



Designation: D7035 – 21

# Standard Test Method for Determination of Metals and Metalloids in Airborne Particulate Matter by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)<sup>1</sup>

This standard is issued under the fixed designation D7035; 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 test method specifies a procedure for collection, sample preparation, and analysis of airborne particulate matter for the content of metals and metalloids using inductively coupled plasma-atomic emission spectrometry (ICP-AES). The method is generally applicable to occupational exposure monitoring.

1.2 This test method is applicable to personal sampling of the inhalable or respirable fraction of airborne particles and to area sampling.

1.3 This test method should be used by analysts experienced in the use of ICP-AES, the interpretation of spectral and matrix interferences, and procedures for their correction.

1.4 This test method specifies a number of alternative methods for preparing test solutions from samples of airborne particulate matter. One of the specified sample preparation methods is applicable to the measurement of soluble metal or metalloid compounds. Other specified methods are applicable to the measurement of total metals and metalloids.

1.5 It is the user's responsibility to ensure the validity of this test method for sampling materials of untested matrices.

1.6 The following is a non-exclusive list of metals and metalloids for which one or more of the sample dissolution methods specified in this document is applicable. However, there is insufficient information available on the effectiveness of dissolution methods for those elements in *italics*.

|           |               |                 |
|-----------|---------------|-----------------|
| Aluminum  | <i>Indium</i> | Sodium          |
| Antimony  | Iron          | Strontium       |
| Arsenic   | Lead          | <i>Tantalum</i> |
| Barium    | Lithium       | Tellurium       |
| Beryllium | Magnesium     | Thallium        |
| Bismuth   | Manganese     | Tin             |
| Boron     | Molybdenum    | Titanium        |
| Cadmium   | Nickel        | Tungsten        |

|                |                |                |
|----------------|----------------|----------------|
| Calcium        | Phosphorus     | <i>Uranium</i> |
| Cesium         | Platinum       | Vanadium       |
| Chromium       | Potassium      | Yttrium        |
| Cobalt         | <i>Rhodium</i> | Zinc           |
| Copper         | Selenium       | Zirconium      |
| <i>Hafnium</i> | Silver         |                |

1.7 This test method is not applicable to the sampling of elemental mercury, or to inorganic compounds of metals and metalloids that are present in the gaseous or vapor state.

1.8 No detailed operating instructions are provided because of differences among various makes and models of suitable ICP-AES instruments. Instead, the analyst shall follow the instructions provided by the manufacturer of the particular instrument. This test method does not address comparative accuracy of different devices or the precision between instruments of the same make and model.

1.9 This test method contains notes that are explanatory and are not part of the mandatory requirements of this test method.

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

1.11 *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.*

1.12 *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:<sup>2</sup> **D1193 Specification for Reagent Water**

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**D1356** Terminology Relating to Sampling and Analysis of Atmospheres  
**D4185** Test Method for Measurement of Metals in Workplace Atmospheres by Flame Atomic Absorption Spectrophotometry  
**D4840** Guide for Sample Chain-of-Custody Procedures  
**D5337** Practice for Flow Rate Adjustment of Personal Sampling Pumps  
**D6062** Guide for Personal Samplers of Health-Related Aerosol Fractions  
**D6785** Test Method for Determination of Lead in Workplace Air Using Flame or Graphite Furnace Atomic Absorption Spectrometry  
**D7202** Test Method for Determination of Beryllium in the Workplace by Extraction and Optical Fluorescence Detection  
**D7439** Test Method for Determination of Elements in Airborne Particulate Matter by Inductively Coupled Plasma–Mass Spectrometry  
**D7440** Practice for Characterizing Uncertainty in Air Quality Measurements  
**D8344** Practice for Ammonium Bifluoride and Nitric Acid Digestion of Airborne Dust and Dust-Wipe Samples for the Determination of Metals and Metalloids  
**D8358** Guide for Assessment and Inclusion of Wall Deposits in the Analysis of Single-Stage Samplers for Airborne Particulate Matter  
**E288** Specification for Laboratory Glass Volumetric Flasks  
**E438** Specification for Glasses in Laboratory Apparatus  
**E882** Guide for Accountability and Quality Control in the Chemical Analysis Laboratory  
**E1154** Specification for Piston or Plunger Operated Volumetric Apparatus  
**E1370** Guide for Air Sampling Strategies for Worker and Workplace Protection  
**E1613** Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques (Withdrawn 2021)<sup>3</sup>  
**E1728** Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination  
**E3203** Test Method for Determination of Lead in Dried Paint, Soil, and Wipe Samples by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES)  
**2.2 ISO Standards:**<sup>4</sup>  
**ISO 4225** Air quality — General aspects  
**ISO 7708** Particle size definitions for health-related sampling  
**ISO 15202** Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry (3 parts)  
**ISO 18158** Workplace atmospheres — Terminology

**ISO 20581** Workplace atmospheres — General requirements for the performance of procedures for the measurement of chemical agents

### 3. Terminology

**3.1 Definitions**—For definitions of pertinent terms not listed here, see Terminology **D1356**.

**3.2 Definitions of Terms Specific to This Standard:**

**3.2.1 atomic emission**—characteristic radiation emitted by an electronically excited atomic species.

**3.2.1.1 Discussion**—In atomic (or optical) emission spectrometry, a very high-temperature environment, such as a plasma, is used to create excited state atoms. For analytical purposes, characteristic emission signals from elements in their excited states are then measured at specific wavelengths.

**3.2.2 axial plasma, n**—a horizontal inductively coupled plasma that is viewed end-on (versus radially; see **3.2.31**).

**3.2.3 background correction, n**—the process of correcting the intensity at an analytical wavelength for the intensity due to the underlying spectral background of a blank. **ISO 15202**

**3.2.4 background equivalent concentration, n**—the concentration of a solution that results in an emission signal of equivalent intensity to the background emission signal at the analytical wavelength. **ISO 15202**

**3.2.5 batch, n**—a group of field or quality control (QC) samples that are collected or processed together at the same time using the same reagents and equipment. **E3203**

**3.2.6 blank solution, n**—solution prepared by taking a reagent blank or field blank through the same procedure used for sample dissolution.

**3.2.7 calibration blank solution, n**—calibration solution prepared without the addition of any stock standard solution or working standard solution. **ISO 15202**

**3.2.7.1 Discussion**—The concentration of the analyte(s) of interest in the calibration blank solution is taken to be zero.

**3.2.8 calibration solution, n**—solution prepared by dilution of the stock standard solution(s) or working standard solution(s), containing the analyte(s) of interest at a concentration(s) suitable for use in calibration of the analytical instrument. **ISO 15202**

**3.2.8.1 Discussion**—The technique of matrix matching is normally used when preparing calibration solutions.

**3.2.9 chemical agent, n**—any chemical element or compound, on its own or admixed as it occurs in the natural state or as produced, used or released, including release as waste, by any work activity, whether or not produced intentionally and whether or not placed on the market. **ISO 4225**

**3.2.10 continuing calibration blank (CCB), n**—a solution containing no analyte added, that is used to verify blank response and freedom from carryover. **E1613**

**3.2.10.1 Discussion**—The measured concentration of the CCB is to be (at most) less than five times the instrumental detection limit.

**3.2.11 excitation interferences, n**—non-spectral interferences that manifest as a change in sensitivity due to a change

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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