National Institute of Standards and Technology
U.S. Department of Commerce

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Standard Reference Material® 2584

Trace Elements in Indoor Dust

(Nominal Mass Fraction of 1 % Lead)

CERTIFICATE OF ANALYSIS

Purpose: This Standard Reference Material (SRM) is intended for use in the evaluation of methods and for the calibration of apparatus used to determine lead and other trace elements in dust.

Description: SRM 2584 is composed of dust collected from vacuum cleaner bags used in the cleaning of interior dwelling spaces. A unit of SRM 2584 consists of 8 g of particulate material, 99+ % of which passes a 100 µm (No. 145) sieve.

Certified Values: The certified values and uncertainties for five elements in SRM 2584 are listed in Table 1. A certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or accounted for [1,2]. The certified mass fractions of the elements in Table 1 are metrologically traceable to the International System of Units (SI) unit of mass fraction expressed as milligrams per kilogram on a dry-mass basis.

Table 1. Certified Mass Fractions (Dry-Mass Basis) for Elements in SRM 2584

Element	Mass Fraction[(a)] (mg/kg)		
Arsenic (As)	17.4	±	4.2
Cadmium (Cd)	10.0	±	1.1
Chromium (Cr)	135.0	±	9.1
Lead (Pb)	9761	±	67
Mercury (Hg)	5.20	±	0.24

(a) Values are expressed as $x \pm U_{95\%}(x)$, where x is the certified value and $U_{95\%}(x)$ is the expanded uncertainty of the certified value [3].

Non-Certified Values: Non-certified values for mass fractions of 10 elements are provided in Appendix A.

Additional Information: Values of potential interest to users, methods used for the analysis of SRM 2584, and additional information are provided in Appendix B.

Period of Validity: The certified values delivered by **SRM 2584** are valid within the measurement uncertainty specified until **31 October 2033**. The certified values are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Certified Values: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm) and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Steven J. Choquette, Director
Office of Reference Materials

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Safety: SRM 2584 is intended for research use. Please consult the Safety Data Sheet for this product.

Storage: SRM 2584 is packaged as a dry material in glass bottles. The SRM must be stored in its original bottle at climate-controlled room temperature (20 °C ± 5 °C) away from fumes and direct sunlight.

Use: To relate analytical determinations to the certified values in this Certificate of Analysis, a minimum sample mass of 100 mg should be used, and the sample should be handled according to the "Instructions for Drying". Sample preparation procedures should also be designed to effect complete dissolution to relate the determined value to the certified value.

Instructions for Drying: When nonvolatile elements such as cadmium, chromium, and lead are to be determined, samples should be oven dried for 2 h at 110 °C. Volatile elements, such as arsenic and mercury, should be determined on samples as-received; separate samples should be dried according to these drying instructions to obtain a correction factor for moisture. Moisture corrections should then be made to measurement values before comparing them to the certified values.

REFERENCES

[1] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Molloy, J.; Nelson, M.A.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sander, L.C.; Schiel, J.E.; Sharpless, K.E.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136, 2021 edition; National Institute of Standards and Technology, Gaithersburg, MD (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Oct 2023).

[2] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at http://www.nist.gov/pml/pubs/sp811/index.cfm (accessed Oct 2023).

[3] JCGM 100:2008; *Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology (JCGM) (2008); available at http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Oct 2023); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at http://www.nist.gov/pml/pubs/index.cfm (accessed Oct 2023).

Certificate Revision History: 06 November 2023 (Change of period of validity; updated format; editorial changes); 29 January 2016 (Change of expiration date; editorial changes); 07 November 2010 (Change of expiration date; editorial changes); 15 December 1999 (Original certification date).

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APPENDIX A

Non-Certified Values: Non-certified values are suitable for use in method development, method harmonization, and process control but do not provide metrological traceability to the SI or other higher-order reference systems. Non-certified mass fraction values and uncertainties for elements in SRM 2584 are given below in Table A1.

Table A1. Non-Certified Mass Fractions (Dry-Mass Basis)

Element	Mass Fraction (mg/kg)		
Aluminum (Al)	23 200	±	600
Calcium (Ca)	63 300	±	3 000
Iron (Fe)	16 400	±	1 200
Potassium (K)	9 500	±	1 400
Lanthanum (La)	19	±	2
Magnesium (Mg)	15 900	±	300
Sodium (Na)	27 700	±	1 200
Phosphorus (P)	2 000	±	120
Titanium (Ti)	4 200	±	300
Zinc (Zn)	2 580	±	150

The uncertainties are an estimated 95 % confidence interval for the true value, including the combined effect of the measurement uncertainty for each method and an allowance for differences between the analytical methods used [3]. Non-certified values are values that are the best estimate of the true value; however, the values do not meet the NIST criteria for certification and are provided with associated uncertainties that may not include all sources of uncertainty. The non-certified values and uncertainties are based on measurements from two or more analytical methods performed at NIST and/or the U.S. Geological Survey (USGS).

Period of Validity: The non-certified values are valid within the measurement uncertainty specified until **31 October 2033.** The value assignments are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Non-Certified Values: NIST will monitor this material to the end of its period of validity. If substantive technical changes occur that affect the non-certified values during this period, NIST will update this Certificate of Analysis and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

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APPENDIX B

Collection: Approximately 65 % of the material used for SRM 2584 was obtained from households in Montana, New Jersey, Ohio, and Wisconsin involved in lead poisoning intervention programs in which HEPA® vacuum cleaners were used to remove dust and other surface debris from homes where cases of lead poisoning had occurred. This material was mixed with low level material taken from the sources used for the preparation of SRM 2583, namely routine vacuum cleaner bags from households, cleaning services, motels, and hotels from North Carolina, Maryland, Ohio, and New Jersey. The vacuum cleaner bags were collected under the direction of the Research Triangle Institute (RTI) and the EPA. The collection process was coordinated by E.D. Hardison and D.A. Binstock of RTI (Research Triangle Park, NC) under the leadership of W.F. Gutknecht.

Preparation: From RTI the bags were labeled, boxed and sent to Neutron Products (Dickerson, MD) for radiation sterilization, and then shipped to NIST for processing. The initial screening and preparation to select suitable material were directed by P.A. Pella and performed by A.F. Marlow, C. Desai, and P. Seo of NIST. Final processing and blending were performed by the NIST Office of Reference Materials. The raw material from each bag was mixed and tumbled in a modified food processor using chopping blades and a compressed air jet. While still tumbling, the dust was separated from unwanted debris by vacuuming through a series of screens into a clean HEPA vacuum cleaner. The dust collected in this manner was then screened through a 90 μm stainless steel sieve using vibration and a vacuum. Processed sub-lots of approximately 5 kg each were set aside and analyzed for lead by X-ray fluorescence in order to develop a blending protocol for the target lead concentration. Selected high and low level sub-lots were blended in a cone blender and then bottled.

Analysis: Certification analyses were performed in the NIST Chemical Sciences Division. Non-certified and values of potential interest analyses were performed by the USGS (Denver, CO) using inductively coupled plasma mass spectrometry (ICPMS) and wavelength dispersive X-ray fluorescence spectrometry (WDXRF) and by the NIST Chemical Sciences Division using instrumental neutron activation analysis (INAA). Analytical methods used for this SRM are given in Table B3.

Table B1. Methods Used for the Analysis of SRM 2584

Method[(a)]	Element[(b)]
CVAAS	**Hg**
HR-ICPMS	**As**, **Cr**
ICPMS (NIST)	Cd
ICPMS (USGS)	Al, Ba, Be, Bi, Ca, Ce, Co, Ca, Cu, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Rb, Sb, Sc, Se, Sr, Th, Ti, U, V, Y, Zn
ID-ICPMS	Cd, Pb
ID-TIMS	**Cd**, **Pb**
INAA	**As**, **Cr**, Fe, **Hg**, La, Zn
WDXRF (USGS)	Al, Ca, Fe, K, Mg, Na, P, Si, Ti

[(a)] Methods:

CVAAS	Cold vapor atomic absorption spectrometry
ICPMS	Inductively coupled plasma mass spectrometry
ID-ICPMS	Isotope dilution quadrupole inductively coupled plasma mass spectrometry
ID-TIMS	Isotope dilution thermal ionization mass spectrometry
INAA	Instrumental neutron activation analysis
HR-ICPMS	High resolution inductively coupled plasma mass spectrometry
WDXRF	Wavelength dispersive X-ray fluorescence spectrometry

[(b)] Element results used for establishment of certified values are indicated by bold-face type.

Analysts NIST Chemical Sciences Division: C.M. Beck, J.R. Sieber, S.J. Christopher, R.D. Vocke, A.F. Marlow, L.L. Yu, K.E. Murphy, R.L. Zeisler, M.S. Rearick.

Values of potential interest to users: Values for elements in SRM 2584 are provided in Table B2 below. The values were measured using the methods described above (Table B1). Uncertainties for the values in Table B2 were not assigned because measurements were not made to sufficiently account for all sources of uncertainty or their magnitude.

Table B1. Mass Fractions (Dry-Mass Basis) for Elements with Values of Potential Interest to Users

Element	Mass Fraction (mg/kg)	Element	Mass Fraction (mg/kg)
Antimony (Sb)	14	Nickel (Ni)	90
Barium (Ba)	1300	Niobium (Nb)	10
Beryllium (Be)	0.7	Rubidium (Rb)	33
Bismuth (Bi)	9	Scandium (Sc)	4
Cerium (Ce)	35	Selenium (Se)	2
Cesium (Cs)	1.4	Silicon (Si)	106000
Cobalt (Co)	10	Strontium (Sr)	160
Copper (Cu)	320	Thorium (Th)	4
Gallium (Ga)	6.4	Uranium (U)	1.6
Lithium (Li)	17	Vanadium (V)	34
Manganese (Mn)	370	Yttrium (Y)	10
Molybdenum (Mo)	5.5		

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