Designation: D6784 – 24

# Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method)[1]

This standard is issued under the fixed designation D6784; 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 applies to the determination of elemental, oxidized, particle-bound, and total mercury emissions from stationary combustion sources.

1.2 This test method is applicable to elemental, oxidized, particle-bound, and total mercury concentrations ranging from approximately 0.5 μg/Nm$^3$ to 100 μg/Nm$^3$.

1.3 This test method describes equipment and procedures for obtaining samples from effluent ducts and stacks, equipment and procedures for laboratory analysis, and procedures for calculating results.

1.4 This test method is applicable to sampling elemental, oxidized, and particle-bound mercury in flue gases of coal-fired stationary sources. It may not be suitable at all measurement locations, particularly those with high particulate loadings, as explained in Section 16.

1.5 Method applicability is limited to flue gas stream temperatures within the thermal stability range of the sampling probe and filter components.

1.6 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.7 This standard requires users to be familiar with EPA stack-gas sampling procedures as stated in EPA Methods 1–4, Method 5, and Method 17.

1.8 The method requires a high level of experience and quality control both in the field testing and analytical procedures to obtain high quality data.

1.9 *Warning—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.*

1.10 *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.*

1.11 *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]

D1193 Specification for Reagent Water

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D3154 Test Method for Average Velocity in a Duct (Pitot Tube Method)

D3685/D3685M Test Methods for Sampling and Determination of Particulate Matter in Stack Gases

D3796 Practice for Calibration of Type S Pitot Tubes

D4840 Guide for Sample Chain-of-Custody Procedures

D7036 Practice for Competence of Air Emission Testing Bodies

[1] This test method is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.03.01 on Source Emissions.

Current edition approved March 1, 2024. Published April 2024. Originally approved in 2002. Last previous edition approved in 2016 as D6784 – 16. DOI: 10.1520/D6784-24.

[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.

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

2.2 *Other Standards:*[3]

EPA Method 1 Sample and Velocity Traverses for Stationary Sources

EPA Method 2 Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

EPA Method 3 Gas Analysis for the Determination of Dry Molecular Weight

EPA Method 4 Determination of Moisture Content in Stack Gases

EPA Method 5 Determination of Particulate Emissions from Stationary Sources

EPA Method 12 Determination of Inorganic Lead Emissions from Stationary Sources

EPA Method 17 Determination of Particulate Emissions from Stationary Sources (In-Stack Filtration Method)

EPA Method 29 Determination of Metals Emissions from Stationary Sources

EPA Method 101A Determination of Particle-Bound and Gaseous Mercury Emissions from Sewage Sludge Incinerators

EPA Method 301 Field Validation of Pollutant Measurement Methods from Various Waste Media

EPA SW 846 7470A Mercury in Liquid Waste—Manual Cold Vapor Technique

EPA Water and Waste 600/4-79-020 Methods for Chemical Analysis of Water and Wastes

## 3. Terminology

3.1 Definitions other than those given below in 3.2 and 3.3 are listed in Terminology D1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *elemental mercury, n*—mercury in its zero-oxidation state, $Hg^0$.

3.2.2 *elemental mercury catch, n*—mercury collected in the acidified hydrogen peroxide ($HNO_3$–$H_2O_2$) and potassium permanganate ($H_2SO_4$–$KMnO_4$) impinger solutions employed in this test method; this is gaseous $Hg^0$.

3.2.3 *front half of the sampling train, n*—all mercury collected on and upstream of the sample filter.

3.2.4 *impinger train, n*—setup including only the impingers and connectors.

3.2.5 *oxidized mercury, n*—mercury in its mercurous or mercuric oxidation states: $Hg_2^{2+}$ and $Hg^{2+}$, respectively.

3.2.6 *oxidized mercury catch, n*—mercury collected in the aqueous potassium chloride (KCl) impinger solutions employed in this test method; this is gaseous $Hg^{2+}$.

3.2.7 *particle-bound mercury catch, n*—mercury associated with the particulate matter collected in the front half of the sampling train.

3.2.8 *sample train, n*—complete setup including nozzle, probe, probe liner, filter, filter holder, impingers, and connectors.

3.2.9 *total mercury, n*—all mercury (solid-bound, liquid, or gaseous) however generated or entrained in the flue gas stream (that is, summation of elemental, oxidized, and particle-bound mercury).

3.3 *Symbols:*

3.3.1 $A$—cross-sectional area of stack, $m^2$ ($ft^2$)

3.3.2 $B_{ws}$—water vapor in the gas stream, proportion by volume

3.3.3 $\Delta H$—average pressure differential across the orifice meter, kPa (in. $H_2O$)

3.3.4 $Hg_{ash}$—concentration of mercury in sample filter ash, µg/g

3.3.5 $Hg^{tp}$—concentration of particle-bound mercury, µg/$Nm^3$

3.3.6 $Hg^0$—concentration of elemental mercury, µg/$Nm^3$

3.3.7 $Hg^{2+}$—concentration of oxidized mercury, µg/$Nm^3$

3.3.8 $IR$—instrument reading from mercury analyzer, µg/L

3.3.9 $L_p$—leakage rate observed during the post-test leak check, $m^3$/min (cfm)

3.3.10 $L_a$—maximum acceptable leakage rate

3.3.11 $M_s$—molecular weight of stack gas, wet basis g/g-mole (lb/lb-mole)

3.3.12 $M_w$—molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole)

3.3.13 $N$—normal conditions, defined as 0 °C and 101.3 kPa (in the U.S. standard conditions 32 °F and 1 atmosphere)

3.3.14 $P_{bar}$—barometric pressure at the sampling site, kPa (in. Hg)

3.3.15 $P_s$—absolute stack gas pressure, kPa (in. Hg)

3.3.16 $P_{std}$—standard absolute pressure, 101.3 kPa (29.92 in. Hg)

3.3.17 $R$—ideal gas constant, 0.008314 kPa-$m^3$/K-g-mole (21.85 in. Hg-$ft^3$/°R-lb-mole)

3.3.18 $T_m$—absolute average dry gas meter temperature, K (°R)

3.3.19 $T_s$—absolute stack temperature, K (°R)

3.3.20 $T_{std}$—standard absolute temperature, 293 K

3.3.21 $V_D$—total digested volume, mL

3.3.22 $V_m$—volume of gas sample as measured by dry gas meter, $m^3$ (dscf)

3.3.23 $V_{m(std)}$—volume of gas sample measured by the dry gas meter in $Nm^3$ (dscf)

3.3.24 $V_{w(std)}$—volume of water vapor in the gas sample in $m^3$ (scf)

3.3.25 $W_{ash}$—total mass of ash on sample filter, g

3.3.26 $W_{lc}$—total weight of liquid collected in impingers and silica gel, g (lb)

3.3.27 $Y$—dry gas meter calibration factor

[3] EPA Methods 1 – 29 available from the U.S. Environmental Protection Agency's Emission Measurement Technical Information Center or Code of Federal Regulations (40 CFR Part 60, Appendix A), Method 101A in 40 CFR Part 61, Appendix B, Method 301 in 40 CFR 63 Appendix A40 CFR Part 61, Appendix B.