NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Date of Issue:
28 April 2025

Standard Reference Material® 1643f
Trace Elements in Water
CERTIFICATE OF ANALYSIS

Purpose: This Standard Reference Material (SRM) is intended primarily for use in evaluating methods used in the determination of trace elements in fresh water.

Description: A unit of SRM 1643f consists of approximately 250 mL of acidified water in a polyethylene bottle, which is sealed in an aluminized plastic bag to maintain stability. SRM 1643f simulates the elemental composition of fresh water. The solution contains nitric acid at a volume fraction of approximately 2 %, equivalent to an amount of substance concentration (molarity) of approximately 0.32 mol/L.

Certified Values: The certified values for elements in SRM 1643f are listed in Table 1. These values are traceable to the International System of Units (SI) [1]. All values are reported both as mass fractions (µg/kg) and as mass concentrations (µg/L). A NIST 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 taken into account [1]. The certified mass fraction values are consensus estimates that blend the results of the gravimetric preparation value and a value determined by either inductively coupled plasma mass spectrometry (ICP-MS) or inductively coupled plasma optical emission spectrometry (ICP-OES) [2]. The certified mass concentration values are derived from the certified mass fraction values using the measured density of SRM 1643f.

The expanded uncertainty for each certified value is calculated as

$$U = ku_c$$

where k is the coverage factor for a 95 % confidence interval and u_c is the combined standard uncertainty calculated through the application of the Monte Carlo method described in the ISO/JCGM Supplement 1 [3]. The value of u_c for the certified mass fraction values is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with the gravimetric preparation, the ICP-MS or ICP-OES determination, method bias, and stability. Additionally, the uncertainty evaluations associated with the certified mass concentration values assume that the temperature at which the material will be measured is between 15 °C and 25 °C.

Additional Information: Additional information is provided in Appendix A.

Period of Validity: The certified values delivered by **SRM 1643f** are valid within the measurement uncertainty specified until **01 August 2027**. 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). 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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Table 1. Certified Values, Expanded Uncertainties, and Coverage Factors (k) for Elements in SRM 1643f

Element	Mass Fraction[(a)] (µg/kg)			k	Mass Concentration[(a)] (µg/L)			k
Aluminum (Al)	132.5	±	1.2	1.9	133.8	±	1.2	1.9
Antimony (Sb)	54.90	±	0.39	1.9	55.45	±	0.40	2.0
Arsenic (As)	56.85	±	0.37	2.0	57.42	±	0.38	2.0
Barium (Ba)	513.1	±	7.3	2.1	518.2	±	7.3	2.1
Beryllium (Be)	13.53	±	0.11	2.1	13.67	±	0.12	2.1
Bismuth (Bi)	12.50	±	0.10	1.9	12.62	±	0.11	1.9
Boron (B)	150.8	±	6.6	2.2	152.3	±	6.6	2.2
Cadmium (Cd)	5.83	±	0.13	2.2	5.89	±	0.13	2.2
Calcium (Ca)	29 140	±	320	2.1	29 430	±	330	2.1
Chromium (Cr)	18.32	±	0.10	2.0	18.50	±	0.10	2.1
Cobalt (Co)	25.05	±	0.17	2.0	25.30	±	0.17	2.0
Copper (Cu)	21.44	±	0.70	2.1	21.66	±	0.71	2.2
Iron (Fe)	92.51	±	0.77	2.1	93.44	±	0.78	2.1
Lead (Pb)	18.303	±	0.081	2.0	18.488	±	0.084	2.1
Lithium (Li)	16.42	±	0.35	2.2	16.59	±	0.35	2.2
Magnesium (Mg)	7 380	±	58	1.9	7 454	±	60	2.0
Manganese (Mn)	36.77	±	0.58	2.1	37.14	±	0.60	2.2
Molybdenum (Mo)	114.2	±	1.7	2.1	115.3	±	1.7	2.1
Nickel (Ni)	59.2	±	1.4	2.2	59.8	±	1.4	2.2
Potassium (K)	1 913.3	±	9.0	2.0	1 932.6	±	9.4	2.1
Rubidium (Rb)	12.51	±	0.12	2.0	12.64	±	0.13	2.0
Selenium (Se)	11.583	±	0.078	2.0	11.700	±	0.081	2.0
Silver (Ag)	0.9606	±	0.0053	2.0	0.9703	±	0.0055	2.0
Sodium (Na)	18 640	±	240	2.1	18 830	±	250	2.1
Strontium (Sr)	311	±	18	2.1	314	±	19	2.2
Tellurium (Te)	0.9672	±	0.0082	2.0	0.9770	±	0.0084	2.0
Thallium (Tl)	6.823	±	0.034	1.9	6.892	±	0.035	2.0
Vanadium (V)	35.71	±	0.27	2.0	36.07	±	0.28	2.0
Zinc (Zn)	73.7	±	1.7	2.1	74.4	±	1.7	2.1

[(a)] The measurand is the total mass fraction for each element. Metrological traceability is to the SI unit for mass, expressed as micrograms per kilogram and micrograms per liter.

Use: The SRM should be shaken before use because of possible water condensation on the inner surfaces of the bottle. To prevent possible contamination of the SRM, **DO NOT** insert pipettes into the bottle. Samples should be decanted at a room temperature of 15 ºC to 25 ºC. The accuracy of trace element determinations, especially at the micrograms per liter level, is limited by contamination. Apparatus should be scrupulously cleaned and only high purity reagents employed. Sampling and manipulations, such as evaporations, should be done in a clean environment, such as a Class-100 clean hood.

Storage: This material should be stored at a room temperature between between 15 °C and 25 °C. After use, the bottle should be recapped tightly and returned to the aluminized plastic bag, which should be folded and sealed with sealing tape. This safeguard will protect the SRM from possible environmental contamination and long-term evaporation. Loss of solvent mass during storage can be monitored using an analytical balance.

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; U.S. Government Printing Office: Washington, DC (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Apr 2025).

[2] DerSimonian, R.; Laird, N.; *Meta-Analysis in Clinical Trials*; Control. Clin. Trials, Vol. 7, pp. 177–188 (1986).

[3] JCGM 101:2008; *Evaluation of Measurement Data — Supplement 1 to the "Guide to the Expression of Uncertainty in Measurement" — Propagation of Distributions using a Monte Carlo Method*; Joint Committee for Guides in Metrology (JCGM) (2008); available at https://www.bipm.org/en/committees/jc/jcgm/publications (accessed Apr 2025).

Certificate Revision History: 28 April 2025 (Changed period of validity; editorial changes); **04 August 2023** (Changed period of validity, updated format, editorial changes); **08 August 2015** (Original certificate date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

Preparation of Material: SRM 1643f was prepared at NIST using only high purity reagents. A polyethylene cylindrical tank was filled with deionized water and sufficient nitric acid to bring the nitric acid amount of substance concentration (molarity) to approximately 0.32 mol/L. Known masses of the matrix elements (sodium, potassium, calcium, and magnesium) were added to the tank as solutions prepared from the same materials used to prepare the SRM 3100 series of single element solutions. Known masses of the other elements were then added to the tank solution using weighed aliquots of the SRM 3100 series. After mixing thoroughly, the tank solution was transferred into the acid-cleaned, 250 mL, polyethylene, SRM bottles and immediately sealed in individual aluminized plastic bags.

Certification of Material: Each of the certified elements was determined using either ICP-MS or ICP-OES. The final total mass of the tank solution prior to bottling was determined from the sum of the mass fraction values of the elements in Table 1 and the sum of the known masses of those elements added to prepare the solution, therefore allowing calculation of the gravimetric preparation mass fraction for each element. Certified mass fraction values were calculated by combining the gravimetric preparation values with the ICP-MS or ICP-OES values, as described under Certified Values. Certified mass concentration values were calculated using the measured density of 1.0101 g/mL ± 0.0012 g/mL, where the uncertainty is expressed at a confidence level of approximately 95 %, within the temperature range of 15 °C to 25 °C.

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