Pollution Prevention Practices for Metal Machining

DEPARTMENT OF ECOLOGY
State of Washington

Washington State Department of Ecology
Hazardous Waste and Toxics Reduction Program
Revised January 2014
Publication 99-412

Publication and Contact Information

This publication is available on the Department of Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/99412.html.

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Hazardous Waste and Toxics Reduction Program
Washington State Department of Ecology
Olympia, Washington

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The Department of Ecology works with businesses that use metal working fluids and need to dispose of waste fluids. This guide explains some Pollution Prevention (P2) practices that should be common to every metal machine shop. They will help you reduce the amount of waste from your shop and make it easier to comply with the dangerous waste regulations. They might even save you money.

Your business is responsible for determining whether any of your wastes designate as a dangerous waste. You can do this by sending your waste for testing or following the designation procedures described on Ecology's website.

According to the Pollution Prevention Act of 1990, **pollution prevention** (P2) is defined as: "source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or protecting resources through conservation."

Testing must be done according to the requirements under the dangerous waste regulations (WAC 173-303-090 and -100). If you have questions about whether any of your wastes are dangerous, please contact your closest regional office for help. (See contact information inside the front cover.) This guidance doesn't replace state or federal regulations regarding the management or disposal of metal working fluids.

Selecting and Using Metalworking Fluids (MWFs)

Types of MWFs

Fluid Type	Composition	Advantages	Disadvantages
Straight oils	Consist of solvent-refined or hydro-treated petroleum oil or other oils of animal or vegetable origin.	• Resistant to biological degradation. • Good rust protection. • Very little maintenance required.	• Higher cost, difficult to clean, fire and health hazard.
Water-soluble oils	Contain about 50-90% water, with refined base oil and emulsifiers to mix the oil and water. Other additives commonly found in soluble oils are biocides, soaps, softening agents, and rust inhibitors.	• Good cooling capacity and lubricity.	• Tramp oil removal required. • A maintenance program is necessary to minimize bacterial growth.
Semi-synthetic fluids	Contain small amounts of refined base oil that are micro-emulsified (5 -20%), water, and a solution of additives. These fluids tend to be similar to water-soluble oils.	• Good cooling capacity. • Average lubricity. • Longer sump life.	• Difficult to treat. • May emulsify tramp oil. • High foaming potential.

Fluid Type	Composition	Advantages	Disadvantages
Synthetic fluids	Aqueous (water-based) solutions that do not contain refined oil. Similar additives as seen in semi-synthetic fluids.	• Excellent cooling properties. • Longer sump life. • Good rust protection. • Clear fluid allows work piece to be visible.	• Poor lubrication. • Difficult to treat.
High-pressure additives	High-pressure additives found in MWFs are chlorine, sulfur, and phosphorus compounds. These compounds are sometimes referred to as EP (extreme pressure) agents, and are most commonly found as halogenated organic compounds (e.g., chlorinated paraffins). Halogenated EP fluids should not be used unless they are critical to the operation. In addition, sulfur and phosphorus are a food source for microbes and sulfur can stain metals. If you use any fluids with these compounds, remember to recycle and reuse them as much as possible.		

P2 Practices for Selecting and Using MWFs

☑ Use high quality MWFs to get the longest life

High quality MWFs are more resistant to biological attack and additive breakdown, allowing them to be used many times without loss of performance.

☑ Separate tramp oil

Thoroughly separate the tramp oil from the MWF prior to skimming the tramp oil for removal. This will reduce the amount of MWF that is wasted with the removal of the tramp oil.

☑ Look at the compatibility of way oils and MWFs

Way lubricants and MWFs that separate easily help in the treatment and recycling process. Use a way oil that doesn't cause foaming problems or impair the separation characteristics. High-grade way oils typically separate easily from MWF and contain few or no sulfur compounds (a food source for bacteria).

☑ Use chlorine-free MWFs

Chlorine largely affects waste designation, disposal costs, management options, and management requirements. Waste MWF formulated with chlorinated compounds can only be classified as used oil when sent for re-refining and **not** when burned for energy recovery.

☑ Use distilled or deionized water

Use distilled or deionized water to keep dissolved minerals out of the MWF. As the water in the fluid evaporates, contaminants can build up, causing separation of the concentrate from the water.

☑ Limit the number of MWFs

Use the smallest number of different MWFs as possible. This simplifies the variability in MWF management and minimizes the overall amount of management required.

☑ Monitor MWF concentration

Keep the concentration of the MWF in the correct range (according to the manufacturer) to ensure the right amount of concentrate is used. It also helps control gumming, sticking, or smearing left on work pieces from excess concentrate. Refractometry and titration are common techniques for measuring fluid concentration.

☑ Monitor pH

Monitor the pH of the MWF to detect problems with the fluid. A drop in pH could mean there is a high microbe count in the fluid or a buildup of impurities. Keep the pH in the correct range according to the manufacturer to help control bug growth and help reduce foaming and separation of the fluid.

☑ Keep a log of monitoring data

Keep a log of fluid characteristics, such as pH and concentration, to help identify trends, solve problems, and keep the fluid in the proper condition.

Maintaining MWFs

No matter what type of fluid you use, an **MWF maintenance plan** will help extend the life of the fluid. An MWF maintenance plan optimizes fluid performance and reduces oily wastewater volume, fluid concentrate, and disposal costs. Contaminated and spoiled fluids are the largest source of waste from machining operations. An established maintenance plan allows corrective action before fluids become rancid. A written maintenance plan should include the elements identified below and can be used to educate employees about MWF management.

Key Elements of an MWF Maintenance Plan

Operator responsibilities	List all tasks needed to implement a successful maintenance plan and responsibilities.
Monitoring/fluid testing **Examples: product concentration** **pH**	Monitor fluids to anticipate problems. Physical characteristics such as product concentration, pH, fluid odor, color, and texture are good indicators of fluid degradation. Measure product concentration by using a refractometer or by titration. Measure the pH of the fluid with litmus paper or a pH meter. If the pH of a fluid in a sump falls below 8.5, the fluid loses efficiency, is prone to rusting, and biological activity will increase significantly.
Data tracking system	Keep a log of observations and test data.
Sump fluid change-out	Set criteria for change-out to reduce unnecessary disposal of MWF fluid and create a standard for fluid reuse. Examples: odor, appearance (milky appearance is normal), length of use, pH (between 8.4 - 9.4 is normal), residue or film left on parts.
Change-out procedures	Document how to handle and process the fluid through your recycling system.
Sump cleaning	Remove biological growth in the sump to reduce health risks and improve fluid life. Examples: steam cleaning or use of a disinfectant solution.
Removal of chips	Regular removal of chips reduces the habitat for biological organisms in your sumps.

P2 Practices to Include in Your MWF Maintenance Plan

☑ Inspect daily

Conduct daily inspections of each machine to help identify problems early and make repairs more quickly. This contributes to less downtime and less fluid waste.

☑ Add biocide if needed

If other methods do not work, adding a biocide/fungicide can help extend the life of MWFs. These additives should be used sparingly and only as a last resort. Some biocides contain chlorinated compounds. Test spent fluids containing biocides to determine if they are a dangerous waste.

☑ Keep the MWF cool

Keep the MWF cool to help slow the growth of microbes in the sumps and fluid areas.

☑ Wash hands to reduce bacteria

Machinists frequently come in contact with MWFs and humans are a primary source of bacteria. Washing hands regularly will reduce the spread of bacteria.

☑ Train operators

Limit maintenance of MWF to one person or team trained and knowledgeable about fluid maintenance. This will reduce fluid property variances and help cut down on the overuse of coolants.

Managing Spent MWFs

To manage dangerous waste properly, businesses need to determine their "generator status." Generator status depends on the total amount of dangerous waste generated per month and the amount of waste stored on site (see Appendix A). For help in determining your generator status, call your nearest Ecology regional office or visit Ecology's Generator Status website.

Spent MWF Containing Chlorinated Compounds

Spent MWFs meeting the definition of used oil[1] and formulated with chlorinated paraffins can be managed as used oil, but only if they are sent to be re-refined. Otherwise, these spent MWFs must be managed as dangerous waste.

Spent MWFs that designate as dangerous waste and are sent to be burned, must be managed as dangerous waste fuel under WAC 173-303-510. This rule prohibits burning spent chlorinated MWFs in improper combustion units, which can generate dioxins. Note that the terms "chlorinated paraffins" and "chlorinated alkanes" (examples of chlorinated compounds) are synonymous and are used interchangeably on Material Safety Data Sheets (MSDSs).

Not all chlorinated compounds are required to be listed on a MSDS sheet. Don't assume there are no chlorinated compounds in the MWF merely because they aren't listed on the MSDS. Ask the manufacturer or supplier for written documentation that there are no chlorinated compounds in the MWF.

[1] Used oil is defined as any oil that has been refined from crude oil, or any synthetic oil, that has been used and as a result, is contaminated by physical or chemical impurities.

Two parts of an MSDS sheet may contain information about chlorinated compounds. Please note that all MSDS sheets are not always in the same format.

1. Find Section 2 of the MSDS. This section is sometimes titled **Product Composition**, **Hazardous Ingredients Information**, or **Hazard Identification**. Look through the ingredients list for *Cl*, *chloro*, *chlorine*, or *chlorinated*. If it contains any of these, the MWF contains chlorinated compounds.
2. If chlorinated compounds are not found in Section 2, look in Sections 4 and 5, which are usually titled **Fire and Explosion Hazard Data** or **Reactivity Data**. Find the line items titled **Hazardous Decomposition Products** or **By Products**. Look for any chlorinated compounds in the list, such as *hydrochloric acid* (HCl) or *oxides of chlorine*.

Managing Spent MWFs as Used Oil

If your spent MWF meets the definition of used oil, you can manage it under WAC 173-303-515 (see Step 1. Does the spent MWF meet the definition of used oil? under Disposing of Spent MWF on page 9).

If you manage your spent MWF as used oil, remember these key aspects:

- Manage used oil in a manner that does not threaten human health or the environment.
- Businesses are liable for the mismanagement of used oil and are required to report spills that are a threat to human health or the environment.
- Businesses are required to dispose of used oil properly. For example, the use of used oil as dust abatement or to control weeds is not proper disposal and is illegal.
- Keep used oil containers closed except when adding or removing contents.
- Don't open, handle, manage, or store used oil containers in a manner that could cause the container to leak or rupture.

Managing Spent MWF When Prohibited from Being Managed as Used Oil

Spent MWFs are prohibited from being managed as used oil and are considered dangerous waste if:

- The MWF does not meet the definition of used oil (see Step 1 on page 9).
- MWFs are formulated with chlorinated paraffins and are not going to be re-refined (see Step 2 on page 10).
- Non-chlorinated MWF has been intentionally mixed with other waste streams and now designates as a dangerous waste (see Step 3 on page 10).
- The MWF contains more than 10,000 ppm halogenated organic compounds (HOC) and will be burned (see Step 6, on page 11).

Recycling Spent MWFs

A good fluid recycling system extends the useful life of MWFs and:

- Improves product quality.
- Reduces the amount of new fluids purchased.
- Reduces costs of disposal for spent fluids.
- Reduces downtime for machine clean-outs and recharges.

Recycling systems remove contaminants such as tramp oil, dirt, and bacteria. They also readjust the fluid concentration before the fluid is returned to an individual sump. There are two types of recycling systems.

1. Central Recycling System (including portable systems)

A central system is a large reservoir that supplies fluid to several individual machines. A major advantage of a centralized system is that contaminants can be controlled at one location. This eliminates the need for many different systems on each machine and reduces the time needed to monitor and maintain the fluids. With proper fluid controls and management techniques, the typical fluid in a central system can last one to three years (or even longer).

Portable recycling systems are a cost-effective alternative to centralized recycling systems. The fluid from an individual sump is pumped into a portable unit that removes contaminants. The fluid is then returned to the sump and the portable system is moved to the next machine. If the fluid from each machine is treated according to a prescribed maintenance schedule, daily fluid monitoring might not be required.

Contaminant Removal Equipment Used in Central Recycling Systems

Equipment	Separates Oil	Removes Dirt and Metal Chips	Reduces Bacterial Growth
Settling/Dragout		✓	
Flotation	✓	✓	
Positive Filters • Gravity • Pressure • Vacuum		 ✓ ✓ ✓	
Centrifuge	✓	✓	
Oil Skimmer	✓		
Coalescer	✓	✓	
Pasteurization			✓

2. Individual Recycling Systems

Unlike central recycling systems, individual recycling systems tend to control only one type of contaminant. For example, a milling machine might only have a skimmer to remove excess tramp oil. The benefits of using individual systems are their low capital costs and ability to focus on one particular problem for a given machine.

Commonly Used Individual Machine Recycling Systems

	Separates Oil	Removes Dirt and Metal Chips	Reduces Bacterial Growth
Media-based Systems			
Filtration		✓	
Pressure		✓	
Vacuum		✓	
Gravity		✓	
Natural Force Systems			
Settling/Gravity		✓	
Coalescers	✓	✓	
Flotation/Aeration	✓		
Mechanical Separation Systems			
Centrifuges	✓	✓	
Other			
Pasteurization			✓
Ozonation			✓

Common Recycling Components and Considerations

Equipment	Description	Considerations
Settling/ Dragout	Particulates in many MWF systems are often adequately removed by installation of a simple gravity/settling tank. Such a tank is enhanced when an automatic bar, rake device, or conveyer belt system is added to remove metal shavings and other settled solids.	**Advantages:** no media replacement or disposal required. **Disadvantages:** clarity is dependent on retention time and chip weight; not effective with aluminum chips or swarf, which tend to float.
Flotation/ Aeration	A device that uses aeration to float solids and tramp oil to the surface.	**Advantages:** no media replacement or disposal required. It works on fine particles. **Disadvantages:** greater floor space requirements and increased use of plant compressed air.
Gravity Filters	Because of gravity, the weight of the MWF provides enough force to penetrate the filter medium. Most common filter media are cloth, paper, organic, polymers, or wire screens.	**Advantages:** low cost and ease of operation. **Disadvantages:** greater floor space requirements and increased media disposal.
Pressure Filters	A device with two horizontal compartments; a movable top and stationary bottom. During operation, air pressure seals the two compartments together. The filter medium may be a continuous nylon belt used as is or one coated with a disposable medium.	**Advantages:** removes small particles efficiently; large volumes can be handled within minimal floor space. **Disadvantages:** prematurely plugs filters if tramp oil is not removed first.

Equipment	Description	Considerations
Vacuum Filters	This common positive filter system is driven by a vacuum. Fluid is pulled by vacuum through a permanent roll or cylinder.	**Advantages:** low capital costs; efficient filtration; no media replacement or disposal required. **Disadvantages:** greater floor space requirements.
Centrifuge	A rotating bowl that uses centrifugal force to separate oil, water, and solids. Low-speed centrifuges remove suspended solids from most liquids. High-speed units remove tramp oils and solids. The goal is to separate free tramp oil and loosely emulsified oil (such as mechanically emulsified oil.) Chip wringers separate chips from cutting fluids by alternating high to low-speed cycles.	**Advantages:** high throughput rate (about 2 gallons per minute); good suspended solid and tramp oil separation. **Disadvantages:** solids and grease require frequent cleaning; separation of product components.
Coalescer	Uses the property of oil attraction to polypropylene media (or oleophilic, "oil-loving" materials) for removal of tramp oil.	**Advantages:** applicability to either central or portable systems. **Disadvantages:** are not effective for removing water-miscible hydraulic oils or emulsified lubricating oils.
Pasteurization	A heating process that improves separation of solids and reduces biological growth.	**Advantages:** successfully controls microbial growth under certain conditions. **Disadvantages:** can reduce a fluid's lubricity and corrosion inhibition properties.
Filtration	Fluid is passed through a disposable filter to remove solid particles.	**Advantages:** enhances part finish, tool life, bacteria control, and lubricity properties. They are most advantageous when used with central recycling systems or portable recycling units. **Disadvantages:** units on individual machines tend to be labor intensive.
Oil Skimmers	Devices that skim tramp oil from fluid reservoirs in machine sumps. The most common are belt and disc skimmers.	For individual systems, a combination of settling tank and skimmers will remove coarse particles and tramp oil. This relatively inexpensive combination often provides sufficient clean lubricant ready for reuse.
Ozonation	Contaminated fluid is treated with ozone for control of microbial growth.	Unlike pasteurization, this process does not reduce a fluid's lubricity and corrosion inhibition properties.

Portable and individual recycling systems may be used in combination with other recycling methods. Some examples might include:

- A combination of settling tank, skimmers, and aeration devices will remove coarse particles by settling fine particles and skim the tramp oil for removal.

- A high efficiency sump cleaner will remove fluids and solids from sumps. The fluid passes through a central batch-recycling unit using a coalescer, pasteurization, and filtration technique and then is returned to the sump. Other central batch combinations include skimmers/filtration/ozonators; skimmers/coalescer; skimmer/fluid concentration adjuster.
- A portable unit equipped with a skimmer and ozonator for treating individual sumps.
- A portable unit equipped with a coalescer, filter, and fluid concentration adjuster.
- A portable sump cleaner, or "brown cow," to transfer used fluid to a three-stage separation tank. Particulate settles out and tramp oil is skimmed off in the first two stages. "Clean cows" are used to return treated fluid to individual sumps.
- Portable units that act only as filtration units.
- A settling tank, ozonation/aeration, tramp oil skimmer, and a filter.

P2 Practices for Recycling Systems

☑ Skim tramp oil

Skimmers come in several different types including rope, belt, and disk skimmers. They remove the oil that makes its way into the MWF and floats on the surface of the fluid. Oil removal helps keep the fluid aerated with dissolved oxygen, and reduces the food source for microorganisms.

☑ Aerate/Ozonate the MWF to keep the dissolved oxygen level up

Aerate the MWF or use an ozone generator to bubble oxygen through the fluid to keep the anaerobic microbe count low. Dissolved oxygen in the water prevents anaerobic bacterial growth. MWF treated with dissolved ozone reduces the microbe count. Ozone is highly toxic to microbes and kills them.

☑ Use central recycling systems

Central recycling systems treat large volumes of fluid at once. Small-wheeled versions (about the size of a large shopping cart) are available. A good recycling system includes a settling tank, oil skimmer, coalescer, and an aeration device.

Disposing of Spent MWFs

Metalworking fluid (MWF) that is no longer usable must be evaluated and disposed of properly. The steps described below are summarized in the flowchart on page 12.

Step 1: Does your spent MWF meet the definition of used oil?

"Used oil means any oil that has been refined from crude oil, or any synthetic oil, that has been used, and as a result of such use, is contaminated by physical or chemical impurities." (WAC 173-303-040). Not all MWFs are formulated from crude oil or synthetic oil, and so do not meet the definition of used oil.

Step 2: Is the spent MWF formulated with chlorinated compounds?

Send a sample to a laboratory or use a test kit. If chlor-detect tests are used, businesses should keep a written record of the name and telephone number of the person performing the test along with the sampling date and equipment calibration date. All written test records should be kept on site for five years. If you already know that your MWFs are formulated with chlorinated compounds, you do not need to perform the test.

Use generator knowledge (such as MSDS information) to determine if the MWF is made with chlorinated compounds. If so, it can't be managed as used oil when burned for energy recovery. See *Spent MWFs Containing Chlorinated Compounds*, on page 4.

Step 3: Has the spent MWF been mixed with any other waste stream?

Businesses can avoid the problems associated with mixed waste streams by training employees to keep waste streams separate, label containers properly, and by restricting container access.

If spent MWF is mixed with another waste stream (such as mop water or antifreeze), you must designate the resulting mixture to determine whether it's a dangerous waste according to WAC 173-303-070(3). Use process knowledge and MSDSs to develop a complete list of chemicals in the mixture. You might also need to send your sample to a lab to test for lead, cadmium, chromium, selenium, total halogens, and any other suspected contaminants.

Step 4: Is the MWF derived from animal or vegetable oils?

The definition of used oil excludes animal and vegetable oils (lard, canola, etc.). Spent MWFs that contain animal or vegetable oils do not meet the definition and are subject to designation under WAC 173-303 (see Step 3 for common waste constituents to test for).

Step 5: Does the MWF have more than 1,000 parts per million (ppm) total halogens?

MWF with more than 1,000 ppm total halogens is *presumed* to have been deliberately mixed with a dangerous waste and is required to be managed as dangerous waste. However, you may demonstrate that the MWF does not contain halogenated dangerous waste constituents as a result of intentional mixing. This is known in the regulations as "rebutting the presumption[2]."

Rebutting the presumption can be as simple as meeting these three criteria:

1. The source of the halogens is the MWF itself (soluble MWFs typically contain chlorinated paraffins). A material safety data sheet (MSDS) would be able to show this.
2. Avoid using products that introduce chemicals listed in WAC 173-303-9903 and -9904 into the MWF.
3. Manage other waste streams to prevent mixing.

[2] Halogenated dangerous waste constituents are listed in WAC 173-303-9903 and -9904.

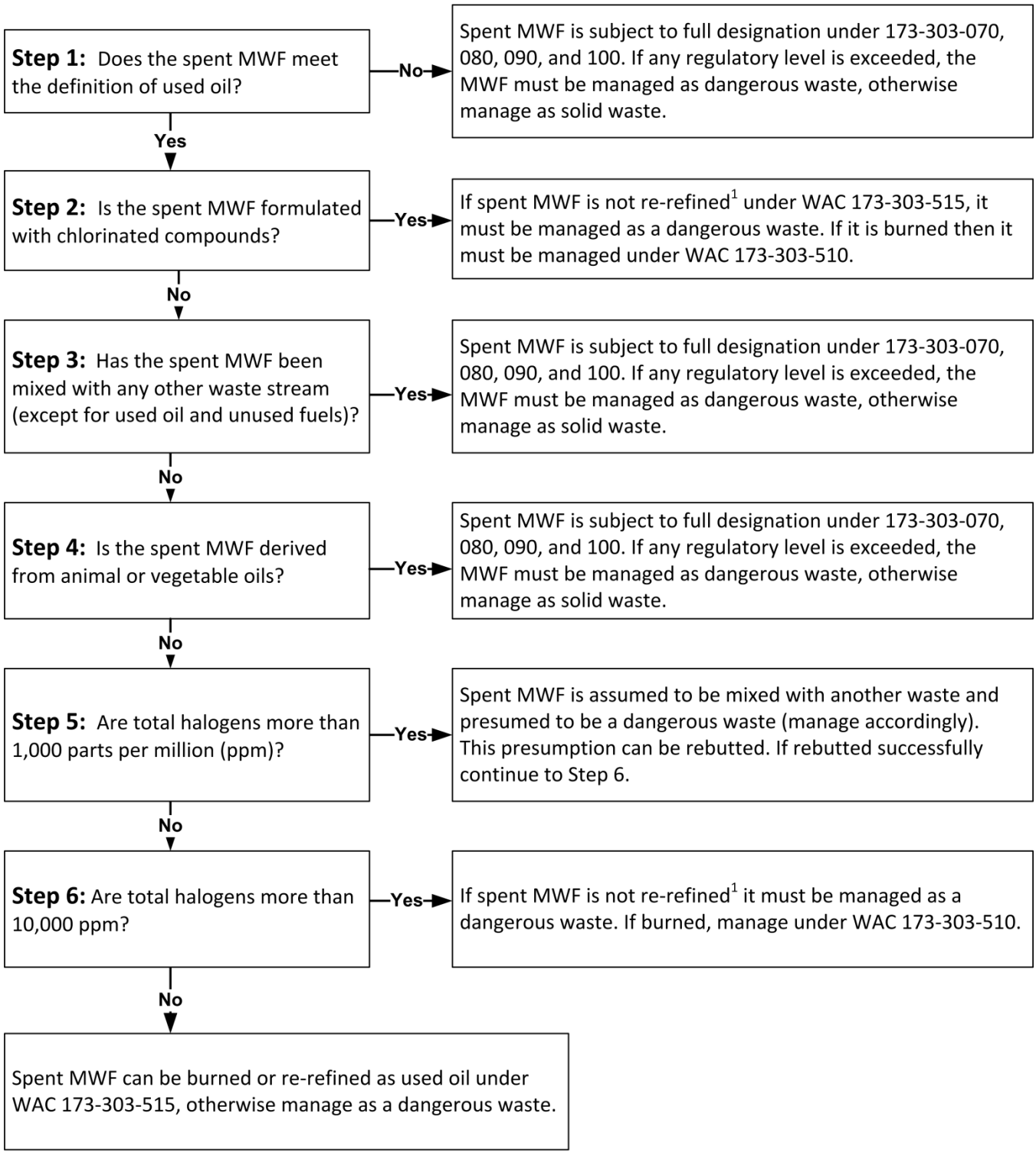
Step 6: Does the spent MWF have more than 10,000 ppm total halogens?

MWF with more than 10,000 ppm total halogens is considered extremely hazardous waste (EHW) per WAC 173-303-100. EHW is prohibited from being managed as used oil when burned for energy recovery. If burned, it must be managed as dangerous waste fuel under WAC 173-303-510. If re-refined, it must be processed into lube stock and not into a fuel.

However, water-soluble MWFs typically contain less than 10,000 ppm total halogens unless they are evaporated or mixed with other halogenated waste streams (e.g., chlorinated compounds). Evaporator residues from chlorinated MWFs will typically exceed the 10,000 ppm total halogen limit. See next section for more information about evaporation.

Spent Metalworking Fluid (MWF) Disposal

This is a flowchart summary of the steps beginning on page 9.



1 **Note**: *Re-refining* is limited to processing the used oil back into lube stock, not into a fuel.

Evaporating Spent MWFs

Businesses that generate spent water-based MWF may wish to evaporate water from this waste stream to reduce waste volume and disposal cost. Water-based MWFs include soluble, synthetic, or semi-synthetic fluids but not straight oils. These water-based fluids usually contain non-volatile substances and therefore are amenable to evaporation.

Evaporating spent MWF that does not designate as dangerous waste may generate residue that is dangerous waste.

Use care when building and operating an evaporator to prevent exceeding air quality standards, which can cause health concerns, potential worker and/or neighbor complaints, and may draw undesired regulatory attention. Evaporator units designed to remove water from non-volatile wastes are allowable under the following conditions:

- Evaporate only aqueous (water-based) wastes containing non-volatile organic substances such as water-based MWF, rinse water, and water-based coolants.
- Don't evaporate volatile organic solutions, such as solvents, paints, oils, or aqueous wastes containing straight oil MWF.
- Don't evaporate to dryness. Soluble spent MWF is typically 95 percent water and 5 percent additives (oil, surfactants, etc.). If you evaporate to dryness, the emulsion portion will be evaporated as well and toxic air pollutants may be emitted.
- Designate and dispose of remaining sludge properly; it will typically be hazardous.
- Incorporate secondary containment around the evaporator to catch a spill.

Example of Evaporation

100 gallons of spent soluble machine coolant needs to be disposed. The spent coolant contains:

- *5% tramp oil (5 gallons)*
- *5% emulsified napthenic oil, chlorinated paraffins, and metals (5 gallons)*
- *90% water (90 gallons)*

The spent coolant is placed into an oil-water separator, which removes the 5 gallons of tramp oil. The remaining 5 gallons of emulsified compounds and 90 gallons of water are placed into an evaporator. Only 95% of the total amount of water should be evaporated. In other words, leave 5% of the water in the evaporator (about 4.5 gallons in this scenario). Otherwise, compounds will volatilize, creating toxic air pollution. Excessive evaporation also leads to formation of a baked on residue that is very difficult to clean. At the end of the evaporation process, remove the resulting concentrated solution and dispose of properly. In this example, 9.5 gallons would be removed (5 gallons emulsified compounds and 4.5 gallons water).

"Clean" the solution as much as possible prior to evaporation. This will minimize the evaporation of toxic air pollutants, and prevent fouling of pipes and the evaporator. For spent MWF, this means using an oil-water separator prior to evaporation. Skim oil from the oil-water separator and collect it for disposal.

At the end of the evaporation process, remove and dispose of the concentrated emulsion properly. Note: Oil-water separators do not remove emulsified additives from MWFs.

1. **Service the evaporator at regular intervals and keep a service log.** Make one person responsible for seeing that the log is kept current and work is performed as required.

2. **Carefully regulate the operating temperature of the evaporator.** Use the lowest temperature possible to avoid vaporizing toxic air pollutants. The water in soluble MWF boils at 212° F at sea level and at slightly lower temperatures at higher elevations. Temperature controls should be set and "locked" at or below 212° F, as appropriate.

3. **Make sure the evaporator has emergency temperature and water level shutoffs.** The emergency high temperature shutoff should be set no more than 230° F. The low level water shutoff should be set at five percent of capacity. This seems unimportant to everyone except those who have had their facilities catch fire.

4. **Properly size mist eliminators.** High velocity airflows create water droplets that suspend metals and other toxic air pollutants in the exhaust air stream. Suspended pollutants will be carried out of the stack unless trapped by a mist eliminator. A good vendor will make sure that your evaporator has a properly sized mist eliminator.

Air pollution control authorities regulate evaporation processes that emit toxic air pollutants. Some toxic air pollutants that might be found in spent MWFs include:

- Cadmium compounds
- Chromium (II, III, VI, & metal)
- Oil mist (mineral)
- Lead compounds
- Iron oxide fume (Fe2O3)
- Iron salts
- Aluminum
- Copper
- Selenium
- Borates
- Tin
- Zinc

Currently, there is no minimum of toxic air pollutants that will exempt a business from regulatory review. If a business wishes to evaporate a waste stream that contains or could contain a toxic air pollutant, they should contact their local air authority.

Evaporating spent MWF that designates as dangerous waste is explained in the fact sheet: *Treatment by Generator Treatment-specific Guidance: Evaporation*. Treatment by generator requirements include:

- **Following rules for managing dangerous waste.** For example, containers used to hold dangerous waste MWF must have secondary containment and be labeled "Dangerous Waste" and "Toxic" (Refer to the *Dangerous Waste Regulations*, publication number 92-91, for more information).
- **Counting the spent MWF towards generator status before and after placement into the evaporator.** Businesses that evaporate dangerous waste must log the pounds of dangerous waste being evaporated. The counting rules are explained in Ecology's *Counting Dangerous Waste Under the Dangerous Waste Regulations*, publication number 98-414.

Sump Maintenance

Periodically clean out the MWF sumps and trenches to help keep them free of solid matter that can restrict fluid flow. Solid materials provide excellent areas for microbe growth, which may clog up MWF lines. Disinfect sumps and trenches with non-chlorine bleach or alcohol when fluid is removed. Without the disinfecting step, new fluid will be contaminated as soon as it is added to the sump.

P2 Practices for Maintaining Sumps and Trenches

☑ Cover sumps

Many of the microbes that contaminate fluids are airborne. Covering the MWF sumps keeps out airborne microorganisms, along with dust, cigarette butts, food, and other materials.

☑ Leave machine MWF pumps on during downtime

While the machine is not in operation, leave the MWF circulating through the machine to help aerate the fluid and keep it from becoming stagnant.

☑ Circulate fluid in sump

Use a small pump to circulate fluid in a sump, preventing stagnation and microbial growth in the fluid. Keep the sump size small to give the fluid a greater flow-through rate.

Chip Management

Metal chips are one of the two main waste streams generated at metal fabricating facilities. When large volumes of waste metal are generated, most metal fabricating facilities find that it makes economic sense to recycle their waste chips. Recycling is the standard industry practice for managing waste metal chips.

Recycling Chips

The key pollution prevention issue in recycling metal chips is separating MWFs from the chips. This separation achieves two benefits simultaneously:

- The more fluid recovered, the more fluid recycled and reused, effectively reducing the amount the facility needs to purchase.
- Separating the fluids from the chips also reduces the potential contamination of stormwater when the chips are stored outside, or during loading and transportation. Most metal recyclers require that chips be well drained prior to pick-up.

There are multiple methods for draining chips at metal machining facilities.

- Some facilities manually shut off the chip conveyor for a period of time allowing the fluids to drain back into the machine sump.
- Centrifuges and chip wringers are also commonly used to drain chips. At low RPMs, centrifuges can also be used for separating tramp oils from MWFs.

- A more passive chip draining system consists of drums with screens on top set at the end of the conveyor belt. In this system, the fluid coated chip falls off the conveyor belt onto the screen. Over time, the fluid will drain through the screen and the dry chips can be transported to waste chip storage containers and the collected fluids can be recycled.

Overall, the best method is one that allows the fluid to drain from the metal chip before the fluid has a chance to begin evaporating. This prevents chemical residues from drying on the chips. These residues have the potential to contaminate stormwater.

Facilities normally separate their chips by metal type to get the highest price from their metal recycling company. Metal recyclers may also offer a higher price to a facility if the chips are compressed into a briquette through the use of a briquetting machine. The cost/benefit analysis for purchasing such a machine includes the price of the machine, the price offered for briquettes versus loose chips, and the volume of chips the facility generates.

Storing Chips

Inside storage of waste chips is highly recommended, if enough space exists at the facility. Outside storage introduces the possibility that stormwater will become contaminated from contact with the MWF residue on the waste chips. Depending on the fluid used, the residue may contain metals, oils, and/or chlorinated paraffins. However, if chips need to be stored outside, use the following precautions to avoid stormwater contamination:

- **Drain fluid completely before placing chips in storage containers.** Any fluid or fluid residue has the potential to contaminate stormwater at your facility or when stored at the recycling company.
- **Cover outside chip storage containers.** This will eliminate the possibility that clean rainwater will become contaminated by contact with residue on the chips.
- **Place chip storage containers on a concrete or asphalt surface to prevent spills and leaks to bare ground.** Installing a perimeter berm or curb further reduces the possibility of contaminating soils.
- **Continue draining fluids, if necessary.** If it is necessary to store chips before they are completely drained, be sure that your storage containers allow drainage to continue. Many facilities simply tilt the waste chip dumpster towards one end and excess fluids drain through an opening into a residue container.
- **Check often for leaks.** Be sure that outside storage and residue containers do not have cracks or holes in them.
- **Monitor and maintain containers on a regular basis.** Empty storage or residue containers and do not allow them to overflow.

P2 Practices for Chip Management

☑ Use chip filters

Filters keep the chips and grit created in the machining process from contaminating the MWF sump. The high amount of surface area created by the chips provides an excellent area for microbe growth. Thus, filtering helps lower the bacteria count.

☑ Drain metal chips to recover fluid

Drain metal chips by placing them into a perforated container with a catch basin and reuse the collected MWF. Another option is to manually shut off the chip conveyor for a period of time, allowing the fluids to drain back into the machine sump. This process also creates higher quality chips for recycling. Use a chip wringer or centrifuge to get even more fluid from the chips.

☑ Recycle the metal chips and scrap

Many metal recyclers will take chips but may require chips to be segregated by metal type and free of oil. Chips that are compressed into briquettes using a briquetting machine may bring a higher price.

Spills and General Maintenance

In the metal machining industry, the presence of spilled or leaked MWFs, hydraulic oils, or tapping fluids can cause floor mop water to designate as a dangerous waste. This is especially true if these fluids contain chlorinated paraffins.

You should test and designate your mop water from floor cleaning to determine whether it is dangerous waste. Testing must be done in accordance with the requirements under the state dangerous waste regulations (WAC 173-303-090 and -100). Common dangerous waste constituents to test for include lead, cadmium, chromium, and selenium. Zinc-bearing metals (i.e., brass) and zinc-plated parts often contain lead.

If the MWF or hydraulic oil contains chlorinated paraffins, the mop water should be tested for total halogens. Also, depending on the chemical make-up of some cleaning agents and cleaning solvents, mop water may designate as a dangerous waste.

Mop water disposal options depend on whether or not it is dangerous waste:

Mop water that is NOT dangerous waste:

- May be discharged to a sewer system if the mop water does not exceed the sewer district's limits for oil and grease. Contact your local sewer district for approval.
- Must not be discharged to storm drains, dry wells, or septic systems. Businesses need to know where their drains lead before using them.
- Should not be mixed with spent MWF. See Step 3 on page 11.

Mop water that IS dangerous waste:

- Must be managed as dangerous waste. Management requirements depend on the generator status of the business. For more information on management requirements, refer to the *Dangerous Waste Regulations*, publication number 92-91.
- Must not be mixed with any other non-dangerous wastes, otherwise the entire waste stream becomes dangerous waste and must be managed as such.
- May be shipped off-site by small quantity generators to a permitted treatment, storage, or disposal facility, local moderate risk waste facility, or other permitted solid waste facility (WAC 173-303-070 (8) (b)(iii).
- Must meet two conditions to be discharged to a sewer system: 1) It must be treatable by the local sewer district and 2) before discharge, a business needs to obtain an appropriate permit issued by Ecology or their local sewer district (WAC 173-303-071(3)(a)). This mop water is excluded from dangerous waste counting requirements unless it is treated before discharge. See Ecology's *Domestic Sewage Exclusion*, publication number 94-136, revised 12/04, for more information.

Mop water with characteristics of dangerous waste (ignitable, reactive, corrosive, toxic) must be managed as dangerous waste. The Domestic Sewage Exclusion does not apply to such mop water if the receiving publicly owned treatment works (POTW) cannot treat the waste. You may wish to consider using treatment by generator options, such as evaporation, to reduce the volume of waste.

These suggestions may keep mop water from designating as dangerous waste:

- Don't use mop water to clean up solvent or oily spills.
- Don't mix normal mop water with water that is used during the cleanup of spilled solvent or chlorinated fluids and oils.
- Prevent leaks by properly maintaining equipment.

Absorbent Waste Disposal

The same constituents that can cause mop water to become dangerous waste can also cause floor absorbent to become dangerous waste. These constituents include lead, chrome, selenium, zinc, copper, chlorinated paraffins, solvents, etc. Test according to the requirements of the dangerous waste regulations (WAC 173-303-090 and -100).

Absorbents are often used to clean up wastes that are managed as used oil, such as way oils and spent MWF. It is often incorrectly assumed that these contaminated absorbents may then also be managed as used oil. Ecology's current policy concerning used oil states that:

"Materials that are not dangerous waste and that contain or are otherwise contaminated with used oil in recoverable quantities can be managed as used oil."

Under normal conditions, spent absorbents used to clean up oil spills do not contain recoverable quantities; therefore, they cannot be managed as used oil. Instead, the waste absorbent will need to follow the designation process to determine if it is dangerous waste, as mentioned above. Disposal options for waste absorbents depend on whether or not they are dangerous waste.

Waste absorbents that are NOT dangerous waste:

- Can be disposed of in a dumpster with the approval of the local landfill or solid waste hauler. Use enough absorbent to soak up all of the liquid.

Waste absorbents that ARE dangerous waste:

- Must be managed as dangerous waste.
- May be shipped off-site by small quantity generators to a permitted treatment, storage, or disposal facility, local moderate risk waste facility, or other permitted solid waste facility (WAC 173-303-070 (8) (b)(iii)).

Reduce the need for absorbents or prevent them from designating as dangerous waste:

- Use catch basins or spill pans in place of pads.
- Vacuum spills.
- Use rags or absorbents that can be wrung out and laundered for reuse.

Be sure to reuse, recycle, or properly dispose of recovered liquids.

P2 Practices for Spills and General Maintenance

☑ Fix leaking seals and gaskets

This keeps the fluid where it belongs, instead of on the floor or all over the machine and operator. Even small leaks can waste a surprising amount of fluid over time.

☑ Use pumps, spigots, and funnels

Use pumps, spigots, and funnels when transferring MWF to reduce the amount of lost fluid and the risk of spilling fluids.

☑ Reuse absorbent pads

Use absorbent pads that can be wrung out and reused. This will cut down on the amount of absorbent material discarded as dangerous waste and reduce handling costs. Fewer purchases of fresh absorbent pads will also save money. Another option is to dedicate a mop for the cleanup of oily spills only.

Stormwater Regulations

Ecology's regulations require most industrial facilities to have a stormwater permit. Any facility that discharges stormwater to surface water, or into a storm sewer that leads to surface water, must apply for a stormwater permit. If all of the stormwater from a facility discharges to the ground or a combined storm/ sanitary sewer, a permit is not required. Facilities that need a stormwater permit and fail to apply for one could be subject to legal action.

The permit requires industrial facilities to develop a Stormwater Pollution Prevention Plan. The plan should identify existing and potential sources of stormwater pollution, and describe how the facility will reduce or eliminate that pollution. Additional specific planning requirements are detailed in the permit.

Contact your nearest Ecology regional office if you are uncertain if your facility needs a stormwater permit or you have questions about current practices and possible stormwater impacts at your facility.

Appendix A: Generator Status

A dangerous waste generator is any person, by site, whose act or process produces dangerous waste or whose act first causes a dangerous waste to become subject to regulation. Generator status depends on the amount of dangerous waste of a particular quantity exclusion limit (QEL) generated or accumulated onsite each month. Annual reporting, waste shipment manifesting, and management requirements are different for each generator status.

- Large Quantity Generators (LQGs) have the most stringent requirements.
- Medium Quantity Generators (MQGs) have some reporting and manifesting requirements similar to LQGs.
- Small Quantity Generators (SQGs) have the least stringent requirements.

Dangerous Waste Generator Status

<table>
<tr><th></th><th>If the QEL is 2.2 pounds and the waste is EHW[3]:</th><th>If the QEL is 2.2 pounds and the waste is acute dangerous waste:</th><th>If the QEL is 220 pounds and the waste is EHW or dangerous waste</th></tr>
<tr><td>SQGs generate:</td><td>Less than 2.2 pounds per month</td><td>Less than 2.2 pounds or less at any time</td><td>Less than 220 pounds per month</td></tr>
<tr><td>SQGs accumulate or store:</td><td>2.2 pounds or less at any time</td><td>2.2 pounds or less at any time</td><td>2,200 pounds or less at any time</td></tr>
<tr><td>MQGs generate:</td><td colspan="2" rowspan="2">There is no MQG status for 2.2 pounds waste. If more than 2.2 pounds is generated in a month or accumulated at any time, go straight to LQG status</td><td>At least 220 pounds, but less than 2,200 pounds</td></tr>
<tr><td>MQGs accumulate or store:</td><td>2,200 pounds, or less at any time</td></tr>
<tr><td>LQGs generate:</td><td>2.2 pounds or more per month</td><td>2.2 pounds or more per month</td><td>2,200 pounds or more per month</td></tr>
<tr><td>LQGs accumulate or store:</td><td>More than 2.2 pounds at any time</td><td>More than 2.2 pounds at any time</td><td>More than 2,200 pounds at any time</td></tr>
</table>

[3] Extremely Hazardous Waste: dangerous wastes that persist in hazardous form for several years upon disposal (persistent) and may be concentrated by living organisms through the food chain (bioaccumulative).

Appendix B: Health Concerns

While machinists, machinery mechanics, metalworkers, and other machine operators and setters have the greatest contact with MWFs, workers performing assembly operations can also be exposed if MWFs remain on the machined product. Workers can be exposed to MWFs by skin contact, or by inhaling (breathing in) or ingesting (swallowing) particles, mists, and aerosols.

Although changes in MWF formulations have resulted in safer products, MWFs can still contain substances that are harmful to your health. The most commonly observed illnesses associated with MWF use are:

Skin Problems

Skin contact with MWFs is very common, since MWFs are often applied to the machine tool in large volumes. Workers' skin can be covered with mist or spray while machining, or by handling parts and tools covered with residual fluid. MWF-soaked rags and clothing can prolong the length of time that the MWF is in contact with the skin. MWFs have been shown to cause numerous skin problems, ranging from dermatitis due to irritation or allergy (very common) to skin cancer (relatively rare).

Cancer

Evidence suggests exposures to some MWFs can increase workers' risk for cancer of the skin, esophagus, stomach, pancreas, larynx, colon, rectum, and other organs. However, the link between MWF exposure and cancer is controversial, since the epidemiological studies were performed on workers who were exposed to MWFs as long as 20-30 years ago. Before the 1950s and 1960s, some MWFs contained relatively high concentrations of substances suspected to cause cancer (mostly polycyclic aromatic hydrocarbons and nitrosamines).

Since then, industry actions have resulted in substantially reduced concentrations of these substances in MWFs. However, it is unclear whether these changes have eliminated the cancer risk because it is not known if the cancer-causing substances are present in the MWFs themselves, or whether they are constituents of MWF additives or contaminants.

Lung Disease

Inhaling the aerosols, particles, and mists generated by MWFs while machining is a common source of exposure. Several lung diseases are associated with inhaling MWFs, including asthma, acute airway irritation, hypersensitivity pneumonitis, lipid pneumonia, chronic bronchitis, and possibly lung cancer. NIOSH researchers suggest that machinists face an increased risk of asthma at concentrations below the current permissible exposure limits (PELs).

Occupational Standards that Apply to MWFs

The two most important occupational standards that apply to MWFs are those for "particulates not otherwise regulated" and "oil mists." In Washington State, the PEL for "total" particulates is ten milligrams of total particulate per cubic meter of air (10 mg/m3), based on an 8-hour time weighted average (TWA). This means that exposures to total particulates can legally exceed 10 mg/m3 at times, but only if concentrations are below 10 mg/m3 at other times, so that the average exposure for any 8-hour work shift is 10 mg/m3 or less. The PEL for oil mists is an 8-hour TWA of 5 mg/m3. PELs also exist for certain additives and other MWF constituents.

The Department of Labor and Industries has done substantial work with health concerns in the metal fabrication industry through their Safety & Health Assessment & Research for Prevention (SHARP) Program. Find more information on their website at www.lni.wa.gov/safety/research/pubs/default.asp.

Another good source for information about metal fabrication is on the Pacific Northwest Pollution Prevention Resource Center's website.

Appendix C: Definitions

Biocide	A chemical additive used to kill organisms in MWFs. Biocides include bactericides and fungicides. Bactericides kill bacteria and fungicides kill fungus.
Chlorinated	Contains chlorine.
Coalescer	Material that is oleophilic (attracts oil) with a large surface area. Tiny drops of suspended oil attach to the surface and when enough attaches, it forms a clump and breaks away and floats to the surface.
Designation	A step-by-step process for determining if a waste is a dangerous waste and what kind it is.
Dioxins	A group of very toxic chemical compounds that share certain chemical structures and biological characteristics. Dioxins break down very slowly and studies have shown that exposure to dioxins at high enough levels may cause a number of adverse health effects, including cancer.
Emulsifier	A substance that allows two substances to mix (such as water and oil), without separating.
Emulsion	A mixture of two or more liquids where one liquid does not dissolve within the other, such as oil and water, but is dispersed evenly within the mixture.
Extra pressure (EP) additives	These additives are commonly composed of halogenated paraffins. The halogen in the compound interacts with the metal work piece and adds extra lubrication for increased tool life.
Extremely hazardous waste	Dangerous wastes that persist in hazardous form for several years upon disposal (persistent) and may be concentrated by living organisms through the food chain (bioaccumulative).
Halogenated	A compound containing any one of the halogen series of elements. These are commonly chlorine, bromine, and iodine in MWFs.
Metalworking fluid (MWF)	MWF is used in machining metal parts to cool and lubricate the tool pieces, thus prolonging the life of the tool.
Oil skimmers	Oil skimmers remove the tramp oil and debris from the surface of the MWF. They use a rotating disk, a moving belt, or a moving rope that dips into the tank, and attracts the tramp oil to its surface. The tramp oil is then scraped off the disk, belt, or rope and into a container.
Paraffin	Paraffins are long, straight carbon chain organic molecules with no cyclic or ring structures in their molecular makeup. They are primarily composed of carbon and hydrogen and may have halogens attached for extra properties.

Secondary containment	A method or structure used to contain unexpected releases, leaks, or spills of toxic or hazardous substances.
Semi-synthetic fluid	This fluid is the same as the synthetic fluid (below), but has a small amount of oil added (2-20%).
Soluble oil fluid	A concentrate of severely hydro-treated oils combined with large amounts of emulsifiers. This combination allows the fluid to mix with water into a solution.
Straight oil fluid	A fluid that consists of solvent-refined or hydro-treated petroleum oil or other oils of animal or vegetable origin.
Sump	A tank that holds metalworking fluid.
Swarf	Fine chips for filings of stone, metal, or other material produced by a machining operation.
Synthetic fluid	A concentrate that is added to water to form an aqueous metalworking fluid. The concentrate does not contain crude oil, or oil of any other kind. This fluid is commonly made up of amines, nitrites, nitrates, phosphates, soaps, and glycol.
Tramp oil	Tramp oil is most commonly made up of way oil (the lubrication used for the sliding parts of the machine) and hydraulic oils that fall, or are carried into the metalworking fluid.
Way oil	A lubricating oil made and used specifically for machine tool ways (guiding surfaces on the bed of a machine).