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An American National Standard

Standard Practice for Prevention of Dermatitis in the Wet Metal Removal Fluid Environment[1]

This standard is issued under the fixed designation E2693; 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 reducing dermatitis caused by exposure to the wet metal removal environment. The scope of this practice does not include exposure to chemicals that enter the body through intact skin (cutaneous route), which has the potential to cause other toxic effects.

1.2 This practice incorporates means and mechanisms to reduce dermal exposure to the wet metal removal environment and to control factors in the wet metal removal environment that have the potential to cause dermatitis.

1.3 This practice focuses on employee exposure to the skin via contact and exposure to metal removal fluid (MRF).

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D2881 Classification for Metalworking Fluids and Related Materials

E1302 Guide for Acute Animal Toxicity Testing of Water-Miscible Metalworking Fluids

E1497 Practice for Selection and Safe Use of Water-Miscible and Straight Oil Metal Removal Fluids

E1542 Terminology Relating to Occupational Health and Safety

E1972 Practice for Minimizing Effects of Aerosols in the Wet Metal Removal Environment (Withdrawn 2017)[3]

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

E2525 Test Method for Evaluation of the Effect of Nanoparticulate Materials on the Formation of Mouse Granulocyte-Macrophage Colonies

E2889 Practice for Control of Respiratory Hazards in the Metal Removal Fluid Environment

2.2 *OSHA Standards:*[4]

29 CFR 1910.132 Personal Protective Equipment: General Requirements

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 1910.1200 Hazard Communication

29 CFR 1910 Appendix B to Subpart I Non-Mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection

2.3 *Other Document:*[5]

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

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

3. Terminology

3.1 For definitions and terms relating to this practice, refer to Terminologies D1356 and E1542.

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 received fluid, such as abrasive particles, tramp oils, cleaners, dirt, metal fines and shavings, dissolved metal and hard water salts, bacteria, fungi, micro biological decay products, and waste. **E1497**

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. **E1497**

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) can develop. The condition is usually reversible when exposure to the causative agent ceases. More severe cases can require more time and some medical attention. Some individuals can be at higher risk. **E2525**

3.2.4 *dilution ventilation, n*—referring to the supply and exhaust of air with respect to an area, room, or building, the 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*.[6]

3.2.5 *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. **E1497**

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

3.2.7 *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.

3.2.8 *folliculitis, n*—an inflammatory response to excess oil in hair follicles. **E1497**

3.2.9 *metal removal fluid (MRF), n*—any fluid in the subclass of metalworking fluids used to cut or otherwise take away material or piece of stock. **E2148**

3.2.9.1 *Discussion*—Metal removal fluids include straight or neat oils (Classification D2881), 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: 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. **E2148**

3.2.10 *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 can include airborne contaminants of a microbial origin. **E1972**

3.2.10.1 *Discussion*—Metal removal fluid aerosol does not include background aerosol in the workplace atmosphere, which can include suspended insoluble particulate. **E2525**

3.2.11 *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.

3.2.12 *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.

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

3.2.13 *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. **E1497**

3.2.13.1 *Discussion*—Tramp oils can contaminate the metal removal fluid with components that are emulsifiable but which were not part of the metal removal fluid as formulated. **E2525**

3.2.14 *wet metal removal fluid environment, n*—the workplace environment in which wet metalworking operations occur. **E1497**

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

4.1 Routes of exposure to metal removal fluids include inhalation, ingestion, eye contact, and dermal contact. This practice focuses on exposure through dermal contact with the fluid, contact with residual fluid on machinery, parts, or clothing, and in some cases contact with fluid mists, splashes, or aerosols. Refer to Practice E2889 for information about the health risks related to inhalation exposure and guidance on how to reduce these risks.

4.2 Prolonged or repeated dermal contact can cause dry and cracked skin, rash, redness, burning, or itching. Skin abrasions can intensify the effects. Some metal removal fluids and additives can sensitize the skin of affected employees, which can result in a response to very low levels of exposure. This practice defines dermatitis as an inflammatory response to the skin. Dermatitis can result from a wide variety of sources and

[6] Available from American Conference of Governmental Industrial Hygienists, Inc. (ACGIH), 1330 Kemper Meadow Dr., Cincinnati, OH 45240, http://www.acgih.org.

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) can develop. The condition is usually reversible when exposure to the causative agent ceases. More severe cases can require more time and some medical attention.

4.3 Aerosols, mist, and vapors can contact and expose the skin as well as contaminate clothing.

5. Significance and Use

5.1 Use of this practice is intended to reduce occupational dermatitis caused by exposure to the wet metal removal environment.

5.2 Complaints of dermatitis conditions are often associated with exposures to metal removal fluid.

5.3 Implementation of this practice and incorporation of metal removal fluid management program has the potential to reduce complaints of occupational dermatitis. Elements of an effective program include: understanding dermatitis and associated causes; prevention of dermatitis and exposure to metal removal fluids; appropriate product selection; good management of additives, microorganisms, and fluids; appropriate additive (including antimicrobial pesticides) selection and additive control; appropriate tool design and assessment; and control of metal removal fluid exposures, including aerosols.

6. Dermatitis and Associated Causes

6.1 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) can develop. The condition is usually reversible when exposure to the causative agent ceases. More severe cases can require more time and some medical attention.

6.2 Some examples of occupational dermatitis include:

6.2.1 Irritant contact dermatitis (from irritant chemicals or physical irritants),

6.2.2 Allergic contact dermatitis,

6.2.3 Folliculitis (oil acne),

6.2.4 Dyshydrotic eczema,

6.2.5 Keratoses,

6.2.6 Eczema,

6.2.7 Skin warts,

6.2.8 Pigment disorders,

6.2.9 Granuloma,

6.2.10 Erythematous papules,

6.2.11 Papulovesicles,

6.2.12 Chronic lichenified,

6.2.13 Fisssured palmar eczema,

6.2.14 Discoid eczema,

6.2.15 Psoriasis,

6.2.16 Skin infections,

6.2.17 Skin burns,

6.2.18 Skin microtrauma and mechanical injury, and

6.2.19 Itchy nummular dermatitis.

6.3 Dermatitis resulting from exposure to metal removal fluids is usually either irritant contact dermatitis or allergic contact dermatitis.

6.4 Irritant contact dermatitis can be caused by two mechanisms, chemical and physical abrasion. Examples of a chemical mechanism include metal removal fluid concentrates, higher than recommended in-use metal removal fluid concentrations, high alkalinity, and solvents. Examples of physical abrasion include exposure to physical irritants such as metal shavings, turnings, or fines contained in the fluid from a malfunctioning filter; fines in dirty shop rags; and hand washing with abrasive soaps.

6.5 Allergic contact dermatitis can be caused by exposure of sensitive individuals to certain metal contaminants (for example, chromium, cobalt, or nickel) dissolved or suspended in the metal removal fluid, or to certain ingredients, including some antimicrobials or odorants. Some workers are sensitized to contaminants.

6.6 Microorganisms can grow in all metal removal fluids, often producing an unpleasant odor. Unless open cuts, wounds, or severe dermatitis are already present, microorganisms which commonly grow in water-miscible metal removal fluids are not frank pathogens and are not normally associated with onset of dermatitis.

6.7 The greater the concentration or duration of exposure to an irritant, the greater the possibility for skin irritation to develop or for skin sensitization to develop in sensitive individuals.

6.8 Consider activities outside work, such as gardening, painting, or car repair, which can contribute to dermatitis, when investigating potential dermatitis causes.

6.9 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, can also predispose the skin to dermatitis.

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

6.11 Finding the cause of a worker's case of dermatitis can be a long, laborious process. Detecting an occupational dermal causative agent requires cooperation from the patient, the metal removal fluid manufacturer, workplace management, and specialized medical expertise.

6.12 Poor personal hygiene both on and off the job can influence development of dermatitis.

6.13 Dermatitis causation varies with worker population demographics. The frequency of exposure, the concentration of exposure, a person's predisposition to specific dermatitis, etc. with metal removal fluids all influence the outcome if dermatitis will develop. Occupational dermatitis exposure focuses on the hands, especially on the dorsal part of the hands as well as

the bony prominences, the lateral sides of the fingers, and finger webs where fluids tend to be retained if hands are not cleansed properly

6.14 Occupational dermatitis has sometimes been associated with exposure to as-received metal removal fluid concentrates as well as to in-use metal removal fluids.

6.14.1 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.

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

6.14.3 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.

6.14.4 Malfunctioning or insufficient filters can increase suspended particulate, such as grinding turnings, abrasive wheel residue, and metallic fines.

6.14.5 Contamination of the metal removal fluid by dissolved metals, such as nickel, cobalt, and chromium, other abrasive particulates, or alkaline materials, such as in-process cleaners, increase occurrences of occupational dermatitis.

6.14.6 Causes of dermatitis associated with the metal removal environment include chemicals such as additives and antimicrobial pesticides. 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 fluids to control microbial growth. See Practice E2169 for further guidance. Antimicrobial pesticides must be used in accordance with manufacturer's label instructions. Some antimicrobial pesticides are corrosive, and appropriate personal protective equipment must be worn to prevent skin or eye injury. Other antimicrobial pesticides, if overused, can cause allergic contact dermatitis.

6.14.7 Examples of chemical causes of dermatitis include agents such as 1,2-dibromo-2,4-dicyanobutane, triazine, metal filings, strong detergents in hand washing, paraphenylenediamine, formaldehyde, neomycin, thiuram, mercaptobenzothiazole, ethylenediamine, fragrances, and some antimicrobial pesticides. This is not an inclusive list. Even metal removal fluids with similar alkalinity show different irritant skin reactions due to their chemical components. Other potential agents include corrosion inhibitors, coupling agents, and emulsifiers. The type of fluid is important. For example, straight mineral oils can have higher levels of fines than water-mix fluids.

7. Metal Removal Fluid Management Program

7.1 Management of metal removal fluids is the most important step in improving fluid life and reducing the occurrence of dermatitis and other occupational hazards. Health risks and economic losses are enormous when large, centralized metal removal fluid systems get out of control compared to the effort required to maintain control and chemical stability. On the other hand, small systems can get out of control with haphazard, inappropriate, or poorly timed additions and dilutions. A systems approach to metal removal process management is recommended and includes some or all of the following program elements:

7.1.1 Water treatment (Section 8),

7.1.2 Product selection (Section 9),

7.1.3 Additive selection and control (Section 10),

7.1.4 Machine tool design, selection, and maintenance (Section 11),

7.1.5 Work layout and design (Section 12),

7.1.6 Safe work practices and PPE (Section 13),

7.1.7 Assessment (Section 14),

7.1.8 Process control (Section 15),

7.1.9 Education and training (Section 16),

7.1.10 Medical, industrial hygiene, and administrative controls (Section 17), and

7.1.11 Emergency preparedness (Section 18).

7.2 Metal removal fluid management programs can be easily integrated with process control requirements of quality systems such as ISO 9001 or QS–9000.

7.3 Additional detailed guidance is provided in Practices E1497 and E2889 and in *Metal Removal Fluids, A Guide To Their Management and Control*, and in *Metalworking Fluids: Health & Safety Best Practices Manual*.[7] Consult with your metal removal fluid suppliers.

7.4 It is important that the management program include a continuous improvement plan to control for dermatitis.

8. Water Treatment

8.1 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 can lead to increased use of metal removal fluid concentrate, additives, or antimicrobials, or a combination thereof. Good water quality is fundamental 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.

8.2 Where suitable water is not available, use a water treatment program to produce enough water of sufficient quality for metal removal fluid use. Treated water needs to 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 is often available from the metal removal fluid manufacturer.

9. Product Selection

9.1 Proper product selection is fundamentally critical to reducing or eliminating respiratory conditions and occupational dermatitis associated with exposure to metal removal

[7] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, or at http://www.osha.gov/SLTC/metalworkingfluids/metalworkingfluids_manual.html.

fluids. The goal is for metal removal fluids to 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.

9.1.1 Consult *Metal Removal Fluids, A Guide to Their Management and Control* and *Metal Working Fluid Optimization Guide*[8] for further information on selecting the proper fluid for the application. In addition, your fluid supplier, chemical manager, or corporate subject matter expert could provide information on the proper selection of the appropriate fluid and recommended concentration for use.

9.2 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.

9.3 Before the fluid is handled, the user shall have an accurate and current safety data sheet (SDS) as required by the OSHA Hazard Communication Standard. See 29 CFR 1910.1200. Precautions shall be taken to ensure the fluid is, without modification, the fluid represented in the SDS. The metal removal fluid manufacturer's SDS and toxicological data must be complete and must provide all applicable information on metal removal fluids, ingredients, and additives, and this data shall be reviewed in order to evaluate potential hazards and establish appropriate control procedures.

9.4 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.

9.5 As supplied, antimicrobials and other additives for tank-side addition can 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.

9.5.1 To avoid recognized health and safety hazards, MRF 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.

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

9.6 For information on selection and safe use of metal removal fluids, additives, and antimicrobials including product selection, storage, dispensing, and maintenance, refer to Practices E1497 and E2169.

9.7 Workers are not only exposed to components in these metal removal fluids but also frequently to antimicrobial pesticides that have been implicated in occupational irritant dermatitis.

9.8 Fluids vary in their characteristics and chemical components as well as 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 can 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 can be useful in reducing aerosol from straight or neat oils and some water-miscible metal removal fluids. Components or contaminants can be more concentrated in the aerosol phase relative to their concentrations in the bulk fluid.

9.9 Practice E1497 and *Metal Removal Fluids, A Guide To Their Management and Control*[9] 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.

9.10 Select fluids with an understanding of their acute and chronic toxicity characteristics. Guide E1302 references procedures to assess the acute toxicity of water-miscible metalworking fluids as manufactured. Review the SDS, required by 29 CFR 1910.1200, for health and safety information for the metal removal fluids being considered for the operation.

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

9.12 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.

9.13 Select metal removal fluids with the least toxic materials.

9.14 Select antimicrobial pesticides with the least toxic materials. Ensure proper use of antimicrobial pesticides.

9.15 Maintain machines and exhaust.

9.16 If appropriate personal protective equipment for the task is not adequate, use engineering controls.

9.17 Use splash guards.

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

[9] Available from Organization Resources Counselors, 1910 Sunderland Place, NW, Washington, DC 20036 or from members of the Metal Working Fluid Product Stewardship Group (MWFPSG). Contact Independent Lubricant Manufacturers Association, 400 N. Columbus Street, Suite 201, Alexandria, VA 22314, for a list of members of the MWFPSG.

9.18 Ensure that employees are aware of, and promptly report skin symptoms which can be related to the wet metal removal environment.

9.19 Inform users prior to modifications in fluid formulation so that they have an opportunity to assess potential effects on health and safety and productivity. Seemingly insignificant changes in fluid composition can result in adverse interaction with other additives or can produce unforeseen changes in fluid performance.

9.20 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.

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

10. Additive Selection and Control

10.1 Dermatitis can be caused by a number of substances including metal removal fluids, oils, additives, contaminants, or degradation products formed through heat or bacterial action. Additives include antimicrobial pesticides, potential sensitizers, irritants, etc.

10.2 Additives can change the fluid formulation and the pH, as well as interaction between the fluid and the worker's skin such as absorption and permeability.

10.3 If a full declaration of all ingredients in metal removal fluids is not available, contact manufacturer for additional information and information on interaction with additives/antimicrobial pesticides.

10.4 Chemicals that are examples of EPA-registered antimicrobial pesticides approved for use in metal removal fluids are listed in Table 2 of Practice E2169.

10.5 Single or various combinations of chemical additives can initiate occupational dermatitis. Significant effects of mixtures are recognized but still not completely understood. Moreover, different additives have different potential to cause dermatitis.

10.6 Contact additive, chemical, antimicrobial pesticide, and metal removal fluids manufacturers to assist in determining possible effects on workers' skin. Request information or guidance on how these chemicals influence dermal disposition of additives. Some additive and fluid mixtures enhance additive transport and increase absorption of chemicals into skin. Physicochemical interactions in fluids and additive mixtures influence the variability of an additive for absorption and distribution in the skin and thus influence toxicological responses in skin.

11. Machine Tool Design, Selection, and Maintenance

11.1 ANSI B11 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 need to be well versed in these considerations and implement them when practical where occupational exposures to metal removal fluids are expected to occur.

11.2 Design metal removal fluid delivery systems to minimize exposure and generation of metal removal fluid aerosols. For transfer line machines, as the earliest operation in the line is often the heaviest cut, early operations can contribute most to metal removal fluid aerosol generation. Consider workplace layouts to reduce exposure via workers working over open tanks, workers placing themselves in the pathway of metal removal fluids or aerosols, or a contaminant exhaust.

11.3 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.

11.4 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.

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

11.6 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 can escape through openings in the enclosure.

11.7 Consider retrofitting existing equipment using ANSI B11 TR 2–1997 as a guide. It is possible that improperly designed or poorly constructed retrofits will not effectively capture metal removal fluid aerosols.

11.8 Properly design and maintain exhaust ductwork from machine tool enclosures. ANSI B11 TR 2–1997 provides useful guidance. Inspect and clean ductwork regularly, and repair ductwork not in good working order.

11.9 Properly design and maintain mist collectors. ANSI B11 TR 2–1997 provides useful guidance. In some cases other technologies are appropriate. Poorly maintained mist collectors can 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.

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

11.11 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.

11.12 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.

11.12.1 Reduce hydraulic fluid contamination by maintaining hydraulic systems and repairing leaks, by using mechanical