



Standard Practice for Control of Respiratory Hazards in the Metal Removal Fluid Environment¹

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1. Scope*

1.1 This practice sets forth guidelines to control respiratory hazards in the metal removal environment.

1.2 This practice does not include prevention of dermatitis, which is the subject of Practice E2693, but it does adopt a similar systems management approach with many control elements in common.

1.3 This practice focuses on employee exposure via inhalation of metal removal fluids and associated airborne agents.

1.4 Metal removal fluids used for wet machining operations (such as cutting, drilling, milling, or grinding) that remove metal to produce the finished part are a subset of metalworking fluids. This practice does not apply to other operations (such as stamping, rolling, forging, or casting) that use metalworking fluids other than metal removal fluids. These other types of metalworking fluid operations are not included in this document because of limited information on health effects, including epidemiology studies, and on control technologies. Nonetheless, some of the exposure control approaches and guidance contained in this document may be useful for managing respiratory hazards associated with other types of metalworking fluids.

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.*

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. Referenced Documents

2.1 ASTM Standards:²

- D1356 Terminology Relating to Sampling and Analysis of Atmospheres
- D2881 Classification for Metalworking Fluids and Related Materials
- D7049 Test Method for Metalworking Fluid Aerosol in Workplace Atmospheres
- E1302 Guide for Acute Animal Toxicity Testing of Water-Miscible Metalworking Fluids
- E1370 Guide for Air Sampling Strategies for Worker and Workplace Protection
- E1497 Practice for Selection and Safe Use of Water-Miscible and Straight Oil Metal Removal Fluids
- E1542 Terminology Relating to Occupational Health and Safety
- E2144 Practice for Personal Sampling and Analysis of Endotoxin in Metalworking Fluid Aerosols in Workplace Atmospheres
- 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
- E2563 Practice for Enumeration of Non-Tuberculosis *Mycobacteria* in Aqueous Metalworking Fluids by Plate Count Method
- E2564 Practice for Enumeration of *Mycobacteria* in Metalworking Fluids by Direct Microscopic Counting (DMC) Method
- E2657 Practice for Determination of Endotoxin Concentrations in Water-Miscible Metalworking Fluids
- E2693 Practice for Prevention of Dermatitis in the Wet

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

Metal Removal Fluid Environment

E2694 Test Method for Measurement of Adenosine Triphosphate in Water-Miscible Metalworking Fluids

E3265 Guide for Evaluating Water-Miscible Metalworking Fluid Foaming Tendency

2.2 *OSHA (U.S. Occupational Safety and Health Administration) Standards:*³

29 CFR 1910.132 Personal Protective Equipment

29 CFR 1910.134 Use of Respiratory Protection in the Workplace

29 CFR 1010.1020 Access to Employee Exposure and Medical Records

29 CFR 1910.1048 Formaldehyde

29 CFR 1910.1200 Hazard Communication

2.3 *EPA (U.S. Environmental Protection Agency) Standards:*⁴

40 CFR 156 Labeling Requirements for Pesticides and Devices

2.4 *Other Documents:*

ANSI Technical Report B11 TR 2-1997 Mist Control Considerations for the Design, Installation and Use of Machine Tools Using Metalworking Fluids⁵

National Center for Manufacturing Sciences Metal Working Fluid Optimization Guide⁶

ACGIH Industrial Ventilation: A Manual of Recommended Practice for Design⁷

ACGIH Industrial Ventilation: A Manual of Recommended Practice for Operation and Maintenance⁸

NIOSH Criteria for a Recommended Standard: Occupational Exposure to Metalworking Fluids⁹

OSHA Metalworking Fluids: Safety and Health Best Practices Manual¹⁰

NIOSH Method 5524 Metalworking Fluids (MWF) All Categories¹¹

3. Terminology

3.1 For definitions and terms relating to this guide, refer to Terminologies **D1356**, **E1542**, and **E2523**.

3.2 *Definitions of Terms Specific to This Standard:*

³ Available from United States Government Printing Office, Washington, DC 20402 or at eCFR, 29 CFR Part 1910, <https://www.ecfr.gov/current/title-29/subtitle-B/chapter-XVII/part-1910?toc=1>.

⁴ Available from United States Government Printing Office, Washington, DC 20402 or at eCFR, 40 CFR Part 156, <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-E/part-156>.

⁵ Available from American National Standards Institute (ANSI); see B11 Standards, Inc. (www.ansi.org).

⁶ Available from National Center for Manufacturing Sciences, Report 0274RE95, 3025 Boardwalk, Ann Arbor, MI 48018.

⁷ Available from ACGIH at <https://portal.acgih.org/s/store#/store/browse/detail/a158a00000CgqcfAAB>.

⁸ Available from ACGIH at <https://portal.acgih.org/s/store#/store/browse/detail/a154W00000BOaw1QAD>.

⁹ Available from National Institute for Occupational Safety and Health (NIOSH) at <https://www.cdc.gov/niosh/docs/98-102/>.

¹⁰ Available from U.S. Occupational Health and Safety Administration (OSHA) at <https://www.osha.gov/metalworking-fluids/manual>.

¹¹ Available from National Institute for Occupational Safety and Health (NIOSH) at <https://www.cdc.gov/niosh/docs/2003-154/pdfs/5524.pdf>.

3.2.1 *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*.

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 **D7049** or NIOSH Method 5524.

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

3.2.3.1 *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**

3.2.4 *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 microbial origin.

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

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 **D7049**.

3.2.5.1 *Discussion*—As defined in Test Method **D7049**, total particulate matter is not a measure of the inhalable or thoracic particulate mass.

3.3 *Acronyms:*

3.3.1 *GHS, n*—globally harmonized system

3.3.1.1 *Discussion*—GHS is an acronym for the Globally Harmonized System of Classification and Labeling of Chemicals.

4. Significance and Use

4.1 Exposure to aerosols in the industrial metal removal environment has been associated with adverse respiratory effects.

4.2 Use of this practice will mitigate occupational exposure and effects of exposure to aerosols in the metal removal environment.

4.3 Through implementation of this practice, users should be able to reduce instances and severity of respiratory irritation and disease through the effective use of a metal removal fluid management program, appropriate product selection, appropriate machine tool design, proper air handling mechanisms, and control of microorganisms.

5. Respiratory Health Hazards Associated with Metal Removal Fluids

5.1 General:

5.1.1 Metal removal fluids (MRF) can cause adverse health effects through skin contact with contaminated materials, spray, or mist and through inhalation from breathing MWF mist or aerosol.

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

5.2 Skin Disorders:

5.2.1 Skin contact occurs when the worker dips his/her hands into the fluid or handles parts, tools, and equipment covered with fluid without the use of personal protective equipment, such as gloves and aprons. Skin contact may also result from fluid splashing onto the employee from the machine if guarding is absent or inadequate. For further information, refer to Practice [E2693](#).

5.3 Respiratory Diseases:

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

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

5.3.3 Exposure to MRF has been associated with asthma. In asthma, airways of the lung become inflamed, causing a reduction of the flow of air into and out of the lungs. During an asthmatic attack, the airways become swollen, go into spasms

and fill with mucous, reducing airflow and producing shortness of breath and a wheezing sound. A variety of components, additives, and contaminants of MRF can induce new onset asthma, aggravate pre-existing asthma, and irritate the airways of non-asthmatic employees.

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

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

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

5.3.7 Respiratory effects have been observed among workers with exposures below 1.0 mg/m³ to diverse fluids,¹² with water-reduced fluids generally appearing more potent. Poorly controlled fluids have generally been more likely to be associated with adverse effects.

5.4 Cancer:

5.4.1 A number of studies have found an association between working with MRF and a variety of cancers, including cancer of the rectum, pancreas, larynx, skin, scrotum, and bladder (NIOSH 1998a). No authoritative review of studies of workers exposed to MRF has been conducted since 1999, although additional data have been published. Studies of MRF and cancer reflect the health experiences of workers exposed decades earlier. This is because the effects of cancers associated with MRF may not become evident until many years after the exposure. Airborne concentrations of MWF were known to be much higher in the 1970s and 80s than those today. The composition of MRF has also changed dramatically over the years. The fluids in use prior to 1985 may have contained nitrite, mildly refined petroleum oils, and other chemicals that were removed after 1985 for health concerns. Based on the substantial changes that have been made in the metalworking industry over the last decades, the cancer risks have likely been reduced, but there is not enough data to prove this.

6. Fluid Properties Associated with Adverse Health Effects

6.1 Aerosol Physical Properties:

6.1.1 Metal removal fluid aerosols consist of a broad range of particle sizes. Airborne particles shrink as water and other

¹² Gauthier, S. L., "Metal Working Fluids: Oil Mist and Beyond," *Applied Occupational & Environmental Hygiene*, Vol 18, 2003, pp. 818-824.