

Standard Reference Materials:

Summary of the Biological and Botanical Standards Issued by the National Bureau of Standards

R. Mavrodineanu¹

Center for Analytical Chemistry
National Measurement Laboratory
National Bureau of Standards
Gaithersburg, MD 20899

and

R. Alvarez

Office of Standard Reference Materials
National Measurement Laboratory
National Bureau of Standards
Gaithersburg, MD 20899

¹Present Address: 227 Almeria Road
West Palm Beach, FL 33405



U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, Secretary
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Issued October 1985

Library of Congress Catalog Card Number: 85-600605

National Bureau of Standards Special Publication 260-104
Natl. Bur. Stand. (U.S.), Spec. Publ. 260-104, 68 pages (Oct. 1985)
CODEN: XNBSAV

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1985

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

Preface

Standard Reference Materials (SRM's) as defined by the National Bureau of Standards (NBS) are well-characterized materials, produced in quantity and certified for one or more physical or chemical properties. They are used to assure the accuracy and compatibility of measurements throughout the Nation. SRM's are widely used as primary standards in many diverse fields in science, industry, and technology, both within the United States and throughout the world. They are also used extensively in the fields of environmental and clinical analysis. In many applications, traceability of quality control and measurement processes to the national measurement system is carried out through the mechanism and use of SRM's. For many of the Nation's scientists and technologists it is therefore of more than passing interest to know the details of the measurements made at NBS in arriving at the certified values of the SRM's produced. An NBS series of papers, of which this publication is a member, called the NBS Special Publication - 260 Series, is reserved for this purpose.

This 260 Series is dedicated to the dissemination of information on different phases of the preparation, measurement, certification and use of NBS SRM's. In general, much more detail will be found in these papers than is generally allowed, or desirable, in scientific journal articles. This enables the user to assess the validity and accuracy of the measurement processes employed, to judge the statistical analysis, and to learn details of techniques and methods utilized for work entailing the greatest care and accuracy. These papers also should provide sufficient additional information not found on the certificate so that new applications in diverse fields not foreseen at the time the SRM was originally issued will be sought and found.

Inquiries concerning the technical content of this paper should be directed to the author(s). Other questions concerned with the availability, delivery, price, and so forth, will receive prompt attention from:

Office of Standard Reference Materials
National Bureau of Standards
Gaithersburg, MD 20899

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

OTHER NBS PUBLICATIONS IN THIS SERIES

- Catalog of NBS Standard Reference Materials (1984-85 edition), Catherine H. Hudson, ed., NBS Spec. Publ. 260 (February 1984). \$5.50* SN003-003-02558-5.
- Michaelis, R. E., and Wyman, L. L. Standard Reference Materials: Preparation of White Cast Iron Spectrochemical Standards. NBS Misc. Publ. 260-1 (June 1964). COM74-11061**
- Michaelis, R. E., Wyman, L. L., and Flitsch, R., Standard Reference Materials: Preparation of NBS Copper-Base Spectrochemical Standards. NBS Misc. Publ. 260-2 (October 1964). COM74-11063**
- Michaelis, R. E., Yakowitz, H., and Moore, G. A., Standard Reference Materials: Metallographic Characterization of an NBS Spectrometric Low-Alloy Steel Standard. NBS Misc. Publ. 260-3 (October 1964). COM74-11060**
- Hague, J. L. Mears, T. W., and Michaelis, R. E., Standard Reference Materials: Sources of Information, NBS Misc. Publ. 260-4 (February 1965). COM74-11059
- Alvarez, R., and Flitsch R., Standard Reference Materials: Accuracy of Solution X-Ray Spectrometric Analysis of Copper-Base Alloys. NBS Misc. Publ. 260-5 (March 1965). PB168068**
- Shultz, J. I., Standard Reference Materials: Methods for the Chemical Analysis of White Cast Iron Standards, NBS Misc. Publ. 260-6 (July 1965). COM74-11068**
- Bell, R. K., Standard Reference Materials: Methods for the Chemical Analysis of NBS Copper-Base Spectrochemical Standards. NBS Misc. Publ. 260-7 (October 1965). COM74-11067**
- Richmond, M.S., Standard Reference Materials: Analysis of Uranium Concentrates at the National Bureau of Standards. NBS Misc. Publ. 260-8 (December 1965). COM74-11066**
- Anspach, S. C., Cavallo, L. M. Garfinkel, S. B. Hutchinson, J. M. R., and Smith, C. N., Standard Reference Materials: Half Lives of Materials Used in the Preparation of Standard Reference Materials of Nineteen Radioactive Nuclides Issued by the National Bureau of Standards NBS Misc. Publ. 260-9 (November 1965). COM74-11065**
- Yakowitz, H., Vieth, D. L., Heinrich, K. F. J., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards II: Cartridge Brass and Low-Alloy Steel, NBS Misc. Publ. 260-10 (December 1965). COM74-11064**
- Napolitano, A., and Hawkins, E. G., Standard Reference Materials: Viscosity of Standard Lead-Silica Glass, NBS Misc. Publ. 260-11 (November 1966). NBS Misc. Publ. 260-11**
- Yakowitz, H., Vieth, D. L., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards III: White Cast Iron and Stainless Steel Powder Compact, NBS Misc. Publ. 260-12 (September 1966). NBS Misc. Publ. 260-12**
- Spijkerman, J. L., Snediker, D. K., Ruegg, F. C., and DeVoe, J. R., Standard Reference Materials: Mossbauer Spectroscopy Standard for the Chemical Shift of Iron Compounds, NBS Misc. Publ. 260-13 (July 1967). NBS Misc. Publ. 260-13**
- Menis, O., and Sterling, J. T., Standard Reference Materials: Determination of Oxygen in Ferrous Materials - SRM 1090, 1091, and 1092, NBS Misc. Publ. 260-14 (September 1966). NBS Misc. Publ. 260-14**
- Passaglia, E., and Shouse, P. J., Standard Reference Materials: Recommended Method of Use of Standard Light-Sensitive Paper for Calibrating Carbon Arcs Used in Testing Textiles for Colorfastness to Light, NBS Misc. Publ. 260-15 (June 1967). (Replaced by NBS Spec. Publ. 260-41.)
- Yakowitz, H., Michaelis, R. E., and Vieth, D. L., Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards IV: Preparation and Microprobe Characterization of W-20% MO Alloy Fabricated by Powder Metallurgical Methods, NBS Spec. Publ. 260-16 (January 1969). COM74-11062**
- Catanzaro, E. J., Champion, C. E., Garner, E. L., Marinenko, G., Sappenfield, K. M., and Shields, W. R., Standard Reference Materials: Boric Acid; Isotopic and Assay Standard Reference Materials, NBS Spec. Publ. 260-17 (February 1970). Out of Print.
- Geller, S. B., Mantek, P.A., and Cleveland, N. G., Standard Reference Materials: Calibration of NBS Secondary Standard Magnetic Tape (Computer Amplitude Reference) Using the Reference Tape Amplitude Measurement "Process A," NBS Spec. Publ. 260-18 (November 1969). (See NBS Spec. Publ. 260-29.)
- Paule, R. C., and Mandel, J., Standard Reference Materials: Analysis of Interlaboratory Measurements on the Vapor Pressure of Gold (Certification of Standard Reference Material 745). NBS Spec. Publ. 260-19 (January 1970). PB190071**
- Paule, R. C., and Mandel, J., Standard Reference Materials: Analysis of Interlaboratory Measurements on the Vapor Pressures of Cadmium and Silver, NBS Spec. Publ. 260-21 (January 1971). COM74-11359**
- Yakowitz, H., Fiori, C. E., and Michaelis, R. E., Standard Reference Materials: Homogeneity Characterization of Fe-3 Si Alloy, NBS Spec. Publ. 260-22 (February 1971). COM74-11357**
- Napolitano, A., and Hawkins, E. G., Standard Reference Materials: Viscosity of a Standard Borosilicate Glass, NBS Spec. Publ. 260-23 (December 1970). COM71-00157**
- Sappenfield, K. M., Marineko, G., and Hague, J. L., Standard Reference Materials: Comparison of Redox Standards, NBS Spec. Publ. 260-24 (January 1972). COM72-50058**

- Hicho, G. E., Yakowitz, H., Rasberry, S. D., and Michaelis, R. E., Standard Reference Materials: A Standard Reference Material Containing Nominally Four Percent Austenite, NBS Spec. Publ. 260-25 (February 1971). COM74-11356**
- Martin, J. F., Standard Reference Materials: National Bureau of Standards-US Steel Corporation Joint Program for Determining Oxygen and Nitrogen in Steel, NBS Spec. Publ. 260-26 (February 1971). 85 cents* PB 81176620
- Garner, E. L., Machlan, L. A., and Shields, W. R., Standard Reference Materials: Uranium Isotopic Standard Reference Materials, NBS Spec. Publ. 260-27 (April 1971). COM74-11358**
- Heinrich, K. F. J., Myklebust, R. L., Rasberry, S. D., and Michaelis, R. E., Standard Reference Materials: Preparation and Evaluation of SRM's 481 and 482 Gold-Silver and Gold-Copper Alloys for Microanalysis, NBS Spec. Publ. 260-28 (August 1971). COM71-50365**
- Geller, S. B., Standard Reference Materials: Calibration of NBS Secondary Standard Magnetic Tape (Computer Amplitude Reference) Using the Reference Tape Amplitude Measurement "Process A-Model 2," NBS Spec. Publ. 260-29 (June 1971). COM71-50282
- Gorozhanina, R. S., Freedman, A. Y., and Shaievitch, A. B. (translated by M. C. Selby), Standard Reference Materials: Standard Samples Issued in the USSR (A Translation from the Russian), NBS Spec. Publ. 260-30 (June 1971). COM71-50283**
- Hust, J. G., and Sparks, L. L., Standard Reference Materials: Thermal Conductivity of Electrolytic Iron SRM 734 from 4 to 300 K, NBS Spec. Publ. 260-31 (November 1971). COM71-50563**
- Mavrodineanu, R., and Lazar, J. W., Standard Reference Materials: Standard Quartz Cuvettes, for High Accuracy Spectrophotometry, NBS Spec. Publ. 260-32 (December 1973). 55 cents* SN003-003-01213-1
- Wagner, H. L., Standard Reference Materials: Comparison of Original and Supplemental SRM 705, Narrow Molecular Weight Distribution Polystyrene, NBS Spec. Publ. 260-33 (May 1972). COM72-50526**
- Sparks, L. L., and Hust, J. G., Standard Reference Materials: Thermoelectric Voltage, NBS Spec. Publ. 260-34, (April 1972). COM72-50371**
- Sparks, L. L., and Hust, J. G., Standard Reference Materials: Thermal Conductivity of Austenitic Stainless Steel, SRM 735 from 5 to 280 K, NBS Spec. Publ. 260-35 (April 1972). 35 cents* COM72-50368**
- Cali, J. P., Mandel, J., Moore, L. J., and Young, D. S., Standard Reference Materials: A Referee Method for the Determination of Calcium in Serum, NBS SRM 915, NBS Spec. Publ. 260-36 (May 1972). COM72-50527**
- Shultz, J. I. Bell., R. K. Rains, T. C., and Menis, O., Standard Reference Materials: Methods of Analysis of NBS Clay Standards, NBS Spec. Publ. 260-37 (June 1972). COM72-50692**
- Richmond, J. C., and Hsia, J. J., Standard Reference Materials: Preparation and Calibration of Standards of Spectral Specular Reflectance, NBS Spec. Publ. 260-38 (May 1972). COM72-50528**
- Clark, A. F., Denson, V. A., Hust, J. G., and Powell, R. L., Standard Reference Materials: The Eddy Current Decay Method for Resistivity Characterization of High-Purity Metals, NBS Spec. Publ. 260-39 (May 1972). COM72-50529**
- McAdie, H. G., Garn, P. D., and Menis, O., Standard Reference Materials: Selection of Thermal Analysis Temperature Standards Through a Cooperative Study (SRM 758, 759, 760), NBS Spec. Publ. 260-40 (August 1972.) COM72-50776**
- Wood, L. A., and Shouse, P. J., Standard Reference Materials: Use of Standard Light-Sensitive Paper for Calibrating Carbon Arcs Used in Testing Textiles for Colorfastness to Light, NBS Spec. Publ. 260-41 (August 1972) COM72-50775**
- Wagner, H. L. and Verdier, P. H., eds., Standard Reference Materials: The Characterization of Linear Polyethylene, SRM 1475, NBS Spec. Publ. 260-42 (September 1972). COM72-50944**
- Yakowitz, H., Ruff, A. W., and Michaelis, R. E., Standard Reference Materials: Preparation and Homogeneity Characterization of an Austenitic Iron-Chromium-Nickel Alloy, NBS Spec. Publ. 260-43 (November 1972). COM73-50760**
- Schooley, J. F., Soulen, R. J., Jr., and Evans, G. A., Jr., Standard Reference Materials: Preparation and Use of Superconductive Fixed Point Devices, SRM 767, NBS Spec. Publ. 260-44 (December 1972). COM73-50037**
- Greifer, B., Maienthal, E. J., Rains, T. C., and Rasberry, S. D., Standard Reference Materials: Powdered Lead-Based Paint, SRM 1579, NBS Spec. Publ. 260-45 (March 1973). COM73-50226**
- Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials: Austenitic Stainless Steel, SRM's 735 and 798, from 4 to 1200 K, NBS Spec. Publ. 260-46 (March 1975). SN003-003-01278-5*
- Hust, J. G., Standard Reference Materials: Electrical Resistivity of Electrolytic Iron, SRM 797, and Austenitic Stainless Steel, SRM 798, from 5 to 280 K, NBS Spec. Publ. 260-47 (February 1974). COM74-50176**
- Mangum, B. W., and Wise, J. A., Standard Reference Materials: Description and Use of Precision Thermometers for the Clinical Laboratory, SRM 933 and SRM 934, NBS Spec. Publ. 260-48 (May 1974). 60 cents* SN003-003-01278-5
- Carpenter, B. S., and Reimer, G. M., Standard Reference Materials: Calibrated Glass Standards for Fission Track Use, NBS Spec. Publ. 260-49 (November 1974). COM74-51185

- Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials: Electrolytic Iron, SRM's 734 and 797 from 4 to 1000 K, NBS Spec. Publ. 260-50 (June 1975). \$1.00* SN003-003-01425-7
- Mavrodineanu, R., and Baldwin, J. R., Standard Reference Materials: Glass Filters As a Standard Reference Material for Spectrophotometry; Selection; Preparation; Certification; Use-SRM 930, NBS Spec. Publ. 260-51 (November 1975). \$1.90* SN003-003-01481-8
- Hust, J. G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials 730 and 799, from 4 to 3000 K, NBS Spec. Publ. 260-52 (September 1975). \$1.05* SN003-003-01464-8
- Durst, R. A., Standard Reference Materials: Standardization of pH Measurements, NBS Spec. Publ. 260-53 (December 1975, Revised). \$1.05 SN003-003-01551-2
- Burke, R. W., and Mavrodineanu, R., Standard Reference Materials: Certification and Use of Acidic Potassium Dichromate Solutions as an Ultraviolet Absorbance Standard, NBS Spec. Publ. 260-54 (August 1977). \$3.00* SN003-003-01828-7
- Ditmars, D. A., Cezairliyan, A., Ishihara, S., and Douglas, T. B., Standard Reference Materials: Enthalpy and Heat Capacity; Molybdenum SRM 781, from 273 to 2800 K, NBS Spec. Publ. 260-55 (September 1977). \$2.20* SN003-003-01836-8
- Powell, R. L., Sparks, L. L., and Hust, J. G., Standard Reference Materials: Standard Thermocouple Materials, Pt.67: SRM 1967, NBS Spec. Publ. 260-56 (February 1978). \$2.20* SN003-003-01886-4
- Cali, J. P. and Plebanski, T., Guide to United States Reference Materials, NBS Spec. Publ. 260-57 (February 1978). \$2.20* PB 277173
- Barnes, J. D., and Martin, G. M., Standard Reference Materials: Polyester Film for Oxygen Gas Transmission Measurements SRM 1470, NBS Spec. Publ. 260-58 (June 1979) \$2.00* SN003-003-02077
- Chang, T., and Kahn, A. H. Standard Reference Materials: Electron Paramagnetic Resonance Intensity Standard; SRM 2601, NBS Spec. Publ. 260-59 (August 1978) \$2.30* SN003-003-01975-5
- Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., and Moody, J. R., Standard Reference Materials: A Reference Method for the Determination of Sodium in Serum, NBS Spec. Publ. 260-60 (August 1978). \$3.00* SN003-003-01978-0
- Verdier, P. H., and Wagner, H. L., Standard Reference Materials: The Characterization of Linear Polyethylene (SRM 1482, 1483, 1484), NBS Spec. Publ. 260-61 (December 1978). \$1.70* SN003-003-02006-1
- Soulen, R. J., and Dove, R. B., Standard Reference Materials: Temperature Reference Standard for Use Below 0.5 K (SRM 768). NBS Spec. Publ. 260-62 (April 1979). \$2.30* SN003-003-02047-8
- Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., Machlan, L. A., and Gramlich, J. W., Standard Reference Materials: A Reference Method for the Determination of Potassium in Serum. NBS Spec. Publ. 260-63 (May 1979). \$3.75* SN003-003-02068
- Velapoldi, R. A., and Mielenz, K. D., Standard Reference Materials: A Fluorescence Standard Reference Material Quinine Sulfate Dihydrate (SRM 936), NBS Spec. Publ. 260-64 (January 1980). \$4.25* SN003-003-02148-2
- Marinenko, R. B., Heinrich, K. F. J., and Ruegg, F. C., Standard Reference Materials: Micro-Homogeneity Studies of NBS Standard Reference Materials, NBS Research Materials, and Other Related Samples. NBS Spec. Publ. 260-65 (September 1979). \$3.50* SN003-003-02114-1
- Venable, W. H., Jr., and Eckerle, K. L., Standard Reference Materials: Didymium Glass Filters for Calibrating the Wavelength Scale of Spectrophotometers (SRM 2009, 2010, 2013). NBS Spec. Publ. 260-66 (October 1979). \$3.50* SN003-003-02127-0
- Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., Murphy, T. J., and Gramlich, J. W., Standard Reference Materials: A Reference Method for the Determination of Chloride in Serum, NBS Spec. Publ. 260-67 (November 1979). \$3.75* SN003-003-02136-9
- Mavrodineanu, R. and Baldwin, J. R., Standard Reference Materials: Metal-On-Quartz Filters as a Standard Reference Material for Spectrophotometry-SRM 2031, NBS Spec. Publ. 260-68 (April 1980). \$4.25* SN003-003-02167-9
- Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., Machlan, L. A., Garner, E. L., and Rains, T. C., Standard Reference Materials: A Reference Method for the Determination of Lithium in Serum, NBS Spec. Publ. 260-69 (July 1980). \$4.25* SN003-003-02214-4
- Marinenko, R. B., Biancaniello, F., Boyer, P. A., Ruff, A. W., DeRobertis, L., Standard Reference Materials: Preparation and Characterization of an Iron-Chromium-Nickel Alloy for Micro-analysis, NBS Spec. Publ. 260-70 (May 1981). \$2.50* SN003-003-02328-1
- Seward, R. W., and Mavrodineanu, R., Standard Reference Materials: Summary of the Clinical Laboratory Standards Issued by the National Bureau of Standards, NBS Spec. Publ. 260-71 (November 1981). \$6.50* SN003-003-02381-7
- Reeder, D. J., Coxon, B., Enagonio, D., Christensen, R. G., Schaffer, R., Howell, B. F., Paule, R. C., Mandel, J., Standard Reference Materials: SRM 900, Antiepilepsy Drug Level Assay Standard, NBS Spec. Publ. 260-72 (June 1981). \$4.25* SN003-003-02329-9

- Interrante, C. G., and Hicho, G. E., Standard Reference Materials: A Standard Reference Material Containing Nominally Fifteen Percent Austenite (SRM 486), NBS Spec. Publ. 260-73 (January 1982). \$2.75* SN003-003-02386-8
- Marinenko, R. B., Standard Reference Materials: Preparation and Characterization of K-411 and K-414 Mineral Glasses for Microanalysis: SRM 470. NBS Spec. Publ. 260-74 (April 1982). \$3.50 SN003-003-023-95-7
- Weidner, V. R., and Hsia, J. J., Standard Reference Materials: Preparation and Calibration of First Surface Aluminum Mirror Specular Reflectance Standards (SRM 2003a), NBS Spec. Publ. 260-75 (May 1982). \$3.75 SN003-003-023-99-0
- Hicho, G. E. and Eaton, E. E., Standard Reference Materials: A Standard Reference Material Containing Nominally Five Percent Austenite (SRM 485a), NBS Spec. Publ. 260-76 (August 1982). \$3.50 SN003-003-024-33-3
- Furukawa, G. T., Riddle, J. L., Bigge, W. G., and Pfeiffer, E. R., Standard Reference Materials: Application of Some Metal SRM's as Thermometric Fixed Points, NBS Spec. Publ. 260-77 (August 1982). \$6.00 SN003-003-024-34-1
- Hicho, G. E. and Eaton, E. E., Standard Reference Materials: Standard Reference Material Containing Nominally Thirty Percent Austenite (SRM 487), NBS Spec. Publ. 260-78 (September 1982). \$3.75* SN003-003-024-35-0
- Richmond, J. C., Hsia, J. J., Weidner, V. R., and Wilmering, D. B., Standard Reference Materials: Second Surface Mirror Standards of Specular Spectral Reflectance (SRM's 2023, 2024, 2025), NBS Spec. Publ. 260-79 (October 1982). \$4.50* SN003-003-024-47-3
- Schaffer, R., Mandel, J., Sun, T., Cohen, A., and Hertz, H. S., Standard Reference Materials: Evaluation by an ID/MS Method of the AACC Reference Method for Serum Glucose, NBS Spec. Publ. 260-80 (October 1982). \$4.75* SN003-003-024-43-1
- Burke, R. W., and Mavrodineanu, R. (NBS retired), Standard Reference Materials: Accuracy in Analytical Spectrophotometry, NBS Spec. Publ. 260-81 (April 1983). \$6.00* SN003-003-024-8
- Weidner, V. R., Standard Reference Materials: White Opal Glass Diffuse Spectral Reflectance Standards for the Visible Spectrum (SRM's 2015 and 2016). NBS Spec. Publ. 260-82 (April 1983). \$3.75* SN003-003-024-89-9**
- Bowers, G. N., Jr., Alvarez, R., Cali, J. P. (NBS retired), Eberhardt, K. R., Reeder, D. J., Schaffer, R., Uriano, G. A., Standard Reference Materials: The Measurement of the Catalytic (Activity) Concentration of Seven Enzymes in NBS Human Serum SRM 909, NBS Spec. Publ. 260-83 (June 1983). \$4.50* SN003-003-024-99-6
- Gills, T. E., Seward, R. W., Collins, R. J., and Webster, W. C., Standard Reference Materials: Sampling, Materials Handling, Processing, and Packaging of NBS Sulfur in Coal Standard Reference Materials, 2682, 2683, 2684, and 2685, NBS Spec. Publ. 260-84 (August 1983). \$4.50* SN003-003-025-20-8
- Swyt, D. A., Standard Reference Materials: A Look at Techniques for the Dimensional Calibration of Standard Microscopic Particles, NBS Spec. Publ. 260-85 (September 1983). \$5.50* SN003-003-025-21-6
- Hicho, G. E. and Eaton, E. E., Standard Reference Materials: A Standard Reference Material Containing Two and One-Half Percent Austenite, SRM 488, NBS Spec. Publ. 260-86 (December 1983). \$1.75* SN003-003-025-41-1
- Mangum, B. W., Standard Reference Materials: SRM 1969: Rubidium Triple-Point - A Temperature Reference Standard Near 39.30 °C, NBS Spec. Publ. 260-87 (December 1983). \$2.25* SN003-003-025-44-5
- Giadney, E. S., Burns, C. E., Perrin, D. R., Roelandts, I., and Gills, T. E., Standard Reference Materials: 1982 Compilation of Elemental Concentration Data for NBS Biological, Geological, and Environmental Standard Reference Materials. Spec. Publ. 260-88 (March 1984). \$7.00* SN003-003-02565-8
- Hust, J. G., Standard Reference Materials: A Fine-Grained, Isotropic Graphite for Use as NBS Thermophysical Property RM's from 5 to 2500 K, NBS Spec. Publ. 260-89 (September 1984). \$4.50* SN003-003-02608-5
- Hust, J. G., and Lankford, A. B., Standard Reference Materials: Update of Thermal Conductivity and Electrical Resistivity of Electrolytic Iron, Tungsten, and Stainless Steel, NBS Spec. Publ. 260-90 (September 1984). \$3.00* SN003-003-02609-3
- Goodrich, L. F., Vecchia, D. F., Pittman, E. S., Ekin, J. W., and Clark, A. F., Standard Reference Materials: Critical Current Measurements on an NbTi Superconducting Wire Standard Reference Material, NBS Spec. Publ. 260-91 (September 1984). \$2.75* SN003-003-02614-0
- Carpenter, B. S., Standard Reference Materials: Calibrated Glass Standards for Fission Track Use (Supplement to NBS Spec. 260-49). NBS Spec. Publ. 260-92 (September 1984). \$1.50* SN003-003-02610-7
- Ehrstein, J., Preparation and Certification of Standard Reference Materials for Calibration of Spreading Resistance Probes, NBS Spec. Publ. 260-93 (January 1985). \$2.25* SN003-003-02633-6
- Gills, T. E., Koch, W. F., Stolz, J. W., Kelly, W. R., Paulsen, P. J., Colbert, J. C., Kirklin, D. R., Pei, P.T.S., Weeks, S., Lindstrom, R. M., Fleming, R. F., Greenberg, R. R., and Paule, R. C., Methods and Procedures Used at the National Bureau of Standards to Certify Sulfur in Coal SRM's for Sulfur Content, Calorific Value, Ash Content, NBS Spec. Publ. 260-94 (December 1984). \$2.25* SN003-003-02629-8
- Mulholland, G. W., Hartman, A. W., Hembree, G. G., Marx, E., and Lettieri, T. R., Standard Reference Materials: Development of a 1 μm Diameter Particle Size Standard, SRM 1690, NBS Spec. Publ. 260-95 (May 1985). SN003-003-02665-4
- Carpenter, B. S., Gramlich, J. W., Greenberg, R. R., and Machlan, L. A., Standard Reference Materials: Uranium-235 Isotopic Abundance Standard Reference Materials for Gamma Spectrometry Measurements, NBS Spec. Publ. 260-96 (In Preparation).

Mavrodineanu, R. and Gills, T. E., Standard Reference Materials: Summary of the Coal, Ore, Mineral, Rock, and Refractory Standards Issued by the National Bureau of Standards, NBS Spec. Publ. 260-97 (September 1985).

Hust, J. G., Standard Reference Materials: Glass Fiberboard SRM for Thermal Resistance, NBS Spec. Publ. 260-98 (August 1985). SN003-003-02674-3

Callanan, J. E., Sullivan, S. A., and Vecchia, D. F., Standard Reference Materials: Feasibility Study for the Development of Standards Using Differential Scanning Calorimetry, NBS Spec. Publ. 260-99 (August 1985). SN003-003-02675-1

Taylor, J. K., Standard Reference Materials: Handbook for SRM Users, NBS Spec. Publ. 260-100 (In Press).

Mangum, B. W., Standard Reference Materials: SRM 1970, Succinonitrile Triple-Point Standard: A Temperature Reference Standard Near 58.08 °C, NBS Spec. Publ. 260-101 (In Preparation).

Mavrodineanu, R., Standard Reference Materials: Holmium Oxide Solution Wavelength Standard from 240- 650 nm, SRM 2034, NBS Spec. Publ. 260-102 (In Press).

Hust, J. G., Standard Reference Materials: Glass Fiberblanket SRM for Thermal Resistance, NBS Spec. Publ. 260-103 (September 1985). SN003-003-02687-5

Mavrodineanu, R. and Alvarez, R., Standard Reference Materials: Summary of the Biological and Botanical Standards Issued by the National Bureau of Standards, NBS Spec. Publ. 260-104 (In Press).

* Send order with remittance to Superintendent of Documents, US Government Printing Office Washington, DC 20402. Remittance from foreign countries should include an additional one-fourth of the purchase price for postage.

** May be ordered from: National Technical Information Services (NTIS). Springfield Virginia 22161.

TABLE OF CONTENTS

	Page
Preface	iii
Abstract	x
Introduction	1
Table 1. Categories of Standard Reference Materials available from the National Bureau of Standards	2
Biological and Botanical Standards	4
Table 2. Summary of the Biological and Botanical Standards	6
Table 3. Summary of the Analytical Data Obtained for the Biological and Botanical Standard Reference Materials and Research Material	12
Appendix I. Alphabetical Index by Standard Reference Material Name	14
Appendix II. Certificates for Biological and Botanical Standards (listed in numerical order)	27

Abstract

This publication is a summary of the biological and botanical Standard Reference Materials and Research Materials issued by the National Bureau of Standards. The material, composition, certification, use, and remarks concerning each of the ten materials described are presented in tabular form. Copies of the Certificates of Analysis for these materials are contained in the appendix for more detailed information.

Key Words: Biological materials; botanical materials;
chemical compositions; Research Material;
Standard Reference Material.

Introduction

Since its inauguration in 1901, the National Bureau of Standards (NBS) has issued nearly 2000 different Standard Reference Materials (SRM's). Many of these have been renewed several times, many have been replaced or discontinued as technology changed. Today, over 900 SRM's are available, together with a large number of scientific publications related to the fundamental and applied characteristics of these materials. Each material is certified for chemical composition, chemical properties, or its physical or mechanical characteristics. Each SRM is provided with a Certificate or Certificate of Analysis that contains the essential data concerning its properties or characteristics. The SRM's currently available cover a wide range of chemical, physical, and mechanical properties, and a corresponding wide range of measurement interests in practically all aspects of fundamental and applied science. These SRM's constitute a unique and invaluable means of transferring to the user accurate data obtained at NBS, and provide essential tools that can be used to improve accuracy in practically all areas where measurements are performed.

In addition to SRM's, the National Bureau of Standards issues a variety of Research Materials (RM's) having various properties described in individual "Reports of Investigation." They are intended primarily to further the scientific or technical research on that particular material. Other materials, called Special Reference Materials (GM's), are also available from NBS. These are materials produced and certified by other Government agencies, standard organizations, or other nonprofit organizations, that are considered useful to the public and for which no alternate method of national distribution exists.

The various categories of materials available from NBS are given in Table 1. This table lists these materials according to their chemical composition, physical properties, or engineering characteristics. A more detailed alphabetic enumeration of these materials is given in Appendix I. Table 1 and Appendix I were taken from NBS Special Publication 260, NBS Standard Reference Materials Catalog, 1984-85 Edition¹. This publication lists every material available from the NBS Office of Standard Reference Materials.

Further information on the reference materials available from NBS may be obtained from the Office of Standard Reference Materials, National Bureau of Standards, Gaithersburg, MD 20899. Information on other NBS services may be obtained from the Technical Information and Publications Division, National Bureau of Standards, Gaithersburg, MD 20899.

In addition to these types of materials, NBS provides many additional services. These include: Measurement Assurance Programs, Calibration and Related Measurement Services, Proficiency Sample Programs, a National Voluntary Laboratory Accreditation Program, Standards Information Services, Standard Reference Data, and Technical Information and Publications.

¹For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, under Stock No. 003-003-02558-5 (Price \$5.50, add 25 percent for foreign orders.)

Table 1. Categories of Standard Reference Materials available from the National Bureau of Standards.

CERTIFIED CHEMICAL COMPOSITION STANDARDS

Steels (chip form)	Gases in Metals
Plain carbon	High-Purity Metals
Low alloy	Electron Probe Microanalytical Standards
High alloy	Primary, Working, and Secondary
Stainless	Standard Chemicals
Tool	Microchemical Standards
Steels (granular form)	Clinical Laboratory Standards
Steels (solid form)	Biological Standards
Ingot iron and low alloy	Environmental Standards
Special ingot irons and low alloy	Analyzed gases
Stainless	Analyzed liquids and solids
Specialty	Permeation tubes
High-temperature alloys	Industrial Hygiene Standards
Tool	Forensic Standards
Steelmaking Alloys	Hydrocarbon Blends
Cast Irons (chip form)	Metallo-Organic Compounds
Cast Steels, White Cast Irons, Ductile	Fertilizers
Irons, and Blast Furnace Irons	Ores
(solid form)	Minerals, Refractories, Glasses, and
Nonferrous Alloys (chip form)	Carbides
Aluminum "Benchmarks"	Cement
Cobalt	Trace Element Standards
Copper	Nuclear Materials
Copper "Benchmarks"	Special nuclear materials
Lead	Plutonium assay
Magnesium	Plutonium isotopic
Nickel	Uranium assay
Nickel Superalloy, Trace Elements	Uranium isotopic
Nickel oxide	Neutron density standards
Selenium	Fission track glass standards
Tin	Isotopic Reference Standards
Titanium	
Zinc	
Zirconium	
Nonferrous Alloys (solid form)	
Aluminum "Benchmarks"	
Copper	
Copper "Benchmarks"	
Lead	
Nickel	
Titanium	
Zinc	
Zirconium	

Table 1. continued.

CERTIFIED PHYSICAL PROPERTY STANDARDS

<p>Ion Activity Standards</p> <p>pH standards pD standards Ion selective electrodes</p> <p>Mechanical and Metrology Standards</p> <p>Magnification Coating thickness Glass Elasticity Density Polymer Rheology</p> <p>Heat Standards</p> <p>Superconductive thermometric fixed point devices Freezing Points</p> <p>Defining fixed points Determined reference points</p> <p>Melting points Calorimetric</p> <p>Combustion Solution Heat source Enthalpy and heat capacity</p> <p>Vapor pressure Thermal expansion Thermocouple materials Thermal resistance</p> <p>Magnetic Standards</p> <p>Magnetic susceptibility Magnetic moment Paramagnetic resonance</p>	<p>Optical Standards</p> <p>Spectrophotometric Thermal emittance Refractive index</p> <p>Radioactivity Standards</p> <p>Alpha-particle standards Beta-particle and gamma-ray gas standards Alpha-particle, beta-particle, gamma-ray, and electron-capture solution standards Contemporary standard for carbon-14 dating laboratories Environmental standards Low energy photon sources Gamma-ray "point-source" standards Radium gamma-ray solution standards Radium solution standards for random analysis Radioactivity standard reference materials currently not in stock</p> <p>Metallurgical</p> <p>Mössbauer</p> <p>X-ray Diffraction</p> <p>Gas Transmission</p> <p>Permittivity</p> <p>Reference Fuels</p> <p>Resistivity</p>
--	--

ENGINEERING TYPE STANDARDS

<p>Standard Rubber and Rubber- Compounding Materials</p> <p>Reference Magnetic Tapes</p> <p>Centerline Drawings, OCR-B</p> <p>Sizing Standards</p> <p>Glass spheres for particle size Turbidimetric and fineness (cement)</p> <p>RESEARCH MATERIALS</p>	<p>X-ray and Photographic Standards</p> <p>Surface Flammability Standards</p> <p>Smoke Density Chamber Standards</p> <p>Water Vapor Permeance</p> <p>Tape Adhesion Testing Standards</p> <p>Color Standards</p> <p>SPECIAL REFERENCE MATERIALS</p>
---	--

Biological and Botanical Standards

The first NBS biological and botanical Standard Reference Material designed specifically for the analytical laboratory use was issued in January 1971. This standard, SRM 1571, Orchard Leaves, was developed in response to requests from numerous analytical chemists.

Since then, the number of biological and botanical SRM's has grown to 10, and during the next decade this growth is expected to continue at much the same rate.

This publication is an attempt to describe in general terms the composition, certification, and use of these biological and botanical SRM's.

Table 2 contains the essential information concerning the material, composition, the certification parameters, and use. Under "Remarks," additional data such as storage conditions and stability is provided. All the data and information contained in this table were extracted from the Certificates of Analysis issued for the SRM's included in the table. An examination of this table gives the reader a general view of these SRM's. For more detailed information, the individual certificates reproduced in Appendix II should be consulted as well as the references cited in each certificate.

A summary of the quantitative distribution of the 47 chemical elements determined in the 9 Standard Reference Materials and 1 Research Material from Table 2 is presented in Table 3. The values with an asterisk are expressed in wt. %, the others are expressed in $\mu\text{g/g}$, and the data in parentheses are non-certified values.

The certificates in Appendix II are arranged in numerical order. The SRM's listed in the table include all of the biological and botanical standards that were issued or were in preparation by the end of 1984. These SRM's are the result of the concerted efforts of a number of scientists from the NBS National Measurement Laboratory as well as those from cooperating institutions. Each certificate lists the individuals who contributed to the certification of the SRM.

In addition to the SRM's and their certificates, NBS issues a series of Special Publications (SP), called the "260 Series," that relate directly to Standard Reference Materials as stated in the Preface. The list of available publications in the "260 Series" is given in the beginning of this publication.

Other NBS publications, not in the "260 Series," and a number of NBS staff authored papers have been published that deal with specific SRM's or measurement techniques. Some of these are: SP 148, The Role of Standard Reference Materials in Measurement Systems; SP 378, Accuracy in Spectrophotometry and Luminescence Measurements (255 pp., 1973); and SP 466, Standardization in Spectrophotometry and Luminescence Measurements (150 pp., 1977), contains papers of interest to analytical chemists. Another publication that should be of particulate interest to the users of the SRM's described in Table 2 is SP 492, "Procedures Used at the National Bureau of Standards to Determine Selected Trace Elements in Biological and Botanical Materials."

This work consists of a collection of analytical procedures used in the Center for Analytical Chemistry, National Measurement Laboratory of the National Bureau of Standards for the determination of trace levels of Ag, Al, As, Be, Bi, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Pt, Sb, Se, Te, Tl, V, and Zn in biological and botanical materials. These procedures were critically selected or adapted, and often specially developed, by the scientific staff members of the Center for Analytical Chemistry to provide measurements with the best obtainable accuracy. They were considered to be most appropriate for the analysis and certification of various Standard Reference Materials issued by NBS such as SRM 1577a, Bovine Liver, SRM 1567, Wheat Flour, etc.

The description of these procedures is given with sufficient detail to permit the analyst to use them as a protocol for routine analyses in the laboratory.

They are assembled according to the analytical disciplines involved in the measuring process: sample preparation, neutron activation analysis, spark source mass spectrometric isotope dilution, atomic absorption and flame emission spectrometry, molecular absorption spectrometry, fluorescence spectrometry, and polarography.

Special Publication 492 contains also a detailed description of the methods and instrumentation used to produce high-purity reagents, including the analytical techniques used to test their purity.

The important subject of blanks, a determining factor common to all analytical measurements, is examined including a detailed description of the environmental conditions necessary to control this essential factor, and to insure a maximum protection against contamination.

The lyophilization method for preconcentration and drying of various analytical samples is also discussed in this work.

The analytical procedures assembled in these publications are believed to provide the best measuring capabilities available at this time. They are, however, continuously being revised, improved, or replaced by more accurate ones.

Hence, it is recommended that the analyst who desires to be informed of these advancements maintain a contact with the scientific staff of the Center for Analytical Chemistry at NBS.

Another work, NBS Special Publication 422, "Accuracy in Trace Analysis: Sampling, Sample Handling, Analysis," Vol. I and II, P. D. LaFleur, Editor, issued in 1976 as a proceeding of the 7th Materials Research Symposium held at NBS in 1974, contains valuable information on the subject, to the analytical chemist.

¹NOTE: The use of proprietary designations in Table 2 is for information only, and should not be construed as an endorsement of the product by either the Department of Commerce or the National Bureau of Standards.

²For complete bibliographic reference and ordering information, see "Other NBS Publications in This Series," pp. iv.

Table 2. Summary of the Biological and Botanical Standards

SRM	Material	Composition
RM50 Albacore Tuna	Tuna fish muscle tissue from albacore tuna caught in the San Diego, California area. It was frozen, ground, mixed, lyophilized, ground again, placed in polyethylene bags, and canned under nitrogen. To improve homogeneity the material was reground, re-blended and recanned.	Minor elements: K 1.22%, Na 0.11%. Trace elements (ppm): Hg 0.95; Se 3.6; Zn 13.6; As 3.3; Pb 0.46; Mn 1.3. Organic constituents (ppm): heptadiene 0.6; toluene 0.7; limonene 0.4; 2-nonanone 0.7; 2-undecanone 0.1; 2,6-di- <i>t</i> -butyl- <i>p</i> -cresol 1.0; hexadecane, trace; heptadecane, trace; pristane, 0.03.
1549 Non-Fat Milk Powder	This material was obtained from a commercial source as a portion of a single lot. The moisture content of the material was reduced to a low level by the spray process.	Certified constituents: (wt. %) Ca 1.30; Cl 1.09; Mg 0.120; P 1.06; K 1.69; Na 0.497; S .351; ($\mu\text{g/g}$) Cd .0005; Cr .0026; Cu .7; Fe 1.78; I 3.38; Pb 0.019; Mn .26; Hg .0003; Se .11; Zn 46.1. Non-certified values given for 11 elements; also for lactose and ascorbic acid.
1566 Oyster Tissue	The oysters were obtained by the FDA Bureau of Shellfish Sanitation from a commercial source, frozen in sealed plastic bags. The material was ground, freeze-dried and powdered at the U.S. Army Natick Research & Development Command, Mass., blended and bottled at NBS and freeze-dried again.	Certified minor constituents: Ca 0.15%; Mg 0.128%; K 0.969%; Na 0.51%. Trace constituents ($\mu\text{g/g}$): As 13.4; Cd 3.5; Cr 0.69; Cu 63.0; Fe 195; Pb 0.48; Mn 17.5; Hg 0.057; Ni 1.03; Rb 4.45; Se 2.1; Ag 0.89; Sr 10.36; U 0.116; V 2.3; Zn 852. Non-certified information: Cl (1.0%); S (0.76%); P (0.81%); ($\mu\text{g/g}$) Br (55); Co (0.4); F (5.2); I (2.8); Mo (≤ 0.2); Tl (≤ 0.005); Th (0.1). Homogeneity was determined by neutron activation and atomic absorption spectrometry on Na, Cl, V, Mn, Mg, K, Cu, Zn, Cd. Calcium exhibits some inhomogeneity.

Certification	Use	Remarks
<p>RM 50 is not an SRM, hence, none of the data presented are certified. For further information see the Report of Investigation describing this Research Material.</p>	<p>RM 50 is intended to be used in the measurement of inorganic and organic chemical species in marine tissue at trace concentrations. It should be useful to scientists interested in evaluating analytical methods and interlaboratory comparisons.</p>	<p>RM 50, sealed in metal cans, should have an indefinite storage life under normal room conditions. The open sample can be kept for 6 months to 2 years in a polyethylene bag at 0 °C.</p>
<p>The analytical methods used in the certification were: atomic absorption spectrometry; atomic emission spectrometry; ion chromatography, isotope dilution mass spectrometry, neutron activation, and photon activation. All measurements are based on a minimum 500 mg of the dried material.</p>	<p>SRM 1549 is intended for use in calibrating instrumentation and evaluating the reliability of analytical methods for the determination of constituents in milk, milk powders, and other biological matrices.</p>	<p>The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation. The bottle should be kept tightly closed and stored in a desiccator in the dark. This certification is invalid after 3 years from date of shipping.</p>
<p>The analytical methods used in the certification were: atomic absorption, flame and spark emission spectrometry, inductively coupled plasma, thermal ionization and isotope dilution, isotope dilution mass spectrometry, spark source mass spectrometry; neutron activation, and polarography. All measurements are based on a minimum 250 mg of the dried material.</p>	<p>SRM 1566 is intended for calibrating instrumentation and validating methodology for the chemical analysis of marine animal tissue for minor and trace elements.</p>	<p>The material should be kept in its original bottle, stored at 10-30 °C in a dark desiccator. Under these conditions it should be stable for 5 years from date of shipping.</p>

Table 2. Biological and Botanical Standards.

SRM	Material	Composition
1567 Wheat Flour	Wheat flour was milled from a blend of Hard Red Spring and Hard Red Winter wheat grown in South Dakota and subjected to 2.5 megarads of Co-60 radiation for microbiological control at Neutron Products, Inc., Dickerson, Md. The material was passed through a sieve with openings of 425 μ m and blended.	Certified minor constituents: K 0.136%; Ca 0.019%. Trace constituents (μ g/g): Fe 18.3; Zn 10.6; Mn 8.5; Na 8.0; Cu 2.0; Se 1.1; Cd 0.032; Hg 0.001. Non-certified information (μ g/g): Br (9); Rb (1); Mo (0.4); Ni (0.18); As (0.006); Te (<0.002). Homogeneity was determined by instrument neutron activation measurements on Mn, K, Zn, Na, and Br.
1568 Rice Flour	Rice flour was prepared from 100% long grain from Arkansas and subjected to 2.5 megarads of Co-60 radiation for microbiological control at Neutron Products, Inc., Dickerson, Md. The material was passed through a sieve with openings of 425 μ m and blended.	Certified minor constituents: K 0.112%; Ca 0.014%. Trace constituents (μ g/g): Mn 20.1; Zn 19.4; Fe 8.7; Na 6.0; Cu 2.2; As 0.41; Se 0.4; Cd 0.029; Co 0.02; Hg 0.0060. Non-certified information (μ g/g): Rb (7); Mo (1.6); Br (1); Ni (0.16); Te (<0.002). Homogeneity was determined by instrumental neutron activation measurements on Mn, K, Zn, Na, and Br.
1569 Brewers Yeast	Yeast was obtained from the Nutrition Institute, U.S. Dept. of Agriculture, Beltsville, Md. It was sieved (0.15 mm) and blended.	Cr, 2.12 ± 0.05 μ g/g determined on the sample without drying and calculated on a dry weight basis. Homogeneity was determined by a neutron activation technique.
1572 Citrus Leaves	The plant material was collected from the Lake Alfred area of central Florida and prepared at Michigan State University. It was air-dried, ground to pass a 425 μ m sieve, dried at 85 °C and mixed. It was sterilized with Co-60 radiation at the U.S. Army Research & Development Command, Natick, Mass.	Certified major and minor constituents (wt. % on dry weight basis): Ca 3.15; Mg 0.58; P 0.13; K 1.82; S 0.407. Trace constituents (μ g/g): Al 92; As 3.1; Ba 21; Cd 0.03; Cr 0.8; Cu 16.5; I 1.84; Fe 90; Pb 13.3; Mn 23; Hg 0.08; Mo 0.17; Ni 0.6; Rb 4.84; Na 160; Sr 100; Zn 29. Non-certified values (μ g/g): Sb (0.04); Br (8.2); Ce (0.28); Cs (0.098); Cl (414); Co (0.02) Eu (0.01); La (0.19); Sm (0.052); Sc (0.01); Se (0.025); Te (0.02) Tl (<0.01); Sn (0.24); U (<0.15); N (2.86 wt. %).

Certification	Use	Remarks
<p>The analytical methods used in the certification were: atomic absorption and optical emission spectroscopy, isotope dilution and spark source mass spectrometry, Kjeldahl, neutron activation, nuclear track technique, spectrophotometry, polarography. A minimum of 500 mg of the dried material should be used for the analysis.</p>	<p>SRM 1573 is intended for calibrating instrumentation and validation of analytical methods for the determination of major, minor, and trace elements in botanical materials and other agricultural products.</p>	<p>The material should be kept in the original bottle stored at 10-30 °C in a dark desiccator. Under these conditions SRM 1573 should be stable for 5 years after shipping date.</p>
<p>The analytical methods used in the certification were: atomic absorption spectroscopy, isotope dilution mass spectrometry, isotope dilution spark source mass spectrometry, Kjeldahl method, neutron activation, nuclear track technique, optical emission spectroscopy, spectrophotometry, polarography. A minimum of 500 mg of the dried material should be used for the analysis.</p>	<p>Same as SRM 1573.</p>	<p>Same as SRM 1573.</p>
<p>The analytical methods used in the certification were: atomic absorption and flame emission spectrometry, ion chromatography, inductively coupled plasma emission spectrometry, isotope dilution thermal and spark source mass spectrometry, Kjeldahl method for nitrogen, neutron activation, polarography, and spectrophotometry. A minimum of 250 mg of the dried material should be used for the analysis.</p>	<p>SRM 1577a is intended for calibration of instrumentation and validation of methods in the chemical analysis of animal tissue for major, minor, and trace elements.</p>	<p>Same as SRM 1573.</p>

Table 3. Summary of the Analytical Data Obtained for the Biological and Botanical Standard Reference Materials and Research Material.

SRM	1549	1566	1567	1568	1569	1572	1573	1575	1577a	RM 50†
	Non-Fat Milk Powder	Oyster Tissue	Wheat Flour	Rice Flour	Brewers Yeast	Citrus Leaves	Tomato Leaves	Pine Needles	Bovine Liver	Albacore Tuna
Element										
Ag	<0.0003	0.89	---	---	---	---	---	---	0.04	---
Al	(2)	---	---	---	---	92	(0.12)*	545	(2)	---
As	(0.0019)	13.4	(0.006)	0.41	---	3.1	0.27	0.21	0.047	(3.3)
B	---	---	---	---	---	---	(30)	---	---	---
Ba	---	---	---	---	---	21	---	---	---	---
Br	(12)	(55)	(9)	(1)	---	(8.2)	(26)	(9)	(9)	---
Ca	1.30*	0.15*	0.019*	0.014*	---	3.15*	3.00*	0.41*	120	---
Cd	0.0005	3.5	0.032	0.029	---	0.03	(3)	<0.5	0.44	---
Ce	---	---	---	---	---	(0.28)	(1.6)	(0.4)	---	---
Cl	1.09*	(1.0)*	---	---	---	(414)	---	---	0.28*	---
Co	(0.0041)	(0.4)	---	0.02	---	(0.02)	(0.6)	(0.1)	0.21	---
Cr	0.0026	0.69	---	---	2.12	0.8	4.5	2.6	---	---
Cs	---	---	---	---	---	(0.098)	---	---	---	---
Cu	0.7	63.0	2.0	2.2	---	16.5	11	3.0	158	---
Eu	---	---	---	---	---	(0.01)	(0.04)	(0.006)	---	---
F	(0.20)	(5.2)	---	---	---	---	---	---	---	---
Fe	1.78	195	18.3	8.7	---	90	690	200	194	---
Hg	0.0003	0.057	0.001	0.0060	---	0.08	(0.1)	0.15	0.004	(0.95)
I	3.38	(2.8)	---	---	---	1.84	---	---	---	---
K	1.69*	0.969*	0.136*	0.112*	---	1.82*	4.46*	0.37*	0.996	(1.22)*
La	---	---	---	---	---	(0.19)	(0.9)	(0.2)	---	---
Mg	0.120*	0.128*	---	---	---	0.58*	(0.7)*	---	600	---
Mn	0.26	17.5	8.5	20.1	---	23	238	675	9.9	(1.3)
Mo	(0.34)	<0.2	(0.4)	(1.6)	---	0.17	---	---	3.5	---
N	---	---	---	---	---	(2.86)*	(5.0)*	(1.2)*	(10.7)*	---

SRM	1549	1566	1567	1568	1569	1572	1573	1575	1577a	RM 50†
Element	Non-Fat Milk Powder	Oyster Tissue	Wheat Flour	Rice Flour	Brewers Yeast	Citrus Leaves	Tomato Leaves	Pine Needles	Bovine Liver	Albacore Tuna
Na	0.497*	0.51*	8.0	6.0	---	160	---	---	0.243*	(0.11)*
Ni	---	1.03	(0.18)	(0.16)	---	0.6	---	(3.5)	---	---
P	1.06	(0.81)*	---	---	---	0.13*	0.34*	0.12*	1.11*	---
Pb	0.019	0.48	0.020	0.045	---	13.3	6.3	10.8	0.135	(0.46)
Rb	(11)	4.45	(1)	(7)	---	4.84	16.5	11.7	12.5	---
S	0.351*	(0.76)*	---	---	---	0.407*	---	---	0.78*	---
Sb	(0.00027)	---	---	---	---	(0.04)	---	(0.2)	(0.003)	---
Sc	---	---	---	---	---	(0.01)	(0.13)	(0.03)	---	---
Se	0.11	2.1	1.1	0.4	---	(0.025)	---	---	0.71	(3.6)
Si	(<50)	---	---	---	---	---	---	---	---	---
Sm	---	---	---	---	---	(0.052)	---	---	---	---
Sn	(<0.5)	---	---	---	---	(0.24)	---	---	---	---
Sr	---	10.36	---	---	---	100	44.9	4.8	0.138	---
Te	---	---	(<0.002)	(<0.002)	---	(0.02)	---	---	---	---
Th	---	(0.1)	---	---	---	---	0.17	0.037	---	---
Tl	---	(<0.005)	---	---	---	(<0.01)	(0.05)	(0.05)	(0.003)	---
U	---	0.116	---	---	---	(<0.15)	0.061	0.020	0.00071	---
V	---	2.3	---	---	---	---	---	---	0.099	---
Zn	46.1	852	10.6	19.4	---	29	62	---	123	(13.6)

REMARKS

*The certified data with an asterisk are expressed in wt. %; those in parentheses are non-certified values. The remaining certified data are expressed in µg/g.

†This is not an SRM, hence the values given for this Research Material are not certified. Several organic compounds are also identified.

Appendix I.

Alphabetical Index by Standard Reference Material Name

Name	SRM	Name	SRM
Acetanilide	141c	Aluminum, Freezing Point Standard	44f
Acid Open-Hearth Steel, 0.2% Carbon	19G	Aluminum, Magnetic Gram Susceptibility	763
Acid Potassium Phthalate	84j	Aluminum Oxide, Melting Point	742
AISI 1045 Steel	20g	Aluminum Rod Ultra Purity	RM 1R
AISI 4340 Steel	36l	Aluminum-26 Radioactivity Standard	4229
AISI 4340 Steel	1261a	Americium-241 Alpha-Particle Standard	4904F
AISI 94B17 Steel (Modified)	362	Americium-241 Gamma-ray Standard	4213
AISI 94B17 Steel (Modified)	1262a	Ammonium Dihydrogen Phosphate	194
Albacore Tuna	RM 50	Angiotensin I (Human)	998
Alkali Lead Silicate Glass	712	Anisic Acid	142
Alpha Quartz	1878	Anticonvulsant Drug Level Assay Standard	1599
Alumina (Reduction Grade)	699	Antiepilepsy Drug Level Assay Standard	900
Alumina Silicate Glass	714	Antimony-125-Tellurium-125m, Europium-154, Europium-155 Mixed- Radionuclide Point-Source Standard	4275B
Aluminosilicate Glass	715	Antimony-125-Tellurium-125m, Europium-154, Europium-155 Mixed- Radionuclide Solution Standard	4276B
Aluminum Alloy	85B	A.O.H., 0.4C Spectrographic Steel Standard	413
Aluminum Alloy 6011 (Modified)	858	Argillaceous Limestone	1C
Aluminum Alloy 6011 (Modified)	1258	Arsenic Trioxide Reductometric Standard	83d
Aluminum Alloy 7075	859	Assay-Isotopic Standard for Potassium	985
Aluminum Alloy 7075	1259	Assay-Isotopic Standard for Rhenium	989
Aluminum Block, Eddy Current Conductivity	1860	Assay-Isotopic Standard for Silicon	990
Aluminum Block, Eddy Current Conductivity	1861	Assay-Isotopic Standard for Strontium	987
Aluminum Block, Eddy Current Conductivity	1862	2% Austenite in Ferrite	488
Aluminum Block, Eddy Current Conductivity	1863	5% Austenite in Ferrite	485a
Aluminum Brass Standard for Optical Emission and X-ray Spectroscopic Analysis	1118	15% Austenite in Ferrite	486
Aluminum Brass Standard for Optical Emission and X-ray Spectroscopic Analysis	C1118	30% Austenite in Ferrite	487
Aluminum Brass Standard for Optical Emission and X-ray Spectroscopic Analysis	1119		
Aluminum Brass Standard for Optical Emission and X-ray Spectroscopic Analysis	C1119		
Aluminum Casting Alloy 356	855		
Aluminum Casting Alloy 380	856		
Aluminum Cube Ultra Purity	RM 1C		
Aluminum 2-Ethylhexanoate	1075a		

Name	SRM	Name	SRM
Austenitic Stainless Steel, Thermal Conductivity and Electrical Resistivity	1460	Beryllium on Filter Media	2675
Austenitic Stainless Steel, Thermal Conductivity and Electrical Resistivity	1461	Bessemer Steel (Simulated) 0.1% Carbon	8j
Austenitic Stainless Steel, Thermal Conductivity and Electrical Resistivity	1462	Bilirubin	916
Barium Crown Glass	713	Bis(1-phenyl-1, 3-butanediono) copper (II)	1080a
Barium Cyclohexanebutyrate	1051b	Bis(1-phenyl-1, 3-butanediono) oxovanadium (IV)	1052b
Barium-133 Radioactivity Point-Source Standard	4241B	Black Porcelain Enamel for Directional Hemispherical Reflectance	2021
Barium-133 Radioactivity Standard	4251B	Black Porcelain Enamel for Directional Hemispherical Reflectance	2022
Basalt Rock	688	Blast Furnace Iron Standard (Chill Cast White)	1143a
Base Oil	1083	Blast Furnace Iron Standard (Chill Cast White)	1144a
Basic Electric Spectrographic Steel Standard	404a	B.O.H., 0.4C Spectrographic Steel Standard	417a
Basic Open-Hearth Steel, 0.1% Carbon	15g	Boric Acid	951
Basic Open-Hearth Steel, 0.1% Carbon	335	Boron-Doped Silicon Slices for Resistivity Measurements	1521
Basic Open-Hearth Steel, 0.1% Carbon	1228	Borosilicate Glass	93a
Basic Open-Hearth Steel, 0.2% Carbon	11h	Borosilicate Glass	623
Basic Open-Hearth Steel, 0.4% Carbon	12H	Borosilicate Glass	717
Basic Open-Hearth Steel, 0.5% Carbon	152A	Borosilicate Glass	1825
Basic Open-Hearth Steel, 0.8% Carbon	14f	Borosilicate Glass, Thermal Expansion	731
Basic Open-Hearth Steel, 1% Carbon (Disk)	1227	Bovine Liver	1577a
Basic Open-Hearth Steel, 1.1% Carbon	16f	Bovine Serum Albumin	926
Basic Open-Hearth Steel, 1.1% Carbon	337	Bovine Serum Albumin (7% Solution)	927
0.4C Basic Oxygen Furnace Steel	178	Branched Polyethylene	1476
Bauxite (Arkansas)	69b	Brewers Yeast	1569
Bauxite (Dominican)	697	Bright Copper Microhardness Standard	1894
Bauxite (Jamaican)	698	Bright Nickel Microhardness Standard	1895
Bauxite (Surinam)	696	Bromobenzoic Acid	2142
Benzene in Nitrogen	1805	Burnt Refractory	76a
Benzene in Nitrogen	1806	Burnt Refractory	77a
Benzene Permeation Device	1911	Burnt Refractory	78a
Benzoic Acid	140b	Cadmium Cyclohexanebutyrate	1053a
Benzoic Acid	350a	Cadmium, Vapor Pressure	746
Benzoic Acid Calorimetric Standard	39i	Calcium Carbonate	915
Benzothiazyl Disulfide Rubber Compound	373f	Calcium 2-Ethylhexanoate	1074a
Beryllium-Copper Standard	1122	Calcium in Low-Alloy (Silicon) Steel	1254
Beryllium-Copper Standard	C1122	Calcium Molybdate	71
Beryllium-Copper Standard	C1123	Calibrated Glass Beads	1004
		Calibrated Glass Beads	1017a
		Calibrated Glass Beads	1018a
		Calibrated Glass Spheres	1003a
		Carbon Dioxide in Air	1670
		Carbon Dioxide in Air	1671
		Carbon Dioxide in Air	1672
		Carbon Dioxide in Nitrogen	1674b
		Carbon Dioxide in Nitrogen	1675b
		Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2619a
		Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2620a

Name	SRM	Name	SRM
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2621a	Catalyst Package for Lubricant Oxidation	1817
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2622a	Centerline Drawings for Optical Character Recognition, B Characters	1901
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2623a	Centroid Color Chart	2106
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2624a	Centroid Color Kit	2107
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2625a	Cesium-137, Barium-137m Point-Source Radioactivity Standard	4200B
Carbon Dioxide in Nitrogen (Combustion Efficiency Gas Standard)	2626a	Cesium-137, Barium-137m Point-Source Radioactivity Standard	4207
Carbon Dioxide in Nitrogen (Mobile Source Emission Gas Standard)	2632	Cesium-137 Burn-Up Standard	4233B
Carbon Dioxide in Nitrogen (Mobile Source Emission Gas Standard)	2633	Cesium-134 Radioactivity Standard	4250B
Carbon Monoxide in Air (Ambient Air Quality Gas Standard)	2612a	Channel Black Rubber Compound	375g
Carbon Monoxide in Air (Ambient Air Quality Gas Standard)	2613a	Chlorine-36 Beta-ray Standard	4943
Carbon Monoxide in Air (Ambient Air Quality Gas Standard)	2614a	Chlorine-36 Radioactivity Standard	4422L
Carbon Monoxide in Nitrogen	1677c	Chlorobenzoic Acid	2144
Carbon Monoxide in Nitrogen	1678c	Chrome Refractory	103a
Carbon Monoxide in Nitrogen	1679c	Chromium-Molybdenum-Aluminum Steel	106B
Carbon Monoxide in Nitrogen	1680b	Chromium-Molybdenum Steel	36b
Carbon Monoxide in Nitrogen	1681b	Chromium-Molybdenum Steel	133B
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2635	Chromium-Nickel-Molybdenum Steel	139b
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2636	Chromium-Nickel-Molybdenum Steel	1222
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2637	17Chromium-9 Nickel-0.2 Selenium Steel	339
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2638	Chromium-Nickel Spectrographic Steel Standard	408a
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2639	15Chromium-7 Nickel Steel	344
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2640	16Chromium-4 Nickel Steel	345
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2641	Chromium-51 Radioactivity Standard	4400L-F
Carbon Monoxide in Nitrogen (Mobile Source Emission Gas Standard)	2642	Chromium Steel	163
Carbon-14 Radioactivity Standard	4245	Chromium-Tungsten Steel	155
Carbon-14 Radioactivity Standard	4246	Chromium-Vanadium Spectrographic Steel Standard	407a
Carbon Steel	1224	Cholesterol	911a
Carbon Steel, 0.6%	13g	Chrysotile Asbestos Fibers	1876
Cast Iron	4k	Citrus Leaves	1572
Cast Iron	5L	Clinical Laboratory Thermometer	934
Cast Iron	6g	Cobalt Cyclohexanebutyrate	1055b
Cast Iron	7G	Cobalt-Molybdenum-Tungsten Steel	153A
Cast Iron Car Wheel	122h	Cobalt-57 Radioactivity Standard	4408L-C
Cast Steel 3	C1173	Cobalt-60 Radioactivity Standard	4915D
Cast Steel Standard	1138a	Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	1115
Cast Steel Standard	1139a	Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	C1115
		Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	1116

Name	SRM	Name	SRM
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	C1116	Cupro-Nickel, 10% (CDA 706) High Purity	874
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	1117	Cystine	143c
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	C1117	Dextrose	41b
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	981	D-Glucose	917
Common Lead Isotopic Standard	332	Dibutyltin Bis(2-ethylhexanoate)	1057b
Copper Concentrate	RM5	Didymium Glass Filter for Checking the Wavelength Scale of Spectrophotometers	2009
Copper Heat Capacity Test Specimen	115A	Didymium Glass Filter for Checking the Wavelength Scale of Spectrophotometers	2010
Copper-Nickel-Chromium Cast Iron	330	Disodium Hydrogen Phosphate	186IIc
Copper Ore, Mill Heads	331	Disodium Hydrogen Phosphate	2186II
Copper Ore, Mill Tails	736a	D-Mannitol	920
Copper-Thermal Expansion	45d	Dolomitic Limestone	88a
Copper, Secondary Freezing Point Standard	921	Doped Platinum	681L1
Cortisol (Hydrocortisone)	914	Doped Platinum	681L2
Creatinine	1270	Ductile Cast Iron	341
Cr-Mo Low Alloy Steel	291	Electrical Residual Resistivity Ratio Standard	769
Cr-Mo Steel (ASTM A-213)	414	Electrolytic Iron	365
Cr-Mo (SAE 4140) Spectrographic Steel Standard	427	Electrolytic Iron	1265a
Cr-Mo (SAE 4150) Spectrographic Steel Standard	418a	Electrolytic Iron, Thermal Conductivity and Electrical Resistivity	1463
Cr-Mo (SAE X4130) Spectrographic Steel Standard	293	Electrolytic Iron, Thermal Conductivity and Electrical Resistivity	1464
Cr-Ni-Mo Steel (AISI 8620)	101f	Electronic and Magnetic Alloy Standard	1159
18Cr-10Ni Steel (AISI 304L)	363	Electronic and Magnetic Alloy Standard	1160
Cr-V Steel (Modified)	1263a	Enriched Boric Acid	952
Cr-V Steel (Modified)	30f	Equal-Atom Lead Isotopic Standard	982
Cr-V Steel (SAE 6150)	935	Estuarine Sediment	1646
Crystalline Potassium Dichromate	2032	Europium-152 Point-Source Standard	4218E
Crystalline Potassium Iodide, Heterochromatic Stray Radiant Energy Standard	2601	Europium-152 Radioactivity Standard	4370B
Crystalline (Ruby) Electron Paramagnetic Resonance Absorption Intensity Standard	1275	Extra Dense Lead Glass	709
Cupro-Nickel (CDA 706)	1276	Fe-Cr-Ni Alloy Microprobe Standard	479a
Cupro-Nickel (CDA 715)	875	Fe-3Si Alloy Microprobe Standard	483
Cupro-Nickel, 10% (CDA 706) Doped		Feldspar	70a
		Feldspar	99a
		Ferrochromium (Low Carbon)	196
		Ferrochromium Silicon	689
		Ferroniobium	340
		Ferrophosphorus	90
		Ferrosilicon	58a
		Ferrosilicon	59a
		Ferrosilicon (75% Si)	195
		First Surface Aluminum Mirror for Specular Reflectance	2003a
		First Surface Mirror, Gold on Glass	2008a

Name	SRM	Name	SRM
Fission Track Glass Standard	961	Gold-198 Radioactivity Standard	4405L-B
Fission Track Glass Standard	962a	Gold-Silver Wires for Microprobe	481
Fission Track Glass Standard	963a	Analysis	
Fission Track Glass Standard	964	Gold, Vapor Pressure	745
Flint Clay	97a	Gray Cast Iron	334
Fluorobenzoic Acid	2143	Halocarbons (in methanol) for Water	1639
Fluorspar	79a	Analysis	
Free-Cutting Brass	1103	High-Alloy Steel (A-743)	C1288
Free-Cutting Brass	C1104	High-Alloy Steel (AISI 310 Mod.)	C1287
Freeze-Dried Urine	2670	High-Alloy Steel, (AISI 414 Mod.)	C1289
Freeze-Dried Urine Certified	2671a	High-Alloy White Cast	892
for Fluoride		High-Alloy White Cast Iron	890
Freeze-Dried Urine Certified	2672a	High-Alloy White Cast Iron	891
for Mercury		High-Carbon Ferrochromium	64c
Fused-Silica Thermal Expansion	739	High-Carbon Ferromanganese	68c
Gadolinium-148 Alpha-Particle	4907	High-Carbon Steel (Modified)	364
Standard		High-Carbon Steel (Modified)	1264a
Gallium Melting-Point Standard	1968	High-Grade Fluorspar	180
Gallium-67 Radioactivity Standard	4416L-D	High-Nickel Steel	126c
Gas Furnace Black Rubber Compound	382a	High-Nickel Steel	1158
Gasometric Set (1095-1099)	1089	High-Purity Gold	685
Gasometric Standard for Unalloyed	357	High-Purity Platinum	680L1A
Zirconium		High-Purity Platinum	680L2A
Gasometric Standard for Unalloyed	358	High-Purity Platinum Thermoelement	1967
Zirconium		High-Purity Zinc	682
Generator Columns for Polynuclear	1644	High-Silicon Steel	179
Aromatic Hydrocarbons		High-Silicon Steel	1134
Gilding Metal	1112	High-Silicon Steel	1135
Gilding Metal	C1112	High-Silicon Steel (Calcium Bearing)	125b
Gilding Metal	1113	High-Sulfur Steel	105
Gilding Metal	C1113	High-Sulfur Steel	129c
Gilding Metal	1114	High-Sulfur Steel	1136
Gilding Metal	C1114	High Temperature Alloy A286	348
Glasses for Microchemical Analysis	1871	High Temperature Alloy M308	1197
Glasses for Microchemical Analysis	1872	High Temperature Alloy L605 and	S1199
Glasses for Microchemical Analysis	1873	S816	
Glasses for Microchemical Analysis	1874	High-Temperature Alloy	1206-2
Glasses for Microchemical Analysis	1875	High-Temperature Alloy	1207-1
Glass Fibers for Microanalysis	RM 31	High-Temperature Alloy	1207-2
Glass Filter for Transmittance	2030	High-Temperature Alloy	1208-1
Measurement		High-Temperature Alloy	1208-2
Glass Filters for Spectrophotometry	930D	Homogeneous River Sediment for	RM 45B
Glass Fluorescence Source	477	Radioactivity Measurements	
Glass Sand	81a	Human Liver, Environmental	4352
Glass Sand	165a	Radioactivity	
Glass Spheres	1019a	Human Lung, Environmental	4351
Gold Coating on Glass Sealing Alloy	1398a	Radioactivity	
Gold Coating on Nickel	1379	Human Serum	909
Gold Coating on Nickel	1380		
Gold Coating on Nickel	1399b		
Gold-Copper Wires for Microprobe	482		
Analysis			
Gold-195 Radioactivity Standard	4421L		

Name	SRM	Name	SRM
Hydrogen in Unalloyed Titanium	352b	Iron Ore (Sibley)	27f
Hydrogen in Unalloyed Titanium	1086	Iron Ore Concentrate (Canada)	690
Hydrogen in Unalloyed Titanium	1087	Iron-59 Radioactivity Standard	4411L-B
Hydrogen in Unalloyed Titanium	1088	Isobutylene-Isoprene (Butyl) Rubber	1495
Hydrogen-3 Radioactivity Standard	4361	Isobutylene-Isoprene (Butyl) Rubber	388L
Hydrogen-3 Radioactivity Standard	4926C	Isotopic Standard for Bromine	977
Hydrogen-3 Toluene Radioactivity Standard	4947	Isotopic Standard for Chlorine	975
4-Hydroxy-3 methoxy-DL-mandelic Acid (VMA)	925	Isotopic Standard for Chromium	979
ICTA High Temperature Set Differential Thermal Analysis	GM 760	Isotopic Standard for Copper	976
ICTA Low Temperature Set Differential Thermal Analysis	GM 757	Isotopic Standard for Magnesium	980
ICTA Mod Temperature Set Differential Thermal Analysis	GM 759	Isotopic Standard for Silver	978
ICTA Mid Temperature Set Differential Thermal Analysis	GM 758	Krypton-85 Gaseous Radioactivity Standard	4308C
ICTA Polystyrene Differential Thermal Analysis	GM 754	Krypton-85 Radioactivity Standard	4235
ICTA Thermogravimetry Set	GM 761	Krypton-85 Radioactivity Standard	4935C
Incoloy, 901 and Hastelloy X	S1198	Lead-Barium Glass	89
Inconels, Alloy 600 (Chips)	864	Lead-Base Bearing Metal	53e
Inconels, Alloy 600 (Solid)	1244	Lead-Base Bearing Metal	1132
Inconels, Alloy 625 (Chips)	865	Lead Cyclohexanebutyrate	1059c
Inconels, Alloy 625 (Solid)	1245	Lead in Reference Fuel	1636a
Incoloy, Alloy 800 (Chips)	866	Lead in Reference Fuel	1637a
Incoloy, Alloy 800 (Solid)	1246	Lead in Reference Fuel	1638a
Incoloy, Alloy 825 (Chips)	867	Lead Nitrate	928
Incoloy, Alloy 825 (Solid)	1247	Lead on Filter Media	2674
Indium-111 Radioactivity Standard	4417L-C	Lead-203 Radioactivity Standard	4420L
Ingot Iron Spectrographic Steel Standard	420a	Lead, Secondary Freezing Point Standard	49e
Intermediate Purity Selenium	726	Lead-Silica Glass	1827
Intermediate-Purity Zinc	728	Lead-Silica Glass (Viscosity)	711
Iodine-123 Radioactivity Standard	4414L-C	Lead-Silica Glass for dc Volume Resistivity	624
Iodine-125 Radioactivity Standard	4407L-H	Lead-Silica Glass for Dielectric Constant	774
Iodine-129 Radioactivity Standard	4949B	Lead 206 Spike Assay and Isotopic Solution Standard	991
Iodine-131 Radioactivity Standard	4401L-I	Leaded-Tin Bronze Alloy	1035
Iron Foil Mössbauer Standard	1541	Light-Sensitive Paper	700d
Iron-55 Low-Energy Photon Standard	4260C	Light-Sensitive Paper	701d
Iron Metal (Clinical Standard)	937	Light-Sensitive Plastic Chip	703
Iron Ore (Labrador)	692	Linear Polyethylene	1475
Iron Ore (Nimba)	693	Linear Polyethylene	1482
		Linear Polyethylene	1483
		Linear Polyethylene	1484
		Linerboard, Standard for Tape Adhesion Testing	1810
		Liquid Absorbance Standard for Ultraviolet and Visible Spectrophotometry	931c
		Lithium Carbonate	924
		Lithium Ore	181
		Lithium Ore	182
		Lithium Ore	183
		Low-Alloy Steel, (AISI 4130)	1225
		Low Alloy Steel	1226
		Low Alloy Steel (A242 Mod.)	C1285
		Low-Alloy Steel, AISI 4130	72g
		Low Alloy Steel (AISI 1526, Modified)	1269
		Low-Alloy Steel (Hy 80)	1286

Name	SRM	Name	SRM
Low-Alloy Steel Set (661-665)	S668	Naval Brass Standards for Optical Emission and Spectroscopic Analysis	1108
Low-Carbon Silicon Steel	131c	Naval Brass Standards for Optical Emission and Spectroscopic Analysis	C1108
Low-Carbon Silicon Steel	1036	Neutral Glass	716
Low-Carbon Stainless Steel (AISI 316L)	166c	Neutron Density Monitor Wire	953
Magnesium-base Alloy	171	Nickel-Chromium Cast Iron	82b
Magnesium Cyclohexanebutyrate	1061c	Nickel-Chromium-Molybdenum Cast Iron	107C
Magnesium Gluconate Dihydrate	929	Nickel-Chromium Steel	32E
Magnetic Coating on Magnetic Substrate (Nickel on Steel)	1365a	Nickel-Copper Alloy	882
Magnetic Coating on Magnetic Substrate (Nickel on Steel)	1366a	Nickel Cyclohexanebutyrate	1065B
Magnetic Coating on Non-Magnetic Substrate (Nickel and Chromium on brass)	1367a	Nickel Oxide, No. 1	671
Magnetic Tape, High Density	6250	Nickel Oxide, No. 2	672
Manganese Fluoride, Magnetic Gram Susceptibility	766	Nickel Oxide, No. 3	673
Manganese Ore	25d	Nickel-63 Radioactivity Standard	4226
Manganese-54 Point-Source Radioactivity Standard	4997E	Nickel Silver (CDA 762)	879
Manganese-54 Radioactivity Standard	4257	Nickel Silver (CDA 770)	880
Manganese Steel	100B	Nickel Spectrographic Steel Standard	409b
Manganous Cyclohexanebutyrate	1062b	Nickel Sphere, Magnetic Moment	772
Maraging Steel	1156	Nickel Steel	33d
Metal on Quartz Filters for Spectrophotometry	2031	Ni-Cr-Mo-V Steel	1173
Metals on Filter Media	2676b	Nicotinic Acid	148
Methane in Air	1658a	Niobium-94 Gamma-ray Standard	4201B
Methane in Air	1659a	Nitric Oxide in Nitrogen	1683b
Methane in Air	1660a	Nitric Oxide in Nitrogen	1684b
Medium Manganese Spectrographic Steel Standard	405a	Nitric Oxide in Nitrogen	1685b
Mercaptobenzothiazole	383a	Nitric Oxide in Nitrogen	1686b
Mercury, Freezing Point	743	Nitric Oxide in Nitrogen	1687b
Mercury-203 Radioactivity Standard	4418L	Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2627
Mercury in Water, $\mu\text{g}/\text{mL}$	1641b	Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2628
Mercury in Water, ng/mL	1642b	Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2629
Microcopy Resolution Test Chart	1010a	Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2630
Microprobe Standard - Cartridge Brass	478	Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2631
Mineral Glasses for Microanalysis	470	Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2653
Molybdenum Concentrate	333	Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2654
Molybdenum, Heat Capacity	781	Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2655
Molybdenum-99 Radioactivity Standard	4412L-H	Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2656
Molybdenum-Tungsten-Chromium-Vanadium Steel	134A	Nitrogen Dioxide Permeation Device	1629a
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	1106	4-Nitrophenol	938
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	C1106		
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	1107		
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	C1107		

Name	SRM	Name	SRM
Nodular Cast Iron	342a	Organics in Shale Oil	1580
Nominal One Micrometer Polystyrene Spheres	1690	Oxalic Acid	4990C
Non-Fat Powdered Milk	1549	Oxygen in Ferrous Materials Ingot Iron	1090
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1359	Oxygen in Ferrous Materials (Stainless Steel AISI 431)	1091
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1360	Oxygen in Ferrous Materials Vacuum Melted Steel	1092
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1361b	Oxygen in Maraging Steel	1094
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1362a	Oxygen in Nitrogen (Gas Standard)	2657
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1363a	Oxygen in Nitrogen (Gas Standard)	2658
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1364a	Oxygen in Nitrogen (Gas Standard)	2659
NPL GM Alpha Alumina	8005	Oxygen in Titanium-Base Materials	355
NPL GM Alpha Alumina	8006	Oxygen in Valve Steel	1093
NPL GM Alpha Alumina	8007	Oyster Tissue	1566
NPL GM Alpha Alumina	8008	Palladium, Magnetic Gram	765
NPL GM Graphitized Carbon Black	8001	Susceptibility	
NPL GM Graphitized Carbon Black	8002	Penetrant Test Block	1850
NPL GM Melting Point Set	8000	Peruvian Soil, Environmental	4355
NPL GM Non-porous Silica	8003	Radioactivity	
NPL GM Non-porous Silica	8004	Petroleum Crude Oil	1582
N-tertiary-Butyl-2-benzothiazolesulfenamide Rubber Compound	384d	Phosphate Rock (Florida)	120b
Obsidian Rock	278	Phosphor Bronze (CDA 521)	871
Octaphenylcyclotetrasiloxane	1066a	Phosphor Bronze (CDA 544)	872
Oil Furnace Black Rubber Compound	378b	Phosphorized Copper, Cu VIII	C1251
Opal Glass Powder	91	Phosphorized Copper, Cu IX	C1252
Optical Emission and X-ray Spectroscopic Analysis	1102	Phosphorized Copper, Cu X	C1253
Optical Microscope Linewidth Measurement Standard	474	Phosphorus-32 Radioactivity Standard	4406L-G
Optical Microscope Linewidth Measurement Standard	475	Photographic Step Tablet	1008
Optical Microscope Linewidth Measurement Standard	476	Pine Needles	1575
		Plastic Clay	98a
		Platinum, Magnetic Gram	764
		Susceptibility	
		Plutonium-238 Alpha-Particle Standard	4906B
		Plutonium-240 Alpha-Particle Emission Rate Solution Standard	4338
		Plutonium-239 Alpha-Particle Solution Standard	4331
		Plutonium-242 Alpha Particle Solution Standard	4334B
		Plutonium Isotopic Standard	946
		Plutonium Isotopic Standard	947
		Plutonium Isotopic Standard	948
		Plutonium Metal	949f
		Plutonium Metal (Standard Matrix Material)	945
		Plutonium-244 Spike Assay and Isotopic Standard	996
		Polychlorinated Biphenyls in Oil	1581
		Polycrystalline Alumina Elasticity Standard	718
		Polyester Plastic Film for Oxygen Gas Transmission	1470
		Polyisobutylene Solution in Cetane	1490
		Polystyrene	1478
		Polystyrene	1479
		Polystyrene (Broad Molecular Weight)	706
		Polystyrene (Narrow Molecular Weight)	705
		Polystyrene Spheres	1691
		Portland Cement (Black)	1880

Name	SRM
Portland Cement (Blue)	635
Portland Cement (Clear)	639
Portland Cement (Gold)	634
Portland Cement (Green)	638
Portland Cement (Pink)	637
Portland Cement (Red)	633
Portland Cement (White)	1881
Portland Cement (Yellow)	636
Portland Cement Fineness Standard	114n
Potassium Chloride	2202
Potassium Chloride (Clinical Standard)	918
Potassium Chloride (Primary Chemical)	999
Potassium Chloride for Solution Calorimetry	1655
Potassium Dichromate	136d
Potassium Dihydrogen Phosphate	200
Potassium Dihydrogen Phosphate	186Ic
Potassium Dihydrogen Phosphate	2186I
Potassium Erucate	1076
Potassium Feldspar	607
Potassium Fluoride	2203
Potassium Hydrogen Phthalate	185e
Potassium Hydrogen Tartrate	188
Potassium Iodide with Attenuator	2033
Potassium Nitrate	193
Potassium Tetroxalate	189
Powdered Lead Based Paint	1579
Priority Pollutant Polynuclear Aromatic Hydrocarbons (in Acetonitrile)	1647
Propane in Air	1665b
Propane in Air	1666b
Propane in Air	1667b
Propane in Air	1668b
Propane in Air	1669b
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2643
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2644
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2645
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2646
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2647
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2648
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2649
Propane in Nitrogen (Mobile Source Emission Gas Standard)	2650
Propane in Nitrogen and Oxygen (Mobile Source Emission Gas Standard)	2651
Propane in Nitrogen and Oxygen (Mobile Source Emission Gas Standard)	2652
Quartz Cuvette for Spectrophotometry	932
Quartz for Hydrofluoric Acid Solution Calorimetry	1654

Name	SRM
Quartz on Filter Media	2679a
Quinine Sulfate Dihydrate	936
Radiogenic Lead Isotopic Standard	983
Radium-226 Gamma-ray Standard	4956
Radium-226 Gamma-ray Standard	4957
Radium-226 Gamma-ray Standard	4958
Radium-226 Gamma-ray Standard	4959
Radium-226 Gamma-ray Standard	4960
Radium-226 Gamma-ray Standard	4961
Radium-226 Gamma-ray Standard	4962
Radium-226 Gamma-ray Standard	4963
Radium-226 Gamma-ray Standard	4964B
Radium Standard (Blank Solution)	4952B
Radon-226 for Radon Analysis	4953C
Red Brass	1109
Red Brass	C1109
Red Brass	1110
Red Brass	C1110
Red Brass	1111
Red Brass	C1111
Reduced Iron Oxide	691
Reference Fuel Isooctane	1816a
Reference Fuel n-Heptane	1815a
Reflection Step Tablet	2061
Refractive Index Glass	1820
Refractive Index Silicone Liquids	1823
Refractive Index, Soda-Lime Glass	1822
Relative Stress-Optical Coefficient Glass	708
Resulfurized-Rephosphorized Steel	C1221
Rice Flour	1568
River Sediment	1645
River Sediment, Environmental Radioactivity	4350B
Rocky Flats Soil Number 1, Environmental Radioactivity	4353
Rubidium Melting Point	1969
Rutile Ore	670
Scanning Electron Microscope Magnification Standard	484c
Scanning Electron Microscope Performance Standard	2069
Secondary Standard Flexible Disk Cartridge (Computer Amplitude Reference)	3210
Secondary Standard Magnetic Tape	3200
Secondary Standard Magnetic Tape Cassette	1600
Secondary Standard Magnetic Tape Cartridge (Computer Amplitude Reference)	3216
Second Surface Aluminum Mirror for Specular Reflectance	2023

Name	SRM	Name	SRM
Second Surface Aluminum Mirror for Specular Reflectance	2024	Soda-Lime Sheet Glass	1831
Second Surface Aluminum Mirror with Wedge for Specular Reflectance	2025	Soda-Lime Silica Glass	622
Selenium-Bearing Steel	1170b	Soda-Lime Silica Glass	710
Selenium-75 Radioactivity Standard	4409L-D	Soda-Lime Silica Glass for Liquidus Temperature	773
Sheet Brass	37E	Sodium Bicarbonate	191a
Silica Brick	198	Sodium Bicarbonate	2191
Silica Brick	199	Sodium Carbonate	192a
Silicon-Aluminum Alloy	87a	Sodium Carbonate	2192
Silicon Bronze	158A	Sodium Chloride	2201
Silicon Density Standard	1840	Sodium Chloride (Clinical Standard)	919
Silicon Density Standard	1841	Sodium Cyclohexanebutyrate	1069b
Silicon Metal	57a	Sodium Oxalate Reductometric Standard	40h
Silicon Powder, Spacing Standard for X-ray Diffraction	640a	Sodium Pyruvate	910
Silicon Power Device Level Resistivity Standard	1522	Sodium Tetraborate Decahydrate (Borax)	187b
Silicon Resistivity Standard for Eddy Current Testers	1523	Solder	127b
Silver 2-Ethylhexanoate	1077a	Solder	1131
Silver-Gold Thermocouple Wire	733	Special Nuclear Container DOT 6M, 15 gal.	9940
Silver, Vapor Pressure	748	Special Nuclear Container, 55 gal.	9941
Sintered and Arc-Cast Tungsten, Thermal Conductivity and Electrical Resistivity	1465	Special Nuclear Container Type A, 10 gal.	9942
Sintered and Arc-Cast Tungsten, Thermal Conductivity and Electrical Resistivity	1466	Special Nuclear Container, Type A, 55 gal.	9943
Sintered and Arc-Cast Tungsten, Thermal Conductivity and Electrical Resistivity	1467	Special Nuclear Material Package Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	9910
Sintered and Arc-Cast Tungsten, Thermal Conductivity and Electrical Resistivity	1468	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	461
Smoke Density Chamber Standard (Flaming Exposure Condition)	1007a	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	462
Smoke Density Chamber Standard (Non-flaming Exposure Condition)	1006b	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	463
Soda-Lime Container Glass	621	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	464
Soda-Lime Flat Glass	620	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	465
Soda-Lime Float Glass	1830	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	466
Soda-Lime Glass	1826	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	467
Soda-Lime Glass Powder	92	Spectrographic Ingot Iron and Low-Alloy Steel Standard (Rod)	468
		Spectrographic Ingot Iron and Low-Alloy Steel Standard	1166
		Spectrographic Stainless Steel Standard	442
		Spectrographic Stainless Steel Standard	443
		Spectrographic Stainless Steel Standard	444
		Spectrographic Stainless Steel Standard (Disc)	D849
		Spectrographic Stainless Steel Standard (Disc)	D850
		Spectrographic Stainless Steel Standard (Group II)	445

Name	SRM	Name	SRM
Spectrographic Stainless Steel Standard (Group II)	446	Spectroscopic Titanium-Base Standard	644
Spectrographic Stainless Steel Standard (Group II)	447	Spectroscopic Titanium-Base Standard	645
Spectrographic Stainless Steel Standard (Group II)	448	Spectroscopic Titanium-Base Standard	646
Spectrographic Stainless Steel Standard (Group II)	449	Spheroidized Iron Carbide in Ferrite	493
Spectrographic Stainless Steel Standard (Group II)	450	Spreading Resistance Calibration (100) n-Type Silicon	2529
Spectrographic Stainless Steel Standard (Rod)	849	Spreading Resistance Calibration (100) p-Type Silicon	2528
Spectrographic Stainless Steel Standard (Rod)	850	Spreading Resistance Calibration (111) n-Type Silicon	2527
Spectrographic Steel Standard (Disc)	D803a	Spreading Resistance Calibration (111) p-Type Silicon	2526
Spectrographic Steel Standard (Disc)	D807a	Stabilized Wine	1590
Spectrographic Steel Standard (Rod)	803a	Stainless Steel	121d
Spectrographic Steel Standard (Rod)	804a	Stainless Steel	123c
Spectrographic Steel Standard (Rod)	805a	Stainless Steel	160b
Spectrographic Steel Standard (Rod)	807a	Stainless Steel (AISI 446)	367
Spectrographic Steel Standard (Rod)	808a	Stainless Steel (AISI 446)	1267
Spectrographic Steel Standard (Rod)	809a	Stainless Steel, 13% Chromium	73c
Spectrographic Steel Standard (Rod)	817b	Stainless Steel, Cr-Ni	C1151
Spectrographic Steel Standard (Rod)	820a	Stainless Steel, Cr-Ni	1151a
Spectrographic Steel Standard (Rod)	821	Stainless Steel, Cr-Ni	C1152
Spectrographic Steel Standard (Rod)	827	Stainless Steel, Cr-Ni	1152a
Spectrographic Tool Steel Standard	436	Stainless Steel, Cr-Ni	C1153
Spectrographic Tool Steel Standard	437	Stainless Steel, Cr-Ni	1153a
Spectrographic Tool Steel Standard	438	Stainless Steel, Cr-Ni	C1154
Spectrographic Tool Steel Standard	439	Stainless Steel, Cr-Ni	1154a
Spectrographic Tool Steel Standard	440	Stainless Steel, Cr-Ni-Mo	1155
Spectrographic Tool Steel Standard	441	Stainless Steel, Cr-Ni-Nb	1172
Spectrographic Tool Steel Standard	837	Stainless Steel, Cr-Ni-Ti	1171
Spectrographic Tool Steel Standard	840	Stainless Steel for Pitting or Crevice Corrosion	1890
Spectrographic Tool Steel Standard (Disc)	D837	Stainless Steel Thermal Expansion	738
Spectrographic Tool Steel Standard (Disc)	D840	Stearic Acid Rubber Compound	372h
Spectrographic Tool Steel Standard (Disc)	D841	Steel (AISI 1211)	368
Spectrographic Zinc-Base Die-Casting Alloy A	625	Steel (Lead-Bearing)	1169b
Spectrographic Zinc-Base Die-Casting Alloy B	626	Strontium Cyclohexanebutyrate	1070a
Spectrographic Zinc-Base Die-Casting Alloy C	627	Strontium-85 Radioactivity Standard	4403L-B
Spectrographic Zinc-Base Die-Casting Alloy D	628	Strontium-89 Radioactivity Standard	4945D
Spectrographic Zinc-Base Die-Casting Alloy E	629	Styrene-butadiene Rubber (Type 1500)	386h
Spectrographic Zinc-Base Die-Casting Alloy F	630	Succinonitrile Freezing Point	1970
Spectrographic Zinc Spelter Standard	631	Sucrose	17c
Spectroscopic Titanium-Base Standard	641	Sulfate and Nitrate on Filter Media	2673
Spectroscopic Titanium-Base Standard	642	Sulfur Dioxide in Nitrogen	1661a
Spectroscopic Titanium-Base Standard	643	Sulfur Dioxide in Nitrogen	1662a
		Sulfur Dioxide in Nitrogen	1663a
		Sulfur Dioxide in Nitrogen	1664a
		Sulfur Dioxide in Nitrogen	1693
		Sulfur Dioxide in Nitrogen	1694

Name	SRM	Name	SRM
Sulfur Dioxide in Nitrogen	1696	Titanium-Base Alloy (Unalloyed)	650
Sulfur Dioxide Permeation Tube (2 cm tube)	1627	Titanium-Base Alloy (Unalloyed)	651
Sulfur Dioxide Permeation Tube (5 cm tube)	1626	Titanium-Base Alloy (Unalloyed)	652
Sulfur Dioxide Permeation Tube (10 cm tube)	1625	Titanium Dioxide	154b
Sulfur in Coal	2682	Toluene	211c
Sulfur in Coal	2683	Tomato Leaves	1573
Sulfur in Coal	2684	Tool Steel (AISI M2)	132b
Sulfur in Coal	2685	Tool Steel (AISI M2)	1157
Sulfur in Residual Fuel Oil	1619	Tool Steel Abrasive Wear Standard	1857
Sulfur in Residual Fuel Oil	1620a	Tracealloy (Nickel-Base High-Temperature Alloy)	897
Sulfur in Residual Fuel Oil	1621b	Tracealloy (Nickel-Base High-Temperature Alloy)	898
Sulfur in Residual Fuel Oil	1622b	Tracealloy (Nickel-Base High-Temperature Alloy)	899
Sulfur in Residual Fuel Oil	1623a	Trace Elements in a Glass Matrix	610
Sulfur in Residual Fuel Oil	1624a	Trace Elements in a Glass Matrix	611
Sulfur Rubber Compound	371g	Trace Elements in a Glass Matrix	612
Superconductive Thermometric Fixed Point Device	767a	Trace Elements in a Glass Matrix	613
Superconductive Thermometric Fixed Point Device	768	Trace Elements in a Glass Matrix	614
Surface Flammability Standard	1002c	Trace Elements in a Glass Matrix	615
Synthetic Sapphire	720	Trace Elements in a Glass Matrix	616
Technetium-99 Radioactivity Standard	4288	Trace Elements in a Glass Matrix	617
Technetium-99m Radioactivity Standard	4410H-I	Trace Elements in Coal (Bituminous)	1632a
Tetrachloroethylene in Nitrogen	1808	Trace Elements in Coal (Sub- bituminous)	1635
Thallium-201 Radioactivity Standard	4404L-F	Trace Elements in Coal Fly Ash	1633a
Thermal Resistance, Fibrous Glass Batt	1451	Trace Elements in Fuel Oil	1634a
Thermal Resistance, Fibrous Glass Board	1450b	Trace Elements in Water	1643a
Thorium-228, Thallium-208 Gamma-ray Point-Source Standard	4206C	Trace Mercury in Coal	1630
Tin-Base Bearing Metal	54D	2,2,4-Trimethylpentane	217c
Tin, Freezing Point	741	Tripalmitin	1595
Tin-113-Indium-113m Radioactivity Standard	4402L-C	Tris, Basimetric	723a
Tin-121m Point-Source Gamma-ray Emission-Rate Standard	4264B	Tris, for Solution Calorimetry	724a
Tin, Secondary Freezing Point Standard	42g	Tris(hydroxymethyl)aminomethane	922
Titanium Alloy	654a	Tris(hydroxymethyl)aminomethane hydrochloride	923
Titanium-Base Alloy	173b	Tris(1-phenyl-1, 3-butanediono) Chromium (III)	1078b
Titanium-Base Alloy	176	Tris(1-phenyl-1, 3-butanediono) Iron (III)	1079b
		Triphenyl Phosphate	1071b
		Tungsten Carbide	276a
		Tungsten-Chromium-Vanadium Steel	50c
		Tungsten Concentrate	277
		Tungsten, Heat Capacity	782
		Tungsten-20% Molybdenum Alloy Electron Microprobe Standard	480
		Tungsten Thermal Expansion	737
		Unalloyed Copper	1034
		Unalloyed Copper, Cu "O"	393
		Unalloyed Copper, Cu IV	457
		Unalloyed Copper, Cu XI	454
		Unalloyed Copper, Cu I (Chip)	394
		Unalloyed Copper, Cu II (Chip)	395
		Unalloyed Copper, Cu III (Chip)	396
		Unalloyed Copper, Cu V (Chip)	398
		Unalloyed Copper, Cu VI (Chip)	399
		Unalloyed Copper, Cu VII (Chip)	400
		Unalloyed Copper, Cu I (Rod)	494

Name	SRM	Name	SRM
Unalloyed Copper, Cu II (Rod)	495	Wear-Metals in Lubricating Oil (300 ppm)	1085
Unalloyed Copper, Cu III (Rod)	496	Wheat Flour	1567
Unalloyed Copper, Cu V (Rod)	498	White Cast Iron	338
Unalloyed Copper, Cu VI (Rod)	499	White Cast Iron (Disc)	1145
Unalloyed Copper, Cu VII (Rod)	500	White Cast Iron (Disc)	1146
Unalloyed Titanium	354	White Cast Iron (Disc)	1150
Uranium Isotopic Standard (Nominally depleted to 0.02%)	U-0002	White Ceramic Tile for Directional Hemispherical Reflectance	2019b
Uranium Isotopic Standard	U-005a	White Ceramic Tile for Directional Hemispherical Reflectance	2020
Uranium Isotopic Standard (Nominally 1% Enriched)	U-010	White Iron	3d
Uranium Isotopic Standard (Nominally 1.5% Enriched)	U-015	White Opan Glass Diffuse Spectral Reflectance Standard for the Visible Spectrum	2015
Uranium Isotopic Standard	U-020	Xenon-127 Gaseous Radioactivity Standard	4309G
Uranium Isotopic Standard	U-030a	Xenon-133 Gaseous Radioactivity Standard	4307I
Uranium Isotopic Standard (Nominally 5% Enriched)	U-050	Xenon-133 Gaseous Radioactivity Standard	4415L-I
Uranium Isotopic Standard (Nominally 10% Enriched)	U-100	Xenon-133, Xenon-137, Krypton-85 Mixed Gaseous Radioactivity Standard	4310B
Uranium Isotopic Standard (Nominally 15% Enriched)	U-150	X-ray Film Step Tablet	1001
Uranium Isotopic Standard (Nominally 20% Enriched)	U-200	X-ray Powder Diffraction Intensity Standard	674
Uranium Isotopic Standard (Nominally 35% Enriched)	U-350	X-ray Powder Diffraction (Mica) Low 2 Theta	675
Uranium Isotopic Standard (Nominally 50% Enriched)	U-500	Ytterbium-169 Radioactivity Standard	4419L-B
Uranium Isotopic Standard (Nominally 75% Enriched)	U-750	Zinc-Base Alloy (Die Casting)	94c
Uranium Isotopic Standard (Nominally 80% Enriched)	U-800	Zinc Concentrates	113a
Uranium Isotopic Standard (Nominally 85% Enriched)	U-850	Zinc Concentrates	329
Uranium Isotopic Standard (Nominally 90% Enriched)	U-900	Zinc Cyclohexanebutyrate	1073b
Uranium Isotopic Standard (Nominally 93% Enriched)	U-930	Zinc, Freezing Point	740
Uranium Isotopic Standard (Nominally 97% Enriched)	U-970	Zinc, Freezing Point Standard	43h
Uranium Metal	960	Zinc Metal	683
Uranium Oxide	950b	Zinc Oxide Rubber Compound	370e
Uranium Oxide	969	Zircaloy-2	360a
Uranium-233 Spike Assay and Isotopic Solution Standard	995	Zircaloy-4 Metal	1237
Uranium-235 Spike Assay and Isotopic Solution Standard	993	Zircaloy-4 Metal	1238
Urban Dust/Organics	1649	Zircaloy-4 Metal	1239
Urban Particulate Matter	1648	Zirconium-Barium Chromate Formulation for Heat-Source Powder Calorimetry	1651
Urea	912a	Zirconium-Barium Chromate Formulation for Heat-Source Powder Calorimetry	1652
Urea	2141	Zirconium-Barium Chromate Formulation for Heat-Source Powder Calorimetry	1653
Urea	2152	Zirconium Metal	1234
Uric Acid	913	Zirconium Metal	1235
Vanadium and Nickel in Residual Fuel Oil	1618	Zirconium Metal	1236
Vanadium in Curde Oil	8505		
Vanadium-49 Low-Energy Photon Standard	4266		
Waspaloy	349		
Wear-Metals in Lubricating Oil (100 ppm)	1084		

National Bureau of Standards

Report of Investigation

Research Material 50

Albacore Tuna

P. D. LaFleur and W. P. Reed

A lyophilized (freeze-dried) marine biological tissue sample has been prepared in an attempt to satisfy many of the analytical requirements for a base line marine reference material.

Tuna fish muscle tissue was chosen for this purpose because of availability, use as a fish foodstuff, and its oceanographic interest.

The tuna is available as a Research Material (RM), in sets of two cans. Each can contains approximately 35 grams of lyophilized tuna tissue in a polyethylene bag, inside the hermetically-sealed, nitrogen filled can.

Material Application

This particular RM is intended to be used in the measurement of elements present at trace concentrations. In addition, some measurements of trace hydrocarbons have been made. The material represents a typical marine tissue that has been lyophilized. It should prove useful to those scientists who may wish to evaluate analytical methods, or to use a generally available "real" sample matrix in interlaboratory comparisons. It is important to note, however, that this is not a Standard Reference Material and none of the data presented here are certified. For the convenience of the analyst using this material, we have included a discussion for each component reported. It is apparent that there is significant heterogeneity for some elements, specifically the "bone-seeking" elements. The homogeneity of other elements appears to be acceptable. In most instances the heterogeneity of the material is observed between samples from the same can. There is some evidence that this heterogeneity is due primarily to fine particles of cartilage or bone present with the tissue in this RM.

Material Preparation

The tuna tissue used in this research material is from albacore tuna caught in the San Diego area in July of 1971. The tuna was cleaned, filleted, frozen and transported to a lyophilization facility. It was thawed, ground, and mixed using stainless steel equipment. For the final mixing, the entire lot was held in a single stainless steel container. The tuna was then lyophilized in aluminum trays lined with polyethylene. After lyophilization, the material was again ground in a stainless-steel mill, carefully transferred to new, individual polyethylene bags, and canned under nitrogen for storage.

Preliminary studies performed on these canned samples raised serious problems about the homogeneity of the material. In an effort to improve this condition the material was reground, reblended and recanned under the same conditions, as before. Except where stated, all measurements provided in this report were made on the reprocessed material. During the second regrinding, fibrous material tended to "float" to the top due to the action of the mixer. This material was discarded.

(over)

Material Use

The lyophilized tuna tissue, sealed in metal cans, should have an indefinite storage life under normal room conditions. Thus far, no evidence exists to indicate deterioration of the material with time as long as the can remains sealed. Once opened, the possibility exists that the raw material will turn rancid. Researchers using only a portion of the material have successfully stored the remainder by placing the polyethylene bag in a glass jar with lid and storing at or below 0°C. A shelf life of 6 months is not unusual under these circumstances and a 2 year stability has been reported. The freeze-dried material represents only about 30% of the original weight of the tuna tissue. Consequently, for direct comparisons with fresh tissue the researcher may wish to adjust the sample weight for this difference. Please note, however, that all values in this "Report of Investigation" are based on the lyophilized weight of the tuna tissue.

The dissolution of this material is not difficult and researchers have reported using a variety of techniques. These techniques include nitric and perchloric acid digestion, nitric-sulfuric-perchloric (4:1:1) acid digestion, low temperature ashing, and oxygen combustion. Because of the apparent presence of small bits of cartilage and/or bone in the sample, the sample size for analysis should be 250 mg or greater to obtain reproducible results. For "bone-seeking" elements (e.g., Pb, U, Ca, Sr) the sample may be nonhomogeneous even with much larger sample sizes.

For the elements listed below, sufficient analytical work has been performed to permit some evaluation of the data. These brief evaluations are not certified values, but only judgments as to the amount of the element present. Problems encountered by analysts making these measurements are also described.

Mercury

The question of the mercury content of various foodstuffs has been studied by many investigators. It is hoped that this material will provide a base line RM for environmental studies of mercury in food. A value of 0.95 ± 0.1 ppm encompasses the means of all of the reported values for mercury with one exception and extensive studies have indicated good homogeneity for this element.

Agreement among methods appears to be good. The data show very little bias among the three methods used. Sample sizes for these measurements have been 0.25 grams and larger.

The question of volatile mercury was explored by one investigator who reported the mercury content decreasing after opening the container. This decrease amounted to approximately 0.1 ppm over a period of 3 weeks after opening even though stored at -25°C . This work has not been confirmed. Further work by several investigators has suggested that 80-90% of the mercury content is present as methylmercury.

Selenium

This element was determined by four laboratories using both neutron activation analysis and atomic absorption spectroscopy. The range of reported values (\bar{x}) is from 3.27 to 4.01 ppm. A most probable value is 3.6 ± 0.4 . There has been very little indication of heterogeneity for this element.

Zinc

The analysis for zinc was performed by three laboratories using two analytical methods, neutron activation analysis and atomic absorption analysis. The range of mean values (\bar{x}) is 11.4 to 14.6 ppm. Our estimate of the probable value is 13.6 ± 1 ppm. No random behavior has been noted in the analysis of this element.

Arsenic

The analysis for arsenic was performed by 4 laboratories using both neutron activation and atomic absorption techniques. Data obtained within each laboratory appears to be consistent, although there appears to be some disagreement among laboratories analyzing for this element. The range of average values (\bar{x}) between laboratories is 2.74 to 4.6 ppm. The recommended value for the arsenic content is 3.3 ± 0.4 ppm.

Lead

There is a limited amount of data available for lead. The average value is 0.46 ppm. The homogeneity of the material for this element is questionable and the range of individual values is quite large. The use of this Research Material as a control, or for the development of methods for lead cannot be recommended. The isotopic composition, however, has been determined and is: ^{208}Pb 52.2%; ^{207}Pb 21.5%; ^{206}Pb 24.9%; and ^{204}Pb 1.38%.

Other Elements

Manganese was found to be distributed homogeneously and the measured value in the original lot of tuna (not the reblended material) was 1.3 ppm. Sodium also was found to be homogeneous in the original lot of material and the reported value was 0.11%.

Potassium was found to be distributed homogeneously and the measured value on the original lot of tuna (not the reblended material) was 1.22%. The following elements have been found to be heterogeneously distributed in the tuna tissue: uranium, thorium, calcium, and strontium.

Organic Materials

The tuna research material was subjected to headspace sampling and analysis. The concentrations given in the following table are to be considered only as order-of-magnitude estimates of the hydrocarbon compounds present, as they were calculated relative to the amount of naphthalene added to the sample and most of the compounds identified were not aromatic hydrocarbons.

The value for the largest constituent, 2,6-di-*t*-butyl-*p*-cresol, is an especially poor estimate. However, this compound is interesting because it is a common antioxidant used in food packaging. It probably has its origins in one of the handling steps between tuna collection and packaging in plastic. An indication of petroleum pollution in the tuna sample comes from the aliphatic hydrocarbons present.

The identification of the monoterpene, limonene, is reasonably certain. As with pristane this compound is composed of isoprene units, but limonene is generally considered to be a product of plant biosynthesis. Its origin in this sample is uncertain, but it may arise from plant material ingested by tuna.

Identification and Approximate Quantitation of Major Isolated Organic Constituents

<u>Compound Identification*</u>	<u>Amount Present (ppm)</u>
Heptadiene (?)	0.6
Toluene	0.7
Limonene	0.4
2-nonanone (?)	0.7
2-undecanone (?)	0.1
2,6-di- <i>t</i> -butyl- <i>p</i> -cresol	1.0
Hexadecane	trace
Heptadecane	trace
Pristane	0.03

*Identification followed by a (?) is probable but not definite.

Summary

The analytical values presented in this report represent the authors' evaluation of a considerable amount of data. For many elements where the reports were inconclusive, probable values are not given. If more information becomes available in the future, this report will be updated. Your help in reporting data will be appreciated.

Send any reports to:

Office of Standard Reference Materials (R-701)
B316, Chemistry
National Bureau of Standards
Washington, D.C. 20234

May 12, 1977



National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1549

Non-Fat Milk Powder

This Standard Reference Material (SRM) is intended primarily for use in calibrating instrumentation and evaluating the reliability of analytical methods for the determination of constituents in milk, milk powders, and other biological matrices.

Certified Values of Constituents: The certified concentrations of the constituent elements are shown in Table 1. Certified values are based on results obtained by definitive methods of known accuracy; or alternatively, from concordant results by two or more independent analytical methods.

Additional Information on Composition: Noncertified concentrations of additional constituent elements are given for information only in Table 2. Noncertified concentrations of lactose and ascorbic acid were determined by high performance liquid chromatography; and for lactose only, by nuclear magnetic resonance.

Notice and Warnings to Users:

Expiration of Certification: This certification is invalid after 3 years from the date of shipping. Should it become invalid before then, purchasers will be notified by NBS.

Stability: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation. The bottle should be kept tightly closed and stored in a desiccator in the dark.

Use: A minimum sample of 500 mg of the dried material (see Instructions for Drying) should be used for any analytical determination to be related to the certified values of this certificate.

Dissolution procedures should be designed to effect complete dissolution, but without losses of volatile elements, such as mercury. Dissolution for these determinations should be carried out in a closed system.

Statistical consultation was provided by K.R. Eberhardt of the Statistical Engineering Division.

The overall direction and coordination of the analyses were under the chairmanship of F.I. Garner, Chief of the Inorganic Analytical Research Division, and W.E. May, Chief of the Organic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Gaithersburg, MD 20899
July 29, 1985
(Revision of Certificates
dated 4-17-84 and
1-14-85)

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

Instructions for Drying: Samples of this SRM must be dried before weighing according to the following procedure: Dry for 48 hours at 20 to 25 °C in a vacuum oven at a pressure not greater than 30 Pa (0.2 mm Hg).

Analysts:

Center for Analytical Chemistry, National Bureau of Standards:

- | | | |
|----------------------|-------------------|-----------------------|
| 1. E.S. Beary | 8. R.R. Greenberg | 15. T.J. Murphy |
| 2. J.M. Brown-Thomas | 9. W.R. Kelly | 16. P.J. Paulsen |
| 3. T.A. Butler | 10. H.M. Kingston | 17. T.C. Rains |
| 4. B. Coxon | 11. W.F. Koch | 18. T.A. Rush |
| 5. M.S. Epstein | 12. G.M. Lambert | 19. M.E. Watson |
| 6. J.D. Fassett | 13. G.J. Lutz | 20. R.L. Watters, Jr. |
| 7. J.W. Gramlich | 14. J.R. Moody | 21. L. Watts |

Cooperating Analysts:

22. R.W. Dabeka, Food Research Division, Health Protection Branch, Tunney's Pasture, Ottawa, Ontario, Canada.
 23. L. Kosta, A.R. Byrne, M. Dermelj, Institute "Josef Stefan", Ljubljana, Yugoslavia.
 24. C. Veillon and K. Patterson, Beltsville Human Nutrition Research Center, U.S. Department of Agriculture, Beltsville, MD.

Table 1. Certified Concentrations of Constituent Elements

<u>Element</u>	<u>Concentration, weight, %</u>	<u>Element</u>	<u>Concentration, weight, %</u>
Calcium ^{2c, 5a}	1.30 ± 0.05	Potassium ^{2b, 5a}	1.69 ± 0.03
Chlorine ^{3, 5a}	1.09 ± .02	Sodium ^{2c, 5a}	0.497 ± .010
Magnesium ^{2c, 5a}	0.120 ± .003	Sulfur ^{3, 4a}	.351 ± .005
Phosphorus ^{2a, 2c}	1.06 ± .02		
<u>Element</u>	<u>Concentration, µg/g</u>	<u>Element</u>	<u>Concentration, µg/g</u>
Cadmium ^{1b, 5b}	0.0005 ± 0.0002	Lead ^{1b, 4a}	0.019 ± 0.003
Chromium ^{4c, 5b}	.0026 ± .0007	Manganese ^{1b, 2a, 5a}	.26 ± .06
Copper ^{1b, 2a, 5b}	.7 ± .1	Mercury ^{1a, 5b}	.0003 ± .0002
Iodine ^{4a, 6}	3.38 ± .02	Selenium ^{1d, 4b, 5a, 5b}	.11 ± .01
Iron ^{4a, 5a}	1.78 ± .10	Zinc ^{1c, 2c, 4b, 5a}	46.1 ± 2.2

1. Atomic absorption spectrometry

- a. cold vapor
- b. electrothermal
- c. flame
- d. hydride generation

2. Atomic emission spectrometry

- a. dc plasma
- b. flame
- c. inductively coupled plasma

3. Ion chromatography

4. Isotope dilution mass spectrometry

- a. thermal ionization
- b. spark source
- c. electron impact

5. Neutron activation

- a. instrumental
- b. radiochemical

6. Photon Activation

Notes: (1.) Analytical values are based on the "dry-weight" of material (see Instructions for Drying).

(2.) Except for Fe, the stated uncertainty includes the union of 95% confidence intervals computed separately for each analytical method. It includes the effects of measurement error, possible effects of known systematic errors, and between-method differences. The uncertainty for Fe is given as a 95% confidence interval for the weighted mean of the mass spectrometric and neutron activation values, and includes an allowance (added linearly) for systematic error in the methods. The weights were chosen to minimize the estimated mean squared error of the weighted mean, as described in "Approximately Linear Models," by J. Sacks and D. Ylvisaker, *Annals of Statistics* 6, pp. 1122-1137, 1978.

Table 2. Noncertified Concentrations of Constituent Elements

<u>Element</u>	<u>Concentration,</u> <u>µg/g</u>	<u>Element</u>	<u>Concentration,</u> <u>µg/g</u>
Aluminum	(2)	Molybdenum	(0.34)
Antimony	(0.00027)	Rubidium	(11)
Arsenic	(.0019)	Silicon	(<50)
Bromine	(12)	Silver	(<0.0003)
Cobalt	(0.0041)	Tin	(<0.02)
Fluorine	(.20)		

Table 3. Noncertified Concentrations of Organic Constituents

<u>Compound</u>	<u>Number of</u> <u>Determinations</u>	<u>Concentration,^a</u> <u>weight %</u>	<u>Method</u>
Lactose	5	49 ± 3	High Performance Liquid Chromatography
	5	45 ± 2	Proton Nuclear Magnetic Resonance
<u>Compound</u>	<u>Number of</u> <u>Determinations</u>	<u>Concentration,^a</u> <u>µg/g</u>	<u>Methods</u>
Ascorbic Acid	10	53 ± 5	High Performance Liquid Chromatography

^aUncertainties represent one standard deviation.



National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1566

Oyster Tissue

This Standard Reference Material is intended primarily for use in calibrating instrumentation and validating methodology for the chemical analysis of marine animal tissue.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. Certified values are based on results obtained by reference methods of known accuracy; or alternatively, from results obtained by two or more independent and reliable analytical methods. Non-certified values are given for information only in Table 2. All values are based on a minimum sample size of 250 mg of the dried material.

NOTICE AND WARNINGS TO USERS

Expiration of Certification: This certification is invalid after 5 years from the date of shipping. Should it become invalid before then, purchasers will be notified by NBS.

Storage: The material should be kept tightly closed in its original bottle and stored in a desiccator at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight.

Use: A minimum sample weight of 250 mg of the *dried* material (see Instructions for Drying) is necessary for any certified value in Table 1 to be valid within the stated uncertainty. The bottle should be shaken well before each use, and closed tightly immediately after use.

The statistical analysis of the data was performed by K. R. Eberhardt and H. H. Ku of the Statistical Engineering Division.

The overall direction and coordination of the analytical chemistry measurements leading to this certificate were performed in the NBS Center for Analytical Chemistry by P. D. LaFleur.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Washington, D.C. 20234
February 22, 1983
(Revision of Certificate
Dated 12-12-79)

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

Instructions for Drying: Before weighing, samples of SRM 1566 should be dried to constant weight by one of the following procedures:

1. Reduced-pressure drying at room temperature for 48 hours over $Mg(ClO_4)_2$ in a vacuum desiccator at approximately 1.3×10^4 Pa (100 mm Hg).
2. Vacuum drying at room temperature for 24 hours at a pressure of approximately 30 Pa (0.2 mm Hg) using a cold trap.
3. Freeze drying for 20 hours at a pressure of approximately 3 Pa (0.02 mm Hg).

Source and Preparation of Material: The oysters for this reference material were obtained by the FDA Bureau of Shellfish Sanitation from a commercial source. They had been shucked, frozen, and packaged in sealed plastic bags. The oyster material was ground, freeze-dried, and powdered at the U.S. Army Natick Research and Development Command, Natick, Mass., under the direction of L. Hinnegardt and G. C. Walker. At NBS, preliminary analyses of the material homogeneity indicated that an improvement in homogeneity would be required to establish more reliable certified values for a minimum sample size of 250 mg. Accordingly, the material was cryogenically ground by J. R. Moody and J. Matwey. It was then blended and bottled at NBS, after which it was again freeze-dried at the Natick, Mass., laboratory.

Homogeneity Assessment: Randomly selected bottles of SRM 1566 were sampled and tested for homogeneity by neutron activation and atomic absorption spectrometry. No inhomogeneity was observed for the following elements determined by neutron activation: Na, Cl, V, and Mn. The values for Mg, K, Cu, Zn, and Cd determined by atomic absorption spectrometry were within the imprecision of the method; however, Ca does exhibit some inhomogeneity--approximately 4% relative standard deviation.

Analysts:

Center for Analytical Chemistry, National Bureau of Standards:

- | | |
|---------------------|---------------------|
| 1. J. V. Bailey | 17. W. R. Kelly |
| 2. C. Blundell | 18. H. M. Kingston |
| 3. T. J. Brady | 19. W. F. Koch |
| 4. M. Diaz | 20. R. M. Lindstrom |
| 5. L. P. Dunstan | 21. G. J. Lutz |
| 6. M. S. Epstein | 22. L. A. Machlan |
| 7. J. D. Fassett | 23. W. A. MacCrehan |
| 8. M. Gallorini | 24. E. J. Maienthal |
| 9. E. L. Garner | 25. J. Maples |
| 10. T. E. Gills | 26. O. Menis |
| 11. J. W. Gramlich | 27. J. D. Messman |
| 12. R. R. Greenberg | 28. J. R. Moody |
| 13. S. Hanamura | 29. L. J. Moore |
| 14. S. Harrison | 30. T. J. Murphy |
| 15. E. F. Heald | 31. P. J. Paulsen |
| 16. G. M. Hyde | 32. T. C. Rains |
| | 33. H. L. Rook |

Cooperating Analysts:

34. University of Tokyo, Tokyo, Japan; Y. Dokiya (NBS Guest Worker).
35. Division of Chemistry, National Research Council of Canada, Ottawa, Canada; S. Berman, A. Desaulniers, J. McLaren, A. Mykytiuk, D. Russell, and S. Willie.
36. Ibaraki Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Tokai, Ibaraki, Japan; K. Kudo and K. Kobayashi.
37. Food Research Division, Health Protection Branch, Tunney's Pasture, Ottawa, Ontario, Canada; R. W. Dabeka, A. D. McKenzie, and H. B. S. Conacher.

Table 1. Certified Values of Constituent Elements

<u>Element¹</u>	<u>Content², Wt. Percent</u>	<u>Element¹</u>	<u>Content², Wt. Percent</u>
Calcium ^{b,d}	0.15 ± 0.02	Potassium ^d	0.969 ± 0.005
Magnesium ^{a,d}	0.128 ± 0.009	Sodium ^{b,f}	0.51 ± 0.03
<u>Element¹</u>	<u>Content², µg/g</u>	<u>Element¹</u>	<u>Content², µg/g</u>
Arsenic ^{a,f,g,h}	13.4 ± 1.9	Nickel ^{a,e,h}	1.03 ± 0.19
Cadmium ^{a,d,e,f,h}	3.5 ± 0.4	Rubidium ^{d,i}	4.45 ± 0.09
Chromium ^{d,e,f}	0.69 ± 0.27	Selenium ^{a,e,f}	2.1 ± 0.5
Copper ^{a,c,e,f}	63.0 ± 3.5	Silver ^{a,f}	0.89 ± 0.09
Iron ^{b,c,e,f}	195 ± 34	Strontium ^{b,d}	10.36 ± 0.56
Lead ^{a,d,e,h}	0.48 ± 0.04	Uranium ^d	0.116 ± 0.006
Manganese ^{a,c,f}	17.5 ± 1.2	Vanadium ^d	2.3 ± 0.1
Mercury ^{a,f}	0.057 ± 0.015	Zinc ^{a,c,d,e,f,h}	852 ± 14

1. Analytical Methods:

- ^a Atomic absorption spectroscopy
- ^b Atomic emission spectroscopy, flame
- ^c Atomic emission spectroscopy, inductively coupled plasma
- ^d Isotope dilution mass spectrometry, thermal ionization
- ^e Isotope dilution mass spectrometry, spark source
- ^f Neutron activation
- ^g Photon activation
- ^h Polarography

2. Based on dry weight. (For drying instructions, see the section of this certificate on Instructions for Drying.) The estimated uncertainty is given as 95 percent tolerance limits for coverage of at least 95 percent of the measured values of all bottles of SRM 1566. For a given element, the following statement can be made at a confidence limit of 95 percent. "If the concentrations were measured for all bottles, at least 95 percent of these measured values should fall within the indicated limits." The concept of tolerance limits is discussed in Chapter 2, Experimental Statistics, NBS Handbook 91, 1966, and page 14, The Role of Standard Reference Materials in Measurement Systems, NBS Monograph 148, 1975.

Table 2. Non-certified Values of Constituent Elements

<u>Element</u>	<u>Content¹ (Wt. Percent)</u>
Chlorine	(1.0)
Sulfur	(0.76)
Phosphorous	(0.81)
	<u>(µg/g)</u>
Bromine	(55)
Cobalt	(0.4)
Fluorine	(5.2)
Iodine	(2.8)
Molybdenum	(≤0.2)
Thallium	(≤0.005)
Thorium	(0.1)

¹ Based on dry weight. (For drying instructions, see the section of this certificate on Instructions for Drying.)

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 1567
Wheat Flour

This Standard Reference Material is intended primarily for calibrating instrumentation and evaluating the reliability of analytical methods for the determination of minor and trace elements in wheat flour and similar agricultural food products.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. They are based on results obtained by two or more independent, reliable analytical methods. Non-certified values which are given for information only, appear in Table 2.

All values are based on a minimum sample size of 400 mg and are reported on a "dry-weight" basis.

Notice and Warnings to Users:

Expiration of Certification: This certification will be invalid after 5 years from the date of shipping. Should it be invalidated before then, purchasers will be notified by NBS.

Storage: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight. Ideally, the bottle should be kept in a desiccator in the dark at the temperature indicated.

Use: The following procedures should be followed to relate the analytical determinations to the values reported in this Certificate. The bottle should be shaken well before each use, and a minimum sample of 400 mg of the material should be used. Selenium and mercury should be determined in the material without drying and the concentration values adjusted for the moisture content of the material using separate samples. Other elements may be determined either on samples without drying as indicated above or on samples vacuum-dried for 24 hr as indicated under "Instructions for Drying."

The overall direction and coordination of the technical measurements leading to this Certificate were performed under the chairmanship of H. L. Rook.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Washington, D.C. 20234
January 3, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements^a

Minor Constituents

<u>Element</u>	<u>Content</u> <u>Wt. Percent</u>
Potassium	0.136 ± 0.004 ^b
Calcium	0.019 ± 0.001

Trace Constituents

<u>Element</u>	<u>Content</u> <u>µg/g</u>	<u>Element</u>	<u>Content</u> <u>µg/g</u>
Iron	18.3 ± 1.0	Copper	2.0 ± 0.3
Zinc	10.6 ± 1.0	Selenium	1.1 ± 0.2
Manganese	8.5 ± 0.5	Cadmium	0.032 ± 0.007
Sodium	8.0 ± 1.5	Mercury	0.001 ± 0.0008

^aAnalytical values are based on the "dry-weight" of material (see Instructions for Drying). Selenium and mercury should be determined on samples without drying and the results adjusted to a "dry-weight" basis by determining moisture on separate samples.

^bThe estimated uncertainty is based on judgment and represents an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability for samples 400 mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of the constituents).

Table 2. Non-certified Values for Constituent Elements^a

NOTE: The values shown in this table are not certified because they are not based on the results of two or more independent reliable methods. These values are included for information only.

Trace Constituents

<u>Element</u>	<u>Content</u> <u>µg/g</u>	<u>Element</u>	<u>Content</u> <u>µg/g</u>
Bromine	(9)	Nickel	(0.18)
Rubidium	(1)	Arsenic	(0.006)
Molybdenum	(0.4)	Tellurium	(≤0.002)

^aAnalytical values are based on the "dry-weight" of material (see Instructions for Drying).

Preparation of Material: The wheat flour for this Standard Reference Material was described by the supplier as milled from a blend of Hard Red Spring and Hard Red Winter wheat grown primarily in South Dakota. The flour was taken from the mill packer during the middle of a run to obtain homogeneous material. The flour had been bleached and brominated in accordance with standard treatments for commercial bakery use. At NBS, the material was passed through a sieve with openings of 425 μm (No. 40) and blended. The bottled material was then subjected to 2.5 megarads of Co-60 radiation for microbiological control at Neutron Products, Inc., Dickerson, Md.

Homogeneity Assessment: A preliminary evaluation of homogeneity was made by instrumental neutron activation using samples of 150 to 300 mg and counting the activities from radionuclides of Mn, K, Zn, Na, and Br. The homogeneity of other certified elements was evaluated using samples of 400 mg or less with the exception of mercury and calcium for which 500 mg and 1 g, respectively, were used. The uncertainties for the concentrations in Table 1 include these results.

Instructions for Drying: Except for selenium and mercury, elements may be determined on samples which have been dried as follows:

Vacuum-dry the material at approximately 25 °C for 24 hours at a pressure not greater than 70 Pa (0.5 mm Hg) with a cold trap at a temperature of about -30 °C or below.

Se and Hg should be determined on undried samples; other elements may be so determined. However, because the Certificate values are reported on a "dry-weight" basis, the elemental concentrations determined on undried samples should be adjusted for the moisture content of the samples. The moisture content, which was approximately 9% when bottled, should be determined on separate samples by either the vacuum-drying procedure described above or drying the sample in air in an oven at 85 °C for 24 hours. Both of these procedures yielded the same loss in weight. Samples for analysis should not be oven-dried lest elements be lost by volatilization.

Analytical Methods Used and Analysts

Analytical Methods

- A. Atomic absorption spectrometry
- B. Flame emission spectrometry
- C. Isotope dilution spark source mass spectrometry
- D. Neutron activation
- E. Polarography

Analysts

Analytical Chemistry Division, National Bureau of Standards

- | | |
|--------------------|---------------------|
| 1. J. R. Baldwin | 10. G. J. Lutz |
| 2. I. J. Brady | 11. E. J. Maienthal |
| 3. M. G. Diaz | 12. R. Mavrodineanu |
| 4. L. P. Dunstan | 13. J. D. Messman |
| 5. M. S. Epstein | 14. R. M. Morris |
| 6. M. Gallorini | 15. P. J. Paulsen |
| 7. T. E. Gills | 16. T. C. Rains |
| 8. R. R. Greenberg | 17. P. A. Sleeth |
| 9. R. M. Lindstrom | |

Cooperating Analysts

18. W. R. Wolf and J. Holden, Nutrition Institute, U.S. Department of Agriculture, Beltsville, Md.

Addendum to
National Bureau of Standards
Certificate of Analysis
Standard Reference Material 1567
Wheat Flour

Additional Certification

The following certified value is to be added to Table I.

Table I. Certified Values of Constituent Elements^a

<u>Element</u>	<u>Content, $\mu\text{g/g}$</u>
Lead	0.020 ± 0.010^b

^aLead should be determined on samples without drying and the results adjusted to a "dry-weight" basis by determining moisture on separate samples.

^bThe estimated uncertainty, based on judgment, is for samples 2 g or more.

Analytical Methods Used and Analysts

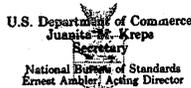
Inorganic Analytical Research Division, National Bureau of Standards.

Isotope dilution, mass spectrometry, I. L. Barnes and E. S. Beary;

Polarography, E. J. Maienthal.

Cooperating Analyst

R. W. Dabeka, Food Directorate, Health Protection Branch, Ottawa, Canada.



National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1568

Rice Flour

This Standard Reference Material is intended primarily for calibrating instrumentation and evaluating the reliability of analytical methods for the determination of minor and trace elements in rice flour and similar agricultural food products.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. They are based on results obtained by two or more independent, reliable analytical methods. Non-certified values which are given for information only, appear in Table 2.

All values are based on a minimum sample size of 400 mg and are reported on a "dry-weight" basis.

Notice and Warnings to Users:

Expiration of Certification: This certification will be invalid after 5 years from the date of shipping. Should it be invalidated before then, purchasers will be notified by NBS.

Storage: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight. Ideally, the bottle should be kept in a desiccator in the dark at the temperature indicated.

Use: The following procedures should be followed to relate the analytical determinations to the values reported in this Certificate. The bottle should be shaken well before each use, and a minimum sample of 400 mg of the material should be used. Selenium and mercury should be determined in the material without drying and the concentration values adjusted for the moisture content of the material using separate samples. Other elements may be determined either on samples without drying as indicated above or on samples vacuum-dried for 24 hr as indicated under "Instructions for Drying."

The overall direction and coordination of the technical measurements leading to this Certificate were performed under the chairmanship of H. L. Rook.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Washington, D.C. 20234
January 3, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements^a

Minor Constituents

<u>Element</u>	<u>Content Wt. Percent</u>
Potassium	0.112 ± 0.002 ^b
Calcium	0.014 ± 0.002

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Manganese	20.1 ± 0.4	Arsenic	0.41 ± 0.05
Zinc	19.4 ± 1.0	Selenium	0.4 ± 0.1
Iron	8.7 ± 0.6	Cadmium	0.029 ± 0.004
Sodium	6.0 ± 1.5	Cobalt	0.02 ± 0.01
Copper	2.2 ± 0.3	Mercury	0.0060 ± 0.0007

^aAnalytical values are based on the "dry-weight" of material (see Instructions for Drying). Selenium and mercury should be determined on samples without drying and the results adjusted to a "dry-weight" basis by determining moisture on separate samples.

^bThe estimated uncertainty is based on judgment and represents an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability for samples 400 mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of the constituents).

Table 2. Non-certified Values for Constituent Elements^a

NOTE: The values shown in this table are not certified because they are not based on the results of two or more independent reliable methods. These values are included for information only.

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Rubidium	(7)	Nickel	(0.16)
Molybdenum	(1.6)	Tellurium	(≤0.002)
Bromine	(1)		

^aAnalytical values are based on the "dry-weight" of material (see Instructions for Drying).

Preparation of Material: The rice flour for this Standard Reference Material was described by the supplier as 100% long grain from Arkansas. At NBS, the material was passed through a sieve with openings of 425 μm (No. 40) and blended. The bottled material was then subjected to 2.5 megarads of Co-60 radiation for microbiological control at Neutron Products, Inc., Dickerson, Md.

Homogeneity Assessment: A preliminary evaluation of homogeneity was made by instrumental neutron activation using samples of 150 to 300 mg and counting the activities from radionuclides of Mn, K, Zn, Na, and Br. The homogeneity of other certified elements was evaluated using samples of 400 mg or less with the exception of mercury and calcium for which 500 mg and 1 g, respectively, were used. The uncertainties for the concentrations in Table I include these results.

Instructions for Drying: Except for selenium and mercury, elements may be determined on samples which have been dried as follows:

Vacuum-dry the material at approximately 25 °C for 24 hours at a pressure not greater than 70 Pa (0.5 mm Hg) with a cold trap at a temperature of about -30 °C or below.

Se and Hg should be determined on undried samples; other elements may be so determined. However, because the Certificate values are reported on a "dry-weight" basis, the elemental concentrations determined on undried samples should be adjusted for the moisture content of the samples. The moisture content, which was approximately 9% when bottled, should be determined on separate samples by either the vacuum-drying procedure described above or drying the sample in air in an oven at 85 °C for 24 hours. Both of these procedures yielded the same loss in weight. Samples for analysis should not be oven-dried lest elements be lost by volatilization.

Analytical Methods Used and Analysts

Analytical Methods

- A. Atomic absorption spectrometry
- B. Flame emission spectrometry
- C. Isotope dilution spark source mass spectrometry
- D. Neutron activation
- E. Polarography

Analysts

Analytical Chemistry Division, National Bureau of Standards

- | | |
|--------------------|---------------------|
| 1. J. R. Baldwin | 10. G. J. Lutz |
| 2. T. J. Brady | 11. E. J. Maienthal |
| 3. M. G. Diaz | 12. R. Mavrodineanu |
| 4. L. P. Dunstan | 13. J. D. Messman |
| 5. M. S. Epstein | 14. R. M. Morris |
| 6. M. Gallorini | 15. P. J. Paulsen |
| 7. T. E. Gills | 16. T. C. Rains |
| 8. R. R. Greenberg | 17. P. A. Sleeth |
| 9. R. M. Lindstrom | |

Cooperating Analysts

18. W. R. Wolf and J. Holden, Nutrition Institute, U.S. Department of Agriculture, Beltsville, Md.

Addendum to
National Bureau of Standards
Certificate of Analysis
Standard Reference Material 1568
Rice Flour

Additional Certification

The following certified value is to be added to Table I.

Table 1. Certified Values of Constituent Elements^a

<u>Element</u>	<u>Concentration, $\mu\text{g/g}$</u>
Lead	0.045 ± 0.010^b

^aLead should be determined on samples without drying and the results adjusted to a "dry-weight" basis by determining moisture on separate samples.

^bThe estimated uncertainty, based on judgment, is for samples 2 g or more.

Analytical Methods Used and Analysts

Inorganic Analytical Research Division, National Bureau of Standards.

Isotope dilution, mass spectrometry, J. L. Barnes and E. S. Beary;

Polarography, E. J. Maienthal.

Cooperating Analyst

R. W. Dabeka, Food Directorate, Health Protection Branch, Ottawa, Canada.

U.S. Department of Commerce
Elliot L. Richardson,
Secretary
National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis Standard Reference Material 1569

Brewers Yeast

This Standard Reference Material is intended for use in calibrating instrumentation and evaluating the accuracy of analytical methods for the determination of chromium in brewers yeast and other biological materials. SRM 1569 and like materials contain a volatile chromium component which presents an especially difficult analytical problem. Care should be taken to avoid its loss; see, "Preparation of Biological Materials for Chromium Analysis," W. R. Wolf and F. E. Greene [1].

*Chromium concentration: $2.12 \pm 0.05 \mu\text{g/g}$

*Calculated on a dry weight basis from determinations made on samples *without drying*. (See "Precautions" below.) A minimum sample size of 150 mg should be used.

The certified value is based on concordant results by independent analytical methods; the uncertainty is estimated from the imprecision of the methods and inhomogeneity of the material.

The overall direction and coordination of the technical measurements leading to this certificate were performed under the chairmanship of L. McClendon.

The technical aspects leading to the preparation, certification and issuance of this material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

[1] Wolf, W. R. and Greene, F. E., Preparation of Biological Materials for Chromium Analysis, Proceedings of the 7th Materials Research Symposium, Accuracy in Trace Analysis: Sampling, Sample Handling and Analysis, NBS Spec. Publ. 422, U. S. Government Printing Office, Washington, D.C. (August 1976).

Washington, D.C. 20234
September 7, 1976

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Analyses were performed in the NBS Analytical Chemistry Division by L. McClendon (neutron activation) and by L. Dunstan and E. Garner (isotope dilution, mass spectrometry). Cooperative analyses were also made by W. R. Wolf, Nutrition Institute, U.S. Department of Agriculture, Beltsville, Md.

The material was furnished by the Nutrition Institute, U.S. Department of Agriculture, Beltsville, Md. At NBS, it was passed through a sieve having openings of 0.15 mm (U.S. Series 100 standard sieve) and blended.

Precautions:

(1) The analytical determinations should be made on samples *without drying*. The determinations should be corrected to a dry weight basis by heating separate samples at 85 °C for 3 hr to determine the weight loss.

(2) Samples should not be dissolved in open vessels.

Material Homogeneity was determined by a neutron activation technique using 150-mg random samples from bottled material representing different locations of the bulk material. The statistical test pattern was proposed by J. Mandel of the NBS Institute for Materials Research.

Stability:

The material should be kept in its original bottle and stored at temperatures between 10-23 °C. Exposure to moisture should be minimized by tightly capping the bottle immediately after use. Ideally, the bottle should be kept in a desiccator at the temperature indicated.

U. S. Department of Commerce
Malcolm Baldrige
Secretary
National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1572

Citrus Leaves

This Standard Reference Material (SRM) is intended primarily for use in calibrating instrumentation and evaluating the reliability of analytical methods for the determination of major, minor, and trace elements in botanical materials, agricultural food products, and similar matrices.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. They are based on results obtained either by definitive methods of known accuracy or by two or more independent analytical methods. Non-certified values, which are given for information only, appear in Table 2.

Notice and Warnings to Users:

Expiration of Certification: This certification is invalid 5 years after the shipping date. Should it be invalidated before then, purchasers will be notified by NBS.

Stability: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation. Ideally, the bottle should be kept tightly closed in a desiccator in the dark at the temperature indicated.

Use: The bottle should be shaken well before each use. A minimum sample of 500 mg of the dried material (see Instructions for Drying) should be used for any analytical determination to be related to the certified values of this certificate.

Statistical consultation was provided by K. Kafadar of the Statistical Engineering Division.

The overall direction and coordination of the analyses leading to this certification were performed under the chairmanship of E.L. Garner, Chief of the Inorganic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Washington, D.C. 20234
December 20, 1982
(Revision of Certificate
dated 2-22-82)

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements

Major and Minor Constituents

<u>Element</u>	<u>Content,¹ (Wt. Percent)</u>
Calcium	3.15 ± 0.10
Magnesium	0.58 ± 0.03
Phosphorus	0.13 ± 0.02
Potassium*	1.82 ± 0.06
Sulfur	0.407 ± 0.009

Trace Constituents

<u>Element</u>	<u>Content,¹ µg/g</u>	<u>Element</u>	<u>Content,¹ µg/g</u>
Aluminum	92 ± 15	Manganese	23 ± 2
Arsenic	3.1 ± 0.3	Mercury	0.08 ± 0.02
Barium	21 ± 3	Molybdenum	0.17 ± 0.09
Cadmium	0.03 ± 0.01	Nickel	0.6 ± 0.3
Chromium	0.8 ± 0.2	Rubidium*	4.84 ± 0.06
Copper	16.5 ± 1.0	Sodium	160 ± 20
Iodine	1.84 ± 0.03	Strontium*	100 ± 2
Iron	90 ± 10	Zinc	29 ± 2
Lead*	13.3 ± 2.4		

¹Based on dry weight. For drying instructions, see the section of this certificate on Instructions for Drying. The uncertainties are based on judgment and represent an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability for samples weighing 500 mg or more.

*For those elements determined by definitive methods, the uncertainties are given as 95%/95% statistical tolerance intervals. See The Role of Standard Reference Materials in Measurement Systems, NBS Monograph 148, 1975 p 14.

Table 2. Non-certified Values for Constituent Elements

NOTE: The following values are not certified because they are not based on the results of either a definitive method of known accuracy or two or more independent methods. These values are included for information only.

Major Constituent

<u>Element</u>	<u>Content,¹ (Wt. Percent)</u>
Nitrogen	(2.86)

Trace Constituents

<u>Element</u>	<u>Content,¹ $\mu\text{g/g}$</u>	<u>Element</u>	<u>Content,¹ $\mu\text{g/g}$</u>
Antimony	(0.04)	Samarium	(0.052)
Bromine	(8.2)	Scandium	(0.01)
Cerium	(0.28)	Selenium	(0.025)
Cesium	(0.098)	Tellurium ^a	(0.02)
Chlorine	(414)	Thallium	(\leq 0.01)
Cobalt	(0.02)	Tin	(0.24)
Europium	(0.01)	Uranium	(\leq 0.15)
Lanthanum	(0.19)		

¹Analytical values are based on the "dry weight" of material (See Instructions for Drying).

^aNot sufficiently homogeneous for certification.

Instructions for Drying: Samples of this SRM must be dried before weighing and analysis by either of the following procedures:

1. Drying for 2 hours in air in an oven at 85 °C.
2. Drying for 24 hours at 20 to 25 °C and at a pressure not greater than 30 Pa (0.2 mm Hg).

Additional Information on Analyses: This SRM contains siliceous material, which is an integral part of the sample. The values in Tables 1 and 2 are based on analyses performed on the *entire* sample. Therefore, dissolution procedures should be capable of complete dissolution of the sample but should not result in losses of volatile elements, such as arsenic and mercury.

Source and Preparation of Material: The plant material for this SRM was collected and prepared under the direction of A. L. Kenworthy, Michigan State University. Its source was the Lake Alfred area of central Florida. The material was air-dried, ground in a comminuting machine to pass a 425- μm (No. 40) sieve, dried at 85 °C, and thoroughly mixed in a feed blender. After packaging the material in polyethylene-lined fiber drums, it was sterilized in situ with cobalt-60 radiation. The sterilization procedure was carried out at the U.S. Army Research and Development Command, Natick, Mass. under the direction of A. Brynjolfsson.

Analytical Methods Used and Analyses

Analytical Methods:

- A. Atomic absorption spectrometry
- B. Atomic emission spectrometry, flame
- C. Atomic emission spectrometry, inductively coupled plasma
- D. Ion chromatography
- E. Isotope dilution thermal source mass spectrometry
- F. Isotope dilution spark source mass spectrometry
- G. Kjeldahl method for nitrogen
- H. Neutron activation
- I. Photon activation
- J. Polarography
- K. Spectrophotometry

Analysts:

Inorganic Analytical Research Division, National Bureau of Standards

- | | |
|-------------------|-----------------------|
| 1. I.L. Barnes | 14. R.M. Lindstrom |
| 2. E.S. Beary | 15. G.J. Lutz |
| 3. K.A. Brletic | 16. L.A. Machlan |
| 4. T.A. Butler | 17. E.J. Maienthal |
| 5. E.R. Deardorff | 18. J.R. Moody |
| 6. J.W. Gramlich | 19. T.J. Murphy |
| 7. R.R. Greenberg | 20. P.J. Paulsen |
| 8. S. Hanamura | 21. L.J. Powell |
| 9. E.F. Heald | 22. T.C. Rains |
| 10. W.R. Kelly | 23. T.A. Rush |
| 11. H.M. Kingston | 24. P.A. Sleeth |
| 12. W.F. Koch | 25. R.L. Watters, Jr. |
| 13. G.M. Lambert | 26. R. Zeisler |

Cooperating Analysts:

- 1. M. Ihnat, Chemistry and Biology Research Institute, Agriculture Canada, Ottawa, Canada.
- 2. M. Gallorini, E. Orvini, and M. DiCasa, Consiglio Nazionale delle Ricerche, Centro di Radiochimica e Analisi per Attivazione presso l'Istituto di Chimica Generale dell' Universita', Pavia, Italy.
- 3. L. Kosta, A. R. Byrne, and A. Prosenec, Institute "Josef Stefan," Ljubljana, Yugoslavia.
- 4. J. B. Jones, Jr., Department of Horticulture, University of Georgia, Athens, Georgia.
- 5. U. M. Cowgill, Department of Biological Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania.

U.S. Department of Commerce
Elliot L. Richardson,
Secretary
National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 1573
Tomato Leaves

This Standard Reference Material is intended primarily for calibrating instrumentation and evaluating the reliability of analytical methods for the determination of major, minor, and trace elements in botanical materials and other agricultural products.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. They are based on results obtained either by reference methods of known accuracy or by two or more independent, reliable analytical methods. Non-certified values, which are given for information only, appear in Table 2. All values are based on a minimum sample size of 500 mg of the material dried as indicated under "Instructions for Drying."

Notice and Warnings to Users:

Expiration of Certification: This certification will be invalid 5 years after the shipping date. Should it be invalidated before then, purchasers will be notified by NBS.

Stability: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight. Ideally, the bottle should be kept in a desiccator in the dark at the temperature indicated.

Use: The bottle should be shaken well before each use. A minimum sample of 500 mg of the *dried* material (see Instructions for Drying) should be used for any analytical determination to be related to the certified values of this certificate.

The overall direction and coordination of the technical measurements leading to this certificate were performed under the chairmanship of H. L. Rook. The overall coordination of the cooperative work performed by the Commission of European Communities, Joint Research Center, Ispra Establishment, Italy, was by G. Rossi of the Chemistry Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by T. W. Mears and R. Alvarez.

Washington, D.C. 20234
October 18, 1976

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements^a

Major and Minor Constituents

<u>Element</u>	<u>Content Wt. Percent</u>
Potassium	4.46 ± 0.03
Calcium	3.00 ± 0.03
Phosphorus	0.34 ± 0.02

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Iron	690 ± 25	Lead	6.3 ± 0.3
Manganese	238 ± 7	Chromium	4.5 ± 0.5
Zinc	62 ± 6	Arsenic	0.27 ± 0.05
Strontium	44.9 ± 0.3	Thorium	0.17 ± 0.03
Rubidium	16.5 ± 0.1	Uranium	0.061 ± 0.003
Copper	11 ± 1		

^aAnalytical values are based on the "dry-weight" of material (See Instructions for Drying).

The uncertainties of the values shown in Table 1 include allowances for inhomogeneity, method imprecision, and an estimate of possible biases of the analytical methods used.

Table 2. Non-certified Values for Constituent Elements^a

NOTE: The following values are not certified because they are not based on the results of either a reference method of known accuracy or two or more independent methods. These values are included for information only.

Major and Minor Constituents

<u>Element</u>	<u>Content Wt. Percent</u>
Nitrogen	(5.0)
Magnesium	(0.7)
Aluminum	(0.12)

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Boron	(30)	Cobalt	(0.6)
Bromine	(26)	Scandium	(0.13)
Cadmium ^b	(3)	Mercury	(0.1)
Cerium	(1.6)	Thallium	(0.05)
Lanthanum	(0.9)	Europium	(0.04)

^aAnalytical values are based on the "dry weight" of material (See Instructions for Drying).

^bCadmium was not sufficiently homogeneous for certification.

Instructions for Drying: Samples of this Standard Reference Material *must* be dried before weighing by either of the following procedures:

1. Drying in air in an oven at 85 °C for 2 hours.
2. Lyophilization using a cold trap at or below -50 °C at a pressure *not greater* than 30 Pa (0.2 mm Hg) for 24 hours.

NOTE: Drying either in an oven at 105 °C or in a vacuum oven at 75 °C causes large losses of volatiles other than water and should *not* be used.

Additional Information on Analyses: This Standard Reference Material contains siliceous material, which is an integral part of the sample. The analyses reported in Tables 1 and 2 were performed on the entire sample. Therefore, dissolution procedures should be capable of complete dissolution of the sample, but should not result in losses of volatile elements, such as arsenic and mercury.

Source and Preparation of Material: The plant material for this SRM was collected and prepared under the direction of A. L. Kenworthy of Michigan State University, East Lansing, Mich. Its source was a field plot of direct seeded tomatoes that had been established at the Horticultural Research Center of the University. For the preparation of the SRM, the terminal portions of the plants were clipped, air-dried, and ground in a comminuting machine. After grinding, the material was dried at 85 °C, thoroughly mixed in a feed blender, packaged in polyethylene-lined fiber drums, and sterilized in situ with cobalt-60 radiation. The sterilization procedure was carried out at the U.S. Army Research and Development Command, Natick, Mass. under the direction of A. Brynjolfsson. At NBS, a preliminary evaluation of the material homogeneity indicated that its improvement would be required to establish more reliable certified values. Therefore, the material was resieved and the portion that had passed a polypropylene sieve having openings of 0.25 mm (equivalent to a U.S. series 60 standard sieve) was retained for the SRM.

Homogeneity Assessment: Material homogeneity was evaluated by determining nine of the certified elements, P, Fe, Mn, Zn, Rb, Cu, Cr, As, and U on samples of 500 mg or less taken at various locations of the freeze-dried bulk material. The other certified elements, K, Ca, Sr, Pb, and Th were determined using sample weights not exceeding one gram. The uncertainties of the concentrations given in Table 1 include these results.

Analytical Methods Used and Analysts

Analytical Methods

- A. Atomic absorption spectroscopy
- B. Isotope dilution mass spectrometry
- C. Isotope dilution spark source mass spectrometry
- D. Kjeldahl method for nitrogen
- E. Neutron activation
- F. Nuclear track technique
- G. Optical emission spectroscopy
- H. Spectrophotometry
- I. Polarography

(over)

Analysts

Analytical Chemistry Division, National Bureau of Standards

- | | |
|-----------------------|---------------------|
| 1. R. W. Burke | 11. S. H. Harrison |
| 2. B. S. Carpenter | 12. R. M. Lindstrom |
| 3. E. R. Deardorff | 13. L. A. Machlan |
| 4. B. I. Diamondstone | 14. L. T. McClendon |
| 5. L. J. Dunstan | 15. L. J. Moore |
| 6. M. S. Epstein | 16. T. J. Murphy |
| 7. R. H. Filby | 17. P. J. Paulsen |
| 8. E. L. Garner | 18. T. C. Rains |
| 9. T. E. Gills | 19. H. L. Rook |
| 10. J. W. Gramlich | |

Cooperating Analysts

20. Chemistry Division, Standards and Reference Substances Secretariat, Commission of European Communities, Joint Research Center, Ispra Establishment, Italy.
- | | | |
|----------------|-------------|--------------|
| G. Serrini | E. Orthmann | F. Colombo |
| G. Renaux | R. Pietra | F. Girardi |
| W. Leyendecker | G. Guzzi | N. Toussaint |
21. Y. Nemoto, K. Okamoto, and K. Fuwa, Division of Chemistry and Physics, National Institute for Environmental Studies, Yatabe, Ibaraki, Japan.
22. L. Kosta, Institute "Josef Stefan," Ljubljana, Yugoslavia.
23. J. B. Jones, Jr. and R. Isaac, University of Georgia, Athens, Georgia.

U.S. Department of Commerce
Elliot L. Richardson,
Secretary
National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 1575

Pine Needles

This Standard Reference Material is intended primarily for calibrating instrumentation and evaluating the reliability of analytical methods for the determination of major, minor, and trace elements in botanical materials and other agricultural products.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. They are based on results obtained either by reference methods of known accuracy or by two or more independent, reliable analytical methods. Non-certified values, which are given for information only, appear in Table 2. All values are based on a minimum sample size of 500 mg of the material dried as indicated under "Instructions for Drying."

Notice and Warnings to Users:

Expiration of Certification: This certification will be invalid 5 years after the shipping date. Should it be invalidated before then, purchasers will be notified by NBS.

Stability: The material should be kept in its original bottle and stored at temperatures between 10-30 °C. It should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight. Ideally, the bottle should be kept in a desiccator in the dark at the temperature indicated.

Use: The bottle should be shaken well before each use. A minimum sample of 500 mg of the *dried* material (see Instructions for Drying) should be used for any analytical determination to be related to the certified values of this certificate.

The overall direction and coordination of the technical measurements leading to this certificate were performed under the chairmanship of H. L. Rook. The overall coordination of the cooperative work performed by the Commission of European Communities, Joint Research Center, Ispra Establishment, Italy, was by G. Rossi of the Chemistry Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by T. W. Mears and R. Alvarez.

Washington, D.C. 20234
October 18, 1976

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements^a

Major and Minor Constituents

<u>Element</u>	<u>Content Wt. Percent</u>
Calcium	0.41 ± 0.02
Potassium	0.37 ± 0.02
Phosphorus	0.12 ± 0.02

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Manganese	675 ± 15	Copper	3.0 ± 0.3
Aluminum	545 ± 30	Chromium	2.6 ± 0.2
Iron	200 ± 10	Arsenic	0.21 ± 0.04
Rubidium	11.7 ± 0.1	Mercury	0.15 ± 0.05
Lead	10.8 ± 0.5	Thorium	0.037 ± 0.003
Strontium	4.8 ± 0.2	Uranium	0.020 ± 0.004

^aAnalytical values are based on the "dry-weight" of material (See Instructions for Drying).

The uncertainties of the values of the constituents shown in Table 1 include allowances for material inhomogeneity, method imprecision, and an estimate of possible biases of the analytical methods used.

Table 2. Non-certified Values for Constituent Elements^a

NOTE: The following values are not certified because they are not based on the results of either a reference method of known accuracy or two or more independent methods. These values are included for information only.

Major Constituent

<u>Element</u>	<u>Content Wt. Percent</u>
Nitrogen	(1.2)

Trace Constituents

<u>Element</u>	<u>Content µg/g</u>	<u>Element</u>	<u>Content µg/g</u>
Bromine	(9)	Lanthanum	(0.2)
Nickel	(3.5)	Cobalt	(0.1)
Cerium	(0.4)	Thallium	(0.05)
Cadmium ^b	(<0.5)	Scandium	(0.03)
Antimony	(0.2)	Europium	(0.006)

^aAnalytical values are based on the "dry-weight" of material (See Instructions for Drying).

^bCadmium was not sufficiently homogeneous for certification.

Instructions for Drying: Samples of this Standard Reference Material *must* be dried before weighing by either of the following procedures:

1. Drying in air in an oven at 85 °C for 2 hours.
2. Lyophilization using a cold trap at or below -50 °C at a pressure *not greater* than 30 Pa (0.2 mm Hg) for 24 hours.

NOTE: Drying either in an oven at 105 °C or in a vacuum oven at 75°C causes large losses of volatiles other than water and should *not* be used.

Additional Information on Analyses: This Standard Reference Material contains siliceous material, which is an integral part of the sample. The analyses reported in Tables 1 and 2 were performed on the entire sample. Therefore, dissolution procedures should be capable of complete dissolution of the sample but should not result in losses of volatile elements, such as arsenic and mercury.

Source and Preparation of Material: The plant material for this SRM was collected and prepared under the direction of A. L. Kenworthy of Michigan State University, East Lansing, Mich. Its source was Manistee State Park, approximately 65 km north of Muskegon, Mich. For the preparation of the SRM, the material was air-dried, and ground in a comminuting machine. After grinding the material, it was dried at 85 °C, thoroughly mixed in a feed blender, packaged in polyethylene-lined fiber drums, and sterilized in situ with cobalt-60 radiation. The sterilization procedure was carried out at the U.S. Army Research and Development Command, Natick, Mass. under the direction of A. Brynjolfsson. At NBS, preliminary evaluation of the material homogeneity indicated that its improvement would be required to establish more reliable certified values. Therefore, the material was resieved and the portion that passed a polypropylene sieve having openings of 0.25 mm (equivalent to a U.S. series 60 standard sieve) was retained for the SRM.

Homogeneity Assessment: Material homogeneity was evaluated by determining ten of the certified elements, P, Al, Fe, Mn, Rb, Cu, Cr, As, Hg, and U on samples of 500 mg or less taken at various locations of the freeze-dried bulk material. The other certified elements, K, Ca, Sr, Pb, and Th were determined using sample weights not exceeding one gram. The uncertainties for the concentrations given in Table 1 include these results.

Analytical Methods Used and Analysts

Analytical Methods

- A. Atomic absorption spectroscopy
- B. Isotope dilution mass spectrometry
- C. Isotope dilution spark source mass spectrometry
- D. Kjeldahl method for nitrogen
- E. Neutron activation
- F. Nuclear track technique
- G. Optical emission spectroscopy
- H. Spectrophotometry
- I. Polarography

(over)

Analysts

Analytical Chemistry Division, National Bureau of Standards

- | | |
|-----------------------|---------------------|
| 1. R. W. Burke | 11. S. H. Harrison |
| 2. B. S. Carpenter | 12. R. M. Lindstrom |
| 3. E. R. Deardorff | 13. L. A. Machlan |
| 4. B. I. Diamondstone | 14. E. J. Maienthal |
| 5. L. J. Dunstan | 15. L. T. McClendon |
| 6. M. S. Epstein | 16. L. J. Moore |
| 7. R. H. Filby | 17. T. J. Murphy |
| 8. E. L. Garner | 18. P. J. Paulsen |
| 9. T. E. Gills | 19. H. L. Rook |
| 10. J. W. Gramlich | |

Cooperating Analysts

20. Chemistry Division, Standards and Reference Substances Secretariat, Commission of European Communities, Joint Research Center, Ispra Establishment, Italy.
- | | |
|------------|--------------|
| G. Guzzi | R. Pietra |
| A. Colombo | N. Toussaint |
| F. Girardi | |
21. Y. Nemoto, K. Okamoto, and K. Fuwa, Division of Chemistry and Physics, National Institute for Environmental Studies, Yatabe, Ibaraki, Japan.
22. R. Schelenz, Federal Research Center for Nutrition, Karlsruhe, West Germany.
23. L. Kosta, Institute "Josef Stefan," Ljubljana, Yugoslavia.
24. J. B. Jones, Jr. and R. Isaac, University of Georgia, Athens, Georgia.

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1577a

Bovine Liver

This Standard Reference Material (SRM) is intended primarily for use in calibrating instrumentation and evaluating the reliability of analytical methods for the determination of major, minor, and trace elements in animal tissue and other biological matrices.

Certified Values of Constituent Elements: The certified values for the constituent elements are shown in Table 1. Certified values are based on results obtained by definitive methods of known accuracy; or alternatively, from results obtained by two or more independent analytical methods. Noncertified values are given for information only in Table 2.

Notice and Warnings to Users:

Expiration of Certification: This certification is invalid after 5 years from the date of shipping. Should it become invalid before then, purchasers will be notified by NBS.

Stability: The material should be kept in its original bottle and stored at temperatures between 10-30°C. It should not be exposed to intense sources of radiation. The bottle should be kept tightly closed and stored in a desiccator in the dark.

Use: A minimum sample of 250 mg of the dried material (see Instructions for Drying) should be used for any analytical determination to be related to the certified values of this Certificate.

Dissolution procedures should be designed to effect complete solution, but without losses of volatile elements, such as mercury. Dissolution for these determinations should be carried out in a closed system.

Statistical consultation was provided by K.R. Eberhardt and T.R. Crichton of the Statistical Engineering Division.

The overall direction and coordination of the analyses leading to this certification were under the chairmanship of E.L. Garner, Chief of the Inorganic Analytical Research Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Alvarez.

Gaithersburg, MD 20899
February 1, 1985
(Revision of Certificates
dated 3-5-82, 6-15-82)

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

Table 1. Certified Values of Constituent Elements

<u>Element</u>	<u>Content,^a (Wt. Percent)</u>
Chlorine	0.28 ± 0.01
Phosphorus	1.11 ± 0.04
Potassium*	0.996 ± 0.007
Sodium	0.243 ± 0.013
Sulfur	0.78 ± 0.01

<u>Element</u>	<u>Content,^a (μg/g)</u>	<u>Element</u>	<u>Content,^a (μg/g)</u>
Arsenic	0.047 ± 0.006	Mercury	0.004 ± 0.002
Cadmium	0.44 ± 0.06	Molybdenum	3.5 ± 0.5
Calcium	120 ± 7	Rubidium*	12.5 ± 0.1
Cobalt	0.21 ± 0.05	Selenium	0.71 ± 0.07
Copper	158 ± 7	Silver	0.04 ± 0.01
Iron	194 ± 20	Strontium*	0.138 ± 0.003
Lead*	0.135 ± 0.015	Uranium*	0.00071 ± 0.00003
Magnesium	600 ± 15	Vanadium*	0.099 ± 0.008
Manganese	9.9 ± 0.8	Zinc	123 ± 8

^aDry weight: For drying instructions, see the section of this Certificate on Instructions for Drying.

The estimated uncertainties are based on judgment and represent an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability for samples weighing 250 mg or more.

*For those elements determined by definitive methods, the uncertainties are given as 95%/95% statistical tolerance limits. See "The Role of Standard Reference Materials in Measurement Systems," NBS Monograph 148, 1975 p 14.

Table 2. Noncertified Values of Constituent Elements

<u>Element</u>	<u>Content,^a (Wt. Percent)</u>
Nitrogen	(10.7)

<u>Element</u>	<u>Content,^a μg/g</u>
Aluminum	(2)
Antimony	(0.003)
Bromine	(9)
Thallium	(0.003)

^aDry weight: For drying instructions, see the section of this Certificate on Instructions for Drying.

Instructions for Drying: Samples of this SRM must be dried before weighing according to the following procedure: Dry for 24 hours at 20 to 25 °C in a vacuum oven at a pressure not greater than 30 Pa (0.2 mm Hg).

Source and Preparation of Material:

The liver for this standard was obtained in the Portland, Oregon, area. The gross fat, major blood vessels, and "skin" were removed and the liver was ground. The ground liver was then mixed, transferred to polyethylene-lined trays, and lyophilized by Oregon Freeze Dry Foods, Inc., Albany, Oregon. After lyophilization, the liver was powdered in a Tornado mill, packaged in moisture-proof bags, and then transported to the National Bureau of Standards.

Analysts and Analytical Methods Used

Analytical Methods:

- A. Atomic absorption spectrometry
- B. Atomic emission spectrometry, flame
- C. Atomic emission spectrometry, inductively coupled plasma
- D. Ion chromatography
- E. Isotope dilution thermal source mass spectrometry
- F. Isotope dilution spark source mass spectrometry
- G. Kjeldahl method for nitrogen
- H. Neutron activation
- I. Polarography
- J. Spectrophotometry

Analysts:

Analytical Chemistry Division, National Bureau of Standards:

- | | |
|--------------------|-----------------------|
| 1. J.V. Bailey | 15. W.R. Kelly |
| 2. I.L. Barnes | 16. H.M. Kingston |
| 3. E.S. Beary | 17. W.F. Koch |
| 4. C.G. Blundell | 18. G.M. Lambert |
| 5. K.A. Brietic | 19. R.M. Lindstrom |
| 6. T.A. Butler | 20. G.J. Lutz |
| 7. E.R. Deardorff | 21. L.A. Machlan |
| 8. M.S. Epstein | 22. E.J. Maienthal |
| 9. J.D. Fassett | 23. T.J. Murphy |
| 10. J.W. Gramlich | 24. P.J. Paulsen |
| 11. R.R. Greenberg | 25. L.J. Powell |
| 12. S. Hanamura | 26. T.C. Rains |
| 13. S.H. Harrison | 27. T.A. Rush |
| 14. E.F. Heald | 28. R.L. Watters, Jr. |
| | 29. R. Zeisler |

Cooperating Analysts:

30. M. Gallorini and E. Orvini, Consiglio Nazionale delle Ricerche, Centro di Radiochimica e Analisi per Attivazione presso l' Istituto di Chimica Generale dell'Universita, Pavia, Italy.
31. L. Kosta, A.R. Byrne, M. Dermelj, Institute "Josef Stefan", Ljubljana, Yugoslavia.