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An American National Standard

Standard Practice for Selection and Safe Use of Water-Miscible and Straight Oil Metal Removal Fluids[1]

This standard is issued under the fixed designation E1497; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice sets forth guidelines for the selection and safe use of metal removal fluids, additives, and antimicrobials. This includes product selection, storage, dispensing, and maintenance.

1.2 Water-miscible metal removal fluids are typically used at high dilution, and dilution rates vary widely. Additionally, there is potential for exposure to undiluted metal removal fluid as manufactured, as well as metal removal fluid additives and antimicrobials.

1.3 Straight oils generally consist of a severely solvent-refined or hydro-treated petroleum oil, a synthetic oil, or other oils of animal or vegetable origin, including oils that are modified for performance characteristics (for example, esterified rapeseed oil, and so forth). Straight oils are not intended to be diluted with water prior to use. Additives are often included in straight oil formulations.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D7049 Test Method for Metalworking Fluid Aerosol in Workplace Atmospheres
E1302 Guide for Acute Animal Toxicity Testing of Water-Miscible Metalworking Fluids
E1542 Terminology Relating to Occupational Health and Safety
~~E1972~~E1687 ~~Practice for Minimizing Effects of Aerosols in the Wet Metal Removal Environment~~Test Method for Determining Carcinogenic Potential of Virgin Base Oils in Metalworking Fluids ~~(Withdrawn 2017)~~
E2144 Practice for Personal Sampling and Analysis of Endotoxin in Metalworking Fluid Aerosols in Workplace Atmospheres

[1] This practice is under the jurisdiction of ASTM Committee E34 on Occupational Health and Safety and is the direct responsibility of Subcommittee E34.50 on Health and Safety Standards for Metal Working Fluids.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

E2148 Guide for Using Documents Related to Metalworking or Metal Removal Fluid Health and Safety
E2169 Practice for Selecting Antimicrobial Pesticides for Use in Water-Miscible Metalworking Fluids
E2275 Practice for Evaluating Water-Miscible Metalworking Fluid Bioresistance and Antimicrobial Pesticide Performance
E2523 Terminology for Metalworking Fluids and Operations
E2693 Practice for Prevention of Dermatitis in the Wet Metal Removal Fluid Environment
E2889 Practice for Control of Respiratory Hazards in the Metal Removal Fluid Environment

2.2 *U.S. Code of Federal Regulations:*[3]
29 CFR 1910.1200 Hazard Communication
29 CFR 1910.132 General Requirements (Personal Protective Equipment) (e.g. gloves, sleeves, aprons, are critical applications that avoid or reduce exposure)
29 CFR 1910.133 Eye and Face Protection
29 CFR 1910.134 Respiratory Protection
29 CFR 1910.138 Hand Protection
29 CFR 1910.1048 Formaldehyde
29 CFR 1910 Appendix B to Subpart I Non-mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection
40 CFR 156 Labeling Requirements for Pesticides and Devices
40 CFR Chapter I, Subchapter N Effluent Guidelines and Standards

2.3 *Other Documents:*
~~Management of the Metal Removal Fluid Environment: A Guide to Safe and Efficient Use of Metal Removal Fluids~~Metalworking Fluids: Safety and Health Best Practices Manual[4]

3. Terminology

3.1 For definitions and terms relating to this practice, refer to ~~Terminology~~Terminologies E1542 and E2523.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *contaminant, n*—substances contained in in-use metal removal fluids that are not part of the as-received fluid, such as abrasive particles, tramp oils, cleaners, dirt, metal fines and shavings, dissolved metal and hard water salts, bacteria, fungi, microbial decay products, and waste.

3.2.2 *control, v*—to prevent, eliminate, or reduce hazards related to use of metal removal fluids in metal removal processes and to provide appropriate supplemental or interim protection, or both, as necessary, to employees.

3.2.3 *dermatitis, n*—an inflammatory response of the skin.

3.2.3.1 *Discussion*—
Dermatitis can result from a wide variety of sources and processes. The most common origins are irritant or allergic responses to a chemical or physical agent. Signs and symptoms that typify the initial onset of dermatitis include: erythema (redness); edema (swelling); pruritis (itching); and, vesiculation (pimple-like eruptions). In more severe cases, fissures (deep cracks) and ulcers (open sores) may develop. The condition is usually reversible when exposure to the causative agent ceases. More severe cases may require more time and some medical attention. Individuals who have fair complexions appear to be at higher risk for dermatitis.

3.2.4 *emergency, n*—any occurrence, such as but not limited to equipment failure, rupture of containers, or failure of control equipment that results in an uncontrolled release of a significant amount of metal removal fluid.

3.2.5 *employee exposure, n*—contact with the metal removal fluid, components, and contaminants by inhalation, skin contact, eye contact, or accidental ingestion.

3.2.6 *endotoxins, n*—lipopolysaccharides derived from the outer membrane of Gram-negative bacteria. These compounds can be pyrogenic (fever producing) at low airborne concentrations.

3.2.7 *folliculitis, n*—an inflammatory response to excess oil in hair follicles

[3] Code of Federal Regulations available from United States Government Printing Office, Washington, DC ~~20402.~~20402 or at eCFR : Home.
[4] Available from ~~ORC Worldwide, Inc., 1800 K Street NW, Suite 810, Washington, DC 20006.~~OSHA at Metalworking Fluids - Metalworking Fluids: Safety and Health Best Practices Manual | Occupational Safety and Health Administration (osha.gov).

3.2.8 *metal removal fluids, n*—the subset of metalworking fluids that are used for wet machining or grinding to produce the finished part.

3.2.8.1 *Discussion*—

Metal removal fluids addressed by this practice include straight or neat ~~oils,~~oils not intended for further dilution with water, and water-miscible soluble oils, semisynthetics, and synthetics, which are intended to be diluted with water before use. Metal removal fluids become contaminated during use in the workplace with a variety of workplace substances including, but not limited ~~to,~~to: abrasive particles, tramp oils, cleaners, dirt, metal fines and shavings, dissolved metal and hard water salts, bacteria, fungi, microbiological decay products, and waste. These contaminants can cause changes in the lubricity and cooling ability of the metal removal fluid as well as have the potential to adversely affect the health and welfare of employees in contact with the contaminated metal removal fluid.

3.2.9 *metal removal process, n*—a manufacturing process that removes metal during shaping of a part, including machining processes, such as milling, drilling, turning, broaching, and tapping, and grinding processes, as well as honing and lapping, and other similar mechanical operations in which metal is removed to produce a finished part.

3.2.10 *tramp oil, n*—oil and oil-soluble additives, sometimes insoluble, resulting from leaking hydraulic or gear oil, or sacrificial spindle oil, or slide way lubricant, that contaminate the metal removal fluid. Tramp oils may contaminate the metal removal fluid with components that are emulsifiable but which were not part of the metal removal fluid as formulated.

3.2.11 *wet metal removal fluid environment, n*—the workplace environment where fluids are used to cool and lubricate machining or grinding operations.

4. Significance and Use

4.1 Use of this practice will improve management and control of metal removal fluids. The proper management and use will reduce dermal and other occupational hazards associated with these fluids.

4.1.1 Guide E2148 covers information on how to use documents related to health and safety of metalworking and metal removal fluids, including this document. Documents referenced in Guide E2148 are grouped as applicable to producers, to users, or to all.

4.1.2 ~~Practice~~Practices E2693 and E2889 ~~augments~~augment the information provided in this practice by providing information on prevention of dermatitis and on approaches to reducing exposures to different types of metal removal fluid related aerosols.

5. Routes of Metal Removal Fluid Exposure and Effects of Overexposure

5.1 Routes of exposure to metal removal fluids include eye contact, inhalation, ingestion, and dermal contact. Exposure may be through contact with the fluid or by contact with airborne fluid mists, vapor, splashing, or residual fluid on machinery, parts, or clothing.

5.2 Eye contact may cause mild to severe irritation, depending on the concentration and specific characteristics (for example, alkalinity) of the product.

5.2.1 Prevent eye contact. Ensure that splash guarding is functional or wear eye protection appropriate for the level of splashing or spraying encountered, such as safety glasses with side shields or goggles. See 29 CFR 1910.133.

5.3 Inhalation may cause respiratory irritation or other types of respiratory effects (see 5.3.4).

5.3.1 Reduce exposure to mists and vapors. Permissible exposure levels (OSHA) of the fluid and component ingredients shall not be exceeded. Engineering controls, such as machine enclosures and exhaust ventilation or substitution with low-mist products, are preferred methods to control exposure.

5.3.2 Test Method D7049 can be used for the determination of both particulate total matter and extractable mass metal removal fluid aerosol concentrations in a range of 0.05 to 5 mg/m^3 in workplace atmospheres.

5.3.3 See Practice ~~E1972~~E2889 for guidelines for ~~minimizing effects of aerosols~~ controlling respiratory hazards in the wet metal removal environment.

5.3.4 For additional information, see Criteria for a Recommended Standard Occupational Exposure to Metal Working Fluids.[5]

5.4 Ingestion may cause gastrointestinal disturbances.

5.5 Prolonged or repeated dermal contact may cause dry and cracked skin, rash, redness, burning, or itching. Skin abrasions can intensify the effects. Some metal removal fluids and additives may sensitize the skin of affected employees, which can result in a response to very low levels of exposure. See Practice E2693.

6. Fluid Product Selection

6.1 Proper product selection is fundamentally critical to reducing or eliminating respiratory conditions and occupational dermatitis associated with exposure to metal removal fluids. The metal removal fluids should perform as intended while providing the safest working conditions. The selection of a metal removal fluid for each different operation must consider the inherent limitations of the product. Water-miscible fluids not properly selected are likely to be used at higher concentrations than other products more appropriate to the operation.

6.1.1 Consult ~~"Management of the Metal Removal Environment" and "Metalworking Fluids Evaluation Guide"~~"Metalworking Fluids: Safety and Health Best Practices Manual" for further information on selecting the proper fluid for the application. In addition, your fluid supplier, chemical manager, or corporate subject matter expert should be able to provide information on the proper selection of the appropriate fluid and recommended concentration for use.

6.2 Potential health hazards can be reduced by careful fluid selection and substitution. See Guide E1302 and consult "Metalworking Fluids: Safety and Health Best Practices Manual" for further information.

6.3 The metal removal fluid manufacturer's safety data sheet (SDS) and toxicological data must be complete and must provide all applicable information on metal removal fluids, ingredients, and additives. This data shall be reviewed in order to evaluate potential hazards and establish appropriate control procedures.

6.4 The metal removal fluid manufacturer must provide all applicable health, safety, and toxicological data on additives, including rust inhibitors, product stabilizers, and antimicrobials of all types, odorants, and dyes. These data shall be reviewed for their impact on the metal removal fluid mixture to which they are added. Additives shall only be used with the agreement of the metalworking fluid manufacturer and the appropriate health and safety personnel in the plant.

6.5 As supplied, antimicrobials and other additives for tankside addition may present greater health and safety risks than the metal removal fluid. Further, additives and antimicrobials are less likely to be handled automatically, or with special delivery equipment, than metal removal fluid concentrate so greater care and attention are required to reduce risks of exposure.

6.5.1 To avoid recognized health and safety hazards, metal removal fluid formulations shall not contain nitrites or nitrosating agents, petroleum oils that are not severely refined, chlorinated paraffins that have been identified as carcinogens, and other constituents listed in applicable purchase specifications. See Test Method E1687.

6.6 All applicable disposal criteria must be met. If there is an on-site wastewater treatment plant, consult with the operator at the time of fluid selection.

7. Water Quality and Treatment

7.1 Water constitutes more than 90 % of the diluted water-miscible metal removal fluid mixture. Water shall be evaluated for hardness, alkalinity, high conductivity, turbidity, corrosivity, biological contaminants, and other factors that may lead to increased use of metal removal fluid concentrate, additives, or antimicrobials, or a combination thereof. Good water quality is fundamental

[5] Available from U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 4676 Columbia Pkwy., Cincinnati, OH ~~45226.~~ 45226 or at Occupational Exposure to Metalworking Fluids (98-102) | NIOSH | CDC.

~~[7] Available from National Center for Manufacturing Sciences, 3025 Boardwalk, Ann Arbor, MI 48108.~~

~~[8] Available from Occupational Safety and Health Administration, Washington, DC 20402, or at http://www.osha.gov/SLTC/metalworkingfluids/metalworkingfluids_manual.html.~~

to proper metal removal fluid use, will help reduce use of additives and antimicrobials, and lengthen fluid life. Consult your metal removal fluid supplier, chemical manager, and corporate subject matter expert.

7.2 Where suitable water is not available, water treatment shall be designed to produce enough water of sufficient quality for metal removal fluid use. Treated water shall be readily available from holding tanks large enough to meet anticipated daily requirements. Treated water quality, including biological contaminants, must be monitored. Tests performed depend on the type of water treatment used. Guidance on water quality and water treatment may be obtained from the metal removal fluid manufacturer.

8. Receipt and Handling of Fluid and Additives

8.1 Before the fluid is handled, the user shall have an accurate and current safety data sheet as required by the OSHA Hazard Communication Standard. See 29 CFR 1910.1200.

8.2 Precautions shall be taken to ensure the fluid is, without modification, the fluid represented in the ~~material safety data sheet.~~Safety Data Sheet.

8.3 Users should be informed prior to modifications in fluid formulation so that they may assess potential effects on health and safety and productivity. Seemingly insignificant changes in fluid composition may result in adverse interaction with other additives or may produce unforeseen changes in fluid performance.

8.4 The user shall ascertain that containers, when received, are properly labeled and can be easily identified. Specific labeling requirements are set forth in 29 CFR 1910.1200, 40 CFR 156, and other applicable regulations.

8.4.1 Concentrated additives may be corrosive. An eyewash station, at a minimum, should be readily accessible to the user.

8.5 Containers filled in the user's plant shall be properly cleaned, inspected, and labeled, whether used for transport or storage.

8.6 A system shall be in place to ensure bulk deliveries of metal removal fluids are not inadvertently delivered to the wrong storage tank.

8.7 Drums and other portable containers shall be stored indoors or otherwise protected from the weather to protect labels, reduce heating by exposure to sunlight, and reduce rusting of steel containers. Metal removal fluid concentrates and additives shall be stored separately from incompatible materials, including acids and oxidizers. They shall also be protected from sources of flame, heat, or ignition and protected from freezing, which can lead to separation or gelation.

9. Metal Removal Fluid Sump and System Design

9.1 Where possible, use the following design practices for the metal removal fluid sump and system to maintain the chemical integrity of the fluid and to reduce or eliminate contamination.

9.2 Reduce hydraulic fluid contamination by maintaining hydraulic systems and repairing leaks, by using mechanical clamping, or by locating hydraulic systems external to the metalworking fluid mainstream.

9.3 Separate lubricating oils from metal removal fluids where possible. The metal removal fluid should not be diverted onto the machine ways, unless it is specifically designed to replace way lubricants.

9.4 Design flumes to remove chips and other debris to the metal removal fluid central system as efficiently as possible, while reducing splashing and misting.

9.5 Include machine bases chip shed plates and sloped floors, which should allow continuous, direct draining to the metal removal fluid central system. Use design features that reduce areas of chip accumulation and stagnation or facilitate regular removal.

9.6 Use oil skimmers to remove non-emulsified, floating tramp oil.

9.7 Use centrifuges and coalescers to remove dispersed and partially emulsified tramp oil.

9.8 Use chip conveyors and modified chip conveyors with filtration devices to remove particulates from the metal removal fluid.

9.9 Review metal removal fluid circulation systems, and reduce or eliminate as appropriate, stagnant areas in pipes or other areas with infrequent fluid circulation.

10. Antimicrobial Pesticides and Control of Microorganisms in Metal Removal Fluids

10.1 Microorganisms can grow in all metal removal fluids, sometimes producing odors, irritation, and reducing product performance. Antimicrobial pesticides are often incorporated into water-miscible metal removal fluid formulations and are commonly added to machine sumps and to centralized water-miscible metal removal fluid systems to control microbial growth. Straight oils that become contaminated with water can also support the growth of bacteria.

10.2 Only antimicrobial pesticides that are registered for use in metalworking fluids by the applicable regulatory agency (the Environmental Protection Agency (EPA) in the United States) shall be used in metal removal fluids. Antimicrobial pesticide labels state approved uses.

10.3 Antimicrobial pesticides are designed to kill microorganisms and therefore have significant biological activity. To avoid potential for harm by mishandling or misapplication, antimicrobial pesticides must be handled with care. The user shall read, understand, and follow all appropriate instructions for handling, storage, and use of each antimicrobial pesticide as specified by the antimicrobial pesticide manufacturer on the safety data sheet.

10.4 Antimicrobial pesticides and combinations of antimicrobial pesticides should be evaluated for stability and efficacy in the specific fluid being used or under consideration prior to use. The use of ineffective antimicrobial pesticides may add to the toxicological burden of the metal removal fluid. See Practices E2275 and E2169.

10.5 Certain antimicrobial pesticides may release formaldehyde in use. Review fluid and antimicrobial pesticide SDS information, and consult your antimicrobial pesticide supplier or metal fluid supplier, or both. See 29 CFR 1910.1048.

10.5.1 As discussed in Practice E2169, no individual antimicrobial pesticide is appropriate for all applications. Antimicrobial pesticides differ in their spectra of activities, speeds of kill, persistence in the treated fluid, and compatibilities with other MWF constituents. All antimicrobial pesticides should be used with an understanding of how these variables will affect their performance in a given system.

10.6 Endotoxin in metal removal fluids and their aerosols may present potential respiratory health hazards to workers who inhale them. See Practice E2144 and consult your metal removal fluid supplier, chemical manager, and corporate health and safety personnel for further information.

10.7 Develop procedures for antimicrobial pesticide additions to individual machine sumps and to central metal removal fluid systems that are suited to the location's specific needs. Request the biocide manufacturer or distributor and metal removal fluid manufacturer to assist in the development of these procedures. Antimicrobial pesticides are to be added judiciously—in conformance with the manufacturer's recommendations and all applicable laws and regulations (for example, the Federal Insecticide, Fungicide and Rodenticide Act in the United States) as specified on the container label—and only when needed as determined by those developed procedures. Loss of apparent antimicrobial activity may be due to development of chemical incompatibility or development of resistant populations, or both.

10.8 Antimicrobial pesticides should be stored in their original containers and stored in secured areas to prevent unauthorized use.

10.9 Antimicrobial pesticides shall be added to the metal removal fluid system at a location that will ensure rapid and complete mixing so as to avoid excessive localized concentrations. Add antimicrobial pesticides slowly to ensure mixing and avoid splashing. Mechanical transfer equipment may be used to make antimicrobial pesticide additions to reduce the likelihood of skin or eye contact.

10.10 Some antimicrobial pesticides have a limited shelf life. Rotate stock regularly and use antimicrobial pesticides before the expiration data (if any). Contact the antimicrobial pesticide supplier for additional information on use, handling, or disposal.

11. Dermatitis

11.1 As formulated and used in accordance with manufacturer's directions, diluted water-containing metal removal fluids and water-immiscible oils do not cause irritant contact dermatitis. Occupational dermatitis has been associated with exposure to as-received metal removal fluid concentrates as well as to in-use metal removal fluids in some individuals.

11.2 Dermatitis resulting from exposure to metal removal fluids may be either irritant contact dermatitis or allergic contact dermatitis.

11.2.1 Irritant contact dermatitis may be caused by exposure of some individuals to metal removal fluid ~~concentrates,~~concentrates; higher than recommended in-use metal removal fluid ~~concentrations, high alkalinity, solvents,~~ concentrations; high-alkalinity solvents; metal shavings or fines contained in the fluid from a malfunctioning filter or dirty shop ~~rags,~~rags; or hand washing with abrasive soaps.

11.2.1.1 The longer the exposure to an irritant, the greater the possibility for skin irritation to develop.

11.2.1.2 Activities outside work, such as gardening, painting, or car repair, may contribute to dermatitis.

11.2.2 Allergic contact dermatitis may be caused by exposure of sensitive individuals to some dissolved or suspended metal contaminants, for example, chromium, cobalt, or nickel, in the metal removal fluid, or some contained ingredients, including some antimicrobial pesticides or odorants.

11.2.2.1 The longer the exposure to an irritant, the greater the possibility for skin sensitization to develop in sensitive individuals.

11.3 Any material or activity that abrades the skin or removes natural oils from skin can cause dermatitis or predispose skin to its onset. Environmental factors such as dry air, extreme cold and changing humidity, or idiopathic factors, such as normal aging, may also predispose the skin to dermatitis.

11.4 Folliculitis (oil acne) may be caused by use of straight oils without proper skin protection.

11.5 Bacteria in water-containing metal removal fluids do not cause dermatitis. Certain bacteria and fungi may aggravate or exacerbate the situation and cause a secondary infection.

12. Prevention of Dermatitis Associated with Occupational Exposure to Metal Removal Fluids

12.1 See Practice E2693. Preventive steps include controlling metal removal fluid concentration and contamination; avoiding prolonged skin contact with the fluid, fluid residues, soiled rags, and clothing; and washing exposed skin with warm water and a mild hand cleaner and gently but thoroughly drying prior to each break and before eating. Proper skin care at home or off work is very important.

12.2 Lack of management of and maintenance of metal removal fluid systems is the most significant contributor to occupational dermatitis associated with exposure to metal removal fluids.

12.2.1 Excess tramp oil, which can carry metallic fines, may cause dermatitis due to mechanical abrasion of the skin with the carried fines.

12.2.2 Water-miscible metal removal fluids that are not carefully controlled for concentration or which contain higher than recommended concentrations of additives can be much more irritating than fluids that are operating at the manufacturer's recommended concentration.

12.2.3 Malfunctioning or insufficient filters may increase suspended particulate, such as grinding swarf, abrasive wheel residue, and metallic fines.