



Standard Test Method for Metal Removal Fluid Aerosol in Workplace Atmospheres¹

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1. Scope

1.1 This test method covers a procedure for the determination of both total collected particulate matter and extractable mass metal removal fluid aerosol concentrations in the range of 0.05 to 5 mg/m³ in workplace atmospheres.

1.2 This test method describes a standardized means of collecting worker exposure information that can be compared to existing exposure databases, using a test method that is also more specific to metal removal fluids.

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

1.4 *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

[D1356 Terminology Relating to Sampling and Analysis of Atmospheres](#)

[D3195 Practice for Rotameter Calibration](#)

[D3670 Guide for Determination of Precision and Bias of Methods of Committee D22](#)

[D4532 Test Method for Respirable Dust in Workplace Atmospheres Using Cyclone Samplers](#)

[D5337 Practice for Flow Rate Adjustment of Personal Sampling Pumps](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

¹ This test method is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.04 on Workplace Air Quality.

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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.

2.2 Government Standards:

[29 CFR 1910.1000 Air Contaminants](#)³

[29 CFR 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories](#)³

2.3 NIOSH Document:

[Method 0500 NIOSH Manual of Analytical Methods \(NMAM\), 4th Ed](#)⁴

3. Terminology

3.1 For definitions of terms relating to this test method, refer to Terminology [D1356](#).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *breathing zone, n*—the worker's breathing zone consists of a hemisphere 300-mm radius extending in front of the face, centered on the midpoint of a line joining the ears; the base of the hemisphere is a plane through this line, the top of the head and the larynx.

3.2.2 *extractable mass, n*—the material removed by liquid extraction of the filter using a mixed-polarity solvent mixture. This mass is an approximation of the metal removal fluid portion of the workplace aerosol.

3.2.3 *filter set, n*—a group of filters from the same production lot that are weighed and assembled into the filter cassettes at one time. The filter set may be used for sampling on multiple days with the appropriate field blanks being submitted for each sampling day.

3.2.4 *metal removal fluids, n*—the subset of metal working fluids that are used for wet machining or grinding to produce the finished part. Metal removal fluids are often characterized as straight, soluble, semisynthetic, and synthetic.

3.2.4.1 *Discussion*—Metal removal fluids addressed by this practice include straight or neat 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, abrasive particles, tramp oils, cleaners, dirt, metal fines and shavings, dissolved

³ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

⁴ Available from National Institute for Occupational Safety and Health, 4676 Columbia Pkwy., Cincinnati, OH 45226.

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.

4. Summary of Test Method

4.1 Workplace air is drawn into a 37-mm filter cassette containing a tared polytetrafluoroethylene (PTFE) filter for a measured period of time. The total particulate matter concentration is calculated from the mass gain of the filter and the volume of air sampled.

4.2 The filter is extracted with a ternary mixture of both nonpolar and polar solvents, a second mixture of methanol and water, dried, and reweighed. The extractable mass concentration is calculated from the loss of mass following extraction and the volume of air sampled.

4.3 As a cost-control procedure, the nonspecific total particulate matter concentration may be used in place of the extractable mass if the total particulate concentration is acceptable to the user of this test method.

5. Significance and Use

5.1 This test method covers the gravimetric determination of metal removal fluid aerosol concentrations in workplace atmospheres.

5.2 The test method provides total particulate matter concentrations for comparison with historical exposure databases collected with the same technology.

5.3 The test method provides an extension to current non-standardized methods by adding an extractable mass concentration which reduces interferences from nonmetal removal fluid aerosols.

5.4 The test method does not address differences between metal removal fluid types, but it does include extraction with a broad spectrum of solvent polarity to remove any of the current fluid formulations from insoluble background aerosol adequately.⁵

5.5 The test method does not identify or quantify any specific putative toxins in the workplace that can be related to metal removal fluid aerosols or vapors.

5.6 The test method does not address the loss of semivolatile compounds from the filter during or after collection.

6. Interferences

6.1 The total particulate matter portion of the test method is not specific to metal removal fluid in the workplace and is subject to positive bias by other aerosol sources.

6.2 The extractable mass concentration measurement improves the specificity of the test method by eliminating insoluble background aerosol from the determination of the

metal removal fluid aerosol concentration. This is an important consideration at low-exposure limits.

6.3 Any metal removal fluid components that are insoluble in either extraction solvent mixture will not be measured in the extractable mass fraction.

6.4 The total particulate and extractable mass concentrations measured with this test method are subject to a negative bias to the extent that semivolatile compounds are lost from the filter during sampling.

6.4.1 Samples of workplace atmospheres in which metal removal fluids containing lower viscosity petroleum fractions or volatile alkanolamines are used may be particularly subject to this negative bias both during sampling and during storage time before analysis.

6.5 Any insoluble materials that are lost from the filter during the extraction process will be reported as extractable mass resulting in a positive bias.

7. Apparatus

7.1 The sampling unit consists of a pump and filter cassette.

7.1.1 *Pump*, a constant-flow personal sampling pump capable of a flow rate of 2.0 L/min ($\pm 5\%$) through the filter cassette for a full work shift (8 h).

7.1.2 *Filter Cassette*, a closed-face (4-mm opening) two- or three-piece 37-mm filter cassette with filter-support pad and inlet and outlet plugs.

7.1.3 *Filter*, the filter shall be a 2- μ m PTFE membrane filter.

7.1.4 Suitable means of attaching the pump and filter cassette to the worker for breathing zone sampling.

7.1.5 *Field Blank*, a filter cassette prepared for sampling that has been taken to the workplace and handled in the same manner as the analytical filters, but which has not had any air drawn through it.

7.1.6 *Precision Flow Meter*, for calibration of sampler flow rates (for example, bubble flow meter, dry seal flow meter, or burette and stopwatch).

7.1.7 *Rotameter*, calibrated in accordance with Practice **D3195** for field check of sampler flow rate.

7.1.8 *Weighing Room*, with temperature and humidity control to allow weighing under reproducible environmental conditions of $22 \pm 2^\circ\text{C}$ and $\pm 5\%$ relative humidity in a range of 30 to 55 %.

7.1.9 *Analytical Balance*, capable of weighing to ± 0.001 mg.

7.1.9.1 *Antistatic Strips*, of ^{210}Po < 200 days old since packaging.

7.1.10 *Plane-Parallel Press*, for assembling of filter cassettes.⁶

7.1.11 *Chemical Desiccator*, with indicating CaSO_4 desiccant for drying of filters.

7.1.12 *Filter Funnel*, for solvent extraction of 37-mm filters using a dichloromethane, methanol, and toluene mixed solvent. Two choices are available, a 37-mm aluminum funnel and 37-mm disposable polypropylene cassettes, modified for use

⁵ Information from Independent Lubricant Manufacturers Assoc., Health and Safety Task Force, 651 S. Washington St., Alexandria, VA 22314.

⁶ See Test Method **D4532**, a plane-parallel press description to aid in the assembly of cassettes.