should be limited to those necessary for operator access, entry of make-up air, utility penetration, to minimize exhaust volume, and to maintain the designed airflow inside the enclosure;

* Locate the exhaust hood duct take-off so that MWF and chips are not removed directly. The hood should be designed with tapered duct entry in order to minimize duct take-off velocity and entry losses; and

* The design must consider the heat that may be added from the process and any motors located within the enclosure. Additional heat can have a contributing effect on metalworking fluid vapor delivered to the collector and replacement air may be effective in negating this trapped heat.

For a more comprehensive listing of exhaust ventilation system design specifications, refer to American National Standard Institute Technical Report: *Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI B11 TR2-1997.*

**Appendix 5. NIOSH-Recommended Respiratory Protection For Workers Exposed to Metalworking Fluid Aerosols\***

Concentration of MWF aerosol (mg/m3) Minimum respiratory protection+

|  |  |  |
| --- | --- | --- |
| <0.5 mg/m3 (1 x REL)~~ | No respiratory protection required for healthy workers@ |   |
| < 5.0 mg/m3 (10 x REL) | Any air-purifying, half-mask respirator including a disposable respirator\*\* , ++ equipped with any P- or R- series particulate filter (P95, P99, P100, R95,R99, or R100) number |   |
| < 12.5 mg/m3 (25 x REL) | Any powered, air-purifying respirator equipped with hood or helmet and a HEPA filter## |   |

|  |  |
| --- | --- |
| \* | Only NIOSH/MSHA-approved or NIOSH-approved (effective date July 10, 1995) respiratory equipment should be used. |
| + | Respirators with higher assigned protection factors (APFs) may be substituted for those with lower APFs [NIOSH 1987a]. |
| ~~ | APF times the NIOSH REL for total particulate mass. The APF [NIOSH 1987b] is the minimum anticipated level of protection provided by each type of respirator. |
| @ | See text for recommendations regarding workers with asthma and for other workers affected by MWF aerosols. |
| \*\* | A respirator that should be discarded after the end of the manufacturer's recommended period of use, or after a noticeable increase in breathing resistance, or when physical damage, hygiene considerations, or other warning indicators render the respirator unsuitable for further use. |
| ++ | An APF of 10 is assigned to disposable particulate respirators if they have been properly fitted. |
| ## | High-efficiency particulate air filter. When organic vapors are a potential hazard during metalworking operations, a combination particulate and organic vapor filter is necessary. |

**Appendix 6. Procedures for Draining, Cleaning, and Recharging Metalworking Fluid Delivery Systems**

When DCR (Drain, Clean, and Recharge) is required, the following procedure, as recommended by the Organization Resources Counselors (ORC 1999), should be followed:

* First, a cleaner containing a biocide that will work effectively with the contaminated (fluid) should be added and circulated thoroughly. Then the old fluid must be pumped out and disposed of. Delivery lines should be drained if possible.
* All chips and swarf should be removed from flumes, trenches, lines and sumps. Covers and guards can be removed to give access to hidden areas for cleaning.
* The system is filled with fresh water and sump cleaner and agitated.
* This solution is circulated and sprayed at high pressure on all contaminated surfaces, especially machine tool surfaces that are not wetted by the normal flow of the circulating MWF. If a high-pressure spray cannot remove buildup, an attempt should be made to scrape it off manually.
* The cleaning solution is then pumped out and the system refilled with fresh water. The water is circulated thoroughly and rinsed off all surfaces. The rinse water should be dumped and the system refilled with fresh water, again circulating and thoroughly washing/rinsing down all appropriate equipment. This should be done as many times as necessary to ensure complete removal of the cleaning solution.
* The addition of a small amount of MWF concentrate to the rinse water may help to protect rapid rusting while the equipment is being rinsed.
* Change all filters in the MWF system. Wipe out the filter canister.
* Immediately after the last rinse has been pumped out, refill with fresh MWF, circulate the MWF, and wet those surfaces that may rust. Also run all machine axes through the full extent of their travel. This will lubricate all slide ways and bearing surfaces and remove fluid from the bearing packs.
* After the machine tool has been refilled, the MWF should be turned on and the fluid coming out of the coolant lines caught before it returns to the sump. Only after clean fluid can be seen coming out of the lines should the fluid be allowed to drain into the sump.
* This spent fluid should be disposed of and not returned to the machine sump. Wash-off hoses connected to the MWF system should also be drained to prevent contaminated fluid from returning to the system. A note should be made and left on the machine tool as to when the fluid was changed.

Consult your metalworking fluid supplier for specific information on dump, clean, and recharge procedures for your fluids.

**Appendix 7. Self-Assessment Procedure**

**How do I determine if my shop has good metal removal fluid (MRF) management?**

We have put together a checklist to help you determine if your shop has good MRF management. It has three parts:

**Part I** asks questions in 6 different sections and covers the features of the management plan that are common to all shop MRF systems.

**Part II** also with 6 sections, covers individual processes, departments, or MRF systems within the shop. Copies of Part II can be distributed and completed for each department or system.

**Part III** is a summary that, when completed, will give you the overall rating for your shop.

The importance of individual checklist questions is rated using the following scale:

**"C" \_ Critical**, e.g., has responsibility for MRF management been assigned?

**"I" \_ Important**, e.g., are machine enclosures maintained in operating condition?

**"G" \_ Good Practice**, e.g., are machines maintained in clean condition?

Only questions that apply to your facility are used to determine the rating. Please see **YourRating** for instructions on figuring out your overall rating.

Regardless of the outcome, the assessment information should be used for improving the MRF management program. Copies of the checklist should be kept available for use in the improvement process.

A downloadable file of the entire **self-assessment procedure** is available in "rich text formatting" (ORC Self-Assessment Procedure.rtf). This file is usable with most word processing programs. Using this file reduces printing problems that may be encountered when printing directly from

**ASSESSMENT: PART I**

**Instructions:** Circle the appropriate answer for the questions below (Y=Yes, N=No, NA=Not Applicable). If "No" is circled, make comments and recommend actions to correct the problem, if possible. Note that NA is not available for some questions. Calculate the scores for the categories as indicated. Transfer the information from this checklist to the summary sheet.

**Type: C** = Critical, **I** = Important, **G** = Good Practice

|  |  |
| --- | --- |
| **A. Management Program Responsibilities** | **Comment** |
|   | **Type** | **Section Score** | **Corrective Action/Comment** |
| 1. Is shop management providing commitment, leadership, and involvement for the shop's overall MRF management program? | **C** | **Y N** |   |
| 2. Has overall responsibility for MRF management been assigned to an individual? | **C** | **Y N** | Responsible Person: |
| 3. Is there a written program specifying procedures for MRF use and management that includes the elements of fluid selection, fluid testing, materialmanagement, training, recordkeeping, delivery systemmanagement, and ventilation system management? (There is a one-year grace period from the first assessment.) | **C** | **Y N** |   |
| 4. Does the written program include goals for the successful management of MRFs? | **C** | **Y N** |   |
| 5. Does the written program specify responsibilities for the employer, the fluid manager, the maintenance or facilities manager, and the employees? (There may be a grace period, see #3 above.) | **C** | **Y N** |   |
| 6. Is the MRF management program evaluated periodically as part of a continuous improvement or quality program? | **C** | **Y N** |   |

|  |  |  |
| --- | --- | --- |
| **B. Employee Participation** | **Section Score** | **Comment** |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Have employees participated in the design and implementation of the fluid management program? | **C** | **Y N** |   |
| 2. Do employees participate in the investigation of hazards or complaints? | **C** | **Y N** |   |
| 3. Are employees required to wear appropriate eye protection for their job function (e.g., safety glasses, goggles, face shield)? | **C** | **Y N** |   |
| 4. Is other personal protective equipment specified as appropriate to specific job functions (e.g., gloves, safety shoes, protectiveclothing, respirators)? | **I** | **Y N  NA** |   |
| **C. Fluid Selection, Testing andManagement** |   | **Section Score** | **Comment** |
| ***For* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***%=Yes/(14-NA)\*100\_\_\_*** |   |   | **Corrective Action/Comment** |
|   | **Type** |   |   |
| 1. Does the written MRF management program include procedure for selecting, sampling, testing and evaluating the fluids? | **C** | **Y N** |   |
| 2. Does the written program include guidelines for use and safe handling instructions for anti-microbial (biocide) additives for water-miscible MRFs? | **C** | **Y N  NA** |   |
| 3. Are water miscible MRF systems routinely monitored for MRF concentration, pH, microbiallevels, tramp oil and suspended particulate matter as appropriate? | **C** | **Y N  NA** |   |
| 4. Are the collected data on fluid condition reviewed on a regular basis? | **C** | **Y N** |   |
| 5. When indicated by the collected data, are corrective action taken in a timely manner? | **C** | **Y N** |   |
| 6. Has a metal removal fluid supplier been selected that can provide the products and support needed for a cost-effective and responsible MRF management program? | **I** | **Y N** |   |
| 7. Are SDSs reviewed to understand the acute and chronic toxicity potential of MRFs? | **I** | **Y N** |   |
| 8. Are MRFs selected to minimize components that may be irritating or objectionable (such as some alkanolamines, some short-chain fatty acids, or volatile petroleum products)? | **I** | **Y N** |   |
| 9. Has the compatibility of the MRFs with machine lubricants, seals, metals, and process cleaners been included in the selection process? | **I** | **Y N** |   |
| 10. Are fluid system additions controlled by the MRF Coordinator/Manager, recorded on a log sheet, and performed "off-shift," when the plant population is reduced? | **I** | **Y N NA** |   |
| 11. Are mechanisms in place to minimize tramp oil contamination of the MRF, i.e., recordkeeping, maintenance systems? | **I** | **Y N NA** |   |
| 12. Are MRF fluid system clean-outs routinely scheduled? | **I** | **Y N NA** |   |
| 13. Do system clean-outs follow a standard operating procedure for draining, cleaning, and recharging (DCR) that is contained in the written management program?    | **I** | **Y N NA** |   |
| 14. Are systems thoroughly cleaned (e.g., power washing and rinsing) before being recharged with fresh fluid? | **I** | **Y N NA** |   |
| 15. Has the effect of the MRFs on the waste treatment system been evaluated? | **I** | **Y N NA** |   |
| 16. Are all wastes generated by the use of the MRFs disposed of in a proper manner? | **I** | **Y N NA** |   |

|  |  |  |
| --- | --- | --- |
| **D. Information and Training** | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(6 -NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Does the shop have a hazard communication program to educate workers about hazards in their workplace? | **C** | **Y N** |   |
| 2. Do employees participate in the investigation of hazards or complaints? | **C** | **Y N** |   |
| 3. Are employees trained on procedures for the safe use of MRFs and applicable additives used on their job? | **C** | **Y N** |   |
| 4. Does the written MRF management program specify the training needs of workers in this environment? | **I** | **Y N** |   |
| 5. Does the training section of the MRF management program include procedures to evaluate the effectiveness of the training? | **I** | **Y N** |   |
| 6. Does the training section of the MRF management program include provisions for refresher training as appropriate? | **G** | **Y N** |   |
| 7. Have employees been instructed on how to obtain the MSDs for the materials they work with? | **I** | **Y N** |   |
| 8. Are employees trained on physical safety concerns of working in metal removal operations? | **I** | **Y N** |   |
| 9. Are employees instructed on how to use the MRFs according to the MSDs and other company-specific instructions? | **I** | **Y N** |   |
| 10. Is there a process to ensure that MRF containers, including transfer containers, are labeled properly? | **I** | **Y N** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **E. Investigation of Hazards and Complaints** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(7-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Does the shop have a program for investigation of hazards related to MRFs? | **C** | **Y N** |   |
| 2. Does the shop have a program to implement and monitor corrective actions when needed? | **C** | **Y N** |   |
| 3. Does the shop have a written program for investigation and review of health and safety complaints? | **C** | **Y N** |   |
| 4. Does the shop have a program for preventative, scheduled, or progressive maintenance of machines, MRF filtration systems, ventilation systems, other support facilities? | **C** | **Y N** |   |
| 5. Is exposure assessment conducted on a periodic basis to identify workers or work areas with potentially high aerosol exposures? | **I** | **Y N** |   |
| 6. Where indicated, are quantitative measurements made of the worker exposures to ensure employee exposures to ambient MRF aerosol do not exceed 1.0 mg/m3? | **I** | **Y N  NA** |   |
| 7. Is exposure assessment used to aid in the investigation of worker respiratory complaints? | **I** | **Y N  NA** |   |
| 8. Where employee exposures exceed 1.0 mg/m3, are equipment repairs or other corrective actions initiated to reduce exposures? | **I** | **Y N  NA** |   |
| 9. Is new machinery specified and tested to ensure MRF aerosol emissions are as low as practicable in order to further reduce workplace MRF aerosol concentrations? | **I** | **Y N  NA** |   |
| 10. Are employees discouraged from smoking and eating in the workplace? | **G** | **Y N  NA** |   |
| 11. Are MRFs and additives for tank-side additions stored according to specifications? | **I** | **Y N  NA** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **F. Medical Monitoring, Management, and Surveillance** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(3-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Does the shop have a medical program or set of procedures to address health concerns in the workplace? | **C** | **Y N** |   |
| 2. Do employees have an effective way to report health complaints, such as respiratory irritation or dermatitis that may be occupational in origin? | **C** | **Y N** |   |
| 3. Do employees utilize the shop medical program when appropriate? |   | **Y N NA** |   |
| 4. Does the shop medical program include preassignment evaluation by a licensed health care provider? | **I****I** | **Y N  NA** |   |
| 5. Does the shop provide for referral to a specialist for necessary follow-up care or a second opinion when appropriate?    | **I** | **Y N NA** |   |
| 6. Does the shop medical program include periodic medical examinations to support occupational health goals? | **G** | **Y N NA** |   |

**ASSESSMENT: PART II
Part II: Individual Departments or Systems**

**Complete as many copies of this checklist as needed to evaluate
each sub-unit of your shop.**

|  |  |
| --- | --- |
| **Plant:** | **Operation:** |
| **Department:** | **Bay/Column:** |
| **Date:** | **Completed by:** |

**Instructions:** Circle the appropriate answer for the questions below (Y = Yes, N = No, NA = Not Applicable). If "No" is circled, make comments and recommend corrective actions if possible. Note that NA is not available for some questions. Calculate scores for each of the six categories as well as for the overall checklist. Transfer results to the Summary Sheet.

**Type: C = Critical, I = Important, G = Good Practice**

|  |  |  |  |
| --- | --- | --- | --- |
| **Self-Assessment Rating for this Unit** |   | **Total Score** | **Total Score** |
| ***Did you answer`No" to any* Critical *question?***  |   |   |   |
| **Is the score of any category less than**  **40%? \_\_\_\_\_** |   |   |   |
| ***For the* "I" (Important) *questionsfrom all of the sections:Total Yes:\_\_\_\_\_ Total No:\_\_\_\_\_Total NA ("I" only) \_\_\_\_\_***  |   |   |   |
| **% = Yes/( 37-NA )\*100** |   |   |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **A. Management Program and Responsibilities**  |   | **Section Score** | **Comment** |
|   | **Type** |   | **Corrective Action/Comment** |
| Has responsibility for the MRF system in this area been assigned to an individual? | **C** | **Y N** | Responsible Person |

|  |  |  |  |
| --- | --- | --- | --- |
| **B. Employee Participation** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(4-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Are employees wearing the appropriate eye protection for their job function in this area (e.g., safety glasses, goggles)? | **I** | **Y N** |   |
| 2. Are employees using other personal protective equipment as specified for their job function in the MRF management program (e.g., gloves, safety shoes, protective clothing, and respirators? | **I** | **Y N NA** |   |
| 3. Do employees practice good personal hygiene in this area? | **I** | **Y N NA** |   |
| 4. Do employees practice good workplace housekeeping in this area? | **I** | **Y N** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **C. Fluid Selection, Testing and Management** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(4-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Has a MRF and concentration been elected that is appropriate for operations in this area? | **I** | **Y N** |   |
| 2. Are the water-miscible MRF systems in this area routinely tested according to the MRF management program? | **I** | **Y N NA** |   |
| 3. Does the fluid handling system adequately remove "fines" andother debris from the MRF? | **I** | **Y N NA** |   |
| 4. Are systems thoroughly cleaned (e.g., power washing and rinsing) before being recharged with fresh fluid? | **I** | **Y N  NA** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **D. Information and Training** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(4-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Do employees in this area understand the potential hazards of MRFs and associated chemicals?   | **C** | **Y N** |   |
| 2. Have employees been trained in procedures for safe use of MRFs and applicable additives used on their job?    | **C** | **Y N** |   |
| 3. Do employees know how to obtain the SDSs for the materials that they work with?    | **C** | **Y N** |   |
| 4. Have the employees been trained on physical safety concerns of working in metal removal operations? | **I** | **Y N** |   |
| 5. Are the MRFs currently being used according to the SDS and other company-specific instructions? | **I** | **Y N** |   |
| 6. Are MRF containers labeled properly and are employees using product according to the label? | **I** | **Y N  NA** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **E. Investigating Hazards and Complaints** |   | **Section Score** | **Comment** |
| ***For the* "I" (Important) *questions in this section only:*** ***Yes:\_\_\_\_ No:\_\_\_\_ NA:\_\_\_\_*** ***% = Yes/(22-NA)\*100\_\_\_*** |   |   |   |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Is the preventative, scheduled, or progressive maintenance of machines, MRF filtrations systems, ventilation systems, and other support facilities in this area conducted as specified? | **I** | **Y N** |   |
| 2. Has exposure assessment been conducted in this work area according to the MRF management plan? | **I** | **Y N** |   |
| 3. Are machine guards in place and in good condition? | **I** | **Y N** |   |
| 4. Is the flow of MRF at each operation interrupted or cycled off when it is not needed for the proper operation of the machine? | **I** | **Y N  NA** |   |
| 5. Is MRF delivered directly to the cutting zone and fluid pressure reduced to the minimum required? | **I** | **Y N  NA** |   |
| 6. Is piping that contains MRF properly labeled? | **I** | **Y N  NA** |   |
| 7. Are coolant pumps covered with solid material or a moderate foam blanket to contain mist? | **G** | **Y N  NA** |   |
| 8. Are supply air diffusers and supply air ductwork in good condition and operating properly?    | **I** | **Y N  NA** |   |
| 9. Is adequate supply air provided for general ventilation and process exhaust?    | **I** | **Y N  NA** |   |
| 10. Is filtration provided for recirculated general ventilation air?    | **I** | **Y N  NA** |   |
| 11. Where necessary, are there provisions for mist containment at each machining station, and does it ad equately capture MRF aerosol?   | **I** | **Y N  NA** |   |
| 12. Are local exhaust ventilation enclosures and hoods in good condition?      | **I** | **Y N  NA** |   |
| 13. Are personnel-cooling fans, if present, placed or directed so as not to interfere with the exhaust ventilation?    | **I** | **Y N  NA** |   |
| 14. Do mist collectors and ductwork meet the requirements of ANSI B11 TR2-1997, and are they free of any visible emissions and in good condition?    | **I** | **Y N  NA** |   |
| 15. Are mist collectors exhausted from the building?    | **G** | **Y N  NA** |   |
| 16. Is there a reliable method to monitor the mist collector performance, e.g., pressure drop across an appropriate element of the system?   | **G** | **Y N  NA** |   |
| 17. Is a record of the mist collector maintenance and performance history (e.g., filter changes and pressure drop readings) attached to the collectors?    | **G** | **Y N  NA** |   |
| 18. If "Floor Dry" or absorbent socks are used around machines to control continuous leaks or splashing, have work orders been submitted for repairs? | **I** | **Y N  NA** |   |
| 19. Are building structures (e.g., trusses, columns, or pipes) free of dripping MRF? | **I** | **Y N  NA** |   |
| 20. Are walking surfaces free of metal removal fluids or other machine fluids (e.g., hydraulic oil) that may be potential slip hazards? | **I** | **Y N  NA** |   |
| 21. Are adequate facilities available for the personal hygiene of the workers, and are they stocked with appropriate hand cleaning supplies? | **I** | **Y N  NA** |   |
| 22. Do employees refrain from smoking and eating in this area? | **G** | **Y N** |   |
| 23. Are drip pans, trenches, and the surrounding floor free of cigarette butts, cups, or other trash? | **G** | **Y N** |   |
| 24. Are machine interiors, exteriors, and the surrounding floor free of chip accumulations that can interfere with proper MRF circulation? | **I** | **Y N  NA** |   |
| 25. Are metal removal fluid containers being stored according to specifications? | **I** | **Y N  NA** |   |
| 26. Are drip pans and other fluid reservoirs in good condition and cleaned regularly to avoid stagnation? | **I** | **Y N  NA** |   |
| 27. Are MRF and oil spills or leaks cleaned up promptly? | **I** | **Y N  NA** |   |
| 28. Are machines washed down and cleaned regularly to prevent stagnation of MRFs? | **I** | **Y N  NA** |   |

|  |  |  |  |
| --- | --- | --- | --- |
| **F. Medical Monitoring, Management, and Surveillance** |   | **Section Score** | **Comment** |
|   | **Type** |   | **Corrective Action/Comment** |
| 1. Do employees know how to report health complaints, such as respirator irritation or dermatitis that may be occupational in origin?    | **C** | **Y N** |   |
| 2. Is there evidence of dermatitis among workers in this area?    | **I** | **Y N** |   |
| 3. Have there been respiratory complaints in this area since the last self-assessment?    | **I** | **Y N** |   |

**ASSESSMENT: SUMMARY
Part III: Summary**

**Plant:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Completed by:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Instructions:** Complete **Part I** and as many copies of **Part II** as necessary to evaluate your shop. Transfer the information from the checklists to the sections below and make the calculations indicated. See the page **Your Rating** to figure out your score and interpret the overall rating.

|  |  |  |
| --- | --- | --- |
| **Part I** | **Total Score** | **Rating** |
| **Part 1**Did you answer "No" to any Critical (C) question? \_\_\_\_\_\_ Did you score less than 40% on any section? ***For the* Important (I) *questions from all sections:*** ***Total Yes:\_\_\_\_\_ Total No:\_\_\_\_\_*** ***Total NA ("I" only) \_\_\_\_\_*** ***% = Yes/(31 - NA)\*100:\_\_\_\_\_\_***  |   | Pass Marginal Failure  |
| **Part II** |   |   |
| Number of checklists completed:\_\_\_\_ Did you answer "No" to any critical (C) question? Is any checklist score less than 40%?\_\_\_\_\_ ***For the* Important (I*) questions from all sections:*** ***Total Yes:\_\_\_\_\_ Total No:\_\_\_\_\_*** ***Total NA ("I" only) \_\_\_\_\_*** ***% = Yes/(Yes + No)\*100:\_\_\_\_\_\_*** |   | Pass Marginal Failure  |
| **Overall Rating** |   |   |
| Did you have a "failure" rating on Part I or II?   ***% = (Part I % + Part II % / 2):***  |     | Pass Marginal Failure |

**YOUR RATING**

Your rating is calculated as follows:

1. For both **Part I** and **Part II** of the checklist, a "no" answer to any of the **Critical (C)** questions results in a **failing** assessment, except that a one-year grace period from the first self-assessment is granted so that the written manage ment program can be developed.
2. For **Part I** of the checklist, rating is arrived at as follow:
	1. A **failing** assessment is given if:

	fewer than 50% of the **I (Important)** questions are answered "Yes" and any of the six sections of Part I receives less than a 40% score.
	2. A **marginal** assessment is made if:

	50% it 75% of the **I** questions are answered "Yes" AND each *section* of questions receives a minimum score of 40%.
	3. A passing assessment requires that:

	75% of the **I** questions answered "Yes" AND each *section* of questions receives minimum score of 40%.
3. For **I** questions on **Part II** of the checklist, a minimum of 40% is required as the overall score of **each** department system, or process. (There is no requirement, however, that each *section* of **Part II** receives 40%.)
4. The **G (Good Practice)** questions are not used in determining the final rating. However, they are indicators of the quality of the overall management program.
5. While an overall percentage is calculated to aid in the continuous improvement process, the **Overall Rating** is the minimum rating received on **Part I** or **Part II**.

**Appendix 8. OSHA Air Sampling Methods**

OSHA Occupational Safety & Health Administration/
U.S. Department of Labor

**Chemical Sampling Information Oil Mist, Mineral**

**General Description**

**NAME:** Oil Mist, Mineral

**SYNONYM(s):** Mist of white mineral petroleum oil; Petroleum-base cutting oil; Heat-treating oil; Hydraulic oil; Cable oil; Lubricating oil.

**IMIS:** 5010

**CAS:** 8012-95-1

**NIOSH:** RTECS PY8030000

**DOT:** 1270 27

**DESCRIPTION:** Mist with an odor like burned lube oil.

**INCOM:** None hazardous

**Exposure Limits**

**OSHA GENERAL INDUSTRY PEL:** 5 mg/m3 TWA

**OSHA CONTRUCTION INDUSTRY PEL:** 5 mg/m3 TWA

**ACGIH TLV:** 5 mg/m3 TWA; 10 mg/m3 STEL; As sampled by method that does not collect vapor.

**NIOSH REL:** 5 mg/m3 TWA; 10 mg/m3 STEL

**Health Factors**

**IARC:** Mineral Oils, untreated and mildly-treated oils - Group 1, carcinogenic to humans

**SYMPTOM(s):** None reported

**HEALTH EFFECTS:** Explosive, Flammable (No adverse effects when Good Housekeeping Practices are used) (HE18) Accumulation in lungs (Pneumonitis) (HE10).

**ORGAN:** Respiratory system, skin

**Monitoring**

**PRIMARY SAMPLING/ANALYTICAL METHOD (SLC1):**

**MEDIA:** Tared Low Ash Polyvinyl. Chloride (LAPVC) filter 5 microns

**MAX V:** 960 Liters **MAX F:** 2.0 L/min

**ANL 1:** Gravimetric

**REF:** 11, 12

**SAE:** 0.10

**CLASS:** Fully validated

**ANL A**: Fluorometric

**REF:** 2 (OSHA ID-128)

**SAE:** 0.14

**CLASS:** Partially validated

**ANL A:** Infrared; IR (Analysis is for oils which do not fluoresce)

**REF:** 2 (OSHA I-178SG)

**CLASS:** Partially validated

**NOTE:** Submit as a separate sample. Submit to laboratory only if sample weight is greater than the PEL. If the filter is not overloaded, samples may be collected up to an 8-hour period. Collect a sample of the bulk substance and send to the lab in a separate mailing container at the time the air samples are submitted. + Indicate on the sample sheet that a bulk sample has been submitted. Cutting oils may contain nitrosamines.

**SECONDARY SAMPLING/ANALYTICAL METHOD (SAM2):**

**DEVICE:** Detector Tube **COMPANY:** Draeger

**PART #:** 67 28371 **RANGE:** 2.5-10 mg/m3

**CLASS:** Mfg.

**DEVICE:** Dector Tube **COMPANY:** Draeger

**PART #:** 67 33031 **RANGE:** 1-10 mg/m3

**CLASS:** Mfg.

**WIPE:** No

Revision Date: 01/12/99

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OSHA Occupational Safety & Health Administration/
U.S. Department of Labor

**Chemical Sampling Information**

**Particulates Not Otherwise Regulated (Total Dust)**

**General Description**

**NAME:** Particulates not otherwise regulated (Total Dust).

**SYNONYM(s):** Dust, (Total) prior to 9/1/89; PNO

**IMIS:** 9135

**DESCRIPTION:** Nuisance dust includes, but is not limited to; inert particulates, glass fibers or dust, mineral wool fiber, inert organic dust, inert mineral dust, provided that these inert particulates contain less than 1% free silica.

**Exposure Limits**

**OSHA GENERAL INDUSTRY PEL:** 15 mg/m3 (Z-3)

**ACGIH TLV:** 10 mg/m3 TWAInhalable (total) dust containing no Asbestos and less than 1% crystalline Silica.

**NIOSH REL:** 10 mg/m3

**Monitoring**

**PRIMARY SAMPLING/ANALYTICAL METHOD (SLC1):**

**MEDIA:** Tared Low Ash Polyvinyl Chloride (LAPVC) filter 5 microns

**MAX V:** 960 Liters MAX F: 2.0 L/min -- DO NOT USE A CYCLONE --

**ANL 1:** Gravimetric

**REF:** 11, 12

**SAE:** 0.10

**CLASS:** Fully validated

**NOTE:** Field method, do not submit to SLTC. Standard is for inert dust; noncompliance can be based on gross weight without analysis. If the filter is not overloaded, samples may be collected up to an 8-hour period.

**Revision Date: 08/28/1995**

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**Appendix 9. NIOSH Analytical Method 0500**

**NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94**

**PARTICULATES NOT OTHERWISE REGULATED, TOTAL 0500**

**DEFINITION:** total aerosol mass

**CAS:** NONE

**RETCS:** NONE

**METHOD:** 0500, Issue 2

**EVALUATION:** full

**Issue 1:** 15 February, 1984

**Issue 2:** 15 August, 1994

**OSHA:** 15 mg/m3

**NIOSH:** no REL less than 1%

**ACGIH:** 10 mg/m3, total dust less than  1% quartz

**PROPERTIES:** contains no asbestos and quartz

**SYNONYMS:** nuisance dust; particulates not otherwise classified

**SAMPLING**

**SAMPLER:** filter (tared 37-mm, 5-um PVC filter)

**FLOW RATE:** 1 to 2 L/min

**VOL-MIN:** 7 L@15 mg/m3

**- MAX:** 133 L@15 mg/m3

**SHIPMENT:** Routine

**SAMPLE STABILITY:** Indefinitely

**BLANKS:**2 to 10 field blanks per set

**BULK SAMPLE:** None required

**MEASUREMENT**

**TECHNIQUE:** gravimetric (filter weight)

**ANALYTE:** airborne particulate material

**BALANCE:** 0.001 mg sensitivity:  use same balance before and after sample collection

**CALIBRATION:** National Institute of Standards and Technology Class S-1.1 weights or ASTM Class 1 weights

**RANGE:** 0.1 to 2 mg per sample

**ESTIMATED LOD:** 0.03 mg per sample

**PRECISION(s):** 0.026[2]

**ACCURACY**

**RANGE STUDIED:** 8 to 28 mg/m3

**BIAS:** 0.01%

**OVERALL PRECISION (srr):** 0.056[1]

**ACCURACY:** +/- 11.04%

**APPLICABILITY:** The working range is 1 to 20 mg/m3 for a 100-L air sample. This method is non-specific and determines the total dust concentration to which a worker is exposed. It may be applied, e.g., to gravimetric determination of fibrous glass[3] in addition to the other ACGIH particulates not otherwise regulated [4].

**INTERFERENCES:** Organic and volitile particulate matter maybe removed by dry ashing [3]

**OTHER METHODS:** This method is similar to the criteria document method for fibrous glass [3] and Method 5000 for carbon black. This mehod replaces Method S349 [5]. Impingers and direct-reading instruments may be used to collect total dust samples, but these have limitations for personal sampling.

**EQUIPMENT:**

1. Sampler: 37-mm PVC, 2- to 5-um pore size membrane or equivalent hydrophobic filter and supporting pad in 37- mm cassette filter holder.
2. Personal sampling pump, 1 to 2 L/min, with flexible connecting tubing.
3. Microbalance, capable of weighing to 0.001 mg.
4. Static neutralizer: e.g., Po-210; replace nine months after the production date.
5. Forceps (preferably nylon).
6. Environmental chamber or room for balance (e.g. 200 C +/- 10 C and 50% +/- 5% RH).

**SPECIAL PRECAUTIONS:** None

**PREPARATION OF FILTERS BEFORE SAMPLING:**

1. Equilibrate the filters in an environmentally controlled weighing area or chamber for at least 2 h.

Note: An environmentally controlled chamber is desirable, but not required.
2. Number the back-up pads with a ball point pen and place them, numbered side down, in filter cassette bottom sections.
3. Weigh the filters in an environmentally controlled area or chamber. Record the filter tare weight, W1(mg).
	1. Zero the balance before each weighing.
	2. Handle the filter with forceps. Pass the filter over an antistatic radiation source. Repeat this step if filter does not release easily from the forceps or if filter attracts balance pan. Static electricity can cause erroneous weight readings.
4. Assemble the filter in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter casssette. Place a cellulose shrinkband around the filter cassette. Allow to dry, and mark with the same number as the back-up pad.

**SAMPLING:**

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at 1 to 2 L/min for a total sample volume of 7 to 133 L. Do not exceed a total filter loading of approximately 2 mg total dust. Take two to four replicate samples for each batch of field samples for quality assurance on the sampling procedure.

**SAMPLE PREPARATION:**

1. Wipe dust from the external surface of the filter cassette with a moist paper towel to minimize contamination. Discard the paper towel.
2. Remove the top and bottom plugs from the filter cassette. Equilibrate - for at least 2 h in the balance room.
3. Remove the cassette band, pry open the cassette, and remove the filter gently to avoid loss of dust.

NOTE: If the filter adheres to the underside of the cassette top, very gently lift away by using the dull side of a scalpel blade. This must be done carefully or the filter will tear.

**CALIBRATION AND QUALITY CONTROL:**

1. Zero the micro-balance before all weighings. Use the same micro-balance for weighings filters before and after sample collection. Maintain and calibrate the balance with National Institute of Standards and Technology Class S-1.1 or ASTM Class 1 weights.
2. The set of replicate samples should be exposed to the same dust environment, either in a laboratory dust chamber [7] or in the field [8]. The quality control samples must be taken with the same equipment, procedures and personnel used in the routine field samples. The relative standard deviation calculated from these replicates should be recorded on control charts and action taken when the precision is out of control.

**MEASUREMENT:**

1. Weigh each filter, including field blanks. Record the post-sampling weight, W2(mg). Record anything remarkabe about a filter (e.g., oveload, leakage, wet, torn, etc.).

**CALCULATIONS:**

1. Calculate the concentration of total pariculate, C (mg/m3), in the air volume sampled, V(L):

C = (W2 - W1 ) - (B2 - B1) . 103, mg/m3
                                             V

where: W1 = tare weight of filter before sampling (mg)

W2 = post-sampling weight of sample-containing filter (mg)

B1 = mean tare weight of blank filters (mg)

B2 = mean post-sampling weight of blank filters (mg)

**EVALUATION METHOD:**

Lab testing with blank filters and generated atmospheres of carbon black was done at 8 to 28 mg/m3 [2,6]. Precision and accuracy data are given on page 0500-1.

**Appendix 10. Best Practices for Training**

The committee identified that training has to be well organized, integrated into the existing requirements of the OSHA Hazard Communication Standard, and be specific to the individual circumstances of each facility. Although there are some common denominators, most training has to be geared to a specific audience. The committee recommended the following outline. The first two sections, A and B, include items that should be part of all training and combined with the specific training as noted for specific groups.

1. Organization of Training Should Include:
	1. A definition of audience and needs;
	2. The development of goals;
	3. High quality program materials;
	4. A determination of the frequency of training;
	5. Program implementation;
	6. Evaluation of the effectiveness of training and skill performance of employees assigned responsibilities for fluid management; and
	7. Program continuous improvement.
2. Generic Training for Any Audience Should Include:
	1. A description of MWFs and how MWFs become contaminated;
	2. A description of good fluid maintenance practices;
	3. Elements of the MWF Management Program for the facility, including the names of personnel responsible for the Program;
	4. Recognition of symptoms and signs associated with exposure to MWFs and the added importance of symptoms when they appear in more than one worker;
	5. In priority order, steps workers and other individuals can take to reduce exposure to MWFs; and
	6. Requirements of an OSHA Standard (if any).
3. Specific Employee/Apprentice Training Should Include in Addition to A & B:
	1. How to reduce one's own exposure and maintain this reduction;
	2. What to do and whom to contact if the individual has a MWF related symptom or determines that exposure control systems are not functioning adequately;
	3. Information that is specific to the fluid and MWF system size;
	4. Specific training to address behaviors that increase exposure to contaminate MWFs;
	5. The use of employee experiences with MWFs;
	6. Specific training about the activities the individual has to do related to MWFs e.g., measurement of fluid concentration, pH etc.;
	7. How to do any needed recordkeeping for MWFs; and
	8. Integration with training required by the Hazard Communication Standard.
4. Specific Training for Industrial Hygienists and Safety Professionals Should Include:
	1. How to recognize any symptoms related to MWFs, determine if symptoms are work related and link symptoms to specific potential diseases;
	2. How to diagnose and treat the symptoms and/or disease;
	3. The significance of identifying more than one worker from a site with symptoms associated with MWF exposure and the needed response actions; and
	4. Procedures for medical removal.
5. Specific Training for Industrial Hygienist and Safety Professionals Should Include:
	1. How to recognize any symptoms related to MWFs, determine if symptoms are work related and link symptoms to specific potential diseases;
	2. How to encourage employee reporting of symptoms etc.;
	3. The significance of identifying more than one worker from a site with symptoms associated with MWF exposure and the needed response actions;
	4. How to qualitatively and quantitatively assess exposure;
	5. How to compare to exposure limits;
	6. How to identify fluid and mist problems and identify solutions;
	7. How to develop a systems management team;
	8. How to design and evaluate enclosure and ventilation systems for MWFs;
	9. How to select and maintain mist collectors;
	10. Additional sampling techniques such as bioaerosols, fluid parameters;
	11. How to develop a MWF management program;
	12. How to identify and change behaviors, of employees and managers, that lead to increased exposure;
	13. How to do any needed recordkeeping for MWFs; and
	14. How to train employees about MWFs.
6. Specific Training for Supervisor/Managers Should Include:
	1. How to recognize any symptoms related to MWFs, determine if symptoms are work related and link symptoms to specific potential diseases;
	2. How to encourage employee reporting of symptoms etc.;
	3. The significance of identifying more than one worker from a site with symptoms associated with MWF exposure and the needed response actions;
	4. How to identify fluid and mist problems and identify solutions;
	5. How to develop a systems management team;
	6. How to develop a MWF management program;
	7. Specific training about the activities the individual has to do related to MWFs, e.g., measurement of fluid concentration, pH etc.;
	8. How to identify and change behaviors, of employees and managers, that lead to increased exposure;
	9. How to do any needed recordkeeping for MWFs; and
	10. Procedures for medical removal.
7. Specific Training for Engineers Should Include:
	1. How to identify fluid and mist problems and identify solutions;
	2. How to develop a systems management team;
	3. How to develop a MWF management program;
	4. How to design fluid systems to minimize exposure and reduce fluid problems;
	5. How to design enclosure and ventilation systems for MWFs;
	6. How to select and maintain mist collectors;
	7. How to minimize water and outdoor air pollution from MWFs;
	8. Specific training about the activities the individual has to do related to MWFs, e.g., measurement of fluid concentration, pH etc.; and
	9. How to do any needed recordkeeping for MWFs.
8. Specific training for OSHA Compliance Officers/Managers Should Include:
	1. How to recognize any symptoms related to MWFs, determine if symptoms are work related and link symptoms to specific potential diseases;
	2. The significance of identifying more than one worker from a site with symptoms associated with MWF exposure and the needed response actions;
	3. How to qualitatively and quantitatively assess exposure;
	4. How to compare to exposure limits;
	5. How to identify fluid and mist problems and identify solutions;
	6. Additional sampling techniques such as bioaerosols, fluid parameters;
	7. How to identify and change behaviors of employees and managers that lead to increased exposure; and
	8. How to interpret any needed recordkeeping for MWFs.