



Designation: D6552 – 06 (Reapproved 2021)

Standard Practice for Controlling and Characterizing Errors in Weighing Collected Aerosols¹

This standard is issued under the fixed designation D6552; 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 Assessment of airborne aerosol hazards in the occupational setting entails sampling onto a collection medium followed by analysis of the collected material. The result is generally an estimated concentration of a possibly hazardous material in the air. The uncertainty in such estimates depends on several factors, one of which relates to the specific type of analysis employed. The most commonly applied method for analysis of aerosols is the weighing of the sampled material. Gravimetric analysis, though apparently simple, is subject to errors from instability in the mass of the sampling medium and other elements that must be weighed. An example is provided by aerosol samplers designed to collect particles so as to agree with the inhalable aerosol sampling convention (see ISO 7708, Guide D6062, and EN 481). For some sampler types, filter and cassette are weighed together to make estimates. Therefore, if the cassette, for example, absorbs or loses water between the weighings required for a concentration estimation, then errors may arise. This practice covers such potential errors and provides solutions for their minimization.

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

1.3 *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.*

1.4 *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 D22 on Air Quality and is the direct responsibility of Subcommittee D22.04 on Workplace Air Quality.

Current edition approved Sept. 1, 2021. Published October 2021. Originally approved in 2000. Last previous edition approved in 2016 as D6552 – 06 (2016). DOI: 10.1520/D6552-06R21.

2. Referenced Documents

2.1 ASTM Standards:²

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D4096 Test Method for Determination of Total Suspended Particulate Matter in the Atmosphere (High-Volume Sampler Method)

D4532 Test Method for Respirable Dust in Workplace Atmospheres Using Cyclone Samplers

D6062 Guide for Personal Samplers of Health-Related Aerosol Fractions

2.2 International Standards:³

EN 481 Workplace Atmospheres — Size Fraction Definitions for Measurement of Airborne Particles in the Workplace

EN 13205 Workplace Atmospheres — Assessment of Performance of Instruments for Measurement of Airborne Particle Concentrations

2.3 ISO Standards:⁴

ISO 7708 Air quality — Particle size fraction definitions for health-related sampling

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

ISO 20988 Air quality — Guidelines for estimating measurement uncertainty

ISO GUM Guide to the Expression of Uncertainty in Measurement (1998)

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this practice, refer to Terminology D1356.

3.2 Definitions of Terms Specific to This Standard:

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 Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

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

3.2.1 *blank substrate, n*—a collection medium or substrate coming from the same batch as the sampling medium, but unexposed.

3.2.2 *equilibration time, n*—For the purposes of this practice, a time constant (seconds) characterizing an approximate exponentially damped approach of the mass of an aerosol collection medium to a constant value. The constant can be defined as the mean difference of the mass from equilibrium per mean mass loss or gain rate as measured over a finite time interval.

3.2.2.1 *Discussion*—There may be important instances in which *several* time constants are required to describe the approach to equilibrium.

3.2.3 *estimated overall uncertainty (U), n*— $2 \times$ estimated standard deviation of estimated mass, in the case of negligible uncorrectable bias (see ISO 20581).

3.2.4 *field blank, n*—a blank substrate that undergoes the same handling as the sample substrate, generally including conditioning and loading into the samplers or transport containers, as well as transportation to the sampling site, but without being exposed.

3.2.4.1 *Discussion*—If blanks are not actually loaded into samplers, losses due to handling could be underestimated.

3.2.5 *lab blank, n*—a blank substrate that undergoes the same handling as the sample substrate in the laboratory, including conditioning and loading into the samplers or transport containers when this is done in the laboratory.

3.2.6 *limit of detection (LOD), n*—a value for which exceedence by measured mass indicates the presence of a substance at given false-positive rate: $3 \times$ estimated standard deviation of the measured blank substrate mass (see [Annex A2](#)).

3.2.7 *limit of quantitation (LOQ), n*—a value for which exceedence by measured mass indicates the quantitation of a substance at given accuracy: $10 \times$ estimated standard deviation of the measured blank substrate mass (see [Annex A2](#)).

3.2.8 *substrate, n*—sampling filter, foam, and so forth together with whatever mounting is weighed as a single item.

3.2.8.1 *Discussion*—The 25 or 37-mm plastic filter cassette often used for total dust sampling in either its closed-face or open-face version is NOT part of the substrate in the definition above, since it is not weighed.

3.3 Symbols:

α	= detection error rate
B	= number of substrate batches in method evaluation
b	= batch index (1, ..., B)
β	= mean substrate mass change during evaluation experiment
$CV_{\max}$	= maximum relative error acceptable in quantifying collected mass
$\Delta m_b(\mu\text{g})$	= substrate mass change
$\varepsilon_b(\mu\text{g})$	= substrate weight-change random variable representing inter-batch variability
$\varepsilon_{fb}(\mu\text{g})$	= substrate weight change residual random variable with variance σ^2

f	= substrate index (1, ..., F)
F	= number of substrates (for example, filters) in each batch tested in method evaluation
γ	= method evaluation error rate
$LOD(\mu\text{g})$	= limit of detection: $3 \times s_w$
$LOD_{1-\gamma}(\mu\text{g})$	= LOD confidence limit
$LOQ(\mu\text{g})$	= limit of quantitation: $10 \times s_w$
$LOQ_{1-\gamma}(\mu\text{g})$	= LOQ confidence limit
N_b	= number of blanks per substrate set
ν	= number of degrees of freedom in method evaluation
Φ	= cumulative normal function
χ^2	= chi-square random variable
$\chi_{\gamma, \nu}^2$	= chi-square quantile (that is, a fixed number that exceeds the random variable χ^2 at probability γ)
RH	= relative humidity
$u(\mu\text{g})$	= uncertainty component in two balance readings, an estimate of σ
$u_w(\mu\text{g})$	= weighing uncertainty, estimate of σ_w
$\sigma(\mu\text{g})$	= uncorrectable (for example, by way of blank correction) standard deviation in (single) mass-change measurement
$\sigma_{1-\gamma}(\mu\text{g})$	= confidence limit on σ
$\sigma_w(\mu\text{g})$	= standard deviation in collected mass determination
U	= overall uncertainty

4. Significance and Use

4.1 The weighing of collected aerosol is one of the most common and purportedly simple analytical procedures in both occupational and environmental atmospheric monitoring (for example, Test Method [D4532](#) or [D4096](#)). Problems with measurement accuracy occur when the amount of material collected is small, owing both to balance inaccuracy and variation in the weight of that part of the sampling medium that is weighed along with the sample. The procedures presented here for controlling and documenting such analytical errors will help provide the accuracy required for making well-founded decisions in identifying, characterizing, and controlling hazardous conditions.

4.2 Recommendations are given as to materials to be used. Means of controlling or correcting errors arising from instability are provided. Recommendations as to the weighing procedure are given. Finally, a method evaluation procedure for estimating weighing errors is described.

4.3 Recommendations are also provided for the reporting of weights relative to LOD (see [3.2.6](#)) and LOQ (see [3.2.7](#)). The quantities, LOD and LOQ, are computed as a result of the method evaluation.

5. Weight Instability, Causes, and Minimization

5.1 Weight instability of sampling substrates may be attributed to several causes. The following subclauses address the more important of these.

5.1.1 Moisture Sorption:

5.1.1.1 Moisture sorption is the most common cause of weight instability. Water may be directly collected by the filter or foam or other substrate material that is weighed. Water