



National Institute of Standards & Technology

Certificate

Standard Reference Material[®] 4352

Human Liver Environmental Radioactivity Standard

This Standard Reference Material (SRM), which has been developed in cooperation with member laboratories of the International Committee for Radionuclide Metrology, is intended for use in the measurement of radionuclides under study by members of the Transuranium Registry and other laboratories studying the movement and effects of heavy alpha-particle-emitting radionuclides within and upon the human body. It should prove useful to those scientists who may wish to evaluate analytical methods or to use as a generally available “real” sample matrix in interlaboratory intercomparisons. A unit of SRM 4352 consists of approximately 45 g of dried, cryogenically ground human liver, vacuum packed in a 125 mL glass bottle.

Certified Values: The certified properties for the human liver radionuclide standard are presented in Tables 1 and 2. NIST certified values, as used within the context of this certificate, are values for which NIST has the highest confidence in its uncertainty assessment. They are consensus values, obtained from a thorough statistical evaluation based on different activity measurement methods as obtained by NIST and outside collaborating laboratories. Each reporting laboratory maintains its own traceability to the derived SI unit, the becquerel (Bq).

Expiration of Certification: The certification of **SRM 4352** is valid indefinitely, within the measurement uncertainty specified, provided the SRM is handled and stored properly and that no change in composition has occurred. Periodic recertification of this SRM is not required. This SRM should be handled in accordance with instructions given in this certificate (see “Instructions for Handling and Storage”). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Radiological and Chemical Hazard: Consult the Safety Data Sheet (SDS), enclosed with the SRM shipment, for radiological and chemical hazard information.

This SRM was prepared in the Center for Radiation Research, Nuclear Radiation Division, Radioactivity Group. Coordination of the technical measurements leading to the certification of this SRM was performed by D.D. Hoppes, formerly of NIST.

Statistical consultation was provided by W.S. Liggett, Jr., formerly of NIST.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

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Details of SRM Preparation: Liver specimens were radiation sterilized and freeze dried. The ratio of the wet-liver-tissue weight to the freeze-dried liver-tissue weight is 4:1. Radioactivity-contaminated livers from two chronically exposed individuals were mixed with diluent material from healthy individuals. The sample was cryogenically milled and blended in a 3 ft³ “V” cone blender. It was then vacuum packed in a glass bottle. Approximately 89 % of the activity contained in the SRM is provided by the highly contaminated livers and approximately 11 % originates in the background contamination of the diluent material.

INSTRUCTIONS FOR HANDLING AND STORAGE

Handling and Storage: The SRM should be stored in a dry location. This SRM material should have a virtually indefinite storage life if kept at temperatures below 0 °C. The content of the whole bottle (45 grams provided) represents a typical working sample for many monitoring laboratories. The bottle should be opened carefully, releasing the vacuum in the bottle first. The sample should be weighed as soon as possible after the bottle is opened. The bottle (or any subsequent container) should always be clearly marked. If the SRM is transported, it should be packed, marked, labeled, and shipped in accordance with applicable local, national, international, and carrier regulations.

Certified Values: Certified values were measured by two or more methods and/or two or more laboratories. If additional data become available, other radionuclides may be certified and purchasers will be notified. To aid in these certifications, users are requested to send their measurement results for uncertified radioactivities, together with the methods used, to the technical contacts listed on page 1.

Table 1. Certified Properties of SRM 4352

Radionuclides	See Table 2
Reference time	01 June 1982
Certified massic activities	See Table 2
Uncertainties	See Table 2

Table 2. Certified Massic Activity Values for SRM 4352

Radionuclide	Massic Activity (Bq·g⁻¹)	Total Uncertainty^(a) (%)	Analytical Methods^(b)
²³⁸ Pu	5.5 × 10 ⁻⁵	44	1a, 2b, 2
²³⁹⁺²⁴⁰ Pu	2.06 × 10 ⁻³	19	1a, 1+2, 2b, 2
²⁴¹ Am	1.5 × 10 ⁻⁴	37	1a, 1+2, 2b, 2

^(a) Because of variation in the determination of radionuclide concentrations, the uncertainties used are the 95 % tolerance limits for coverage of at least 95 % of the measured values. These tolerance limits are based on the standard deviation and number of measurements listed. These tolerance limits are based on the following: for ²³⁹⁺²⁴⁰Pu, a sample standard deviation of 6.8 % calculated from 18 measurements; for ²⁴¹Am, a sample standard deviation of 11.5 % based on 11 measurements; and for ²³⁸Pu, a sample standard deviation of 13.5 % based on 11 measurements.

^(b) Sample Decomposition Methods, all with alpha-particle spectrometry with surface-barrier detector:

- ⁽¹⁾ Dryashing
- ⁽²⁾ HF-HNO₃ or HF-HNO₃-HClO₄ dissolution [2,3]
- ^(a) KF-pyrosulfate fusion [4]
- ^(b) NaNO₃-LiNO₃ fusion [5]

Information Values: Information values for massic activity are provided in Table 3, particle size distribution in Table 4, and iron concentration in Table 5. An information value is considered to be a value that will be of interest to the SRM user, but insufficient information is available to assess the uncertainty associated with the value or only a limited number of analyses were performed [1]. Information values cannot be used to establish metrological traceability.

Table 3. Information Massic Activity Values for SRM 4352

Radionuclide	Massic Activity (Bq•g ⁻¹)	Sample Standard Deviation (%)	Range of Measurements (Bq•g ⁻¹) x 10 ⁴	Number of Assays
²²⁸ Th	5.1 x 10 ⁻⁴	38	3.3 to 7.0	4
²³⁰ Th	2.0 x 10 ⁻⁴	12	1.6 to 2.3	4
²³² Th	5.8 x 10 ⁻⁵	24	0.4 to 0.8	8
²³⁴ U	1.0 x 10 ⁻⁴	11	0.8 to 1.2	8
²³⁵ U	9 x 10 ⁻⁶	113	-0.1 to 0.2	8
²³⁸ U	8.8 x 10 ⁻⁵	12	0.7 to 1.0	8

Table 4. Information Values for Particle Size Distribution of the Freeze-Dried Liver Matrix in SRM 4352

Weight (%)	Diameter (µm) (By Alpine Air Jet Sieve)
81	< 75
8	75 to 90
7	90 to 150
4	> 150

Table 5. Information Iron Concentration Value for SRM 4352

Iron Concentration (mmole Fe•g ⁻¹)	Sample Standard Deviation (%)	Method	Laboratory
0.02171	1.3	Zinc Titration	LANL

Table 6. Participating Laboratories and Technical Points of Contact at Time of Certification

Laboratory Acronym	Laboratory	City/State	Technical Contact
EML	Environmental Measurements Laboratory U.S. Department of Energy	New York, NY	Dr. H.L. Volchok, Mr. M.S. Feiner
LANL	Los Alamos National Laboratory University of California	Los Alamos, NM	Dr. J.F. McInroy Dr. H.A. Boyd Mr. B.C. Eutsler
WHOI	Woods Hole Oceanographic Institution	Woods Hole, MA	Dr. V.T. Bowen, Dr. H.D. Livingston
NIST	National Institute of Standards and Technology (formerly National Bureau of Standards) U.S. Department of Commerce	Gaithersburg, MD	Dr. J.M.R. Hutchinson, Dr. K.G.W. Inn, Dr. W.S. Liggett, Jr.

REFERENCES

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- [2] *Environmental Measurements Laboratory Procedures Manual*; HASL 300 with 8 supplements, Harley, J.H., Ed.; New York: NY (1980).
- [3] Livingston, H.D.; Mann, D.R.; Bowen, V.T.; *Analytical Procedures for Transuranic Elements in Seawater and Marine Sediments*; in *Analytical Methods in Oceanography, Advances in Chemistry Series, No. 147*, Gibb, Jr., T.R.P., Ed.; American Chemical Society, New York, pp. 124-138 (1975).
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- [5] Los Alamos National Laboratory, Industrial Hygiene Group; *Plutonium in Tissue Analytical Procedure*; McInroy, J.F., Ed.; Los Alamos National Laboratory: Los Alamos, NM (1980).
- [6] Wong, K.M.; Noshkin, V.E.; Bowen, V.T.; *Radiochemical Procedures for the Analysis of Strontium, Antimony, Rare earths, Cesium, and Plutonium in Seawater Samples*; in *Reference Methods for Marine Radiochemistry Studies*, International Atomic Energy Agency Technical Report Series, No. 118, International Atomic Energy Agency, Vienna, p. 119 (1970).

Certificate Revision History: 08 December 2016 (Editorial changes); June 1982 (Original certificate issue date).

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail srminfo@nist.gov; or via the Internet at <http://www.nist.gov/srm>.