Designation: E 1972 – 04

An American National Standard

Standard Practice for Minimizing Effects of Aerosols in the Wet Metal Removal Environment[1]

This standard is issued under the fixed designation E 1972; 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 minimizing effects of aerosols in the wet metal removal environment.

1.2 This practice incorporates all practical means and mechanisms to minimize aerosol generation and to control effects of aerosols in the wet metal removal environment.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1356 Terminology Relating to Sampling and Analysis of Atmospheres

E 1302 Guide for Acute Animal Toxicity Testing of Water-Miscible Metalworking Fluids

E 1370 Guide for Air Sampling Strategies for Worker and Workplace Protection

E 1497 Practice for Safe Use of Water-Miscible Metalworking Fluids

E 1542 Terminology Relating to Occupational Health and Safety

E 2144 Practice for Personal Sampling and Analysis of Endotoxin in Metalworking Fluid Aerosols in Workplace Atmospheres

E 2148 Guide for Using Documents Related to Metalworking or Metal Removal Fluid Health and Safety

E 2169 Practice for Selecting Antimicrobial Pesticides for Use in Water-Miscible Metalworking Fluids

E 2250 Method for Determination of Endotoxin Concentration in Water Miscible Metal Working Fluids

PS 42 Provisional Test Method for Metal Removal Fluid Aerosol in Workplace Atmospheres

2.2 *OSHA (US Occupational Safety and Health Administration) Standards:*[3]

29 CFR 1910.134 Use of Respiratory in the Workplace

29 CFR 1910.1200 Hazard Communication

2.3 *Other Documents:*

ANSI Technical Report B11 TR 2–1997, Mist Control Considerations for the Design, Installation and Use of Machine Tools Using Metalworking Fluids[4]

Metal Working Fluid Optimization Guide, National Center for Manufacturing Sciences[5]

Metal Removal Fluids, A Guide To Their Management and Control, Organization Resources Counselors, Inc.[6]

Industrial Ventilation: A Manual of Recommended Practice.[7]

Criteria for a Recommended Standard: Occupational Exposure to Metalworking Fluids[8]

Metalworking Fluids: Safety and Health Best Practices Manual[9]

3. Terminology

3.1 For definitions and terms relating to this guide, refer to Terminology D 1356 and E 1542.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dilution ventilation, n*—referring to the supply and exhaust of air with respect to an area, room, or building, the

[1] This guide 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 Metalworking Fluids.

Current edition approved April 1, 2004. Published May 2004. Originally approved in 1998. Last previous edition approved in 1998 as E 1972 - 98.

[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.

[3] Code of Federal Regulations available from United States Government Printing Office, Washington, DC 20402.

[4] Available from Association for Manufacturing Technology, 7901 Westpark Drive, McLean VA 22102.

[5] Available from National Center for Manufacturing Sciences, Report 0274RE95, 3025 Boardwalk, Ann Arbor, MI 48018.

[6] Available from Organization Resources Counselors, 1910 Sunderland Place, NW., Washington, DC 20036 or from members of the Metal Working Fluid Product Stewardship Group (MWFPSG[SM]). Contact Independent Lubricant Manufacturers Association, 651 S. Washington Street, Alexandria, VA 22314, for a list of members of the MWFPSG[SM].

[7] Available from American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

[8] Available from U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, OH 45226.

[9] Available from US Occupational Health and Safety Administration, 200 Constitution Avenue NW, Washington, DC 20210 or at http://www.osha.gov/SLTC/metalworkingfluids/metalworkingfluids_manual.html

dilution of contaminated air with uncontaminated air for the purpose of controlling potential health hazards, fire and explosion conditions, odors, and nuisance type contaminants, from Industrial Ventilation: A Manual of Recommended Practice.

3.2.2 *extractable mass, n*—the material removed by liquid extraction of the sampling filter using a mixed-polarity solvent mixture as described in Test Method PS 42.

3.2.2.1 *Discussion*—This mass is an approximation of the metal removal fluid portion of the workplace aerosol.

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

3.2.3.1 *Discussion*—Metal removal fluids addressed by this guide include straight or neat oils, not intended for further dilution with water, and soluble oils, semisynthetics, and synthetics, all of which are intended to be diluted with water before use.

3.2.4 *metal removal fluid aerosol, n*—Aerosol generated by operation of the machine tool itself as well as from circulation and filtration systems associated with wet metal removal operations and may include airborne contaminants of a microbial origin.

3.2.4.1 *Discussion*—Metal removal fluid aerosol does not include background aerosol in the workplace atmosphere, which may include suspended insoluble particulate.

3.2.5 *total particulate matter, n*—the mass of material sampled through the 4-mm inlet of a standard 37-mm filter cassette when operated at 2.0 L/min, as described in Test Method PS 42.

3.2.5.1 *Discussion*—As defined in Test Method PS 42, total particulate matter is not a measure of the inhalable or thoracic particulate mass.

4. Significance and Use

4.1 Use of this practice will minimize occupational exposure to aerosols in the wet metal removal environment.

4.2 Excessive exposures to metal removal fluid aerosols are associated with machinist complaints of respiratory irritation.

4.3 Through implementation of this practice and incorporation of a metal removal fluid management program, appropriate product selection, appropriate machine tool design, selection, and maintenance, and control of microorganisms, users should be able to minimize complaints of machinist respiratory irritation.

5. Metal Removal Fluid Management

5.1 Management of metal removal processes is the most important step in minimizing exposure to metal removal fluid aerosols. As factors affecting aerosol generation are interdependent, a systems approach to metal removal process management will be the most effective approach.

5.2 Aerosolization of metal removal fluids may result in airborne exposure not only to the formulated components of the fluid, but also to contaminants introduced into the fluid systems while in use, including microbial contaminants.

5.3 Establish a metal removal fluid control program. Additional detailed guidance may be found in Practice E 1497 and in Metal Removal Fluids, A Guide To Their Management and Control. Consult with your metal removal fluid suppliers.

6. Product Selection

6.1 Fluids vary in their misting characteristics. Select fluids with an understanding of their misting characteristics, bearing in mind available engineering control measures. Some fluids mist less, other factors being equal. Misting characteristics may change significantly with contamination. Some fluids retain entrained air, causing a significant increase in mist generation, possibly in areas away from the metal removal fluid operation. Polymeric additives may be useful in reducing aerosol from straight or neat oils and some water-miscible metal removal fluids. Components or contaminants may be more concentrated in the aerosol phase relative to their concentrations in the bulk fluid.

6.2 Practice E 1497 and Metal Removal Fluids, A Guide To Their Management and Control describe product selection criteria. While specifically directed towards water-miscible metalworking fluids, the same principles generally apply to selection of neat or straight metal removal fluids.

6.3 Select fluids with an understanding of their acute and chronic toxicity characteristics. Guide E 1302 references procedures to assess the acute toxicity of water-miscible metalworking fluids as manufactured. Review the material safety data sheet, required by 29 CFR 1910.1200, for health and safety information for the metal removal fluids being considered for the operation.

6.4 With due consideration for available engineering controls, select fluids that minimize components that may be irritating or may produce objectionable odors.

6.5 As the concentration of metal removal fluid in the machining system sump or reservoir increases, the level of chemicals in the metal removal fluid aerosol increases and the net exposure is greater. Maintaining proper metal removal fluid concentration while in use enhances machining performance and minimizes exposure potential.

7. Machine Tool Design, Selection, and Maintenance

7.1 ANSI B-11 TR 2-1997 provides guidance concerning consideration for the design of metalworking fluid delivery systems, of machine tools, of machine enclosures for the control of airborne contaminants, of exhaust ductwork from machine tool enclosures, and of mist collectors, and guidelines for testing collection systems. Users of this practice should be well-versed in these considerations and implement them when practical where occupational exposures to metal removal fluids is expected to occur.

7.2 Design metal removal fluid delivery systems to minimize generation of metal removal fluid aerosols. For transfer line machines, as the earliest operation in the line is often the heaviest cut, early operations may contribute most to metal removal fluid aerosol generation.

7.3 Maintain metalworking fluid delivery system components, including pumps. Leaking seal packing, leaking mechanical seals, and leaking ports in delivery pumps entrain air in the metal removal fluid, significantly increasing aerosol generation.

7.4 Cover flumes and other sources of aerosol generation. Vent them to the metal removal fluid reservoir, if feasible, to minimize release of aerosol or to maintain negative pressure.

7.5 Select new machining and grinding equipment with enclosures and appropriate ventilation that minimizes generation of metal removal fluid aerosols in the workplace atmosphere.

7.6 Maintain existing equipment enclosures and guarding to minimize release of aerosol. Restore missing equipment and enclosures. If enclosures are not maintained or guarding is removed, larger particles may escape through openings in the enclosure.

7.7 Retrofitting existing equipment should be considered using ANSI B-11 TR 2-1997 as a guide. Unless properly designed and constructed, retrofits may not significantly capture metal removal fluid aerosols.

7.8 Properly design and maintain exhaust ductwork from machine tool enclosures. ANSI B 11 TR 2-1997 may be used as a guide. Inspect and clean ductwork regularly, and repair ductwork not in good working order.

7.9 Properly design and maintain mist collectors, ANSI B 11 TR 2–1997 may be used as a guide. Other technologies may be appropriate. Poorly maintained mist collectors may increase metal removal fluid aerosol concentrations in workplace atmospheres. Check air cleaner filters and clean or replace as appropriate. Do not allow collected aerosol to drain back into the fluid system.

7.10 Measure exhaust airflow and compare to design specification. Make adjustments or repairs as appropriate.

7.11 Evaluate each workplace location in terms of the number of machine tools in a given area, the types of operations performed, existing ventilation patterns, ceiling height, and ultimate disposition of the collected mist.

8. Metal Removal Fluid Aerosol Exposure

8.1 Metal removal fluid aerosols consist of a broad range of particle sizes. Smaller particles are more easily captured by machine tool ventilation exhaust, but may pass through an air cleaner. Larger aerosol particles are more likely to be controlled by enclosures. Controlling metal removal fluid emissions on one machine will not affect background aerosol or other aerosol generated by other work stations; all machine tools need to be considered together.

8.2 Test Method PS 42 covers a procedure for the determination of both total particulate matter and extractable mass metal removal fluid aerosol concentrations in a range from 0.05 to 5 mg/m^3 in workplace atmospheres. Guidance on workplace sampling strategies can be found in Guide E 1370.

8.3 Minimize extractable mass concentration. The amount and average particle size of aerosol generated is dependent on the amount of energy imparted to the fluid. Energy may be imparted to the fluid through high pressure spray application, high speed tools, parts or machines, and any other activity that causes the bulk fluid to generate a mist of liquid droplets. The transfer of energy from the machine to the fluid can be reduced by several means. Combined means may also be required.

8.3.1 In addition to product selection, proper maintenance of metal removal fluid sump concentration, and the design, selection, and maintenance characteristics noted earlier in this section, excessive generation of metal removal fluid aerosol can be affected by parameters, such as compressed air blowoffs and higher than optimum fluid flow rates, pressures, and tool feeds and speeds.

8.3.2 Optimize machine tool feeds and speeds consistent with part finish, dimension, and productivity requirements. Excessively high speeds and feeds increase the amount of aerosol generated.

8.3.3 Minimize fluid flow rates consistent with desired part finish and dimension and movement of generated chips or swarf. If feasible, reduce or temporarily interrupt fluid flow when the metal removal operation is not occurring. Higher-than-required flow rates increase aerosol generation.

8.3.4 Reduce fluid pressure consistent with machine tool design and chip removal requirements. Use flooding instead of spray application, whenever possible.

8.3.5 Consider the geometry of fluid application. Minimize the number of directional changes the fluid must make before reaching the cutting zone.

8.3.6 Control sources of nonmetal removal fluid mists, such as from parts washers or mist lube systems.

8.4 *Insoluble Particulate Matter*:

8.4.1 The difference between total particulate matter and extractable mass, as measured by Test Method PS 42, is an estimate of the insoluble particulate matter in the machining environment. Minimize insoluble particulate matter such as may be generated by dry machining, welding operations, and so forth.

8.4.2 Estimate the background level of insoluble particulate by evaluating exposures in the workplace away from metal removal fluid operations.

8.4.3 Keep the metal removal fluid clean. Minimize accumulation of grinding swarf from cast iron grinding operations or aluminum and silicon from aluminum machining operations through proper design, selection, and maintenance of metal removal fluid filtration systems.

8.4.4 Introduce a sufficient amount of make-up air into the plant ventilation system, particularly where machine enclosures are not present or local exhaust is ineffective. In colder weather, when doors and windows are shut, or in hotter weather in facilities with air conditioning, the amount of plant make-up air affects both the amount of insoluble particulate and extractable mass from metal removal fluid aerosol in workplace atmospheres. See Industrial Ventilation: A Manual of Recommended Practice for guidance on principles of ventilation.

8.5 Requirements concerning use of respirators in the workplace can be found in 29 CFR 1910.134 should permissible exposure levels for the metal removal fluid or included components be exceeded and engineering controls not reduce airborne component concentrations to specified levels.

9. Microbial Aerosols in the Metal Removal Environment

9.1 Microorganisms can grow in all water-miscible metal removal fluid systems, producing offensive odors and potentially other adverse health effects as well as accelerating depletion of functional components of the metal removal fluid. Metal removal fluid aerosols may contain microbial contaminants, both viable and nonviable.

9.2 Monitor and control water-miscible metal removal fluid system microbiology on a routine basis. Practice E 1497 provides guidance regarding biocide selection, storage, and use. Even if extractable mass and total particulate matter concentrations are low, uncontrolled fluid microbiology can potentially cause adverse respiratory health effects.

9.3 If unusual respiratory complaints are reported or if respiratory diseases are suspected, additional microbiological testing may be needed. Consult with your metal removal fluid or biocide supplier for their recommendations.

10. Keywords

10.1 aerosol sampling; bacteria; exposure; management; metal removal fluid aerosols; microbiology; workplace atmospheres