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U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards

Standard Reference Materials:

Summary of the Coal, Ore, Mineral, Rock, and Refractory Standards Issued by the National Bureau of Standards

Radu Mavrodineanu and Thomas E. Gills

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Summary of the Coal, Ore, Mineral, Rock, and Refractory Standards Issued by the National Bureau of Standards

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Preface

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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 measurment 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 concered with the availability, delivery, price, and so forth, will receive prompt attention from:

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* 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.

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Abstract

This publication is a summary of the coal, ore, mineral, rock, and refractory standards issued by NBS as Standard Reference Materials (SRM's). The material, composition, certification, use, and remarks concerning each of the SRM's described are presented in tabular form. Copies of the certificates of these SRM's are contained in the appendix for more detailed information.

Key Words: Chemical composition; coals; ores; refractories; rocks; Standard Reference Materials.

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 Edition[1]. 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.

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[1]For 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)

- Plain carbon
- Low alloy
- High alloy
- Stainless
- Tool

Steels (granular form)

Steels (solid form)

- Ingot iron and low alloy
- Special ingot irons and low alloy
- Stainless
- Specialty
- High-temperature alloys
- Tool

Steelmaking Alloys

Cast Irons (chip form)

Cast Steels, White Cast Irons, Ductile Irons, and Blast Furnace Irons (solid form)

Nonferrous Alloys (chip form)

- Aluminum "Benchmarks"
- Cobalt
- Copper
- Copper "Benchmarks"
- Lead
- Magnesium
- Nickel
- Nickel Superalloy, Trace Elements
- Nickel oxide
- Selenium
- Tin
- Titanium
- Zinc
- Zirconium

Nonferrous Alloys (solid form)

- Aluminum "Benchmarks"
- Copper
- Copper "Benchmarks"
- Lead
- Nickel
- Titanium
- Zinc
- Zirconium

Gases in Metals

High-Purity Metals

Electron Probe Microanalytical Standards

Primary, Working, and Secondary Standard Chemicals

Microchemical Standards

Clinical Laboratory Standards

Biological Standards

Environmental Standards

- Analyzed gases
- Analyzed liquids and solids
- Permeation tubes

Industrial Hygiene Standards

Forensic Standards

Hydrocarbon Blends

Metallo-Organic Compounds

Fertilizers

Ores

Minerals, Refractories, Glasses, and Carbides

Cement

Trace Element Standards

Nuclear Materials

- Special nuclear materials
  - Plutonium assay
  - Plutonium isotopic
  - Uranium assay
  - Uranium isotopic
- Neutron density standards
- Fission track glass standards

Isotopic Reference Standards

Table 1. continued.

CERTIFIED PHYSICAL PROPERTY STANDARDS

Ion Activity Standards

- pH standards
- pD standards
- Ion selective electrodes

Mechanical and Metrology Standards

- Magnification
- Coating thickness
- Glass
- Elasticity
- Density
- Polymer
- Rheology

Heat Standards

- Superconductive thermometric fixed point devices
- Freezing Points
  - Defining fixed points
  - Determined reference points
- Melting points
- Calorimetric
  - Combustion
  - Solution
  - Heat source
  - Enthalpy and heat capacity
- Vapor pressure
- Thermal expansion
- Thermocouple materials
- Thermal resistance

Magnetic Standards

- Magnetic susceptibility
- Magnetic moment
- Paramagnetic resonance

Optical Standards

- Spectrophotometric
- Thermal emittance
- Refractive index

Radioactivity Standards

- 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

Metallurgical

Mössbauer

X-ray Diffraction

Gas Transmission

Permittivity

Reference Fuels

Resistivity

ENGINEERING TYPE STANDARDS

Standard Rubber and Rubber-Compounding Materials

Reference Magnetic Tapes

Centerline Drawings, OCR-B

Sizing Standards

- Glass spheres for particle size
- Turbidimetric and fineness (cement)

X-ray and Photographic Standards

Surface Flammability Standards

Smoke Density Chamber Standards

Water Vapor Permeance

Tape Adhesion Testing Standards

Color Standards

RESEARCH MATERIALS

SPECIAL REFERENCE MATERIALS

The accurate determination of major and minor constituents in coals, ores, minerals, rocks, and refractories is important to our nation's scientific and industrial community as well as to commerce and trade. In many industries, traceability of quality control to the national measurement system is achieved through the use of Standard Reference Materials (SRM's). This publication is an attempt to describe, in general terms, the composition, certification, and use of such SRM's.

Essential information concerning the material composition, the certification parameters, and use is given in Table 2. Under "Remarks," additional data are provided.[1] All the data and information contained in this table were extracted from the Certificates or Certificates of Analysis issued for the included SRM's. An examination of the 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 any references cited in each certificate. The composition of the same SRM's, excepting the coals, by chemical elements are listed in Table 3. In the tables, similar types of SRM's are grouped together to facilitate comparisons of their properties. The Certificates in Appendix II, however, are arranged in numerical order. The SRM's listed in the tables include all of the coal, ore, mineral, rock, and refractory standards that were in stock as of January 1, 1984. These SRM's are the result of the concerted efforts of a number of scientists from the NBS National Measurement Laboratory, Center for Analytical Chemistry, and from industry. Each Certificate lists the individuals and laboratories who contributed to the preparation and certification of the SRM.

In addition to the SRM's and their Certificates, NBS issues a series of Special Publications (SP), call 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 at the beginning of this publication.[2]

Table 4 lists several NBS SP 260 publications directly related to the SRM's described in this work. They should be of value to the user of these particular materials. Also, NBS SP 260-54 contains in its appendices three reprints on: "Standard Quartz Cuvettes for High-Accuracy Spectrophotometry" (Appendix III); "Testing of Glass Volumetric Apparatus, 1959" (Appendix V); and "The Calibration of Small Volumetric Laboratory Glassware, 1974" (Appendix VI). The last two publications have been out of print for several years.

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 used in analytical chemistry. 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 Measurments (150 pp., 1977). NBS Monograph 100, Trace Characterization, Chemical and Physical (580 pp., 1967); SP 422, Accuracy in Trace Analysis, Sampling, Sample Handling, Analysis, Vol. 1 and 2 (1304 pp., 1976); and SP 464, Proceedings of the Eighth Materials Research Symposium, Methods and Standards for Environmental Measurements (691 pp., 1977), provide further information on methodology for the analysis of a variety of materials and the determination of numerous constituents. They all should be of particular interest to the analytical chemist.

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[1] NOTE: 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. Table 3 was taken from an article by S. D. Rasberry published in Amer. Lab., 15 (5), 96 (1983).

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

Table 2. Summary of Coal, Ore, Mineral, Rock, and Refractory Standards

A. Coals

SRM	Material	Composition
1632b Trace Elements in Coal (Bituminous)	Obtained from Humphrey No. 7 mine and coal preparation plant of the Consolidation Coal Co., Christopher Coal Co. Div., Osage, W.V. The coal was reduced in size to -60 mesh and sieved prior to blending. The coal was then blended in a stainless steel coal blender.	Material should be vacuum dried at ambient temperature for 24 hours prior to use. Values based on a minimum sample size of 250 mg. C (total) 78.11; H 5.07; N 1.56; S 1.89; Volatile matter 35.4; Al 0.855; Ca .204; Fe .759; Mg .0383; K .0748; Na .0515; Ti .0454; values % by wt. As 3.72; Ba 67.5; Cd 0.0573; Co 2.29; Cu 6.28; Pb 3.67; Mn 12.4; Ni 6.10; Rb 5.05; Se 1.29; Th 1.342; U 0.436; Zn 11.89; values µg/g. Not certified: 17 additional constituents (see certificate).
1633a Trace Elements in Coal Fly Ash	Supplied by a coal fired power plant and is a product of Pennsylvania and West Virginia coals. Material was sieved through a #170 sieve and blended in a Vee blender.	Material should be dried to a constant weight before use. Values based on a 250-mg or more sample size. Ca 1.11; Fe 9.40; K 1.88; Mg 0.455; Na 0.17; Si 22.8, values % by wt. As 145; Cd 1.0; Cr 196; Cu 118; Hg 0.16; Ni 127; Pb 72.4; Rb 131; Se 10.3; Sr 830; Th 24.7; Tl 5.7; U 10.2; Zn 220, values µg/g. Not certified: 15 additional constituents (see certificate)
1635 Trace Elements in Coal (Sub-bituminous)	Provided by the Eagle Mine of the Imperial Coal Company, Erie, Colorado. Ground and sieved through a 230 m sieve by the Colorado School of Mines Research Institute.	Material should be dried without heat to constant weight before use. Values based on 250-mg or more sample size. As 0.42; Cd 0.03; Cr 2.5; Cu 3.6; Pb 1.9; Mg 21.4; Ni 1.74; Se 0.9; Th 0.62; U 0.24; V 5.2; Zn 4.7, values µg/g. Fe 0.239; S 0.33, values % by wt. Not certified 10 additional constitutents (see certificate).
2682 Sulfur in Coal (Sub-bituminous)	Obtained from Bell Ayr Mine, Gillette, Wyoming The coal was reduced in size to -60 mesh and screened prior to blending. The -60 mesh coal was then blended in a stainless steel cone blender.	Sample vacuum dried at ambient temperature for 24 hours or oven drying for 24 hours at 105 °C. Values based on 250-mg or more sample size. Sulfur (wt. %) 0.47; Furnace Ash (wt. %) 6.37; Calorific Content 27.45 $MJ.Kg^{-1}$. Not certified: 32 inorganic constituents (see certificate).

*National Bureau of Standards, Center for Analytical Chemistry.
°American Society for Testing and Materials.

Certification	Use	Remarks
Analyses performed in the NBS CAC.* Estimated uncertainty 0.0008 TO 2.1 depending on constituent.	For the calibration of apparatus and the evaluation of techniques employed in the analysis of coal or similar materials.	Should be kept in its original bottle. Should not be exposed to intense sources of radiation, including ultraviolet lamps or sunlight.
Analyses performed in the NBS CAC. Estimated uncertainty 0.010 to 30 depending on constituent.	For the calibration of apparatus and methods used in analyses of coal fly ash and other materials with similar matrices for trace elements.	Should be kept in a tightly sealed bottle.
Analyses performed in the NBS CAC. Estimated uncertainty 0.15 to 1.5 depending on constituent.	Same as SRM 1632a.	Same as SRM 1632a.
Analyses performed in the Inorganic Analytical Research Division and Chemical Thermodynaics Division of NBS. Calorific values were determined by procedures recommended in standard ASTM° methods.	For the determination of sulfur in coal.	The Sulfur in Coal SRM's are sold individually rather than in sets; however, only one Certificate of Analysis is provided. Therefore, the user must be careful to use the data specific to the SRM being used. Material should be stored in a tightly sealed bottle away from sunlight and intense sources of radiation.

Table 2. A. Coals - continued.

SRM	Material	Composition
2683 Sulfur in Coal (Bituminous)	Obtained from Humphrey Mine, Osage, West Virginia. Processing same as SRM 2682.	Same as SRM 2682 except: Sulfur (wt. %) 1.85; Furnace Ash (wt. %) 6.85; Calorific Content 32.70 $MJ.Kg^{-1}$.
2684 Sulfur in Coal (Bituminous)	Obtained from Delta Mine, Marion, Illinois. Processing same as SRM 2682.	Same as SRM 2682 except: Sulfur (wt. %) 3.00; Furnace Ash (wt. %) 11.09; Calorific Content 29.68 $MJ.Kg^{-1}$.
2685 Sulfur in Coal (Bituminous)	Obtained from McElroy Mine, Captina, West Virgnia. Processing same as SRM 2682.	Same as SRM 2682 except: Sulfur (wt. %) 4.62; Furnace Ash (wt. %) 16.53; Calorific Content 28.15 $MJ.Kg^{-1}$.

B. Rocks, Minerals, and Refractories

1c Argillaceous Limestone	Provided by Lone Star Ind., Inc., Cement and Construction Materials Group, Houston, Texas.	Limestone, ground, sieved, blended. Analyses performed on 0.5-g or more sample. Dried 2 hours at 110 °C. SiO_2 6.84; Fe_2O_3 0.55; Al_2O_3 1.30; TiO_2 0.07; P_2O_5 0.04; MnO 0.025; CaO 50.3; SrO 0.030; MgO 0.42; Na_2O 0.02; K_2O 0.28; loss on ignition 39.9; all values % by wt.
70a Feldspar	Feldspar, sample dried 2 hours at 105 °C.	SiO_2 67.1; Al_2O_3 17.9; Fe_2O_3 0.07; TiO_2 0.01; CaO 0.11; BaO 0.02; Na_2O 2.5; K_2O 11.8; Rb_2O 0.06; loss on ignition 0.40; all values % by wt.
76a Burnt Refractory	Provided by Harbison-Walker Refractories Co., Garber Research Center, Pittsburgh, Pennsylvania. Dobies were air dried at 120 °C, then fired at 1427 °C for 10 hours. The ground material was converted to a fine powder (95%, 325 mesh) and was thoroughly mixed.	SiO_2 54.9; Al_2O_3 38.7; Fe_2O_3 1.6; TiO_2 2.0; ZrO_2 0.15; MgO 0.52; CaO 0.22; K_2O 1.33; Na_2O 0.07; P_2O_5 0.12; Li_2O 0.042; SrO 0.037; loss on ignition 0.34; all values % by wt.
77a Burnt Refractory	Same as SRM 76a.	SiO_2 35.0; Al_2O_3 60.2; Fe_2O_3 1.0; TiO_2 2.6; ZrO_2 0.21; MgO 0.38; CaO 0.05; K_2O 0.09; Na_2O 0.037; P_2O_5 0.092; Li_2O 0.02; SrO 0.009; loss on ignition 0.22; all values % by wt.

Certification	Use	Remarks
Same as SRM 2682.	Same as SRM 2682.	Same as SRM 2682.
Same as SRM 2682.	Same as SRM 2682.	Same as SRM 2682.
Same as SRM 2682.	Same as SRM 2682.	Same as SRM 2682.
Chemical analysis performed by eight cooperating laboratories including NBS-CAC. The estimated uncertainty: 0.005 to 0.3 depending on constituent.	For calibration and standardization of analytical methods and instrumentation.	Issued in cooperation with ASTM.
		Revision of Certificate dated 3-26-65.
Chemical analyses performed by three cooperating laboratories including NBS-CAC. The values are not expected to deviate from the accurate value by more than ± 1 in the last significant figure reported.	For verifying the chemical and instrumental methods of analysis.	The loss on ignition is not a certified value but is given for information only. Issued in cooperation with ASTM.
Same as SRM 76a.	Same as SRM 76a.	Same as SRM 76a.

Table 2. B. Rocks, Minerals, and Refractories - continued.

SRM	Material	Composition
78a Burnt Refractory	Same as SRM 76a.	SiO_2 19.4; Al_2O_3 71.7; Fe_2O_3 1.2; TiO_2 3.2; ZrO_2 0.31; MgO 0.70; CaO 0.11; K_2O 1.22; Na_2O 0.078; P_2O_5 1.3; Li_2O 0.12; SrO 0.25; loss on ignition 0.42; all vaues % by wt.
81a Glass Sand	Ground glass sand powder 95% less than 106 μm. Blended and dried at 105 °C for 2 hours before use.	Al_2O_3 0.66; Fe_2O_3 0.082; TiO_2 0.12; ZrO_2 0.034; all values % by wt. Cr_2O_3 46 μg/g.
88a Dolomitic Limestone	Limestone	Sample dried 2 hours at 110 °C. SiO_2 1.20; Al_2O_3 0.19; Fe_2O_3 0.28; TiO_2 0.02; MnO 0.03; CaO 30.1; SrO 0.01; MgO 21.3; Na_2O 0.01; K_2O 0.12; P_2O_5 0.01; CO_2 46.6; loss on ignition 46.7; all values expressed as percent.
97a Flint Clay	Provided by A. P. Green Fire Brick Co., Mexico, Missouri.	Sample dried 2 hours at 140 °C. SiO_2 43.67; Al_2O_3 38.79; Fe_2O_3 0.45; TiO_2 1.90; P_2O_5 0.36; K_2O 0.50; Na_2O 0.037; Li_2O 0.11; BaO 0.07; MgO 0.15; CaO 0.11; SrO 0.18; Cr_2O_3 0.03; loss on ignition 13.32; all values are % by wt.
98a Plastic Clay	Same as SRM 97a.	Sample dried for 2 hours at 140 °C. SiO_2 48.94; Al_2O_3 33.19; Fe_2O_3 1.34; TiO_2 1.61; P_2O_5 0.11; K_2O 1.04; Na_2O 0.082; Li_2O 0.070; BaO 0.03; MgO 0.42; CaO 0.31; SrO 0.039; Cr_2O_3 0.03; loss on ignition 12.44; all values % by wt.
99a Feldspar		Sample dried at 105 °C for 2 hours. SiO_2 65.2; Al_2O_3 20.5; Fe_2O_3 0.06; TiO_2 0.007; CaO 2.14; BaO 0.26; MgO 0.02; Na_2O 6.2; K_2O 5.2; P_2O_5 0.02; loss on ignition 0.26; all values are % by wt.

Certification	Use	Remarks
Same as SRM 76a.	Same as SRM 76a.	Same as SRM 76a.
Chemical analyses performed by eight cooperating laboratories including NBS-CAC.	Same as SRM 76a.	The recommended data is the best estimate of the true value based on data from the cooperators and NBS. Issued in cooperation with ASTM.
		Revision of Certificate dated 1-31-67.
Chemical analyses performed by three cooperating laboratories including NBS-CAC.	Same as SRM 76a.	ZrO_2 was determined by only one of the cooperating laboratories and found to be 0.063 % by wt.
Chemical analyses performed by three laboratories including NBS-CAC.	Same as SRM 76a.	ZrO_2 was determined by only one of the cooperating laboratories and found to be 0.042 % by wt.
		Revision of Certificate dated 3-26-65.

Table 2. B. Rocks, Minerals, and Refractories - continued.

SRM	Material	Composition
103a Chrome Refractory		Sample dried at 110 °C for 2 hours. Cr_2O_3 32.06; Al_2O_3 29.96; FeO 12.43; MnO 0.11; MgO 18.54; CaO 0.69; SiO_2 4.63; TiO_2 0.22; ZrO_2 0.01; P_2O_5 0.01; all values are % by wt.
154b Titanium Dioxide	Prepared by the National Lead Industries, Research and Development Dept., St. Louis, Missouri.	TiO_2 99.74% by wt. on samples dried 2 hours at 110 °C.
165a Glass Sand	Glass sand blended to insure homogeneity. Should be dried for 2 hours at 105 °C.	Al_2O_3 0.059; Fe_2O_3 0.012; TiO_2 0.011; ZrO_2 0.006; all values are % by wt.
198 Silica Brick		Al_2O_3 0.16; Fe_2O_3 0.66; TiO_2 0.02; P_2O_5 0.022; MnO 0.008; CaO 2.71; MgO 0.07; Na_2O 0.012; K_2O 0.017; Li_2O 0.001; loss on ignition 0.21; all values % by wt.
199 Silica Brick		Al_2O_3 0.48; Fe_2O_3 0.74; TiO_2 0.06; P_2O_5 0.015; MnO 0.007; CaO 2.41; MnO 0.13; Na_2O 0.015, K_2O 0.094; Li_2O 0.002; loss on ignition 0.17; all values % by wt.
278 Obsidian Rock	Natural glass obtained from Clear lake, Newberry Crater, Oregon, and processed by the Colorado School of Mines, Golden, Colorado, to a powder of <200 mesh.	The material should be dried to constant weight at 350–600 °C. Al_2O_3 14.15; CaO 0.983; FeO 1.36; Fe_2O_3 2.04; K_2O 4.16; MnO 0.052; Na_2O 4.84; P_2O_5 0.036; SiO_2 73.05; TiO_2 0.245; all data wt %. Cu 5.9; Ni 3.6; Rb 127.5; Sr 63.5; Th 12.4; Tl 0.54; U 4.58; Pb 16.4; data wt (μg/g).

Certification	Use	Remarks
Chemical analyses performed by eight cooperating laboratories including NBS-CAC.	Certified primarily for use in the analysis of ores and geological materials containing chromium.	For additional information on methods used for analysis and certification of constituent elements see certificate.
Analyses performed by three cooperating laboratories including NBS-CAC. TiO_2 was determined by controlled-potential coulometry and by volumetry. The uncertainty is 0.05 and represented the 95% confidence interval of the mean of all accepted values.	Certified primarily for application in the paint and ceramic industries.	For additional information on the material and its composition see Certificate.
Chemical analyses performed by eight cooperating laboratories including NBS-CAC.		The certified data is the best estimate of the true value based on the measurements from the cooperators and NBS. SRM 165a was issued in cooperation with ASTM.
Chemical analyses performed by twelve cooperating laboratories including NBS-CAC. All results are based on samples dried at 105-110 °C.		One cooperating laboratory has reported a content of less than 0.01 ZrO_2 % by wt.
Same as SRM 198.		One cooperating laboratory has reported a content of 0.01 0.01 ZrO_2 % by wt.
Chemical analyses performed by four cooperating laboratories including NBS-CAC. Uncertainty of measurements varies from ±0.3 to 0.002 depending on element.	For evaluation of the accuracy of analytical methods and instrumentation used in the analysis of geological type materials.	Additional 21 constituents given but not certified (see certificate).

Table 2. B. Rocks, Minerals, and Refractories - continued.

SRM	Material	Composition
688 Basalt Rock	Obtained from a Cenozoic basalt flow near Jackpot, Nevada, and processed by the Colorado School of Mines, Golden, Colorado.	Sample dried at 105 °C for 24 hours. Al_2O_3 17.36; FeO 7.64; Fe_2O_3 10.35, K_2O 0.187; MnO 0.167; Na_2O 2.15, P_2O_5 0.134; SiO_2 48.4; TiO_2 1.17, all % by wt. Cr 332; Rb 1.91; Sr 169.2 Th 0.33; Pb 3.3, all µg/g.
C. Ores		
27f Iron Ore (Sibley)	The iron ore was provided by the U.S. Steel Corp., Pittsburgh, Pennsylvania. The ore was crushed, dry ground, and sieved at the Colorado School of Mine Research Institute, Golden, Colorado, to pass a 150 mesh sieve with about 50% passing a 200 mesh sieve. Analytical samples were dried 1 hour at 105 °C.	Total Fe 65.97; SiO_2 4.17; Al_2O_3 0.82; P 0.041; S 0.005; TiO_2 0.019; MnO 0.011; CaO 0.039; MgO 0.019; Na_2O 0.012; K_2O 0.008; all values % by wt.
69b Bauxite (Arkansas)	Provided by the Aluminum Company of America, Bauxite, Arkansas. The material was processed at the Colorado School of Mine Research Institute. Mineralogical composition: 30% kaolinite, 60% gibbsite, 10% siderite (semiquantitative).	The bauxite powder (<0.08 mm) was dried at 140 °C for 2 hours. Analytical sample of 1-g or more. Al_2O_3 48.8; Fe_2O_3 7.14; SiO_2 13.43; TiO_2 1.90; ZrO_2 0.29; P_2O_5 0.118; V_2O_5 0.028; Cr_2O_3 0.011; CaO 0.13; MgO 0.085; MnO 0.110; ZnO 0.0035; K_2O 0.068; SO_3 0.63; loss of ignition 27.2 at 1050 °C; all values % by wt. Estimated uncertainty 0.0005 to 0.2 depending on element.
79a Fluorspar	Provided by American Smelting and Refining Co., El Paso, Texas, and ground to pass an 80 mesh screen.	CaF_2 97.39 $\pm$ 0.06 % by wt.

Certification	Use	Remarks
Analyses performed by three cooperating laboratories including NBS-CAC. Uncertainties for % by wt. constituents: from 0.1 to 0.002; for µg/g constituents: 9 to 0.01.	For verifying the accuracy of chemical and instrumental methods of analysis used in the analysis of geological type materials.	
Chemical analyses performed by seven cooperating laboratories including NBS-CAC using the methods described in Part 12, Chemical Analysis of Metals and Metal Bearing Ores, Annual Book of ASTM Standards.	For use in verifying chemical methods of analysis and in calibrating instrumental methods of analysis.	Issued in cooperation with ASTM.
Chemical analyses performed by eleven cooperating laboratories including NBS-CAC.	For verification of chemicals and instrumental methods of analysis.	Additional composition (not certified): BaO (0.008); Na_2O (0.025); Ce (0.024); Co (0.0001); Hf (0.0063); Sc (0.0008). Issued in cooperation with ASTM.
Chemical analyses performed in cooperation with the U.S. Customs Laboratories, Division of Technical Services, following a standard procedure described in detail in the Certificate.	To assay imported fluorspar for industrial applications.	Additional percent composition (not certified): Fe (0.05-0.1) Al and Sr (0.01-0.1); Mg (0.01-0.05); Na (0.001-0.01); Ba (0.001-0.005); K (<0.005); Cu, Li, Mn, Pb, and Ti (<0.001); SiO_2 (0.67); all are % values. Revision of Certificate dated 12-6-71.

Table 2. C. Ores - continued.

SRM	Material	Composition
113a Zinc Concentrate	Provided by Cominco American Inc., Spokane, Washington, and prepared at the Magmont Mines, Bixby, Missouri, in the form of powder (<0.15 mm).	Sample dried 1 hour at 105 °C. Zn 57.3; Co (0.11); Ni (0.07); S 30.6; Cd 0.78; Cu 0.31; Pb 2.80; Fe 2.08; CaO 1.1; MgO 0.75; SiO_2 (1.54); Ag 0.046, all values are % by wt.
120b Phosphate Rock (Florida)	Provided by American Cyanamid Co. as a powder to pass 200 mesh sieve.	Sample dried 1 hour at 105 °C. P_2O_5 34.57; CaO 49.40; SiO_2 4.68; F 3.84; Fe_2O_3 1.10; Al_2O_3 1.06; MgO 0.28; Na_2O 0.35; MnO 0.032; K_2O 0.12-0.090; TiO_2 0.15; CO_2 2.79; CdO 0.002; all values are % by wt. Uranium 128.4 µg/g.
180 High-Grade Fluorspar	Provided by Minera Frisco of San Francisco Del Oro, Chih., Mexico.	CaF_2 98.80 ± 0.03 % by wt.
181, 182, 183 Lithium Ores	Fine powder of spodumene (SRM 181), petalite (SRM 182), and lepidolite (SRM 183).	Li_2O wt. % in SRM 181 - 6.3_9; SRM 182 - 4.3_4; and SRM 183 - 4.1_2.
277 Tungsten Concentrate	Provided by GTE Sylvania, Towanda, Pennsylvania, as a powder sieved (<0.15 mm) and blended. It is a mixture of concentrates from China, Thailand, and USA.	WO_3 - 67.4 wt. %, determined on 1-g or more sample.
329 Zinc Concentrate	Provided by Cominco American Inc., Spokane, Washington, and prepared at the Sullivan Mine, Trail, B.C., Canada, in the form of powder (<0.15 mm).	Sample dried 1 hour at 105 °C. Zn 45.5; Pb 6.06; Fe 12.94; CaO 0.08; MgO 0.16; Cd 0.14; Cu 0.13; Co (0.009); Ni (0.006); S (31.7); SiO_2 (0.61) In 0.019; Ag 0.0089; all values are % by wt.

Certification	Use	Remarks
Chemical analyses performed by four cooperating laboratories including NBS-CAC. The data are not expected to deviate from the true value by more than ±1 in the last significant figures reported.	Intended for the verification of chemical and instrumental methods of analysis.	Figures in parentheses are not certified. Should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.
Chemical analyses performed by six cooperating laboratories including NBS-CAC. Uranium was determined at NBS by thermal ionization mass spectrometry.	For the verification of chemical optical emission and x-ray spectrometric methods of analysis.	For potassium values see Certificate.
Additional trace elements detected but not certified: Fe 0.1-1.0; Al, Ba, Mg, Pb, Si, and Sr 0.01-0.1; Cu, K, Mn, Na, Ti, and V 0.001-0.01; Ag and Li less than 0.001; all values expressed in percent.	Issued primarily for geochemical use.	Detailed information on the method used for the determination of CaF_2 is given in the Certificate.
The deviation from given values is not expected to be more than ±5 subscript number.	For verifying the accuracy of assay methods.	Revision of Certificate dated 2-24-58.
Chemical analyses performed in cooperation with 13 laboratories including NBS-CAC. The estimated uncertainty 0.3 wt. %. Additional elements indicated but not certified are: Ca, Fe, Pb, Mn, Nb, P, Si, S, Sn, Ti, As, Mo, Bi, Ce, Cr, Cu, Gd, La, Nd, O, Sc, Ta, Th, U, Y, and Zr.	To verify the accuracy of chemical and instrumental methods of analysis.	Issued in cooperation with ASTM.
Chemical analyses performed by four cooperating laboratories including NBS-CAC. The data are not expected to deviate from the true value by more than ±1 in the last significant figure reported.	Intended for the verification of chemical and instrumental methods of analysis.	Figures in parentheses are not certified.

Table 2. C. Ores - continued.

SRM	Material	Composition
330 Copper Ore, Mill Heads	Provided by Magma Copper Co., San Manuel, Arizona. It was sieved and blended at NBS.	Sample dried at 105 °C for 2 hours. Cu 0.84; Mo 0.018; both values % by wt. Re 0.30 ppm by wt. Not certified: Au (0.093); Ag (1.51) ppm by wt.
331 Copper Ore, Mill Tails	Provided by Magma Copper Co., San Manuel, Arizona.	Cu 0.091; Mo 0.0022; both % by wt. Re 0.04 ppm by wt. on samples dried at 105 °C for 2 hours. Not certified: Au (0.034); Ag (0.243) ppm by wt.
332 Copper Concentrate	Provided by Magma Copper Co., San Manuel, Arizona.	Cu 28.4; Mo 0.64 % by wt. Re 10.2 ppm by wt. on samples dried at 105 °C for 2 hours. Not certified: Au (2.14); Ag (38.7) ppm by wt.
333 Molybdenum Concentrate	Provided by Magma Copper Co., San Manuel, Arizona. Homogeneity obtained by special blending and mixing procedures.	Cu 1.038; Mo 55.3; Re 0.087; all % by wt. on samples "as received." Not certified: Au (8.9); Ag (25.0) ppm by wt.
690 Iron Ore Concentrate (Canada)	Provided by the Iron Ore Company of Canada, Labrador City, Newfoundland, Canada, as a powder (<0.1 mm).	Fe 66.85; SiO_2 3.71; Al_2O_3 0.18; P 0.011; S 0.003; TiO_2 0.022; MnO 0.23; CaO 0.20; MgO 0.18; Na_2O 0.003; K_2O 0.0030, on samples dried at 105 °C for 1 hours. All values are % by wt.
691 Reduced Iron Oxide	Provided by Allis-Chalmers, Reduction Systems Div., Milwaukee, Wisconsin, and processed as a powder (-200 mesh) at the Colorado School of Mines Research Institute, Golden, Colorado.	Values based on 0.5-g or more sample size. Fe, total 90.8; Fe, metallic 84.6; SiO_2 3.7; Al_2O_3 1.22; TiO_2 0.27; CaO 0.63; MnO 0.043; MgO 0.52; Na_2O 0.186; Cu 0.032; Co 0.030 P 0.006; S 0.008; C 0.12; all values % by wt. Not certified 11 additional constituents (see certificate).
692 Iron Ore (Labrador)	Prepared by the Bethlehem Steel Corp., Bethlehem, Pennsylvania, as a fine powder (200 mesh).	Sample dried 1 hour at 105 °C, values based on 0.5-g or more sample. Fe 59.58; SiO_2 10.14; Al_2O_3 1.41; P 0.039; S 0.005; TiO_2 0.045; MnO 0.46; CaO 0.023; MgO 0.035; Na_2O 0.008; K_2O 0.039, all values % by wt.

Certification	Use	Remarks
Analyses performed by two cooperating laboratories including NBS-CAC. Estimated uncertainty 0.01 and 0.001 for Cu and Mo, and 0.06 for Re.	For verifying the accuracy of chemical and instrumental methods of analysis, and for evaluation of the material balance in copper mining and metallurgical industries.	Keep the material tightly closed in a desiccator over desiccant. Revision of Certificate of 2-20-73.
Estimated uncertainty 0.001 for Cu; 0.0002 for Mo; and 0.02 for Re.	Same as SRM 330.	Same as SRM 330.
Estimated uncertainty 0.1 for Cu; 0.01 for Mo; and 0.2 for Re.	Same as SRM 330.	Same as SRM 330, except revision of Certificate dated 2-20-73 and 1-20-77.
Analyses performed by two cooperating laboratories including NBS-CAC. Estimated uncertainty 0.010 for Cu; 0.1 for Mo; 0.001 for Re.	Same as SRM 330.	Same as SRM 330.
Analyses performed by six cooperating laboratories including NBS-CAC. Estimated uncertainty from 0.0005 to 0.01 depending on constituent.	For verifying the chemical and instrumental methods of analysis.	Issued in cooperation with ASTM.
Analyses performed by six cooperating laboratories including NBS-CAC. Estimated uncertainty 0.001 to 0.6 depending on constituent.	For the evaluation of chemical and spectroscopic methods of analysis.	Material packaged in dry nitrogen to prevent oxidation. Should be stored in desiccator over desiccant. Issued in cooperation with ASTM.
Analyses performed by six cooperating laboratories including NBS-CAC. Estimated uncertainty 0.001 to 0.06 depending on constituent.	For verifying the chemical and instrumental methods of analysis.	Issued in cooperation with ASTM.

Table 2. C. Ores - continued.

SRM	Material	Composition
693 Iron Ore (Nimba)	Prepared by the Bethlehem Steel Corp., Bethlehem, Pennsylvania, as a fine powder (200 mesh).	Sample dried 1 hour at 105 °C, values based on 0.5-g or more sample. Fe 65.11; SiO_2 3.87; Al_2O_3 1.02; P 0.056; S 0.005; TiO_2 0.035; MnO 0.091; CaO 0.016; MgO 0.013; Na_2O 0.0028; K_2O 0.0028; all values % by wt
696 Bauxite (Surinam)	Same as SRM 69b. The material was mined in Surina, South America. Mineralogical composition: 5% kaolinite, 80% gibbsite, 10% pyrite, 5% anatase (semiquantitative).	The bauxite powder (<0.08 mm) was dried at 140 °C for 2 hours. Analytical sample of 1-g or more. Al_2O_3 54.5; Fe_2O_3 8.70; SiO_2 3.79; TiO_2 2.64; ZrO_2 0.14; P_2O_5 0.050; V_2O_5 0.072; Cr_2O_3 0.047; CaO 0.018; MgO 0.012; MnO 0.004; ZnO 0.0014; K_2O 0.009; SO_3 0.21; loss on ignition 29.9 at 1050 °C; all values % by wt. Estimated uncertainty 0.0007 to 0.3 depending on element.
697 Bauxite (Dominican)	Same as SRM 69b. The material was mined in the Dominican Republic. Mineralogical composition: 15% kaolinite, 50% gibbsite, 10% boehmite, 5% anatase; 20% hematite (semiquantitative).	The bauxite powder (< 0.08 mm) was dried at 140 °C for 2 hours. Analytical sample of 1-g or more. Al_2O_3 45.8; Fe_2O_3 20.0; SiO_2 6.81; TiO_2 2.52; ZrO_2 0.065; P_2O_5 0.97; V_2O_5 0.063; Cr_2O_3 0.100; CaO 0.71; MgO 0.18; MnO 0.41; ZnO 0.037; K_2O 0.062; SO_3 0.13; loss on ignition 22.1 at 1050 °C. All values % by wt. Estimated uncertainty 0.2 to 0.003 depending on element.
698 Bauxite (Jamaican)	Mined in Jamaica, provided by Reynolds Metals Co., Bauxite, Arkansas, processed at the Colorado School of Mines Research Institute. Mineralogical composition: 75% gibbsite, 20% hematite, 5% anatase (semiquantitative).	The bauxite powder (<0.08 mm) was dried at 140 °C for 2 hours. Analytical sample of 1-g or more. Al_2O_3 48.2; Fe_2O_3 19.6; SiO_2 0.69; TiO_2 2.38; ZrO_2 0.061; P_2O_5 0.37; V_2O_5 0.064; Cr_2O_3 0.080; CaO 0.62; MgO 0.058; MnO 0.38; ZnO 0.029; K_2O 0.010; SO_3 0.22; loss on ignition 27.3 at 1050 °C. All values % by wt. Estimated uncertainty 0.002 to 0.4 depending on element.

Certification	Use	Remarks
Analyses performed in cooperation with five laboratories including NBS-CAC. Estimated uncertainty 0.0005 to 0.07 depending on constituent.	Same as SRM 692.	Same as SRM 692.
Same as SRM 69b.	Same as SRM 69b.	Additional composition (not certified): BaO (0.004); Na_2O (0.007); Ce (0.0041); Co (0.00009); Hf (0.0032); Sc (0.0008). Issued in cooperation with ASTM.
Same as SRM 69b.	Same as SRM 69b.	Additional composition (not certified): BaO (0.015); Na_2O (0.036); Ce (0.069); Co (0.0013); Hf (0.0014); Sc (0.0058). Issued in cooperation with ASTM.
Same as SRM 69b.	Same as SRM 69b.	Additional composition (not certified): BaO (0.008); Na_2O (0.015); Ce (0.030); Co (0.0045); Hf (0.0015); Sc (0.0051). Issued in cooperation with ASTM.

Table 3. Composition of SRM's Prepared from Ores, Minerals, Rocks, and Refractories (listed by chemical constituents and category).

Composition of ore SRMs[a]

Constituents	SRM type, wt/unit					
	27f Iron ore, Sibley, 100 g	690 Iron ore, Canada, 150 g	691 Iron oxide, reduced, 100 g	692 Iron ore, Labrador, 150 g	693 Iron ore, Nimba, 150 g	69b Bauxite, Ark., 60 g
Al_2O_3	0.82	0.18	1.22	1.41	1.02	48.8
BaO	—	—	—	—	—	(0.008)[b]
C (Total)	—	—	.12	—	—	—
Cd	—	—	—	—	—	—
CdO	—	—	—	—	—	—
CaO	.039	.20	.63	.023	.016	.13
Co	—	—	.030	—	—	(.0001)
CO_2	—	—	—	—	—	—
Cu	—	—	.032	—	—	—
Cr_2O_3	—	—	—	—	—	.011
F	—	—	—	—	—	—
In	—	—	—	—	—	—
Hf	—	—	—	—	—	(.0063)
Fe (Total)	65.97	66.85	90.8	59.58	65.11	—
Fe_2O_3	—	—	—	—	—	7.14
Pb	—	—	—	—	—	—
Ce	—	—	—	—	—	(0.024)
MgO	0.019	0.18	0.52	0.035	0.013	.085
MnO	.011	.23	.043	.46	.091	.110
P	.041	.011	.006	.039	.056	—
Ni	—	—	—	—	—	—
P_2O_5	—	—	—	—	—	.118
K_2O	.008	.0030	—	.039	.0028	.068
SiO_2	4.17	3.71	3.7	10.14	3.87	13.43
Ag	—	—	—	—	—	—
Na_2O	0.012	0.003	0.186	0.008	0.0028	(0.025)
S	.005	.003	.008	.005	.005	—
Sc	—	—	—	—	—	(.0008)
SO_3	—	—	—	—	—	.63
TiO_2	.019	.022	.27	.045	.035	1.90
U	—	—	—	—	—	—
V_2O_5	—	—	—	—	—	0.028
WO_3	—	—	—	—	—	—
Zn	—	—	—	—	—	—
ZnO	—	—	—	—	—	.0035
ZrO_2	—	—	—	—	—	.29
Loss on ignition	—	—	—	—	—	27.2
Moisture	—	—	—	—	—	—

Constituents	696 Bauxite, Surinam, 60 g	697 Bauxite, Dominican, 60 g	698 Bauxite, Jamaican, 60 g	SRM type, wt/unit 120b Phosphate rock, Fla., 90 g	277 Tungsten conc., 100 g	113a Zinc ore conc., 100 g	329 Zinc conc., 100 g
Al_2O_3	54.5	45.8	48.2	1.06	—	—	—
BaO	(0.004)	(0.015)	(0.008)	—	Ta (0.20)	—	—
C (Total)	—	—	—	—	—	—	—
Cd	—	—	—	—	—	0.78	0.14
CdO	—	—	—	0.002	—	—	—
CaO	0.18	.71	.62	49.40	Ca (.37)	1.1_9	.08
Co	(.00009)	(.0013)	(.0045)	—	—	(0.11)	(.009)
CO_2	—	—	—	2.79	—	—	—
Cu	—	—	—	—	—	0.31	13_2
Cr_2O_3	.047	.100	.080	—	Nb (1.00)	—	—
F	—	—	—	3.84	—	—	—
In	—	—	—	—	—	—	.019
Hf	(.0032)	(.0014)	(.0015)	—	—	—	—
Fe (Total)	—	—	—	—	(7.4)	2.08	12.9_4
Fe_2O_3	8.70	20.0	19.6	1.10	—	—	—
Pb	—	—	—	—	(0.07)	2.80	6.0_6
Ce	(0.0041)	(0.069)	(0.030)	—	—	—	—
MgO	.012	.18	.058	0.28	—	0.75	0.16_5
MnO	.004	.41	.38	.032	Mn (10.0)	—	—
P	—	—	—	—	(0.03)	—	—
Ni	—	—	—	—	—	(.07)	(.006)
P_2O_5	.050	.97	.37	34.57	—	—	—
K_2O	.009	.062	.010	0.12	—	—	—
SiO_2	3.79	6.81	.69	4.68	Si (.85)	(1.54)	(.61)
Ag	—	—	—	—	—	0.046_7	.0089
Na_2O	(0.007)	(0.036)	(.015)	0.35	—	—	—
S	—	—	—	—	(.25)	30.6	(31.7)
Sc	(.0008)	(.0058)	(.0051)	—	—	—	—
SO_3	.21	.13	.22	—	O_2 (21.4)	—	—
TiO_2	2.64	2.52	2.38	.15	Ti (2.2)	—	—
U	—	—	—	128.4 μg/g	—	—	—
V_2O_5	0.072	0.063	0.064	—	Mo (0.06)	—	—
WO_3	— —	—	—	—	67.4	—	—
Zn	—	—	—	—	—	$57._3$	$45._5$
ZnO	.0014	.037	.029	—	Sn (0.54)	—	—
ZrO_2	.14	.065	.061	—	—	—	—
Loss on ignition	29.9	22.1	27.3	—	—	—	—
Moisture	—	—	—	—	—	0.08	0.4_5

[a]Concentrations expressed in wt% unless noted otherwise.
[b]Values in parentheses are not certified, but are given for information only.

Composition of rock, mineral, and refractory SRMs[a]

Constituents	SRM type, wt/unit 1c Limestone, argillaceous, 50 g	88a Limestone, dolomitic, 50 g	70e Feldspar, potash, 40 g	99e Feldspar, soda, 40 g	97e Clay, flint 60 g	98a Clay, plastic 60 g	81a Glass sand, 75 g	165a Glass sand, (low iron), 75 g
Al_2O_3	1.30	0.19	17.9	20.5	38.79	33.19	0.66	0.059
BaO	—	—	0.02	0.26	0.07_5	0.03	—	—
CaO	50.3	30.1_5	.11	2.14	.11	.31	—	—
Cr_2O_3	—	—	—	—	.03	.03	46 μg/g	(1.1)[b] μg/g
CO_2	—	46.6	—	—	—	—	—	—
FeO	—	—	—	—	—	—	—	—
Fe_2O_3	0.55	0.28	0.07_5	0.06_5	0.45	1.34	0.082	0.012
Li_2O	—	—	—	—	.11	0.070	—	—
MgO	0.42	21.3	—	.02	.15	.42	—	—
MnO	.025	0.03	—	—	—	—	—	—
P_2O_5	.04	.01	—	.02	.36	.11	—	—
K_2O	.28	.12	11.8	5.2	.50	1.04	—	—
Rb_2O	—	—	0.06	—	—	—	—	—
SiO_2	6.84	1.20	67.1	65.2	43.67	48.94	—	—
Na_2O	0.02	0.01	2.5_5	6.2	0.037	0.082	—	—
SrO	.030	.010	—	—	.18	.039	—	—
TiO_2	.07	.02	0.10	0.007	1.90	1.61	.12	.011
ZrO_2	—	—	—	—	—	—	.034	.006
Loss on ignition	39.9	46.7	.40	.26	13.32	12.44	—	—

Constituents	SRM type, wt/unit 154b Titanium dioxide, 90 g	278 Obsidian rock, 35 g	688 Basalt rock, 60 g	76a Burnt refractory, (Al_2O_3—40%) 75 g	77a Burnt refractory, (Al_2O_3—60%) 75 g	78a Burnt refractory, (Al_2O_3—70%) 75 g	103a Chrome refractory, 60 g	198 Silica refractory, 45 g	199 Silica refractory, 45 g
Al_2O_3	—	14.15	17.36	38.7	60.2	71.7	29.96	0.16	0.48
BaO	—	—	—	—	—	—	—	—	—
CaO	—	0.983	—	0.22	0.05	0.11	0.69	2.71	2.41
Cr_2O_3	—	—	—	—	—	—	32.06	—	—
CO_2	—	—	—	—	—	—	—	—	—
FeO	—	—	—	—	—	—	12.43	—	—
Fe_2O_3	—	2.04	10.35	1.6_0	1.0_0	1.2	—	0.66	0.74
Li_2O	—	—	—	0.042	0.2_5	0.12	—	.001	.002
MgO	—	—	—	.52	.38	.70	18.54	.07	.13
MnO	—	0.052	0.167	—	—	—	0.11	.008	.007
P_2O_5	—	.036	.134	0.12_0	0.092	1.3	.01	.022	.015
K_2O	—	4.16	.187	1.33	$.09_0$	1.22	—	.017	.094
Rb_2O	—	—	—	—	—	—	—	—	—
SiO_2	—	73.05	48.4	54.9	35.0	19.4	4.63	—	—
Na_2O	—	4.84	2.15	0.07	0.037	0.078	—	.012	.015
SrO	—	—	—	.037	.009	.25	—	—	—
TiO_2	99.74	0.245	1.17	2.0_3	2.6_6	3.2_2	0.22	.02	.06
ZrO_2	—	—	—	0.15	0.21	0.31	0.01		
Loss on ignition	—	—	—	(0.34)	(0.22)	(0.42)	—	.21	.17

[a]Concentrations expressed in wt% unless noted otherwise.
[b]Numbers in parentheses are not certified, but are given for information only.

Composition of ore standard reference materials[a]

Constituents	SRM, Type, wt/unit								
	79a Fluorspar, customs grade, 120 g	180 Fluorspar, high grade, 120 g	181 Lithium ore (spodumene), 45 g	182 Lithium ore (petalite), 45 g	183 Lithium ore (lepidolite), 45 g	330 Copper ore mill heads, 100 g	331 Copper ore mill tails, 100 g	332 Copper conc., 50 g	333 Molybdenum conc., 35 g
CaF_2	97.39	98.80	—	—	—	—	—	—	—
Li_2O	—	—	6.3[9]	4.3	4.1	—	—	—	—
Cu	—	—	—	—	—	0.84	0.091	28.4	1.038
Re	—	—	—	—	—	.30 ppm	.04 ppm	10.2 ppm	.087
Mo	—	—	—	—	—	.018	.0022	.64	55.3
Au	—	—	—	—	—	(0.93) ppm[b]	(.034) ppm	(2.14) ppm	(8.9) ppm
Ag	—	—	—	—	—	(1.51) ppm	(.243) ppm	(38.7) ppm	(25) ppm

[a]Concentrations expressed in wt percent unless noted otherwise.
[b]Values in parentheses are not certified, but are given for information only.

Table 4. NBS Publications in the "260 Series" Related to Coal, Ore, Mineral, Rock, and Refractory Standards

Publication	Title	SRM No.
260-8	Analysis of Uranium Concentrates at the National Bureau of Standards	
260-37	Methods of Analysis of NBS Clay Standards	97a, 98a
260-94	Methods and Procedures Used at the National Bureau of Standards to Certify Sulfur in Coal SRM's for Sulfur Content, Calorific Value, Ash Content	2682, 2683, 2684, 2685

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Appendix I.

Alphabetical Index by Standard Reference Material Name

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

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

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Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	C1116
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	1117
Commercial Bronze Standard for Optical Emission and X-ray Spectroscopic Analysis	C1117
Common Lead Isotopic Standard	981
Copper Concentrate	332
Copper Heat Capacity Test Specimen	RM5
Copper-Nickel-Chromium Cast Iron	115A
Copper Ore, Mill Heads	330
Copper Ore, Mill Tails	331
Copper-Thermal Expansion	736a
Copper, Secondary Freezing Point Standard	45d
Cortisol (Hydrocortisone)	921
Creatinine	914
Cr-Mo Low Alloy Steel	1270
Cr-Mo Steel (ASTM A-213)	291
Cr-Mo (SAE 4140) Spectrographic Steel Standard	414
Cr-Mo (SAE 4150) Spectrographic Steel Standard	427
Cr-Mo (SAE X4130) Spectrographic Steel Standard	418a
Cr-Ni-Mo Steel (AISI 8620)	293
18Cr-10Ni Steel (AISI 304L)	101f
Cr-V Steel (Modified)	363
Cr-V Steel (Modified)	1263a
Cr-V Steel (SAE 6150)	30f
Crystalline Potassium Dichromate	935
Crystalline Potassium Iodide, Heterochromatic Stray Radiant Energy Standard	2032
Crystalline (Ruby) Electron Paramagnetic Resonance Absorption Intensity Standard	2601
Cupro-Nickel (CDA 706)	1275
Cupro-Nickel (CDA 715)	1276
Cupro-Nickel, 10% (CDA 706) Doped	875
Cupro-Nickel, 10% (CDA 706) High Purity	874
Cystine	143c
Dextrose	41b
D-Glucose	917
Dibutyltin Bis(2-ethylhexanoate)	1057b
Didymium Glass Filter for Checking the Wavelength Scale of Spectrophotometers	2009
Didymium Glass Fitler for Checking the Wavelength Scale of Spectrophotometers	2010
Disodium Hydrogen Phosphate	186IIc
Disodium Hydrogen Phosphate	2186II
D-Mannitol	920
Dolomitic Limestone	88a
Doped Platinum	681L1
Doped Platinum	681L2
Ductile Cast Iron	341
Electrical Residual Resistivity Ratio Standard	769
Electrolytic Iron	365
Electrolytic Iron	1265a
Electrolytic Iron, Thermal Conductivity and Electrical Resistivity	1463
Electrolytic Iron, Thermal Conductivity and Electrical Resistivity	1464
Electronic and Magnetic Alloy Standard	1159
Electronic and Magnetic Alloy Standard	1160
Enriched Boric Acid	952
Equal-Atom Lead Isotopic Standard	982
Estuarine Sediment	1646
Europium-152 Point-Source Standard	4218E
Europium-152 Radioactivity Standard	4370B
Extra Dense Lead Glass	709
Fe-Cr-Ni Alloy Microprobe Standard	479a
Fe-3Si Alloy Microprobe Standard	483
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
Fission Track Glass Standard	961
Fission Track Glass Standard	962a
Fission Track Glass Standard	963a
Fission Track Glass Standard	964
Flint Clay	97a
Fluorobenzoic Acid	2143
Fluorspar	79a
Free-Cutting Brass	1103
Free-Cutting Brass	C1104
Freeze-Dried Urine	2670
Freeze-Dried Urine Certified for Fluoride	2671a
Freeze-Dried Urine Certified for Mercury	2672a
Fused-Silica Thermal Expansion	739
Gadolinium-148 Alpha-Particle Standard	4907
Gallium Melting-Point Standard	1968
Gallium-67 Radioactivity Standard	4416L-D
Gas Furnace Black Rubber Compound	382a
Gasometric Set (1095-1099)	1089
Gasometric Standard for Unalloyed Zirconium	357
Gasometric Standard for Unalloyed Zirconium	358
Generator Columns for Polynuclear Aromatic Hydrocarbons	1644
Gilding Metal	1112
Gilding Metal	C1112
Gilding Metal	1113
Gilding Metal	C1113
Gilding Metal	1114
Gilding Metal	C1114
Glasses for Microchemical Analysis	1871
Glasses for Microchemical Analysis	1872
Glasses for Microchemical Analysis	1873
Glasses for Microchemical Analysis	1874
Glasses for Microchemical Analysis	1875
Glass Fibers for Microanalysis	RM 31
Glass Filter for Transmittance Measurement	2030
Glass Filters for Spectrophotometry	930D
Glass Fluorescence Source	477
Glass Sand	81a
Glass Sand	165a
Glass Spheres	1019a
Gold Coating on Glass Sealing Alloy	1398a
Gold Coating on Nickel	1379
Gold Coating on Nickel	1380
Gold Coating on Nickel	1399b
Gold-Copper Wires for Microprobe Analysis	482
Gold-195 Radioactivity Standard	4421L
Gold-198 Radioactivity Standard	4405L-B
Gold-Silver Wires for Microprobe Analysis	481
Gold, Vapor Pressure	745
Gray Cast Iron	334
Halocarbons (in methanol) for Water Analysis	1639
High-Alloy Steel (A-743)	C1288
High-Alloy Steel (AISI 310 Mod.)	C1287
High-Alloy Steel, (AISI 414 Mod.)	C1289
High-Alloy White Cast	892
High-Alloy White Cast Iron	890
High-Alloy White Cast Iron	891
High-Carbon Ferrochromium	64c
High-Carbon Ferromanganese	68c
High-Carbon Steel (Modified)	364
High-Carbon Steel (Modified)	1264a
High-Grade Fluorspar	180
High-Nickel Steel	126c
High-Nickel Steel	1158
High-Purity Gold	685
High-Purity Platinum	680L1A
High-Purity Platinum	680L2A
High-Purity Platinum Thermoelement	1967
High-Purity Zinc	682
High-Silicon Steel	179
High-Silicon Steel	1134
High-Silicon Steel	1135
High-Silicon Steel (Calcium Bearing)	125b
High-Sulfur Steel	105
High-Sulfur Steel	129c
High-Sulfur Steel	1136
High Temperature Alloy A286	348
High Temperature Alloy M308	1197
High Temperature Alloy L605 and S816	S1199
High-Temperature Alloy	1206-2
High-Temperature Alloy	1207-1
High-Temperature Alloy	1207-2
High-Temperature Alloy	1208-1
High-Temperature Alloy	1208-2
Homogeneous River Sediment for Radioactivity Measurements	RM 45B
Human Liver, Environmental Radioactivity	4352
Human Lung, Environmental Radioactivity	4351
Human Serum	909

Name	SRM
Hydrogen in Unalloyed Titanium	352b
Hydrogen in Unalloyed Titanium	1086
Hydrogen in Unalloyed Titanium	1087
Hydrogen in Unalloyed Titanium	1088
Hydrogen-3 Radioactivity Standard	4361
Hydrogen-3 Radioactivity Standard	4926C
Hydrogen-3 Toluene Radioactivity Standard	4947
4-Hydroxy-3 methoxy-DL-mandelic Acid (VMA)	925
ICTA High Temperature Set Differential Thermal Analysis	GM 760
ICTA Low Temperature Set Differential Thermal Analysis	GM 757
ICTA Mod Temperature Set Differential Thermal Analysis	GM 759
ICTA Mid Temperature Set Differential Thermal Analysis	GM 758
ICTA Polystyrene Differential Thermal Analysis	GM 754
ICTA Thermogravimetry Set	GM 761
Incoloy, 901 and Hastelloy X	S1198
Inconels, Alloy 600 (Chips)	864
Inconels, Alloy 600 (Solid)	1244
Inconels, Alloy 625 (Chips)	865
Inconels, Alloy 625 (Solid)	1245
Incoloy, Alloy 800 (Chips)	866
Incoloy, Alloy 800 (Solid)	1246
Incoloy, Alloy 825 (Chips)	867
Incoloy, Alloy 825 (Solid)	1247
Indium-111 Radioactivity Standard	4417L-C
Ingot Iron Spectrographic Steel Standard	420a
Intermediate Purity Selenium	726
Intermediate-Purity Zinc	728
Iodine-123 Radioactivity Standard	4414L-C
Iodine-125 Radiactivity Standard	4407L-H
Iodine-129 Radioactivity Standard	4949B
Iodine-131 Radioactivity Standard	4401L-I
Iron Foil Mössbauer Standard	1541
Iron-55 Low-Energy Photon Standard	4260C
Iron Metal (Clinical Standard)	937
Iron Ore (Labrador)	692
Iron Ore (Nimba)	693
Iron Ore (Sibley)	27f
Iron Ore Concentrate (Canada)	690
Iron-59 Radioactivity Standard	4411L-B
Isobutylene-Isoprene (Butyl) Rubber	1495
Isobutylene-Isoprene (Butyl) Rubber	388L
Isotopic Standard for Bromine	977
Isotopic Standard for Chlorine	975
Isotopic Standard for Chromium	979
Isotopic Standard for Copper	976
Isotopic Standard for Magnesium	980
Isotopic Standard for Silver	978
Krypton-85 Gaseous Radioactivity Standard	4308C
Krypton-85 Radioactivity Standard	4235
Krypton-85 Radioactivity Standard	4935C
Lead-Barium Glass	89
Lead-Base Bearing Metal	53e
Lead-Base Bearing Metal	1132
Lead Cyclohexanebutyrate	1059c
Lead in Reference Fuel	1636a
Lead in Reference Fuel	1637a
Lead in Reference Fuel	1638a
Lead Nitrate	928
Lead on Filter Media	2674
Lead-203 Radioactivity Standard	4420L
Lead, Secondary Freezing Point Standard	49e
Lead-Silica Glass	1827
Lead-Silica Glass (Viscosity)	711
Lead-Silica Glass for dc Volume Resistivity	624
Lead-Silica Glass for Dielectric Constant	774
Lead 206 Spike Assay and Isotopic Solution Standard	991
Leaded-Tin Bronze Alloy	1035
Light-Sensitive Paper	700d
Light-Sensitive Paper	701d
Light-Sensitive Plastic Chip	703
Linear Polyethylene	1475
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
Low-Alloy Steel Set (661-665)	S668
Low-Carbon Silicon Steel	131c
Low-Carbon Silicon Steel	1036
Low-Carbon Stainless Steel (AISI 316L)	166c
Magnesium-base Alloy	171
Magnesium Cyclohexanebutyrate	1061c
Magnesium Gluconate Dihydrate	929
Magnetic Coating on Magnetic Substrate (Nickel on Steel)	1365a
Magnetic Coating on Magnetic Substrate (Nickel on Steel)	1366a
Magnetic Coating on Non-Magnetic Substrate (Nickel and Chromium on brass	1367a
Magnetic Tape, High Density	6250
Manganese Fluoride, Magnetic Gram Susceptibility	766
Manganese Ore	25d
Manganese-54 Point-Source Radioactivity Standard	4997E
Manganese-54 Radioactivity Standard	4257
Manganese Steel	100B
Manganous Cyclohexanebutyrate	1062b
Maraging Steel	1156
Metal on Quartz Filters for Spectrophotometry	2031
Metals on Filter Media	2676b
Methane in Air	1658a
Methane in Air	1659a
Methane in Air	1660a
Medium Manganese Spectrographic Steel Standard	405a
Mercaptobenzothiazole	383a
Mercury, Freezing Point	743
Mercury-203 Radioactivity Standard	4418L
Mercury in Water, μg/mL	1641b
Mercury in Water, ng/mL	1642b
Microcopy Resolution Test Chart	1010a
Microprobe Standard – Cartridge Brass	478
Mineral Glasses for Microanalysis	470
Molybdenum Concentrate	333
Molybdenum, Heat Capacity	781
Molybdenum-99 Radioactivity Standard	4412L-H
Molybdenum-Tungsten-Chromium-Vanadium Steel	134A
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	1106
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
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	1108
Naval Brass Standards for Optical Emission and Spectroscopic Analysis	C1108
Neutral Glass	716
Neutron Density Monitor Wire	953
Nickel-Chromium Cast Iron	82b
Nickel-Chromium-Molybdenum Cast Iron	107C
Nickel-Chromium Steel	32E
Nickel-Copper Alloy	882
Nickel Cyclohexanebutyrate	1065b
Nickel Oxide, No. 1	671
Nickel Oxide, No. 2	672
Nickel Oxide, No. 3	673
Nickel-63 Radioactivity Standard	4226
Nickel Silver (CDA 762)	879
Nickel Siver (CDA 770)	880
Nickel Spectrographic Steel Standard	409b
Nickel Sphere, Magnetic Moment	772
Nickel Steel	33d
Ni-Cr-Mo-V Steel	1173
Nicotinic Acid	148
Niobium-94 Gamma-ray Standard	4201B
Nitric Oxide in Nitrogen	1683b
Nitric Oxide in Nitrogen	1684b
Nitric Oxide in Nitrogen	1685b
Nitric Oxide in Nitrogen	1686b
Nitric Oxide in Nitrogen	1687b
Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2627
Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2628
Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2629
Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2630
Nitric Oxide in Nitrogen (Mobile Source Emission Gas Standard)	2631
Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2653
Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2654
Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2655
Nitrogen Dioxide in Air (Stationary Source Emission Gas Standard)	2656
Nitrogen Dioxide Permeation Device	1629a
4-Nitrophenol	938

Name	SRM
Nodular Cast Iron	342a
Nominal One Micrometer Polystyrene Spheres	1690
Non-Fat Powdered Milk	1549
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1359
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1360
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1361b
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1362a
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1363a
Nonmagnetic Coating on Magnetic Substrate (Copper and Chromium on Steel)	1364a
NPL GM Alpha Alumina	8005
NPL GM Alpha Alumina	8006
NPL GM Alpha Alumina	8007
NPL GM Alpha Alumina	8008
NPL GM Graphitized Carbon Black	8001
NPL GM Graphitized Carbon Black	8002
NPL GM Melting Point Set	8000
NPL GM Non-porous Silica	8003
NPL GM Non-porous Silica	8004
N-tertiary-Butyl-2-benzothiazolesulfenamide Rubber Compound	384d
Obsidian Rock	278
Octaphenylcyclotetrasiloxane	1066a
Oil Furnace Black Rubber Compound	378b
Opal Glass Powder	91
Optical Emission and X-ray Spectroscopic Analysis	1102
Optical Microscope Linewidth Measurement Standard	474
Optical Microscope Linewidth Measurement Standard	475
Optical Microscope Linewidth Measurement Standard	476
Organics in Shale Oil	1580
Oxalic Acid	4990C
Oxygen in Ferrous Materials Ingot Iron	1090
Oxygen in Ferrous Materials (Stainless Steel AISI 431)	1091
Oxygen in Ferrous Materials Vacuum Melted Steel	1092
Oxygen in Maraging Steel	1094
Oxygen in Nitrogen (Gas Standard)	2657
Oxygen in Nitrogen (Gas Standard)	2658
Oxygen in Nitrogen (Gas Standard)	2659
Oxygen in Titanium-Base Materials	355
Oxygen in Valve Steel	1093
Oyster Tissue	1566
Palladium, Magnetic Gram Susceptibility	765
Penetrant Test Block	1850
Peruvian Soil, Environmental Radioactivity	4355
Petroleum Crude Oil	1582
Phosphate Rock (Florida)	120b
Phosphor Bronze (CDA 521)	871
Phosphor Bronze (CDA 544)	872
Phosphorized Copper, Cu VIII	C1251
Phosphorized Copper, Cu IX	C1252
Phosphorized Copper, Cu X	C1253
Phosphorus-32 Radioactivity Standard	4406L-G
Photographic Step Tablet	1008
Pine Needles	1575
Plastic Clay	98a
Platinum, Magnetic Gram Susceptibility	764
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
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

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

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

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Sulfur Dioxide in Nitrogen	1696
Sulfur Dioxide Permeation Tube (2 cm tube)	1627
Sulfur Dioxide Permeation Tube (5 cm tube)	1626
Sulfur Dioxide Permeation Tube (10 cm tube)	1625
Sulfur in Coal	2682
Sulfur in Coal	2683
Sulfur in Coal	2684
Sulfur in Coal	2685
Sulfur in Residual Fuel Oil	1619
Sulfur in Residual Fuel Oil	1620a
Sulfur in Residual Fuel Oil	1621b
Sulfur in Residual Fuel Oil	1622b
Sulfur in Residual Fuel Oil	1623a
Sulfur in Residual Fuel Oil	1624a
Sulfur Rubber Compound	371g
Superconductive Thermometric Fixed Point Device	767a
Superconductive Thermometric Fixed Point Device	768
Surface Flammability Standard	1002c
Synthetic Sapphire	720
Technetium-99 Radioactivity Standard	4288
Technetium-99m Radioactivity Standard	4410H-I
Tetrachloroethylene in Nitrogen	1808
Thallium-201 Radioactivity Standard	4404L-F
Thermal Resistance, Fibrous Glass Batt	1451
Thermal Resistance, Fibrous Glass Board	1450b
Thorium-228, Thallium-208 Gamma-ray Point-Source Standard	4206C
Tin-Base Bearing Metal	54D
Tin, Freezing Point	741
Tin-113-Indium-113m Radioactivity Standard	4402L-C
Tin-121m Point-Source Gamma-ray Emission-Rate Standard	4264B
Tin, Secondary Freezing Point Standard	42g
Titanium Alloy	654a
Titanium-Base Alloy	173b
Titanium-Base Alloy	176
Titanium-Base Alloy (Unalloyed)	650
Titanium-Base Alloy (Unalloyed)	651
Titanium-Base Alloy (Unalloyed)	652
Titanium Dioxide	154b
Toluene	211c
Tomato Leaves	1573
Tool Steel (AISI M2)	132b
Tool Steel (AISI M2)	1157
Tool Steel Abrasive Wear Standard	1857
Tracealloy (Nickel-Base High-Temperature Alloy)	897
Tracealloy (Nickel-Base High-Temperature Alloy)	898
Tracealloy (Nickel-Base High-Temperature Alloy)	899
Trace Elements in a Glass Matrix	610
Trace Elements in a Glass Matrix	611
Trace Elements in a Glass Matrix	612
Trace Elements in a Glass Matrix	613
Trace Elements in a Glass Matrix	614
Trace Elements in a Glass Matrix	615
Trace Elements in a Glass Matrix	616
Trace Elements in a Glass Matrix	617
Trace Elements in Coal (Bituminous)	1632a
Trace Elements in Coal (Subbituminous	1635
Trace Elements in Coal Fly Ash	1633a
Trace Elements in Fuel Oil	1634a
Trace Elements in Water	1643a
Trace Mercury in Coal	1630
2,2,4-Trimethylpentane	217c
Tripalmitin	1595
Tris, Basimetric	723a
Tris, for Solution Calorimetry	724a
Tris(hydroxymethyl)aminomethane	922
Tris(hydroxymethyl)aminomethane hydrochloride	923
Tris(1-phenyl-1, 3-butanediono) Chromium (III)	1078b
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

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

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 1c

Argillaceous Limestone

(In Cooperation with the American Society for Testing and Materials)

(All analyses are based on samples dried 2 hours at 110°C)

Constituent	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	P_2O_5	MnO	CaO	SrO	MgO	Na_2O	K_2O	Loss on Ignition
Certified[1] Value, % by wt.	6.84	0.55	1.30	0.07	0.04	0.025	50.3	0.030	0.42	0.02	0.28	39.9
Estimated[2] Uncertainty	0.08	0.03	0.03	0.01	0.01	0.005	0.3	0.005	0.04	0.01	0.01	0.1
Method[3] / Labs	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption	Photometric	Atomic Absorption			Atomic Absorption	Atomic Absorption	Atomic Absorption	
A	[a] 6.82	[b] 0.53	[b] 1.33	[c] 0.07	[d] 0.04	[e] 0.03	[f] 50.40	---	[f] 0.45	[g] 0.03	[g] 0.28	39.93
B	[h] 6.77	[i] .61	[j] 1.31	[c] .07	[d] .03	[e] .02	[k] 50.19	---	[l] .54	---	[g] .29	39.80
C	6.82 [m] 6.77 [h] 6.80	.55	1.27	[c] .06	[d] .05	.02 [m] .03	[n] 50.18 [m] 50.56 [f] 50.20	0.03	[m] .38 [m] .43	.02	[m] .28 [m] .29	39.82 39.85
D	[h] 6.92	[i] .55	[j] 1.30	[o] .066	[d] .038	.022	50.18	.030	.45	[g] .02	[g] .30	39.90
E	6.92	.57	1.29	[m] .066	[d] .039	.021	[k] 50.57	.031	.41	.028	.27	39.87
F	6.76	.57	---	.08	.04	.027	50.52	.03	.42	.02	---	39.97
G	[p] 6.91	.54	1.35	.07	[d] .04	.027	[k] 50.20	.03	.42	.02	.28	39.89
H	---	---	---	---	---	.022	[g] 50.58 [n] 49.96	.034	.38	[g] .025	[g] .30	---

1. The certified value listed for a constituent is the present best estimate of the "true" value based on results of the cooperative analytical program for certification.
2. The estimated uncertainty of the "true" value 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 of 0.5 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination.)
3. Detailed descriptions of many of the methods of analysis employed in the certification program for this SRM may be found in Part 13, Annual Book of ASTM Standards. They are also available as separate reprints, C25 and C114, from ASTM headquarters. ASTM Standard Technical Publication No. 395 also describes methods of analysis used in this certification work.

[a] Silicomolybdate photometric method.
[b] Ferron (8 hydroxy7-iodo-5-quinolinesulfonic acid) photometric method.
[c] Tiron (disodium-1, 2 dihydroxybenzene-3, 5-dfSulfonate) photometric method.
[d] Molybdenum blue photometric method.
[e] Peroxydisulfate photometric method.
[f] EDTA titration.
[g] Flame emission spectrometry.
[h] Dehydration with HCl.
[i] $SnCl_2$ reduction-$K_2Cr_2O_7$ titration.
[j] By difference between total NH_4OH group and oxides of iron, phosphorus, and titanium.
[k] Calcium precipitated as oxalate and titrated with standard $KMnO_4$.
[l] Magnesium determined gravimetrically as $Mg_2P_2O_7$.
[m] X-ray fluorescence spectrometry.
[n] Atomic absorption spectrometry.
[o] H_2O_2 photometric.
[p] Dehydration with $HClO_4$.

Washington, D.C. 20234
December 14, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, AND ANALYSIS:

The material for this SRM was provided by Lone Star Industries, Inc., Cement and Construction Materials Group, Houston, Texas, through the courtesy of C. W. Moore.

At NBS, the material was ground, sieved and thoroughly blended.

Chemical analyses for certification were performed in the following laboratories:

Atlantic Cement Co., Inc., Ravena, N.Y., F. J. Hogan and W. Twiss.

California Portland Cement Co., Colton, Calif., P. Hawkins and N. Norton.

Ideal Basic Industries, Cement Division, Ft. Collins, Colo., J. W. Yule.

Lone Star Industries, Inc., Cement and Construction Materials Group, Houston, Texas, C. W. Moore, L. S. Scheline, and I. Z. Somcio.

Martin Marietta Laboratories, Baltimore, Md., E. H. Scott.

National Bureau of Standards, Center for Analytical Chemistry, Washington, D.C., T. C. Rains, M. B. Blackburn, T. J. Brady, J. D. Messman, and T. A. Rush, and by R. K. Bell, Assistant Research Associate, ASTM-NBS Research Associate Program.

Portland Cement Association, Skokie, Ill., W. F. Mivelaz, R. F. Crow, E. LaBonde, A. G. Mateos, C. P. Palmiano, and H. Seiler.

Universal Atlas Cement, Division of United States Steel Corp., Gary, Ind., Z. T. Jugovic.

The overall direction and coordination of the technical measurements leading to certification were performed by J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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 W. P. Reed.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 27f

IRON ORE (Sibley)

(In Cooperation with the American Society for Testing and Materials)

This material is in the form of fine powder, for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

(Results based on sample dried for one hour at 105 °C.)

Constituent	Total Fe	SiO_2	Al_2O_3	P	S	TiO_2	MnO	CaO	MgO	Na_2O	K_2O
Certified[1] Value% by wt.	65.97	4.17	0.82	0.041	0.005	0.019	0.011	0.039	0.019	0.012	[a] 0.008
Estimated[2] Uncertainty	0.05	0.03	0.03	0.001	≤0.001	0.002	0.002	0.003	0.004	0.003	0.002
Method[3] / Labs	$SnCl_2$ $K_2Cr_2O_7$	$HClO_4$ Dehydration	Atomic Absorption	Photometric	Combustion-Titration	Photometric	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption
A	66.01	[q] 4.12	0.78	[b] 0.042	0.005	[c] 0.020	0.009	0.042	0.02	[d] 0.012	[d] 0.006
B	[e] 65.98	4.18	.83	.042	.006	[f] .018	[g] .014 .012	[g] .041 .042	[g] .013 .015	[d] .012 [g] .010	[d] .011 [g] .009
C	65.93	[h] 4.18	.87 [i] .84	.039	[j] .005	[k] .019	[l] .010 .011	[d] .039	.018	[d] .009	[d] .008
D	65.92	4.14	[m] .82	.041	.006	.02	.006	.036	.023	[d] .016	[d] .008
E	[n] 65.96	4.17	.79	[b] .040	[j] .005	[o] .021	[p] .011	.035	.021	.010	.009
F	[n] 66.04	-	-	[b] .042	-	[q] .017	.011	-	.027	.015	.007
G	[q] 65.96	4.20	[r] 82 .81	.040	[j] .005	[f] .018	[l] .011 .013	.035	.018	.009	.007

1. The certified value listed for a constituent is the *present best estimate* of the "true" value based on results of the cooperative analytical program for certification.
2. Estimated uncertainty includes method imprecision, bias among methods, and material variability for samples 0.5 g or more.
3. A detailed description of many of the methods of analysis employed in the certification program for this SRM may be found in Part 12, Chemical Analysis of Metals and Metal Bearing Ores, Annual Book of ASTM Standards.

NOTE: Laboratory C reported a value of 0.002 percent ZrO_2 by the pyrocatechol photometric method.

[a] Sample fused in Na_2O_2.
[b] Alkali-molybdate method.
[c] X-ray spectrometric method.
[d] Flame emission spectrometry.
[e] H_2S reduction-$K_2Cr_2O_7$ titration.
[f] Chromotropic acid photometric.
[g] Spectrographic method.
[h] Sample dissolved in HCl, silica removed by double dehydration with HCl. Ignited silica treated with H_2SO_4 and HF.
Aluminum separated by anion-exchange and determined by chelometric titration using 1,2 diaminocyclohexanetetraacetic acid and back titration with standard zinc solution.
[i] Combustion-chromatographic
[j] Titanium separated by anion-exchange and determined photometrically with diantipyrylmethane.
[k] Photometric
[l] Aluminum separated by anion-exchange and determined gravimetrically with phenylhydrazine.
[m] $SnCl_2$ reduction - $KMnO_4$ titration.
[n] H_2O_2 photometric.
[o] Peroxydisulfate-arsenite.
[p] Atomic absorption spectrometry.
[q] Mercury cathode-NH_4OH-Cupferron-$AlPO_4$.

Washington, D.C. 20234
May 31, 1977

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, ANALYSIS: The iron ore material for this SRM was provided to NBS by the United States Steel Corporation, Pittsburgh, Pa., through the courtesy of R. H. Colin.

The "as received" material was crushed, dry ground, and sieved under contract with the Colorado School of Mines Research Institute, Golden, Colorado, under direction of M. G. Pattengill and H. O. VanMale. The final product passed a 150 mesh (105μm) sieve, with about 50% passing a 200 mesh (74μm) sieve.

At NBS the material was sieved and thoroughly blended. Homogeneity testing of selected samples representative of the final lot was performed at NBS by R. K. Bell, Assistant Research Associate, ASTM/NBS Research Associate Program. The observed range of values is as follows:

Constituent	Range, %	No. of determinations	Sample size, grams
Fe	$\pm$ 0.05	16	0.5
SiO_2	$\leq\pm$ 0.02	4	1.0
P	$\leq\pm$ 0.001	4	0.5

It is concluded that the material variability is within the method imprecision.

Chemical analyses for certification were performed in the following laboratories:

Alan Wood Steel Company, Conshohocken, Pa., V. J. Mercaldo.

Andrew S. McCreath and Son, Inc., Harrisburg, Pa., R. F. Lippi.

Booth, Garrett and Blair, Inc., Ambler, Pa., J. H. Ormsbee.

Ledoux and Company, Teaneck, N. J., S. Kallman.

National Bureau of Standards, Analytical Chemistry Division, Washington, D.C. by T. C. Rains and S. A. Wicks, and by R. K. Bell, ASTM Assistant Research Associate.

United States Steel Corporation, Research Laboratory, Monroeville, Pa., by J. D. Selvaggio, D. G. Cunningham, J. DiNardi, J. B. Ferons, A. V. Fioravanti, J. E. Friedline, J. R. Lucas, II, K. G. Mikos, C. W. Ponsonby, D. Shafferman, and R. J. Wargo.

Weirton Steel Division, Weirton, W. Va., R. L. Zickefoose.

The overall direction and coordination of the technical measurements leading to certification were performed jointly by R. E. Michaelis, Office of Standard Reference Materials, and by J. I. Shultz, Research Associate, ASTM/NBS Research Associate Program.

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 W. P. Reed.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 69b

Bauxite (Arkansas)

(In Cooperation with the American Society for Testing and Materials)

(All analyses are based on samples dried 2 hours at 140 °C)

This material is in the form of fine powder (<0.08 mm) for use in checking chemical and instrumental methods of analyses.

Constituent	Certified Value[1] Percent, by weight	Estimated Uncertainty[2]
Al_2O_3	48.8	0.2
Fe_2O_3	7.14	.12
SiO_2	13.43	.10
TiO_2	1.90	.05
ZrO_2	0.29	.07
P_2O_5	.118	.004
V_2O_5	.028	.003
Cr_2O_3	.011	.002
CaO	.13	.02
MgO	.085	.008
MnO	.110	.005
ZnO	.0035	.0005
K_2O	.068	.009
SO_3	.63	.02
Loss on Ignition[3]	27.2	.2

[1]The certified value listed for a constituent is the *present best estimate* of the "true" value.

[2]The estimated uncertainty listed for a constituent 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 1.0 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

[3]Determined by igniting to constant weight at 1050 °C.

Washington, D.C. 20234
August 24, 1979

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

ADDITIONAL INFORMATION ON THE COMPOSITION

Elements other than those certified may be present in this material as indicated below. These are not certified but are given as additional information on the composition.

Constituent	Concentration, Percent by weight	Constituent	Concentration, Percent by weight
BaO	(0.008)	Co	(0.0001)
Na_2O	(0.025)	Hf	(0.0063)
Ce	(0.024)	Sc	(0.0008)

The mineralogical composition of SRM 69b was determined by x-ray diffraction studies at the Geological Survey, U.S. Department of the Interior, Reston, Va., (J.W. Hosterman) to be 30% kaolinite, 60% gibbsite, and 10% siderite. These results are semiquantitative (to the nearest 5%).

PLANNING, PREPARATION, TESTING, ANALYSIS:

The mine run material for this SRM was provided by the Aluminum Company of America, Bauxite, Arkansas, through the courtesy of T.J. Forbes and by the Alcoa Technical Center, Pittsburgh, Pa., courtesy of H.B. Hartman. It was processed (crushed, ground, sieved, and mixed) at the Colorado School of Mines Research Institute under a contract with the National Bureau of Standards.

Homogeneity testing was performed at NBS by J.S. Maples and T.E. Gills.

Cooperative analyses for certification were performed in the following laboratories:

Aluminum Company of America, Alcoa Center, Pa., R. C. Obbink.

Aluminum Company of Canada, Ltd., Arvida Research Center, Arvida, Quebec, Canada, L. Girolami.

Andrew S. McCreath & Son, Inc., Harrisburg, Pa., F. A. Pennington, Jr., R. F. Eakin, and S. L. Miller.

General Refractories Co., U.S. Refractories Division, Research Center, Baltimore, Md., S. Banerjee.

Geological Survey, U.S. Department of the Interior, Reston, Va., H. J. Rose, Jr., and J. W. Hosterman.

Kaiser Aluminum and Chemical Corp., Center for Technology, Pleasanton, Calif., H. J. Seim, A. E. McLaughlin, D. F. G. Marten, A. Kermaninejad, R. C. Kinne, J. R. Skarset, J. Boruk, and U. Vogel.

National Bureau of Standards, Washington, D.C., R. K. Bell, ASTM-NBS Assistant Research Associate.

National-Southwire Aluminum Co., Hawesville, Ky., N. Robinson and E. Gotzy.

Ormet Corp., Burnside, La., W. L. Brown and A. D. Lafleur.

Reynolds Aluminum Co., Alumina Research Division, Bauxite, Ark., J. B. Ezell, Jr.

University of Kentucky, Institute for Mining and Minerals Research, Center for Energy Research Laboratory, Lexington, Ky., T. V. Rebagay.

The overall coordination of the technical measurements leading to certification were performed under the direction of J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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. E. Michaelis and R. Alvarez.

NBS Standard Reference Materials

BAUXITE SERIES

September 4, 1979

R. E. Michaelis and R. Alvarez, NBS Office of Standard Reference Materials
and
J. I. Shultz, ASTM Research Associate

The following table gives the values for four bauxite SRM's that are available in the form of fine powder (<0.08 mm) for use in chemical and instrumental methods of analysis. They are being issued as a culmination of a major Industry-ASTM-NBS cooperative program.

SRM No. Designation	69b Arkansas	696 Surinam	697 Dominican	698 Jamaican
Constituent		Percent by Weight		
Al_2O_3	48.8	54.5	45.8	48.2
Fe_2O_3	7.14	8.70	20.0	19.6
SiO_2	13.43	3.79	6.81	0.69
TiO_2	1.90	2.64	2.52	2.38
ZrO_2	0.29	0.14	0.065	0.061
P_2O_5	0.118	0.050	0.97	0.37
V_2O_5	0.028	0.072	0.063	0.064
Cr_2O_3	0.011	0.047	0.100	0.080
CaO	0.13	0.018	0.71	0.62
MgO	0.085	0.012	0.18	0.058
MnO	0.110	0.004	0.41	0.38
ZnO	0.0035	0.0014	0.037	0.029
BaO	(0.008)[a]	(0.004)	(0.015)	(0.008)
Na_2O	(0.025)	(0.007)	(0.036)	(0.015)
K_2O	0.068	0.009	0.062	0.010
SO_3	0.63	0.21	0.13	0.22
Loss on Ign.	27.2	29.9	22.1	27.3
Ce	(0.024)	(0.0041)	(0.069)	(0.030)
Co	(0.0001)	(0.00009)	(0.0013)	(0.0045)
Hf	(0.0063)	(0.0032)	(0.0014)	(0.0015)
Sc	(0.0008)	(0.0008)	(0.0058)	(0.0051)
Total	(100.0)	(100.1)	(100.1)	(100.1)

[a]Values in parenthesis are *not certified.*

The value listed for a certified constituent is the *present best estimate* of the "true" value based on the results of the analytical program for certification (10-12 laboratories). The individual certificates of analysis list the "estimated uncertainties" associated with the certified values (also listed is a semiquantitative mineralogical composition (±5%) as determined by x-ray diffraction studies at the U.S. Geological Survey).

Inquiries regarding the Bauxite SRM's 69b, 696, 697, and 698, should be directed to the Office of Standard Reference Materials, Chemistry Building, B311, National Bureau of Standards, Washington, D.C. 20234. (301) 921-2045.

George A. Uriano, Chief
Office of Standard Reference Materials

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

Certificate of Analysis

Standard Reference Material 70a

Feldspar

(All Analyses are Based on Samples Dried 2 hours at 105 °C)

	Percent
Silica (SiO_2)	67.1
Alumina (Al_2O_3)	17.9
Iron (as Fe_2O_3)	0.07$_8$
Titania (TiO_2)	.01
Calcium (as CaO)	.11
Barium (as BaO)	.02
Sodium (as Na_2O)	2.5$_5$
Potassium (as K_2O)	11.8
Rubidium (as Rb_2O)	0.06
Loss on Ignition	.40

Washington, D.C. 20234
August 10, 1981
(Revision of Certificate dated
3-26-65)

George A. Uriano, Chief
Office of Standard Reference Materials

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 76a, 77a, and 78a
Burnt Refractories

(In Cooperation With the American Society for Testing & Materials)

These materials are in the form of fine powder (<0.15 mm) and are intended for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

SRM No. Constituent	76a	77a	78a
	Percent by Weight[a]		
SiO_2	54.9	35.0	19.4
Al_2O_3	38.7	60.2	71.7
Fe_2O_3	1.6$_0$	1.0$_0$	1.2
TiO_2	2.0$_3$	2.6$_6$	3.2$_2$
ZrO_2	0.15	0.21	0.31
MgO	.52	.38	.70
CaO	.22	.05	.11
K_2O	1.33	.09$_0$	1.22
Na_2O	0.07	.037	.078
P_2O_5	.12$_0$	.092	1.3
Li_2O	.042	.02$_5$	0.12
SrO	.037	.009	.25
Loss on ignition	(.34)[b]	(.22)	(.42)
Total	(100.0)	(100.0)	(100.0)

[a] Based on samples dried at 105 °C for one hour.
[b] A figure in parenthesis is not certified but is given for additional information on the composition.

CERTIFICATION: The value listed for a certified constituent is the *present best estimate* of the "true" value based on the results of the analytical program. The value is not expected to deviate from the "true" value by more than ± 1 in the last significant figure reported. For a subscript figure, the deviation is not expected to be more than ± 5. Based on the results of the homogeneity testing, maximum variations within and among samples are estimated to be less than the uncertainty figures given above.

Washington, D.C. 20234
April 5, 1977
(Revision of certificate dated 6-23-76.
Only change: SrO values from uncertified to certified.)

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, AND ANALYSIS: These replacements for the original Burnt Refractory SRM's were especially prepared and provided to NBS by Harbison-Walker Refractories Company, Garber Research Center, Pittsburgh, Pa., through the efforts of Dr. R. K. Scott.

Carefully selected raw materials were batched to form extruded dobies. The dobies were air dried, oven dried at 120 °C, and then fired at 1427 °C for ten hours in kilns. The fired dobies were crushed and ground and converted to the fine powder product by air classification (about 95 %-325 mesh). The final products were mixed in a blender. At NBS, each of the materials was reblended and resieved.

Homogeneity testing by chemical analyses was performed at NBS by K. M. Sappenfield on selected samples representative of each lot of material for the key constituents, SiO_2 and Fe_2O_3.

Standard Deviation of a Single Determination (in wt. %), n = 7

Constituent	76a	77a	78a
SiO_2	0.09	0.06	0.08
Fe_2O_3	$.03_7$	$.03_4$	$.03_8$

Cooperative analyses for certification were performed in the analytical laboratories at Harbison-Walker Refractories Company, Pittsburgh, Pa., R. K. Scott and J. Ryan; and at Pennsylvania State University, College of Earth and Mineral Sciences, University Park, Pa., N. H. Suhr, J. C. Devine, and J. B. Bodkin.

Analyses were performed in the NBS Analytical Chemistry Division by R. K. Bell, O. Menis, T. C. Rains, T. A. Rush, K. M. Sappenfield, M. A. Waguespack, and S. A. Wicks.

The overall responsibility for the technical measurements at NBS was under the direction of W. R. Shields, I. L. Barnes, and O. Menis. The final coordination of the technical measurements was under the direction of J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

The technical and support aspects involved in the preparation, certification, and issuance of these SRM's were coordinated through the Office of Standard Reference Materials by R. E. Michaelis.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 79a

Fluorspar

This Standard Reference Material is an acid-grade fluorspar concentrate, to be used primarily for the assay of imported fluorspar for industrial applications. The assay value certified is dependent on the U.S. Customs Laboratory Method given in this Certificate; however, two options exist for the determination of soluble fluoride calculated as calcium fluoride in the acetic acid leach solution. Either the spectrophotometric procedure (Part B), which was used for the original certification of this material, or the ion electrode procedure (Part C), which is included on this Certificate, may be used. The results of the two procedures show excellent agreement.

Constituent	Percent by weight
CaF_2	$97.39^{a} \pm 0.06^{b}$

[a] Mean value based on 32 determinations using the U.S. Customs Laboratory Method of analysis (attached). The determinations were made by two analysts at each of three Customs laboratories and one NBS laboratory.

[b] Standard deviation of a single determination.

The following values, obtained by quantitative spectrochemical analysis, *are given for information only and are not certified:* Fe, 0.05-0.1%; Al and Sr, 0.01-0.1%; Mg, 0.01-0.05%; Na, 0.001-0.01%; Ba, 0.001-0.005%; K, <0.005%; and Cu, Li, Mn, Pb, and Ti, <0.001%.

The chemically determined value for SiO_2 is 0.67%.

The analytical work leading to certification was performed in the Division of Technical Services, U.S. Customs Laboratories, and by J. R. Moody and K. M. Sappenfield of the NBS Center for Analytical Chemistry. The spectrochemical determinations were made by M. Darr of the NBS Center for Analytical Chemistry.

A comparison of the ion electrode procedure with the spectrophotometric procedure was performed by R. L. Zimmerman, Jr., and H. G. Bertrand of the U.S. Customs Laboratory, New Orleans, La., and by J. R. Moody of the NBS Center for Analytical Chemistry.

This material was supplied by the American Smelting and Refining Company of El Paso, Texas; it was ground to pass a 177 μm (80 mesh) screen.

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 J. L. Hague, R. E. Michaelis, and C. L. Stanley.

Washington, D.C. 20234
January 8, 1980
(Revision of Certificate
dated 12-6-71)

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

Method for the Determination of CaF_2 in Fluorspar

A. Calcium Fluoride Determination: Transfer a 0.5 ± 0.01 g sample, previously dried at 100 to 105 °C, to a 60 mL Pt dish. Add 15 mL acetic acid (1:9) and approximately 50 mg of dry, ashless filter pulp. Digest on a steam bath for 30 minutes and stir with a small glass rod at 5-minute intervals. Stir and filter through an 11-cm close-texture filter paper (S&S No. 589 Red Ribbon, or equal) to which has been added approximately 4 mL filter pulp slurry (1 g ash-free pulp in 100 mL of water). Thoroughly wash crucible, stir rod, and paper with small portions of hot water (approximately 35 mL). The filtrate and washings should be collected in a polyethylene bottle for the determination of dissolved fluoride by either the spectrophotometric method described in Part B or the ion-selective electrode method described in Part C. Transfer paper and residue to original crucible, wipe the funnel with a small piece of filter paper,and add the paper to the crucible to assure recovery of fine particles. Dry crucible and contents, ignite to a dull red heat (600 °C), and cool to room temperature.

Transfer the residue, as completely as possible, from the crucible to a 400-mL beaker by gently tapping the crucible. Add 5 to 10 mL HCl to the crucible and warm on a steam bath or a temperature-regulated sand bath. Transfer the HCl to the beaker containing the residue. Police and wash the crucible with a minimum amount of hot water. Repeat adding HCl and washing 2 or 3 times using a total of 25 mL HCl. Add approximately 0.5 g of crystalline boric acid to beaker, cover with a watch glass, and digest on the steam bath for 15 minutes. Remove the beaker and cool to room temperature. Add 0.5 mL HNO_3 and slowly evaporate on the steam bath to approximately 10 mL. During evaporation, the cover glass should be gradually removed from the beaker. Wash down the sides of the beaker with a fine stream of water and adjust the volume to approximately 75 mL. Heat to 70 to 80 °C, remove from heat, and add 100 mL of precipitating solution [3.8 g ammonium oxalate, 1.1 g oxalic acid, and 0.05 g disodium ethylenediaminetetracetate (EDTA) in 100 mL of water]. If a white precipitate forms at this point, add HCl dropwise until it dissolves.

Heat to boiling and slowly add NH_4OH (1:1) until a heavy white precipitate forms. Add 1 mL of bromocresol green solution (0.1 g soluble salt in 100 mL of water) and continue the addition until the color of the solution changes from yellowish-orange to grayish-green. Digest for 30 minutes on the steam bath, let stand for 60 minutes at room temperature, and filter by decantation through a prepared Gooch crucible (size 3, prepared with 2.1 cm glass-fiber filter paper, H. Reeve Angel No. X-934AH, or equivalent). Wash 3 or 4 times with a cold wash solution (0.2 g ammonium oxalate and 0.1 g oxalic add in 100 mL of water) and finally with 3 or 4 10-mL portions of cold water. (The washed precipitate should be free of chloride, ammonium oxalate, or any other contaminant that might reduce the $KMnO_4$ solution.) Transfer the contents of the crucible to a 400-mL beaker, add 250 mL H_2SO_4 (1:19), and adjust the solution temperature to 27 ± 3 °C. While stirring, add approximately 90 percent of the 0.15 N $KMnO_4$ solution to be used for titration. This should be added at a rate of approximately 30 mL per minute from a buret. Allow to stand until the pink color disappears, e.g., approximately 45 seconds. (If pink color persists, too much $KMnO_4$ solution has been added and the determination must be repeated.) Heat to 57 ± 3 °C and complete the titration by slowly adding the last 0.5 to 1 mL $KMnO_4$ solution dropwise and allowing each drop to decolorize completely before adding the next drop. The end point is a pink color persisting for 30 seconds or more. See calculations.

B. Determination of Fluoride in Acetic Acid Leach Solution: Remove all ions from the solution that might cause interference in the spectrophotometric determination of dissolved fluoride, by using either the ion-exchange method, or the fluorine-distillation method described in 2 and 3. Prepare a reagent blank, by substituting 15 mL of acetic acid (1:9), diluted to approximately 55 mL with distilled water and analyze simultaneously with sample.

1. Preparation of calibration curve: Prepare a dilute fluoride standard (1 mL = 0.1 mg CaF_2) from a standard solution (1 mL = 1 mg CaF_2) of 1.0755 g NaF diluted to one liter in a polypropylene volumetric flask with distilled water. Take a series of aliquots of 1, 2, 4, 6, 8, 11, 16 mL,etc., from the diluted fluoride standard and transfer them to 60-mL polyethylene bottles. Add 15 mL of acetic acid (1:9) and sufficient distilled water to bring the final volume to approximately 55 mL. Proceed to the ion-exchange or fluorine-distillation method.

2. Ion-exchange method: Prepare an anion-exchange column by pouring a slurry of distilled water and Rexyn 201 (OH) resin, or equivalent, sufficient to give a total exchange capacity of 27 to 30 meq, into a 25 mL polystyrene buret plugged with washed absorbent cotton (not glass wool) and drain off the excess water without allowing the water level to fall below the top of the resin column at any time. Continue this procedure until the resin is within about 5 mL of the top of the buret. Wash the resin with 20mL N NaOH, and finally with distilled water (approximately 100 mL), until the effluent is no longer alkaline. Adjust the stopcock to give a flow rate of approximately 100 drops per minute. The flow rate is an indicator of the state of the column. Backwash with distilled water whenever the flow rate falls below 100 drops per minute. Resin must be covered with liquid at all times.

Prepare a cation-exchange column in the same manner as the anion exchange column using a slurry of distilled water and Rexyn 101(H) resin, or equivalent, sufficient to give a total exchange capacity of 40 to 45 meq. Wash the resin with 50 mL of 1N HCl, and finally with distilled water (approximately 200 mL) until the effluent is free of chloride ion. Flow rate should be approximately 100 drops per minute.

Each of the diluted aliquots, as well as the blank, is run separately as follows: After completing both columns, pass the entire volume from the polyethylene bottle through the anion-exchange column, always maintaining the liquid level slightly above the top of resin. Wash the polyethylene bottle with distilled water and pass washings through the column using a total of approximately 60 mL for each sample. Discard the effluent and washings. Recover the fluoride, acetate, and other anions from the column by passing 20 mL of 1N NaOH through the column at a flow rate of approximately 100 drops per minute. Collect the effluent in the original polyethylene bottle. Wash the column with distilled water and collect washings in the same bottle to capacity (60 mL). Pour the contents of this bottle, and water used to rinse it, into the cation column and collect the effluent in a 100-mL volumetric flask. Wash the column with distilled water and collect just short of the mark in the same flask. Bring the liquid to the mark with distilled water. Proceed to the spectrophotometric determination.

3. Distillation method: Have water in a steam generator actively boiling, but do not connect to the fluoride distillation apparatus (Willard and Winter, or equivalent) at this time. Distill each of the diluted aliquots,as well as the blank,separately as follows: Transfer the entire volume from the polyethylene bottle to the 500-mL Claisen flask of the distillation apparatus using a minimum quantity of water for rinsing. Add 50 mL H_2SO_4 (1:1) and a few glass beads. Insert a stopper carrying the steam tube and thermometer, and heat the flask with a Bunsen burner or an electric heater. Connect the condenser at once and place a 200-mL polypropylene volumetric flask at the receiving end. Water soon begins to distill over and the temperature of the liquid rises as the H_2SO_4 concentration increases. When the temperature reaches 120 °C connect the flask to the steam generator by means of the rubber tube. The rate of steam generation and the rate at which the Claisen flask is being heated should be regulated so that the temperature of the liquid in the distilling flask is maintained at 135 to 145 °C. Distill until the total volume in the receiver is approximately 185 mL (Note 1). Disconnect the condenser and rinse with a small portion of water, catching the washings in the flask containing the distillate, and fill to mark with distilled water. Proceed to the spectrophtometric determination.

4. Spectrophotometric determination: Pipette about one-tenth of the volume of the solution from steps B-2 or B-3 containing approximately 0.1 to 0.2 mg CaF_2 (not more than 50 mL) into a 100-mL polypropylene volumetric flask and add 15 mL 0.1 N sodium acetate solution and 25 mL methyl cellosolve. Bring the solution level in the flask almost to mark with distilled water and allow to cool to room temperature (mixing reaction is slightly exothermic) before making a final volume adjustment. (Resulting solution should have a pH of 3 to 5; optimum color development occurs in this range.)

Pour the entire contents of the volumetric flask into a 125-mL stoppered erlenmeyer flask containing 0.1 g of thorium chloranilate (Note 2). Stopper the flask and place on a shaking apparatus. Shake for 55 minutes, remove, and allow the contents of the flask to settle for 5 minutes. Filter through a close-texture filter paper, discarding the first 5 to 10 mL of filtrate.

Read the absorbance of sample against the reagent blank using 1 cm absorption cells in a Beckman DU spectrophotometer, or its equivalent, at a wavelength of 330 nm and a slit width of about 0.2 mm. Plot absorbance vs mg of CaF_2. This should yield a straight line passing through the origin.

5. Analysis of acetic acid leach solution: Carry the entire filtrate from the acetic acid digestion through steps B-2 or B-3 and finally B-4. Determine mg of CaF_2 by using the calibration curve and proceed with calculation.

C. Determination of Fluoride in Acetic Acid Leach Solution with an Ion-Selective Electrode.

1. Apparatus, Reagents, and Solutions

a. Special Apparatus
   1) Fluoride specific ion electrode
   2) Single junction reference electrode
   3) Expanded scale pH meter with millivolt capability

b. Reagents
   ACS Reagent grades of sodium fluoride, glacial acetic acid, sodium chloride, and sodium hydroxide, must be used. For (1,2 Cyclohexylenedinitrilo)- tetraacetic acid (CDTA), a practical grade available from a commercial source may be used.

c. Solutions
   1) TISAB II - (Total Ionic Strength Adjustment Buffer)
      To 500 mL of distilled water in an 800 mL beaker, add 57 mL of glacial acetic acid, 58 g of sodium chloride, and 4 g of CDTA. Place the beaker in a cold water bath, on a magnetic stirrer. Stir the mixture, while adding concentrated sodium hydroxide, to provide a pH between 5.0 and 5.5. Transfer the contents of the beaker to a 1-liter flask, and dilute to the mark with distilled water. (TISAB II is used to provide a constant ionic strength background, decomplex the fluoride ions, and adjust and buffer the pH of the solution.)

   2) Standards
      a) Stock Solution (1900 ppmF^-) - Dissolve 4.199 g of sodium fluoride in a 1-liter polypropylene volumetric flask and dilute to volume with distilled water.
      b) Working stock solution (19.00 ppmF^-) - Transfer 10 mL of stock solution (a) to a 1-liter polyproplene volumetric flask and dilute to the mark with distilled water.
      c) Working standards - Prepare standards according to Table I.

TABLE I

F^- Conc. (μg/mL)	Working Stock (mL)	TISAB II (mL)	Distilled Water[1] (mL)
9.50	50.0	50	- -
4.75	25.0	50	25
2.85	15.0	50	35
1.90	10.0	50	40
0.95	5.00	50	45
0.38	2.00	50	48

[1]If prepared in a 100 mL flask, dilute to mark with distilled water.

Store working standards in polyethylene bottles and refrigerate until use.

2. Procedure

Transfer the contents of the polyethylene bottles containing the acetic acid wash (Section A) to 200 mL polyethylene volumetric flasks and dilute to volume with distilled water. Transfer a 25 mL aliquot to a 50 mL polyethylene volumetric flask and dilute to volume with TISAB II. Place in refrigerator until ready for use. In a polyethylene bottle, prepare a reagent blank consisting of 15 mL of acetic acid (1:9) and approximately 55 mL of distilled water.

Transfer the working standards, test solutions, and the reagent blank to 150 mL polyethylene beakers and allow to come to room temperature. Stir all solutions with magnetic stirrers. Adjust the pH meter to −150 mV by use of the 19.00 ppm F^- working stock solution. Record the values of the solutions beginning with the least concentrated working standard. NOTE: For solutions containing low concentrations of fluoride, the pH meter may require approximately two minutes to stablize (cessation of drift). Rinse and dry the electrodes with tissue paper between readings. Record the values of the test solutions and the reagent blank immediately following the working standards.

Plot a curve from the values obtained for the working standards, and determine the concentration of the test solutions from the curve. Proceed with calculations.

D. Calculations:

First, calculate the % CaF_2 found in Part A. Then calculate the % CaF_2 found in either Part B (spectrophotometric procedure) or Part C (electrode procedure). Add the value calculated for either Part B or C to that calculated for Part A, to determine the total % CaF_2 in the sample.

$$\text{For Part A: } \%\ CaF_2 = \frac{3.904\ V_1 N}{W_s}$$

where: V_1 = Volume of $KMnO_4$ solution used (corrected for blank)

N = Normality of $KMnO_4$ solution

W_s = gram weight of sample

$$\text{For Part B: } \%\ CaF_2 = \frac{0.1\ W_c F}{W_s}$$

where: W_c = milligram weight of CaF_2 in aliquot

F = aliquot factor; $\dfrac{\text{Total volume from B-2 or B-3}}{\text{volume used}}$

W_s = gram weight of sample

$$\text{For Part C: } \%\ CaF_2 = \frac{CV_2AG}{W_s} \times 10^{-4}$$

where: C = observed concentration in ppm F^- (μg F^-/mL)

V_2 = volume of test solution

A = aliquot factor; $\dfrac{\text{total volume}}{\text{volume used}}$

G = gravimetric factor; $\dfrac{CaF_2}{2F}$

W_s = gram weight of sample

For the conditions described in Part C, this formula may be simplified as follows:

1) The sample is diluted to 200 mL and a 25 mL aliquot is taken; thus the aliquot factor, A, is: $A = \frac{200}{25} = 8.00$

2) The volume of test solution V_2 is always 50 mL; $V_2 = 50.0$ mL

3) The gravimetric factor, G, is : $G = \frac{CaF_2}{2F} = \frac{78.0768}{37.9968} = 2.055$

by substitution:

$$\% CaF_2 = \frac{C \times 50.0 \times 8.00 \times 2.055}{W_s} \times 10^{-4} \text{ or}$$

$$\% CaF_2 = \frac{0.0822C}{W_s}$$

Note 1. The volume of distillate necessary for complete recovery of fluoride will vary with the capacity of the distillation apparatus. Calibrate the apparatus by distilling a known quantity of fluoride to various final volumes to determine the volume necessary for complete recovery.

Note 2. Chloranilates are supplied as dry powders of high stability. However, long storage may reduce activity. Drying at 105 °C for at least 4 hours restores activity. Keep bottles tightly capped to prevent moisture absorption, which reduces activity and hinders the color development.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 81a

Glass Sand

(In Cooperation with the American Society for Testing and Materials)

This SRM is issued in the form of a ground powder (95% less than 106 μm) blended to ensure homogeneity. It should be dried for 2 hours at 105 °C before use.

Constituent	Recommended Value Percent by Weight	Range	s
Al_2O_3	0.66	0.62 - 0.69	0.011
Fe_2O_3	.082	.075 - .089	.0024
TiO_2	.12	.10 - .14	.0064
ZrO_2	.034	.025 - .042	.0026
Cr_2O_3	46 μg/g	33 - 58	3.9

Certification - The recommended value listed for each oxide is the best estimate of the true value based on the analytical data from both cooperators and NBS. The range of values listed is the tolerance interval, constructed such that it will cover at least 95% of the population with a probability of 0.99. It is computed as $X \pm Ks$: where s is the standard deviation, K is a factor that depends on n (the number of samples measured), p, the proportion of the total sample covered (95%), and γ, the probability level (99%). In all cases none of the n values used exceeded the range specified. Thus, it includes variability between laboratories and between samples.

The overall direction and coordination of the round-robin analysis leading to certification were performed by Paul Close, Chairman of ASTM Subcommittee C-14.02 on Chemical Analysis of Glass and Glass Products.

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 W. P. Reed.

Washington, D.C. 20234
January, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Chemical analyses for certification were performed in the following laboratories:

Anchor Hocking Corp., Lancaster, Ohio, R. E. Carr
Brockway Glass Co., Inc., Brockway, Pa., E. L. McKinley.
Corning Glass Works, Corning, N.Y., Y. S. Su.
Ford Motor Co., Lincoln Park, Mich., T. O. LaFramboise.
National Bureau of Standards, Analytical Chemistry Division, E. J. Maienthal, J. D. Messman and T. C. Rains.
Kimble Div. Owens-Illinois, Vineland, N. J., H. S. Moser.
Owens-Illinois, Inc., Toledo, Ohio, P. Close.
Penn State Univ., University Park, Pa., J. B. Bodkin.

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

Certificate of Analysis

Standard Reference Material 88a

Dolomitic Limestone

(All analyses are based on samples dried two hours at 110 °C)

	Percent
Silica (SiO_2)	1.20
Alumina (Al_2O_3)	0.19
Total Iron (as Fe_2O_3)	.28
Titania (TiO_2)	.02
Manganese (as MnO)	.03
Calcium (as CaO)	30.1 $_5$
Strontium (as SrO)	0.01
Magnesium (as MgO)	21.3
Sodium (as Na_2O)	0.01
Potassium (as K_2O)	.12
Phosphorus (as P_2O_5)	.01
Carbonate (as CO_2)	46.6
Loss on ignition	46.7

Washington, D.C. 20234
July 22, 1982
(Revision of Certificate
dated 1-31-67)

George A. Uriano, Chief
Office of Standard Reference Materials

U. S. Department of Commerce
Maurice H. Stans
Secretary

National Bureau of Standards
L. M. Branscomb, Director

Certificate of Analysis

STANDARD REFERENCE MATERIAL 97a

Flint Clay

(Results based on sample dried for two hours at 140 °C)

Analyst	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	K_2O	Na_2O	Li_2O	ZrO_2	BaO	MgO	CaO	SrO	Cr_2O_3	Loss on Ignition
1[2]	43.74	38.65	{0.45[a] .46[b]}	{1.88[c] 1.89[d]}	0.34	0.53[e]	0.033[e]	0.12[e]	0.063[f]	0.078[e]	0.16[g]	0.11[g]	0.17[g]	0.028[h]	13.32
2[2]	43.68	38.95	.45	1.95	.35	.51[e]	.041[e]	.10[g]	------	.07	.14[g]	.11[g]	.18[g]	.03	13.31
3	43.60	38.79	.43[a]	1.87[d]	.38[i]	.46[e]	------	------	------	------	------	------	------	------	------
Average	**43.67**	**38.79**	**0.45**	**1.90**	**0.36**	**0.50**	**0.037**	**0.11**	------	**0.07_5**	**0.15**	**0.11**	**0.18**	**0.03**	**13.32**

References: [1] G.E.F. Lundell and J.I. Hoffman, NBS J. Res. 1, 91 (1928) RP5.
[2] L. C. Peck, Geological Survey Bulletin 1170, (1964).

[a] o-phenanthroline photometric method.
[b] Iron reduced with $SnCl_2$ and titrated with standard potassium dichromate solution.
[c] Cupferron gravimetric method.
[d] H_2O_2 photometric method.
[e] Flame emission spectrometric method.
[f] Pyrocatechol violet photometric method.
[g] Atomic absorption method.
[h] Diphenylcarbazide photometric method.
[i] Molybdenum-blue photometric method.

List of Analysts

1. R. K. Bell, B. B. Bendigo, T. C. Rains, T. A. Rush, E. R. Deardorff, J. R. Baldwin, R. A. Paulson, W. P. Schmidt, and S. D. Rasberry, Analytical Chemistry Division, Institute for Materials Research, National Bureau of Standards.
2. L. C. Peck, United States Geological Survey, Denver, Colorado.
3. L. M. Melnick, J. D. Selvaggio, and D. G. Cunningham, Applied Research Laboratory, United States Steel Corporation, Pittsburgh, Pennsylvania.

The material for the preparation of this standard was provided by the A. P. Green Fire Brick Company, Mexico, Missouri.

The overall direction and coordination of the technical measurements leading to certification were performed under the chairmanships of O. Menis and J. I. Shultz.

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 J. L. Hague.

Washington, D. C. 20234
October 8, 1969

J. Paul Cali, Acting Chief
Office of Standard Reference Materials

U. S. Department of Commerce
Maurice H. Stans
Secretary

National Bureau of Standards
L. M. Branscomb, Director

Certificate of Analysis

STANDARD REFERENCE MATERIAL 98 a

Plastic Clay

(Results based on sample dried for two hours at 140 °C)

Analyst	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	K_2O	Na_2O	Li_2O	ZrO_2	BaO	MgO	CaO	SrO	Cr_2O_3	Loss on Ignition
1[1]	48.98	33.13	{1.34[a] 1.37[b]}	{1.56[c] 1.63[d]}	0.11	1.07[e]	0.080[e]	0.075[e]	0.042[f]	0.031[e]	0.42[e]	0.31[e]	0.041[e]	0.030[h]	12.40
2[2]	48.91	33.31	1.35	1.64	.10	1.08[e]	.083[e]	.064[g]	.....	.03	.43[e]	.31[e]	.037[e]	.04	12.49
3	.....	33.12	1.28[a]	1.61[d]	.11[i]	0.98[e]	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average	**48.94**	**33.19**	**1.34**	**1.61**	**0.11**	**1.04**	**0.082**	**0.070**	.....	**0.03**	**0.42**	**0.31**	**0.039**	**0.03**	**12.44**

References: [1] G.E.F. Lundell and J.I. Hoffman, NBS J. Res. 1, 91 (1928) RP5.
[2] L.C. Peck, Geological Survey Bulletin 1170, (1964).

[a] o-phenanthroline photometric method.
[b] Iron reduced with $SnCl_2$ and titrated with standard potassium dichromate solution.
[c] Cupferron gravimetric method.
[d] H_2O_2 photometric method.
[e] Flame emission spectrometric method.
[f] Pyrocatechol violet photometric method.
[g] Atomic absorption method.
[h] Diphenylcarbazide photometric method.
[i] Molybdenum-blue photometric method.

List of Analysts

1. R. K. Bell, B. B. Bendigo, T. C. Rains, T. A. Rush, E. R. Deardorff, J. R. Baldwin, R. A. Paulson, W. P. Schmidt, and S. D. Rasberry, Analytical Chemistry Division, Institute for Materials Research, National Bureau of Standards.
2. L. C. Peck, United States Geological Survey, Denver, Colorado.
3. L. M. Melnick, J. D. Selvaggio, and D. G. Cunningham, Applied Research Laboratory, United States Steel Corporation, Pittsburgh, Pennsylvania.

The material for the preparation of this standard was provided by the A. P. Green Fire Brick Company, Mexico, Missouri.

The overall direction and coordination of the technical measurements leading to certification were performed under the chairmenship of O. Menis and J. I. Shultz.

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 J. L. Hague.

Washington, D. C. 20234
October 8, 1969

J. Paul Cali, Acting Chief
Office of Standard Reference Materials

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

Certificate of Analysis

Standard Reference Material 99a

Feldspar

(All Analyses are Based on Samples Dried 2 hours at 105 °C)

	Percent
Silica (SiO_2)	65.2
Alumina (Al_2O_3)	20.5
Iron (as Fe_2O_3)	0.06$_8$
Titania (TiO_2)	.007
Calcium (as CaO)	2.14
Barium (as BaO)	0.26
Magnesium (as MgO)	.02
Sodium (as Na_2O)	6.2
Potassium (as K_2O)	5.2
Phosphorus (as P_2O_5)	0.02
Loss on Ignition	0.26

Washington, D.C. 20234
August 10, 1981
(Revision of Certificate dated
3-26-65)

George A. Uriano, Chief
Office of Standard Reference Materials

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON 25, D.C.

National Bureau of Standards Certificate of Analyses

of

Standard Sample No. 103a

Chrome Refractory

(All results are based on a sample dried for 2 hours at 105 to 110° C)

Analyst	Cr_2O_3	Al_2O_3	Total iron as FeO	MnO	MgO	CaO	SiO_2	TiO_2	ZrO_2	P_2O_5
1	[a] 32.05	[b] 29.95	[c] 12.43	[d] 0.12	[z] 18.57	[f] 0.70	[g] 4.68	[b] 0.22	[i] 0.01	[j] 0.007
2	[k] 31.95	[l] 30.10; [m] 30.01	[n] 12.43	.12	18.50	.69	[o] 4.68	.21		.01
3	[p] 32.07; [q] 32.09	[r] 30.02; [s] 29.95	[t] 12.45	[u].11	18.51	[v].68; [f].67	[w] 4.59	[x].22		[y]<.004
4	[p] 32.08	[s] 30.05		[z'].10	18.62	[b'].60	[w] 4.58	[c'].20		[d'].017
5	[e'] 31.98		[c] 12.43				[g] 4.63			
6	[p] 32.10	[f'] 29.91	[g'] 12.40	[h'].09	[s] 18.45	[f].72	[o] 4.64	[i'].21	[j].01	[j'].01
7	32.12	29.85		.10	18.49	.70		.25		
8	[p, r'] 31.78	[k'] 29.80	[l'] 12.43	[m'].10	[n'] 18.63	[b'].74	[o] 4.60	[o'].23		[p'].009; [q'].009
Average	32.06	29.96	12.43	0.11	18.54	0.69	4.63	0.22	0.01	0.01

[a] Persulfate oxidation and potentiometric titration with ferrous ammonium sulfate. Corrected for vanadium.
[b] Dissolved in perchloric acid, volatilized chromium with hydrochloric acid, extracted R_2O_3 cupferrates with chloroform at pH 3.5, separated aluminum by extracting R_2O_3 cupferrates in 4N hydrochloric acid with chloroform, precipitated aluminum with ammonia and weighed as Al_2O_3.
[c] Dissolved in perchloric acid. $SnCl_2$–$K_2Cr_2O_7$.
[d] Dissolved in perchloric acid. Periodate colorimetric method.
[e] Dissolved in perchloric acid. Gravimetric phosphate method. Corrected for Ca and Mn.
[f] Precipitated with magnesium, separated as sulfate in alcohol, precipitated with oxalate and weighed as CaO.
[g] Perchloric acid dehydration.
[h] Peroxide colorimetric method. Used 2d chloroform extraction footnote "b."
[i] Used R_2O_3 precipitate, separated with cupferron, and determined gravimetrically as phosphate.
[j] Dissolved in perchloric acid, precipitated with ammonia and determined by molybdenum blue colorimetric method.
[k] Average of footnote "a" and leached sodium peroxide fusion with water, filtered, acidified filtrate, added excess ferrous ammonium sulfate and titrated with permanganate.
[l] Precipitated with phenylhydrazine. Corrected for Cr_2O_3, Fe_2O_3, TiO_2, and P_2O_5.
[m] Separated with cupferron, corrected for Cr_2O_3 and P_2O_5.
[n] Leach sodium peroxide fusion, filtered and dissolved precipitate. $SnCl_2$–$KMnO_4$.
[o] Perchloric acid-sulfuric acid dehydration.
[p] Reduced with excess ferrous iron and titrated with permanganate.
[q] Reduced with excess ferrous iron and titrated with dichromate. Corrected for vanadium.
[r] Separated with ammonia and mercury cathode and precipitated with ammonia. Corrected for TiO_2.
[s] Removed chromium by ion exchange, separated with ammonia and mercury cathode and precipitated with ammonia. Corrected for TiO_2.
[t] Leached sodium peroxide-sodium hydroxide fusion, reprecipitated with ammonia. $SnCl_2$–$K_2Cr_2O_7$.
[u] Leached sodium peroxide fusion and dissolved hydroxides. Periodate colorimetric method.
[v] Used filtrate of ammonia precipitation (footnote "t"), precipitated as phosphate, separated as sulfate in alcohol and determined as oxalate.
[w] Fused with sodium peroxide and dehydrated with perchloric acid.
[x] Fused with sodium peroxide. Ammonia and cupferron separations made. Peroxide colorimetric method.
[y] Fused with sodium peroxide and reduced chromium with alcohol. Phosphomolybdate volumetric method.
[z] Leached sodium peroxide fusion, precipitated with NH_4Cl, reprecipitated with ammonia, dehydrated with perchloric acid, filtered, and precipitated with ammonia.
[a'] Dissolved in perchloric acid and volatilized chromium with hydrochloric acid. Volumetric bismuthate method.
[b'] Volumetrically. Oxalate titrated with permanganate.
[c'] Dissolved in perchloric acid and made ammonia separation. Peroxide colorimetric method.
[d'] Dissolved in perchloric acid, precipitated with ammonium molybdate, reduced with Jones reductor and titrated with permanganate.
[e'] Oxidized with permanganate and titrated potentiometrically with ferrous ammonium sulfate. Corrected for vanadium.
[f'] SiO_2 removed, R_2O_3 precipitated with NH_4OH. Acid cupferron separation, aluminum precipitated in filtrate with cupferron after neutralization with NH_4OH. Corrected for Cr_2O_3.
[g'] Dissolved in perchloric and sulfuric acids, precipitated as sulfide, ignited, fused with potassium bisulfate, oxidized with permanganate and titrated with titanous chloride.
[h'] Dissolved in perchloric and sulfuric acids, precipitated with magnesium and calcium, removed calcium with alcoholic sulfate separation. Bismuthate method.
[i'] Used acid cupferrates of aluminum determination (footnote f') and made an ammonical tartrate, hydrogen sulfide separation. Peroxide colorimetric method.
[j'] Gravimetric phosphomolybdate method.
[k'] Fused with sodium carbonate-sodium borate and made a mercury cathode separation. Gravimetric 8-hydroxyquinoline method. Corrected for titanium.
[l'] Dissolved in perchloric and sulfuric acids, precipitated with ammonia, and dissolved in hydrochloric acid. $SnCl_2$–$K_2Cr_2O_7$.
[m'] In filtrate from silicon determination reduced chromium with sulfurous acid, reoxidized iron with nitric acid, precipitated with ammonia, made sodium carbonate separation and determined photometrically with periodate.
[n'] Gravimetric as phosphate. Used filtrate from CaO determination.
[o'] Prepared solution as in footnote "m." Peroxide colorimetric method.
[p'] Dissolved in nitric, hydrochloric and perchloric acids, filtered, volatilized arsenic as bromide, and precipitated phosphorus as phosphomolybdate. Determined the equivalent molybdenum as lead molybdate.
[q'] Dissolved in perchloric acid, volatilized arsenic as bromide and determine phosphorus colorimetrically as phospho-vanado-molybdate in iso-amyl alcohol.
[r'] Omitted from average.

Analyst 1 and analyst 3 reported 0.09 percent vanadium and analyst 6 reported 0.12 percent V_2O_5.

Combustion in a tube furnace at approximately 900° C indicates 0.99 percent of water which is not removed by drying at 105 to 110° C.

List of Analysts

1. Keith M. Sappenfield, National Bureau of Standards.
2. Paul J. Byler, Booth, Garrett & Blair, Philadelphia, Pa.
3. Andrew S. McCreath & Sons, Inc., Harrisburg, Pa.
4. John H. Montague, E. G. Lavino and Co., Norristown, Pa.
5. George Oplinger, K. A. Lane, and M. S. Budd, Solvay Process Division, Allied Chemical Corp., Syracuse, N.Y.
6. B. C. Ruprecht and R. P. Lucas, Harbison-Walker Refractories Co., Pittsburgh, Pa.
7. L. J. Trostel, General Refractories Co., Baltimore, Md.
8. C. E. A. Shanahan, Richard Thomas & Baldwins, Ltd., Whitchurch, Aylesbury, Bucks, England.

WASHINGTON, D.C., September 28, 1962.

A. V. ASTIN, *Director*.

GPO 660530

U.S. Department of Commerce
Rogers C.B. Morton,
Secretary
National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Materials 113a and 329

Zinc Concentrates

These Standard Reference Materials are in the form of fine powder (<.15 mm) and are intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

SRM No. / Element	113a	329
	Percent by Weight[a]	
Zinc	57_3	45_5
Lead	2.80	6.0_6
Iron	2.08	12.9_4
Calcium Oxide	1.1_9	0.08
Magnesium Oxide	0.75	$.16_5$
Cadmium	.78	.14
Copper	.31	$.13_2$
Cobalt	(.11)[b]	(.009)
Nickel	(.07)	(.006)
Sulfur (Total)	30.6	(31.7)
Silicon Dioxide	(1.54)	(0.61)
Indium	---[c]	.019
Silver	0.046_7[d]	.0089[d]

[a] Based on samples dried at 105 °C for one hour. Moisture loss: for SRM 113a 0.08%; for SRM 329 0.4_5%.
[b] Figures in parenthesis are not certified but are given for information only.
[c] Not determined.
[d] Troy ounces per ton is 13.6_3 for SRM 113a and 2.6_0 for SRM 329.

NOTE: The total of constituents reported for SRM 113a is 97.6% and that for SRM 329 is 98.0%. The remainder is expected to consist mainly of oxygen, carbon, and water of crystallization.

CERTIFICATION: The value listed for a certified element is the present best estimate of the "true" value based on the results of the analytical program. The value listed is not expected to deviate from the "true" value by more than ± 1 in the last significant figure reported. For a subscript figure, the deviation is not expected to be more than ± 5. Based on the results of homogeneity testing, maximum variations within and among samples are estimated to be less than the uncertainty figures given above.

Washington, D.C. 20234
December 29, 1975
(Revision of Certificate of May 6, 1974 for change in silver results)

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

The material for these standards was supplied by Cominco American Inc., Spokane, Wash. The material for SRM 113a was prepared at the Magmont Mines, Bixby, Mo., and that for SRM 329 at the Sullivan Mine, Trail, B.C., Canada.

Following sieving and blending operations at NBS, homogeneity testing was performed by S. D. Rasberry and J. McKay, (x-ray fluorescence analyses); by E. J. Maienthal, (polarographic analyses); and by R. K. Bell, (chemical analyses).

Selected samples representative of the lot were analyzed and no significant variability was observed when using subsamples of 0.5 g or larger. (Moisture determinations usually were made on larger samples--up to 10 g.)

Cooperative analyses for certification were performed in the analytical laboratories of Cominco, Sullivan Mine, Trail, B.C., Canada, C. J. Mitchell; Cominco American Inc., Magmont Mines, Bixby, Mo., R. J. Gibson; and St. Joe Minerals Corp., Zinc Smelting Division, Monaca, Pa., J. J. Aldrich.

Analyses were performed in the NBS Analytical Chemistry Division by R. K. Bell and E. J. Maienthal.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of O. Menis and J. I. Shultz.

The technical and support aspects involved in the preparation, certification, and issuance of these SRM's were coordinated through the Office of Standard Reference Materials by R. E. Michaelis.

U. S. Department of Commerce
Peter G. Peterson
Secretary

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 120b

Phosphate Rock

(Florida)

This standard is a finely powdered material intended for use in checking chemical methods of analysis and in calibration with optical emission and x-ray spectrometric methods of analysis.

See ADDENDUM* (Over) for Uranium (Radium and Thorium)
(All results are based on samples dried for 1 hour at 105 °C.)

Percent by Weight

ANALYST*	P_2O_5	CaO	SiO_2	F	Soluble Fe_2O_3	Soluble Al_2O_3	MgO	Na_2O	MnO	K_2O		TiO_2	CO_2	CdO
1	34.51[a]	49.42[b]	4.70[c]	3.82[d]	1.10[e]	1.09[f,g]	0.29[h]	0.33[f]	0.032[i]	0.12[f,j]	--	0.15[k]	--	0.002[l]
2	34.51[m]	49.35[m]	4.73[n]	3.79[m]	1.10[h]	1.07[h]	.28[h]	.36[h]	.031[h]	.12[p]	0.09[o]	--	2.76P	.002[h]
3	34.66[n]	49.38[m]	4.67[q]	3.83	1.09[h]	1.07[h]	.30	.36[h]	.032[h]	.12[p]	.098[o]	.15	2.79	.002[h]
4	34.67[r]	49.47[m]	4.69[q]	3.81[s]	1.13[h]	1.04[h]	.28[h]	.35[h]	.032[h]	--	.087[o]	.15[k]	2.78P	.003[h]
5	34.57	49.32[m]	4.63[q]	3.86	1.06[h]	1.05[h]	.25[h]	.34[h]	--	--	.085[o]	--	2.83	--
6	34.48[m]	49.45[m]	--	3.92[s]	1.14[m]	1.07[t]	--	--	--	--	--	--	--	--
Average	34.57	49.40	4.68	3.84	1.10	1.06	0.28	0.35	0.032	0.12	0.090	0.15	2.79	0.002

[a] Phosphorus precipitated with magnesia mixture, ignited and weighed as $Mg_2P_2O_7$.

[b] Calcium precipitated as oxalate, ignited and weighed as CaO.

[c] Sample fused with Na_2CO_3, silica precipitated with ZnO and dehydrated with HCl. Traces of SiO_2 recovered by H_2SO_4 dehydration.

[d] Fluorine distilled into NaOH solution and precipitated as lead chlorofluoride. Chloride is precipitated with excess $AgNO_3$ and excess $AgNO_3$ is titrated with standard KCNS solution.

[e] $SnCl_2$ reduction – $K_2Cr_2O_7$ titration.

[f] Flame emission spectrometry with repetitive optical scanning.

[g] A value of 1.13 percent was obtained for total Al_2O_3 by gravimetry.

[h] Atomic absorption spectrometry.

[i] KIO_4 spectrophotometric method.

[j] Sample digested with mixed acids for 1 hour. Determination completed by atomic absorption spectrometry.

[k] H_2O_2 spectrophotometric method.

[l] Polarographic method.

[m] Volumetric method.

[n] Gravimetric method.

[o] Sample digested with dilute HCl or aqua regia for 15 minutes. Determination completed by atomic absorption spectrometry.

[p] CO_2 absorbed and weighed.

[q] Dehydration with $HClO_4$ in presence of boric acid.

[r] Molybdovanadophosphate spectrophotometric method.

[s] Distillation – titration with standard thorium nitrate solution.

[t] Aluminum precipitated with 8 hydroxyquinoline and weighed.

Washington, D.C. 20234
July 31, 1972
ADDENDUM* (Over)
July 31, 1979

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

The overall direction and coordination of the technical measurements leading to certification were performed under the chairmanship of O. Menis and J. I. Shultz.

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. E. Michaelis and C. L. Stanley.

PREPARATION, TESTING, AND ANALYSIS: The material for this standard was prepared by the American Cyanamid Company. Eighty five percent of the lot was made to pass 200 mesh sieve and some blending was done at the plant. Final sieving and blending operations were accomplished at NBS.

Homogeneity testing was performed by S. D. Rasberry, C. E. Fiori, and J. McKay with x-ray fluorescence analysis. Calcium and phosphorus determinations were made on 14 samples representative of the top and the bottom of seven containers. The size of the samples taken for analysis was approximately 35 mg. The maximum variations in concentration among samples were within 0.09 percent for CaO and 0.12 percent for P_2O_5.

The laboratories and analysts cooperating in the analytical program for certification were:

1. R. K. Bell, E. R. Deardorff, E. J. Maienthal, T. C. Rains, T. A. Rush, and S. A. Wicks, Analytical Chemistry Division, Institute for Materials Research, National Bureau of Standards.
2. J. Padar, Agrico Chemical Co., Division of Continental Oil Company, Pierce, Florida.
3. D. B. Underhill, Borden Chemical Co., Plant City, Florida.
4. C. C. Thornton, Thornton Laboratories, Inc., Tampa, Florida.
5. W. W. Harwood, R. M. Lynch and H. N. Gomez, International Minerals and Chemical Corp., Bartow, Florida.
6. J. A. Sielski, American Cyanamid Co., Brewster Plant, Bradley, Florida.

*ADDENDUM

Uranium has been determined at NBS by thermal ionization mass spectrometry, E. L. Garner and L. A. Machlan, and the following certification is made:

	Value, $\mu g/g$	Estimated Uncertainty[a]
Uranium	128.4	± 0.5

[a]The estimated uncertainty is based on judgment and represents an evaluation of method imprecision and material variability.

(NOTE: On similar phosphate rock materials, a value of 127 $\mu g/g$ for uranium was reported in Ref. 1; additionally, values of 17 $\mu g/g$ for thorium and 43 pCi $^{225}Ra/g$ for radium also were reported.)

Ref. 1 Agr. Food Chem., 16, No. 2, 1968 (p232)

U. S. Department of Commerce
Frederick B. Dent
Secretary

National Bureau of Standards
Richard W. Roberts, Director

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 154b
Titanium Dioxide

This standard is in the form of fine powder, certified primarily for application in the paint and ceramic industries.

Constituent	Percent by Weight[a]	Uncertainty[c]
Titanium Dioxide (TiO_2)	99.74[b]	0.05

[a] Based on material dried at 110 °C for two hours.

[b] The value given in this certificate is based on the following pertinent analytical data:

[c] The uncertainty figure represents the 95% confidence interval of the mean of all accepted values.

Method	NBS Average	Standard Deviation[1]	Number of Determinations
Controlled-potential coulometric (0.2g samples)	99.73	0.05	9
Volumetric (0.35g samples)	99.71	0.03	10[2]
	Cooperators[3]		
Volumetric (Analyst A)[4]	99.75	0.04	3
Volumetric (ASTM D1394)	99.78	0.05	3

[1] Of single determinations.

[2] Two discrepant results were omitted.

[3] Results from one cooperating laboratory were deemed significantly high and have been omitted.

[4] Results from Analyst B at the same laboratory were deemed significantly low and have been omitted.

Washington, D. C. 20234
May 16, 1973

J. Paul Cali, Chief
Office of Standard Reference Materials

PLANNING, PREPARATION, TESTING, and ANALYSIS: The material for this SRM has been carefully selected and prepared not only to reflect the present composition needs but also the anticipated future requirements.

A particular ilmenite ore was chosen so that, after beneficiation, the material would provide the desired high rutile to anatase ratio (rutile 97+%, anatase about 2%). Bleaching agents were not added; thus the material has the characteristically yellowish color of rutile. The lot was thoroughly blended in the laboratory and then screened through a 44μm (325 mesh) sieve. Preliminary testing on 6 samples, representative of the lot, showed no evidence of inhomogeneity. The planning, preparation and preliminary testing were under the supervision of John J. Libera, Research and Development Department, National Lead Industries, St. Louis, Missouri.

Cooperative analyses for certification were performed in the analytical laboratories of E. I. Du Pont De Nemours & Co., Pigments Department, Wilmington, Delaware, T. D. McKinley; National Lead Industries, Titanium Pigment Division, South Amboy, New Jersey, Benjamin S. Sanderson; and Sherwin-Williams Research Center, Chicago, Illinois, R. W. Scott.

Analyses were performed in the Analytical Chemistry Division of the National Bureau of Standards by J. R. Baldwin and G. Marinenko.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of O. Menis and J. I. Shultz.

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. E. Michaelis and C. L. Stanley.

ADDITIONAL INFORMATION ON THE COMPOSITION:

Certification is made only for the TiO_2 content. Investigations of this material at NBS and at cooperating laboratories provided some additional information that may be useful, but is not certified:

Constituent	Weight Percent
P_2O_5	(0.04)
SiO_2	(0.01)
Fe_2O_3	(0.006)
Pb	(0.003)
CaO	($\sim$0.01)
V	($\sim$0.001
Cr	($\sim$0.0005)
Cu	($\sim$0.0005)
MgO	($\sim$0.01)
Moisture (110 °C-2 hours)	(0.02 to 0.05)
Loss on Ignition (900 °C for one hour under helium)	(0.06 to 0.07)

If in the use of this SRM, determinations are made for any of the uncertified minor and trace constituents, it would be appreciated if the results were forwarded to the Office of Standard Reference Materials. When sufficient information has been received the Certificate will be revised.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 165a
Glass Sand

(In Cooperation with the American Society for Testing and Materials)

This SRM has been blended to ensure homogeneity. It should be dried for 2 hours at 105 °C before use.

Constituent	Percent by Weight	Range	s
Al_2O_3	0.059	0.051 - 0.066	0.0024
Fe_2O_3	.012	.007 - .017	.0018
TiO_2	.011	.0065 - .015	.0016
ZrO_2	.006	.0005 - .012	.002

Certification - The value listed for each oxide is the best estimate of the "true" value based on the analytical data from both cooperators and NBS. The range of values listed is the tolerance interval, constructed such that it will cover at least 95% of the population with a probability of 0.99. It is computed as $X \pm Ks$: where s is the standard deviation, K is a factor that depends on n (the number of samples measured), p, the proportion of the total samples covered (95%), and γ, the probability level (99%). In all cases none of the n values used exceeded the range specified. Thus, it includes variability between laboratories and samples.

The overall direction and coordination of the round-robin analysis leading to certification were performed by Paul Close, Chairman of ASTM Subcommittee C-14.02 on Chemical Analysis of Glass and Glass Products.

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 W. P. Reed.

Washington, D.C. 20234
October 16, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Additional Information

A content of 1 $\mu g/g$ for Cr_2O_3 is not certified but rather is provided for information only.

Chemical analyses for certification were performed in the following laboratories:

Anchor Hocking Corp., Lancaster, Ohio, R. E. Carr.
Brockway Glass Co., Inc., Brockway, Pa., E. L. McKinley.
Corning Glass Works, Corning, N.Y., Y. S. Su.
Ford Motor Co., Lincoln Park, Mich., T. L. LaFramboise.
National Bureau of Standards, Analytical Chemistry Division, E. J. Maienthal, J. D. Messman and T. C. Rains.
Kimble Div. Owens-Illinois, Vineland, N.J., H. S. Moser.
Owens-Illinois, Inc., Toledo, Ohio, P. Close.
Penn State Univ., University Park, Pa., J. B. Bodkin.

U. S. Department of Commerce
Maurice H. Stans
Secretary
National Bureau of Standards
L. M. Branscomb, Director

Certificate of Analysis

Standard Reference Material 180

High-Grade Fluorspar

This Standard Reference Material has a high calcium fluoride content and is issued primarily for the geological and geochemical scientific community. [NOTE: This material is not a substitute for the fluorspar standard, SRM 79, used primarily for the assay of fluorspar imported for industrial use.]

Constituent	Percent, by weight
CaF_2	98.80[a] ± 0.03[b]

[a]The value certified is based entirely on the method given in this certificate and is the mean of eight determinations.
[b]The standard deviation of a single determination.

Trace elements: These were determined by a general qualitative spectrochemical method and are given for information only. Fe, 0.1 – 1.0%; Al, Ba, Mg, Pb, Si, and Sr, 0.01 – 0.1%; Cu, K, Mn, Na, Ti, and V, 0.001 – 0.01%; and Ag and Li, less than 0.001%. Analyst - E. K. Hubbard.

The analytical work leading to certification was performed by K. M. Sappenfield, Analytical Chemistry Division, National Bureau of Standards.

This material was supplied by Minera Frisco of San Francisco Del Oro, Chih., Mexico.

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 J. L. Hague, R. E. Michaelis, and C. L. Stanley.

Washington, D. C. 20234
March 31, 1971

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

METHOD FOR THE DETERMINATION OF CaF_2 IN FLUORSPAR

*Transfer 0.50 g of fluorspar, previously dried at 100 to 105 °C, to a tared, ignited platinum crucible. Add 15 ml of acetic acid (1:9) containing 0.667 g of $CaCO_3$ per liter. Digest on a steam bath for 30 minutes and stir at five minute intervals. Add about 0.04 g of ashless filter pulp and stir for an additional minute. Filter through a double 12.5 cm extra dense filter paper (S & S No. 589 Red Ribbon) to which has been added about 0.04 g ashless filter pulp. Thoroughly wash the crucible, paper, and stirring rod with 5 ml portions of hot water (40 to 60 °C), using a total of about 35 ml. After washing, wipe the stirring rod with a small piece of wet filter paper and add the paper to the filter. Transfer the paper and residue to the crucible, dry in an oven at 80 °C, char slowly under an infrared lamp, and ignite in a muffle furnace at 600 °C.

**Add 3 ml of HF to the residue in the crucible and evaporate to dryness. Add 1 to 2 ml of $HClO_4$ and evaporate to dryness under the hood. Cool, wash the inside of the crucible with 1 ml more of $HClO_4$ (to catch any undecomposed particles of calcium fluoride), and again evaporate to dryness. Cool the crucible and immerse in a beaker containing 150 ml of dilute HCl (5:95). Warm the beaker gently and remove the platinum crucible, being sure to remove adhering particles of $Ca(ClO_4)_2$.

Boil the contents of the beaker for 10 minutes. If any insoluble matter remains; filter, wash, and ignite it in platinum. Treat the ignited residue with a few drops of HF and $HClO_4$ and heat to expel the acids. Add 1 to 2 ml of HCl and digest on a steam bath. Transfer the contents to the main filtrate.

Pass H_2S into the clear filtrate for several minutes and then make the solution ammoniacal. Continue with H_2S for 10 minutes and allow the precipitate to settle for 20 to 30 minutes. Filter and wash with NH_4Cl–$(NH_4)_2S$ solution. (Prepare by passing a moderate stream of H_2S for 5 minutes through a solution containing 5 ml of NH_4OH and 10 g of NH_4Cl per liter.)

Neutralize the filtrate and washings with HCl, and add an additional 20 ml of HCL. Boil for 2 to 3 minutes to expel most of the H_2S. Add KBr-Br_2 solution (20% solution of KBr saturated with Br_2) until the solution remains yellow. Boil until the finely divided sulfur has been oxidized and the bromine has been expelled. If the sulfur or sulfides are not removed by the bromine treatment, filter, wash the paper well and discard the residue. Dilute the filtrate to about 200 ml. Precipitate the calcium by adding 2 g of $(NH_4)_2C_2O_4 \cdot H_2O$ and, while stirring, slowly add NH_4OH until the solution is slightly ammoniacal. Heat on a steam bath for one-half to one hour, stirring occasionally. Cool to room temperature. Filter on a close textured paper. Wash with a cold 0.1 percent solution of $(NH_4)_2C_2O_4 \cdot H_2O$. Ignite to constant weight. Calculate the percent CaF_2 from the weight of the CaO.

References:

*Removal of soluble calcium in acetic acid. Interlaboratory study of soluble calcium.

**Method: Calcium in fluorspar
The Analysis of Fluorspar by G. E. F. Lundell and J. I. Hoffman, J. Res. Nat. Bur. Stand. (U.S.), 2 (1929) R.P. 51.

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

Certificate of Analysis

STANDARD REFERENCE MATERIALS

181, 182, and 183

Lithium Ores

These SRM's are intended for use in checking the accuracy of assay methods. They are certified for their constituent of economic interest. Additional data for information only appears on page 2. These SRM's are supplied in the form of fine powder.

	SRM 181 (Spodumene) %	SRM 182 (Petalite) %	SRM 183 (Lepidolite) %
Li_2O	6.3_9	4.3_4	4.1_2

The value listed for Li_2O in the three SRM's is the best estimate of the "true" value. The deviation is not expected to be more than ± 5 in the subscript number.

Washington, D.C. 20234
October 1, 1981
(Revision of Certificate dated
2/24/58 and Reprinted 8/20/70)

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

The following values are approximate, and are listed only for information.

Constituent	Wt. %	Wt. %	Wt. %
Na_2O	(0.8)	(0.4)	(0.2)
K_2O	(.3)	(.1)	(8.)
Rb_2O	- - -	(.03)	(3.5)
Cs_2O	- - -	- - -	(.3)

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON 25, D.C.

National Bureau of Standards Certificate of Analyses

Standard Sample 198
Silica Brick

(All results are based on samples dried at 105° to 110° C.)

Analyst	Al_2O_3	Total iron as Fe_2O_3	TiO_2	ZrO_2	P_2O_5	MnO	CaO	MgO	Na_2O	K_2O	Li_2O	[a]Loss on ignition
1	[b]0.17 [d].15	[e]0.65 [f].67	0.02	<0.01	[h]0.022	[i]0.006	2.72	0.07	[j]0.007	[j]0.016	[j]0.001	0.21
2	[k].19	[k].64	[k].01		[k].012		[k]2.74	[k].06	[k].009	[k].010	[k].001	.32
3	[b].17 [l].15	[m].67 [n].65	.01		[o].011		2.75	.06	[p].02	[p].03		.22
4	[q].17	[r].69	.02		[o].026		2.73	.08	[r].008	[k].016	[k]<.007	.15
5	[b].17	[s].66	.01		[t].025		2.72	.07	[j].005	[j].012	[j].002	.23
6		.68	.03		.026		2.72	.07	[j].005		[j].001	.23
7	[b].16	[r].68	.03		.025	<.005	2.69	.09	[j].02	[j].02	[j].001	.22
8	[u].16	[r].66	.02		[b].019		2.70	.08				.20
9	[k].15	[v].66	.02		[t].024 [k].02	[l].008	2.74	.07			[k]<.01	.14
10	[b].16	[r].66	.01	nil			2.67	.06				.20
11	[w].16	[r].68	.01		[t].024	[x].01	2.67	.09				
12	[u].16	[r].67	.02		[t].024	.008	2.71	.08	[j].02	[j].018		
Average	0.16	0.66	0.02		0.022	0.008	2.71	0.07	0.012	0.017	0.001	0.21

[a] 1 g heated at 900° to 1,000° C. in a covered platinum crucible to constant weight.
[b] Weighed ignited NH_4OH precipitate corrected for Fe_2O_3, TiO_2, and P_2O_5.
[c] Aluminum separated from iron, titanium, etc., with sodium hydroxide, precipitated, and weighed as $AlPO_4$.
[d] Same value obtained by the Aluminon photometric method.
[e] Thiocyanate photometric method.
[f] $SnCl_2$-$K_2Cr_2O_7$ method.
[g] Same value obtained gravimetrically as Fe_2O_3.
[h] Molybdenum-blue photometric method.
[i] Periodate photometric method.
[j] Flame-photometric method.
[k] Spectrographic determination.
[l] Aluminum separated from iron and titanium by ion exchange, and weighed as aluminum oxyquinolate.
[m] $SnCl_2$-$KMnO_4$ method.
[n] Iron separated from aluminum and titanium by ion exchange, precipitated with ammonium hydroxide, and weighed as Fe_2O_3.
[o] Gravimetric. Weighed as $Mg_2P_2O_7$.
[p] Titration with $AgNO_3$, following ion exchange separation of sodium and potassium chlorides.
[q] 8-Hydroxyquinoline precipitation. Bromate-thiosulfate titration. See Trans. British Ceramic Society 51, No. 9, 438 (1952).
[r] Sodium uranyl zinc acetate-gravimetric method.
[s] Titrated with $TiCl_3$ (SO_3)$_3$.
[t] Phosphomolybdate-alkalimetric method.
[u] Weighed as $AlPO_4$.
[v] Orthophenanthroline photometric method.
[w] Same value obtained by eriochromecyanine-R photometric method.
[x] Persulfate-arsenite method.

List of Analysts

1. K. M. Sappenfield and R. A. Paulson, National Bureau of Standards.
2. G. R. Eusner, U. S. Steel Corp., Monroeville, Pa.
3. B. E. Gumno, W. O. Osborn, and R. N. Smith, Crescent Division, North American Refractories Co., Curwensville, Pa.
4. M. P. Bennett and Falba Whitney, Gladding, McBean & Co., Los Angeles, Calif.
5. B. C. Ruprecht, Harbison-Walker Refractories Co., Pittsburgh, Pa.
6. A. R. Lesar, A. P. Green Fire Brick Co., Mexico, Mo.
7. L. J. Trostel, General Refractories Co., Baltimore, Md.
8. D. J. Halliscy, Jones & Laughlin Steel Corp., Pittsburgh, Pa.
9. J. J. Hazel, Republic Steel Corp., Cleveland, Ohio.
10. Paul Smith, The Refractories Institute, Mellon Institute, Pittsburgh, Pa.
11. J. B. Armstrong, Sparrows Point Plant, Bethlehem Steel Co., Sparrows Point, Md.
12. W. F. Zollinger, Bethlehem Steel Co., Bethlehem, Pa.

WASHINGTON 25, D.C., January 6, 1960.

A. V. ASTIN, *Director.*

U.S. GOVERNMENT PRINTING OFFICE 837863

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON 25, D.C.

National Bureau of Standards Certificate of Analyses

Standard Sample 199

Silica Brick

(All results are based on samples dried at 105° to 110° C.)

Analyst	Al_2O_3	Total iron as Fe_2O_3	TiO_2	ZrO_2	P_2O_5	MnO	CaO	MgO	Na_2O	K_2O	Li_2O	[a] Loss on ignition
1	[b] 0.47 [c] .48	[d] 0.76 [e] .74	0.07	0.01	[f] 0.010	[g] 0.005	2.41	0.13	[h] 0.015	[h] 0.09	[h] 0.001	0.14
2	[i] .49	[i] .70	[i] .05		[i] .016		[j] 2.45	[i] .14	[i] .010	[i] .07	[i] .002	.23
3	[h], [i] .48	[h] .75	.05				2.42	.12	[i] .02	[i] .11		.16
4	[m] .48	[d] .73	.06		[n] .026		2.38	.14	[o] .014	[h] .11	[i] <.007	.12
5	[h] .51	[p] .74	.06		[q] .012		2.39	.13	[h] .010	[h] .088	[h] .002	.16
6			.07		.015	.008	2.46	.14	[h] .004	[h] .10	[h] .001	.12
7	[h] .50	[d] .75	.07		.025	<.005	2.43	.10	[h] .02	[h] .09	[h] .002	.16
8	[r] .48	[d] .76	.07		[f] .005		2.38	.14				.13
9		[s] .72	.06		[q] .013	[g] .007		[i] .14			[i] <.01	.30
10	[h] .49	[d] .75	.06	nil	.03		2.37	.13				.17
11	[r], [t] .48	[d] .74	.06		[q] .008	[u] .01	2.38	.14		[v] .097		
12	[r] .48	[d] .74	.06		[q] .010	[g] .007	2.39	.14	[h] .03	[h] .087		
Average	0.48	0.74	0.06		0.015	0.007	2.41	0.13	0.015	0.094	0.002	0.17

[a] 1 g heated at 900° C. to 1,000° C. in a covered platinum crucible to constant weight.
[b] Weighed ignited NH_4OH precipitate corrected for ZrO_2, Fe_2O_3, TiO_2, and P_2O_5.
[c] Aluminum separated from iron, titanium, and zirconium by cupferron, precipitated with ammonium hydroxide, weighed as Al_2O_3 and corrected for P_2O_5.
[d] $SnCl_2$-$K_2Cr_2O_7$ method.
[e] Weighed as Fe_2O_3.
[f] Molybdenum-blue photometric method.
[g] Periodate photometric method.
[h] Flame-photometric method.
[i] Spectrographic determination.
[j] Same value obtained by separating aluminum from iron and titanium by ion exchange, and weighing as aluminum oxyquinolate.
[k] $SnCl_2$-$KMnO_4$ method.
[l] Titration with $AgNO_3$ following ion exchange separation of sodium and potassium chlorides.
[m] 8-Hydroxyquinoline precipitation. Bromate-thiosulfate titration. See Trans. British Ceramic Society **51**, No. 9, 438 (1952).
[n] Gravimetric. Weighed as $Mg_2P_2O_7$.
[o] Sodium uranyl zinc acetate-gravimetric method.
[p] Titrated with $Ti(SO_4)_2$.
[q] Phosphomolybdate-alkalimetric method.
[r] Weighed as $AlPO_4$.
[s] Orthophenanthroline photometric method.
[t] Same value obtained by eriochromecyanine-R photometric method.
[u] Persulfate-arsenite method.
[v] Gravimetric. Decomposition with NH_4Cl-$CaCO_3$.

List of Analysts

1. K. M. Sappenfield and R. A. Paulson, National Bureau of Standards.
2. G. R. Eusner, U.S. Steel Corp., Monroeville, Pa.
3. B. E. Gummo, W. O. Osborn, and R. N. Smith, Crescent Division, North American Refractories Co., Curwensville, Pa.
4. M. P. Bennett and Falba Whitney, Gladding, McBean & Co., Los Angeles, Calif.
5. B. C. Ruprecht, Harbison-Walker Refractories Co., Pittsburgh, Pa.
6. A. R. Lesar, A. P. Green Fire Brick Co., Mexico, Mo.
7. L. J. Trostel, General Refractories Co., Baltimore, Md.
8. D. J. Hallisey, Jones & Laughlin Steel Corp., Pittsburgh, Pa.
9. J. J. Hazel, Republic Steel Corp., Cleveland, Ohio.
10. Paul Smith, The Refractories Institute, Mellon Institute, Pittsburgh, Pa.
11. J. B. Armstrong, Sparrows Point Plant, Bethlehem Steel Co., Sparrows Point, Md.
12. W. F. Zollinger, Bethlehem Steel Co., Bethlehem, Pa.

WASHINGTON 25, D.C., January 6, 1960.

A. V. ASTIN, *Director.*

U.S. GOVERNMENT PRINTING OFFICE 537562

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 277

Tungsten Concentrate

(In cooperation with the American Society for Testing and Materials)

This material is in the form of powder (<0.15 mm) intended for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

Constituent	Certified Value[1] (wt%)	Estimated Uncertainty[2] (wt%)
WO_3	67.4	0.3

(Results are based on samples dried at 110 °C for one hour)

[1] The certified value is the *present best estimate* of the "true" value based on the results of the cooperative program for certification.

[2] The 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 of 1 g or more (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination.)

CAUTION: The material for this SRM primarily was derived from wolframite ores. It is, however, a mixture of concentrates from China, Thailand, and USA that contains titanium, niobium, tantalum, and tin in amounts not normally encountered in most wolframite concentrates. These constituents may interfere in the "classic" chemical procedures and may necessitate appropriate changes in methodology. Also, x-ray fluorescence methods of analysis that use SRM 277 to make relative measurements of "pure" wolframite (or scheelite) concentrates may exhibit systematic errors because of the unusual constituents contained in this concentrate.

The overall coordination of the technical measurements leading to certification were performed under the direction of J. I. Shultz, Research Associate, NBS-ASTM Research Associate Program.

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. E. Michaelis.

Washington, D.C. 20234
October 24, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, ANALYSIS: The material for SRM 277 was carefully selected and provided to NBS by GTE Sylvania, Towanda, Pennsylvania, courtesy of J. Demangone. At Sylvania, the material was crushed and ground to a fine powder. At NBS the material was sieved (<0.15 mm) and thoroughly blended.

Homogeneity testing of selected samples representative of the lot of SRM 277 was performed by an x-ray fluorescence technique by R. E. Michaelis. The material variability was determined to be within ± 0.1 (wt%) of WO_3.

Cooperative analyses for certification were performed in the following analytical laboratories:

Alfred H. Knight International, Ltd., Cheshire, U.K. - J. F. L. Knight.

Benedict Kitto and Sons, London, U.K. - R. Peck.

General Electric Company, Cleveland, Ohio - J. Rynasiewicz and J. W. Fulton.

GTE Sylvania, Towanda, Pa. - R. Dyck; and Waltham, Mass. - J. F. Cosgrove.

Hermann C. Starck, Berlin, Germany - O. Hilmer.

Ledoux & Company, Teaneck, N. J. - S. Kallmann.

National Bureau of Standards, Washington, D.C. - E. R. Deardorff.

Sandvik, A. B., Stockholm, Sweden - K. Kåårik; and Sandvik Asia Ltd. - N. R. Sanjana.

Spectro Chem Labs , Inc., Franklin Lakes, N. J. - E. W. Hobart.

Treibacher Chemische Werke, Treibach, Austria - Z. Otto.

Westinghouse Electric Corporation, Bloomfield, N. J. - P. J. Walitsky.

Union Carbide Corporation, Bishop, Calif. - E. C. Gibbs and K. M. Wilder; and Niagara Falls, N. Y. - P. Greenberg.

VEW Ternitz, Austria - A. J. Leeb.

NOTE: Details regarding the methodology employed in the analysis of this SRM, along with other pertinent information, will appear in a separate publication.

ADDITIONAL INFORMATION OF THE COMPOSITION: Certification is made only for the WO_3 content; however, SRM 277 contains additional constituents of interest as indicated below. These are *not certified* and are provided for information only. Table 1 lists those constitutents for which data were received from two or more laboratories that were in good agreement. (Most of these are expected to be proposed for certification at a later date and, therefore, an indication of the uncertainty also is given.) Table 2 lists those constituents for which data were received from a single laboratory (or discrepant data from two or more laboratories).

NOT CERTIFIED

Table 1

Constituent	Approximate Value (wt%)	Approximate Uncertainty (wt%)
Calcium	(0.37)	(0.02)
Iron	(7.4)	(.1)
Lead	(0.07)	(.01)
Manganese	(10.0)	(.2)
Molybdenum	(0.06)	(.01)
Niobium	(1.00)	(.03)
Phosphorus	(0.03)	(.01)
Silicon	(.85)	(.05)
Sulfur	(.25)	(.03)
Tin	(.54)	(.07)
Titanium	(2.2)	(.2)

NOT CERTIFIED

Table 2

Constituent	Information Value (wt%)	Constituent	Information Value (wt%)
Arsenic	(0.015)	Oxygen	(21.4)
Bismuth	(.07)	Scandium	(0.05)
Cerium	(.03)	Tantalum	(.20)
Chromium	(.04)	Thorium	(.08)
Copper	(.02)	Uranium	(.13)
Gadolinium	(.01)	Yttrium	(.03)
Lanthanum	(.02)	Zirconium	(.01)
Neodymium	(.03)		

In addition to the above, trace concentrations were reported (ppm by wt.) for the following as an indication of the relative amounts observed: Antimony (3), Barium (20), Boron (20), Dysprosium (30), Erbium (20), Europium (10), Holmium (5), Hafnium (20), Indium (20), Lutetium (5), Praseodymium (50), Samarium (40), Tellurium (2), Terbium (10), Thallium (2), Thulium (10), Vanadium (70), Ytterbium (50) and Zinc (20).

NOTE: Although SRM 277, Tungsten Concentrate, is expected to be stable under normal storage conditions, prudent cautions in the laboratory should be observed. The bottle should be kept tightly capped except when in direct use. Store in a desiccator over desiccant.

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 278

Obsidian Rock

This Standard Reference Material (SRM) is intended for use in evaluating the accuracy of analytical methods and instruments used in the analysis of geological type materials. SRM 278 is a finely powdered obsidian rock, which was obtained from Clear Lake, Newberry Crater, Oregon.

Certified Values of Constituents

The concentrations of the constituents were determined by methods that are widely used in the field of geological analysis and have a demonstrated accuracy. The values given are "certified" values, i.e., those values that were determined by either a definitive method, reference method, or by two or more independent methods, and "information" values that were determined by single or non-reference methods. The certified values are given in Table 1.

Table 1. Certified Values of Constituents

Constituent[1]	Content[2] (wt %)	Constituent[1]	Content[2] wt (μg/g)
Al_2O_3 [d]	14.15 ± 0.15	Cu [e]	5.9 ± 0.2
CaO [c]	0.983 ± 0.002	Ni [e]	3.6 ± 0.3
FeO [i]	1.36 ± 0.02	Rb [a,e]	127.5 ± 0.3
Fe_2O_3 [i,f] (Total Fe as Fe_2O_3)	2.04 ± 0.02	Sr [e]	63.5 ± 0.1
K_2O [a,d,e]	4.16 ± 0.02	Th [e,f]	12.4 ± 0.3
MnO [b,f]	0.052 ± 0.002	Tl [e]	0.54 ± 0.04
Na_2O [a,d,f]	4.84 ± 0.05	U [e]	4.58 ± 0.04
P_2O_5 [b,d]	0.036 ± 0.003	Pb [e]	16.4 ± 0.2
SiO_2 [d]	73.05 ± 0.13		
TiO_2 [b,g]	0.245 ± 0.007		

[1] Methods of Analysis:
[a] Atomic Absorption
[b] Colorimetry
[c] Emission Spectrometry
[d] Gravimetry
[e] Isotope Dilution Mass Spectrometry
[f] Neutron Activation Analysis
[g] Prompt-gamma Activation Analysis
[h] Specific Ion Electrode Potentiometry
[i] Titrimetry
[j] Volumetry

[2] The estimated uncertainties of the certified values are based on judgment and represent an evaluation of the combined effects of method imprecision, possible systematic errors among methods and material variability of 250 mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

The overall direction and coordination of the technical measurements leading to certification were performed in the Inorganic Analytical Research Division, E. L. Garner, Chief.

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. E. Gills.

Washington, D.C. 20234
August 19, 1981

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

Supplemental Information

Preparation

The material was processed by the Colorado School of Mines, Golden, Colorado. Approximately 350 lbs of obsidian rock were crushed, ground, and sieved to <200 mesh. The material was mixed in a cone blender to ensure homogeneity. For homogeneity testing and certification samples were randomly chosen and analyzed for both major and minor constituents. The inhomogeneity of this material is considered to be $\leq 2\%$ relative.

Analysis

SRM 278, a natural glass, is hygroscopic and contains water that cannot be driven off by drying at low temperatures. This material will pick up additional water on exposure to the atmosphere. Thus, exposure time should be kept to a minimum. Furthermore, the sample should be ignited to a constant weight in a muffle furnace or over a small flame at a temperature between 350-600 °C. This procedure will ensure the accurate and precise determination of SiO_2, K_2O, Na_2O, Al_2O_3 and possibly other major constituents.

The analysts and laboratories cooperating in the analytical program for certification were:

M. J. Blackman, E. L. Garner, J. W. Gramlich, L. A. Machlan, L. J. Moore,and R. Zeisler of the Inorganic Analytical Research Division, National Bureau of Standards.

J. B. Bodkin, J. C. DeVine, and N. H. Suhr of the Mineral Constitution Laboratories, The Pennsylvania State University, University Park, Pa.

S. S. Goldich of the Department of Geology, Northern Illinois University, DeKalb, Ill.

M. D. Glascock, C. C. Graham, J. R. Vogt, University of Missouri, Columbia, Mo.

The constituents given in Table 2 are *not certified* but are included for information only.

Table 2. Information Values

Constituent[1]	Content wt %	Constituent[1]	Content wt (μg/g)
C (Total Carbon)[j]	(0.05)	Ba [f]	(1140)
CO_2 [d]	(0.01)	B [g]	(25)
F [h]	(0.05)	Ce [f]	(62.2)
MgO [d]	(0.23)	Co [f]	(1.5)
		Cr [f]	(6.1)
		Cs [f]	(5.5)
		Eu [f]	(0.84)
		Gd [g]	(5.3)
		Hf [f]	(8.4)
		Lu [f]	(0.73)
		Sb [f]	(1.5)
		Sc [f]	(5.1)
		Sm [f,g]	(5.7)
		Ta [f]	(1.2)
		Tb [f]	(1.0)
		Yb [f]	(4.5)
		Zn f	(55)

U.S. Department of Commerce
Rogers C.B. Morton,
Secretary
National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards Certificate of Analysis

Standard Reference Materials 113a and 329

Zinc Concentrates

These Standard Reference Materials are in the form of fine powder (<.15 mm) and are intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

SRM No. / Element	113a	329
	Percent by Weight[a]	
Zinc	57_3	$45._5$
Lead	2.80	6.0_6
Iron	2.08	12.9_4
Calcium Oxide	1.1_9	0.08
Magnesium Oxide	0.75	$.16_5$
Cadmium	.78	.14
Copper	.31	$.13_2$
Cobalt	(.11)[b]	(.009)
Nickel	(.07)	(.006)
Sulfur (Total)	30.6	(31.7)
Silicon Dioxide	(1.54)	(0.61)
Indium	---[c]	.019
Silver	0.046_7[d]	.0089[d]

[a] Based on samples dried at 105 °C for one hour. Moisture loss: for SRM 113a 0.08%; for SRM 329 0.4_5%.
[b] Figures in parenthesis are not certified but are given for information only.
[c] Not determined.
[d] Troy ounces per ton is 13.6_3 for SRM 113a and 2.6_0 for SRM 329.

NOTE: The total of constituents reported for SRM 113a is 97.6% and that for SRM 329 is 98.0%. The remainder is expected to consist mainly of oxygen, carbon, and water of crystallization.

CERTIFICATION: The value listed for a certified element is the present best estimate of the "true" value based on the results of the analytical program. The value listed is not expected to deviate from the "true" value by more than ± 1 in the last significant figure reported. For a subscript figure, the deviation is not expected to be more than ± 5. Based on the results of homogeneity testing, maximum variations within and among samples are estimated to be less than the uncertainty figures given above.

Washington, D.C. 20234
December 29, 1975
(Revision of Certificate of May 6, 1974 for change in silver results)

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

The material for these standards was supplied by Cominco American Inc., Spokane, Wash. The material for SRM 113a was prepared at the Magmont Mines, Bixby, Mo., and that for SRM 329 at the Sullivan Mine, Trail, B.C., Canada.

Following sieving and blending operations at NBS, homogeneity testing was performed by S. D. Rasberry and J. McKay, (x-ray fluorescence analyses); by E. J. Maienthal, (polarographic analyses); and by R. K. Bell, (chemical analyses).

Selected samples representative of the lot were analyzed and no significant variability was observed when using subsamples of 0.5 g or larger. (Moisture determinations usually were made on larger samples--up to 10 g.)

Cooperative analyses for certification were performed in the analytical laboratories of Cominco, Sullivan Mine, Trail, B.C., Canada, C. J. Mitchell; Cominco American Inc., Magmont Mines, Bixby, Mo., R. J. Gibson; and St. Joe Minerals Corp., Zinc Smelting Division, Monaca, Pa., J. J. Aldrich.

Analyses were performed in the NBS Analytical Chemistry Division by R. K. Bell and E. J. Maienthal.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of O. Menis and J. I. Shultz.

The technical and support aspects involved in the preparation, certification, and issuance of these SRM's were coordinated through the Office of Standard Reference Materials by R. E. Michaelis.

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 330

Copper Ore, Mill Heads

This material is in the form of fine powder intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

This SRM is one of a series of four SRM's issued primarily for use in evaluation of the critically important "material balance" in the copper mining and metallurgical industries. The other three are: SRM 331, Copper Ore, Mill Tails; SRM 332, Copper Concentrate; and SRM 333, Molybdenum Concentrate.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

Constituent	Certified Value[a, b]	Estimated Uncertainty[c]
	Percent by Weight	
Total Copper	0.84	0.01
Molybdenum	.018	.001
	PPM by Weight	
Rhenium	0.30	0.06

[a] Based on samples dried at 105 °C for two hours. Separate samples are used for rhenium and calculated to a dry-weight basis.
[b] The certified value is the *best estimate* of the "true" value.
[c] Estimated uncertainty includes both method imprecision and material variability with samples 0.5 g (or more) for total copper, 1.0 g (or more) for molybdenum, and 2.5 g (or more) for rhenium.

The following values indicate the results of the analytical tests made at NBS and the Magma Copper Company.

Constituent / Method[1]	Average	Standard Deviation[2]	Number of Determinations
	Percent by Weight		
Total Copper			
Isotopic dilution mass spectrometry[3] (0.5 g samples)	0.837	0.007	8
Polarographic (0.5 g samples)	.85	.01	3
Iodometric (2.5 g samples)[4]	.85	01	21
Molybdenum		Range	
Isotopic dilution mass spectrometry[3] (1 g samples)	.0180	0.0001	2
	PPM by Weight		
Rhenium		Range	
Isotopic dilution mass spectrometry[3] (2.5 g samples)	0.303	0.054	6

[1] Details of the methods used, including drying and dissolution procedures, are given in a separate publication [1].
[2] Of single determinations for total Cu; range given for Mo and Re.
[3] This method has been studied extensively and the data are considered free from systematic errors [2].
[4] Results from Magma Copper Company.

Washington, D. C. 20234
January 20, 1977
(Revision of Provisional
Certificate of 2-20-73)

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, ANALYSIS: The material for this SRM (330) was carefully selected and provided to NBS by Magma Copper Company, San Manuel, Arizona, through the courtesy of T. L. Young.

At NBS this material was sieved and thoroughly blended, which involved several independent procedures [1].

Homogeneity testing of selected samples representative of the lot of SRM 330 was performed simultaneously with the analytical program for certification. At NBS, 0.5 g samples showed the maximum variability for total copper to be ±0.010 percent. At Magma, 2.5 g samples showed the maximum variability to be ±0.01 percent.

Cooperative analyses were performed at the Magma Copper Company, San Manuel, Arizona, by B. Cripe, R. L. Culder, A. B. Hall, D. A. Shah, J. T. Tadano, and M. Toelkes.

Analyses were performed in the NBS Analytical Chemistry Division by E. L. Garner, J. W. Gramlich, L. A. Machlan, E. J. Maienthal, J. R. Moody, and T. J. Murphy.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of W. R. Shields and I. L. Barnes.

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. E. Michaelis.

ADDITIONAL INFORMATION ON THE COMPOSITION: Certification is made *only* for total Cu, Mo, and Re. Although NOT CERTIFIED, the following additional information on the composition may be of interest.

Gold and Silver

Fire assay determinations for Au and Ag were made at Magma Copper Company:

	Gold	Silver
	PPM by Weight	
Fire assay	(0.093)	*(1.51)

*Revised 02/28/79

"Acid-Soluble" Copper

The total copper content includes "recoverable" sulfide copper and "nonrecoverable" oxide copper. Industrial practice is to determine "acid-soluble" copper and to relate this result to the oxide copper content. Investigation at NBS provided additional information on "acid-soluble" copper that may be useful, but is *not certified:*

Constituent/Method	Average	Range	Number of Determinations
	Percent by Weight		
"Acid-Soluble" Copper Isotopic dilution mass spectrometry (2.5 g samples)	(0.069)	(0.063-0.081)	9

REFERENCES

[1] J. R. Moody, I. L. Barnes, and R. E. Michaelis, Standard Reference Materials: Copper Ore, Mill Heads - SRM 330: Copper Ore, Mill Tails - SRM 331; Copper Concentrate - SRM 332, and Molybdenum Concentrate - SRM 333; Nat. Bur. Stand. Spec. Publ. 260-xx (in press).

[2] W. R. Shields, Editor, Nat. Bur. Stand. Tech. Note 546, (1970).

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 331

Copper Ore, Mill Tails

This material is in the form of fine powder intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

This SRM is one of a series of four SRM's issued primarily for use in evaluation of the critically important "material balance" in the copper mining and metallurgical industries. The other three are: SRM 330, Copper Ore, Mill Heads; SRM 332, Copper Concentrate; and SRM 333, Molybdenum Concentrate.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

Constituent	Certified Value [a,b]	Estimated Uncertainty[c]
	Percent by Weight	
Total Copper	0.091	0.001
Molybdenum	.0022	.0002
	PPM by Weight	
Rhenium	.04	.02

[a] Based on samples dried at 105 °C for two hours. Separate samples are used for rhenium and calculated to a dry-weight basis.
[b] The certified value is the *best estimate* of the "true" value.
[c] Estimated uncertainty includes both method imprecision and material variability with samples 1.0 g (or more) for total copper and molybdenum, and 2.5 g (or more) for rhenium.

The following values indicate the results of the analytical tests:

Constituent/Method[1]	Average	Standard Deviation[2]	Number of Determinations
	Percent by Weight		
Total Copper			
Isotopic dilution mass spectrometry[3] (1.0 g samples)	0.0915	0.0005	15
Polarographic (2.5 g samples)	.091	.001	4
Molybdenum		Range	
Isotopic dilution mass spectrometry[3] (1.0 g samples)	.0022	0.0001	2
	PPM by Weight		
Rhenium		Range	
Isotopic dilution mass spectrometry[3] (2.5 g samples)	0.043	0.016	6

[1] Details of the methods used, including drying and dissolution procedures, are given in a separate publication [1].
[2] Of single determinations for total Cu; range given for Mo and Re.
[3] This method has been studied extensively and the data are considered free from systematic errors [2].

Washington, D. C. 20234
January 20, 1977
(Revision of Provisional
Certificate of 2-20-73)

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, ANALYSIS: The material for this SRM (331) was carefully selected and provided to NBS by Magma Copper Company, San Manuel, Arizona, through the courtesy of T. L. Young.

At NBS, this material was sieved and thoroughly blended, which involved several independent procedures [1].

Homogeneity testing of selected samples representative of the lot of SRM 331 was performed simultaneously with the analytical program for certification. At NBS, the maximum variability for total copper was determined to be ±0.0008 percent (15 determinations with 1 g samples).

Analyses were performed in the NBS Analytical Chemistry Division by E. L. Garner, J. W. Gramlich, L. A. Machlan, E. J. Maienthal, J. R. Moody, L. J. Moore, and T. J. Murphy.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of W. R. Shields and I. L. Barnes.

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. E. Michaelis.

ADDITIONAL INFORMATION ON THE COMPOSITION: Certification is made *only* for total Cu, Mo, and Re. Although NOT CERTIFIED, the following additional information on the composition may be of interest.

Gold and Silver

Fire assay determinations for Au and Ag were made at Magma Copper Company:

	Gold	Silver
	PPM by Weight	
Fire assay	(0.034)	*(0.243)

*Revised 02/28/79

"Acid-Soluble" Copper

The total copper content includes "recoverable" sulfide copper and "nonrecoverable" oxide copper. Industrial practice is to determine "acid-soluble" copper and to relate this result to the oxide copper content. Investigation at NBS provided additional information on "acid-soluble" copper that may be useful, but is *not certified:*

Constituent/Method	Average	Range	Number of Determinations
"Acid-Soluble" Copper	Percent by Weight		
Isotopic dilution mass spectrometry (2.5 g samples)	(0.051)	(0.051-0.052)	3

REFERENCES

[1] J. R. Moody, I. L. Barnes, and R. E. Michaelis, Standard Reference Materials: Copper Ore, Mill Heads - SRM 330; Copper Ore, Mill Tails - SRM 331; Copper Concentrate - SRM 332, and Molybdenum Concentrate - SRM 333, Nat. Bur. Stand. Spec. publ. 260-xx (in press).
[2] W. R. Shields, Editor, Nat. Bur. Stand. Tech. Note 546, (1970).

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Acting Director

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 332
Copper Concentrate

This material is in the form of fine powder intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

This SRM is one of a series of four SRM's issued primarily for use in evaluation of the critically important "material balance" in the copper mining and metallurgical industries. The other three are: SRM 330, Copper Ore, Mill Heads; SRM 331, Copper Ore, Mill Tails; and SRM 333, Molybdenum Concentrate.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

Constituent	Certified Value[a] [b]	Estimated Uncertainty[c]
	Percent by Weight	
Total Copper	28.4	0.1
Molybdenum	0.64	.01
	PPM by Weight	
Rhenium	10.2	0.2

[a] Based on samples dried at 105 °C for two hours. Separate samples are used for rhenium and calculated to a dry-weight basis.

[b] The certified value is the *best estimate* of the "true" value.

[c] Estimated uncertainty includes both method imprecision and material variability with samples 0.5 g (or more) for total copper, 0.2 g (or more) for molybdenum and 2.5 g (or more) for rhenium.

The following values indicate the results of the analytical tests:

Constituent/Method[1]	Average	Standard Deviation[2]	Number of Determinations
	Percent by Weight		
Total Copper			
Isotopic dilution mass spectrometry[3] (0.5 g samples)	28.40	0.04	12
Electrogravimetry (2 g samples)	28.39	.02	6
Molybdenum		Range	
Isotopic dilution mass spectrometry[3] (0.2 g samples)	0.639	0.008	3
	PPM by Weight		
Rhenium		Range	
Isotopic dilution mass spectrometry[3] (2.5 g samples)	10.20	0.20	3

[1] Details of the methods used, including drying and dissolution procedures, are given in a separate publication [1].

[2] Of single determinations for total Cu; range given for Mo and Re.

[3] This method has been studied extensively and the data are considered free from systematic errors. [2].

Washington, D.C. 20234
June 26, 1977
(Revision of Provisional Certificate of 2-20-73
and draft certificates of 7-4-76 and 1-20-77)

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, ANALYSIS: The material for this SRM (332) was carefully selected and provided to NBS by Magma Copper Company, San Manuel, Arizona, through the courtesy of T. L. Young.

At NBS, the material was sieved and thoroughly blended, which involved several independent procedures [1].

Homogeneity testing of selected samples representative of the lot of SRM 332 was performed simultaneously with the analytical program for certification. The maximum variability for total copper was determined to be ±0.06 percent (0.5 g samples).

Analyses were performed in the NBS Analytical Chemistry Division by R. K. Bell, E. L. Garner, J. W. Gramlich, L. A. Machlan, J. R. Moody, L. J. Moore, and T. J. Murphy.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of W. R. Shields and I. L. Barnes.

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. E. Michaelis.

ADDITIONAL INFORMATION ON THE COMPOSITION: Certification is made *only* for total Cu, Mo, and Re. Although NOT CERTIFIED, the following additional information on the composition may be of interest.

Gold and Silver

Fire assay determinations for Au and Ag were made at Magma Copper Company:

	Gold	Silver
	PPM by Weight	
Fire assay	*(2.14)	*(38.7)

*Revised 02/28/79

REFERENCES

[1] J. R. Moody, I. L. Barnes, and R. E. Michaelis, Standard Reference Materials: Copper Ore, Mill Heads - SRM 330; Copper Ore, Mill Tails - SRM 331; Copper Concentrate - SRM 332; and Molybdenum Concentrate - SRM 333, Nat. Bur. Stand. Spec. Publ. 260-xx (in press).
[2] W. R. Shields, Editor, Nat. Bur. Stand. Tech. Note 546, (1970).

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 333

Molybdenum Concentrate

This material is in the form of fine powder intended for use both in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

This SRM is one of a series of four SRM's issued primarily for use in evaluation of the critically important "material balance" in the copper mining and metallurgical industries. The other three are: SRM 330, Copper Ore, Mill Heads; SRM 331, Copper Ore, Mill Tails; and SRM 332, Copper Concentrate.

CAUTION: The bottle should be kept tightly closed except when in direct use. Store in a desiccator over desiccant.

Constituent	Certified Value [a] [b]	Estimated Uncertainty[c]
	Percent by Weight	
Total Copper	1.038	0.010
Molybdenum	55.3	.1
Rhenium	0.087	.001

[a] Based on samples run "as received." CAUTION: The bottle should be kept tightly closed except when in direct use.

[b] The certified value is the *best estimate* of the "true" value.

[c] Estimated uncertainty includes both method imprecision and material variability with samples 0.25 g (or more) for total copper, molybdenum, and rhenium.

The following values indicate the results of the analytical tests made at NBS and the Magma Copper Company.

Constituent/Method[1]	Average	Standard Deviation[2]	Number of Determinations
	Percent by Weight		
Total Copper			
Isotopic dilution mass spectrometry[3] (0.25 g samples)	1.038	0.007	11
Polarographic (1.0 g samples)	1.034	.011	6
Atomic absorption spectrometry[4] (1.0 g samples)	1.033	.002	3
Molybdenum			
Isotopic dilution mass spectrometry[3] (0.25 g samples)	55.31	.02	10
α-Benzoinoxime gravimetric[5] (0.25 g samples)	55.43	.04	10
Rhenium			
Isotopic dilution mass spectrometry[3] (0.25 g samples)	0.0869	0.0003	17
Thermal neutron activation analysis[6] (0.15 g samples)	.085	.002	9

[1] Details of the methods used are given in a separate publication [1].

[2] Of single determinations.

[3] This method has been studied extensively and the data are considered free from systematic errors [2].

[4] Results from Magma Copper Company.

[5] Average of two independent analysts at NBS.

[6] Determinations made relative to an industrial molybdenum concentrate reference material containing 0.1140 wt. % of Re, (as determined by a number of industrial laboratories and by isotopic dilution mass spectrometry at NBS.)

Washington, D. C. 20234
January 20, 1977
(Revision of Provisional
Certificate of 2-20-73)

J. Paul Cali, Chief
Office of Standard Reference Materials

(Over)

NOTE: Recommendation is made that this material be analyzed in the "as received" condition. SRM 333 contains a small quantity (about 1%) of fuel oil introduced in the flotation process. Investigations at NBS indicate that the analytical results made on the "as received" samples may be calculated to the dry-weight basis by use of an acetone stripping procedure (includes fuel oil and moisture)[1]. (For information only, a calculated MoS_2 content thus would be 93.2±0.2%.)

ADDITIONAL INFORMATION ON THE COMPOSITION: Although certification is made only for total Cu, Mo, and Re, recommended values for Au and Ag are given below:

	Au	Ag
	ppm by weight	
Fire Assay, Magma (14.58 g samples)	8.9	25.0

Neutron activation values at NBS on 0.2 g portions (final blended material) gave values of 12.5 ppm Au and 22.6 ppm Ag. Definite evidence of inhomogeneity was observed for Au on these 0.2 g portions. Recommendation is made that sample sizes of 2.5 g (or more) be used to ensure homogeneity (<5% relative), regardless of the method used.

PLANNING, PREPARATION, TESTING, ANALYSIS: The material for this SRM was carefully selected and provided to NBS by Magma Copper Company, San Manuel, Arizona, through the courtesy of T. L. Young.

At NBS, highly specialized blending and mixing procedures were employed to obtain satisfactory homogeneity. Extensive chemical analyses performed by Magma both for total copper and for molybdenum sulfide demonstrated that homogeneity was not achieved until the total blending and mixing procedures were performed three separate times [1].

Final homogeneity testing was performed at NBS simultaneously with the analytical program for certification. The maximum variability of the accepted lot was determined to be ±0.010 percent for total copper, ±0.0010 percent for rhenium; and ±0.06 percent for molybdenum (all using 0.25 g samples).

Cooperative analyses were performed at the Magma Copper Company, San Manuel, Arizona, by Y. Arias, B. Cripe, R. L. Culver, A. B. Hall, D. A. Shah, J. T. Tadano, and M. Toelkes.

Analyses were performed in the NBS Analytical Chemistry Division by R. K. Bell, E. L. Garner, T. E. Gills, J. W. Gramlich, P. D. LaFleur, L. A. Machlan, E. J. Maienthal, J. R. Moody, L. J. Moore, and T. J. Murphy.

The overall direction and coordination of the technical measurements at NBS leading to certification were performed under the direction of W. R. Shields and I. L. Barnes.

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. E. Michaelis.

REFERENCES

[1] J. R. Moody, I. L. Barnes, and R. E. Michaelis, Standard Reference Materials: Copper Ore, Mill Heads - SRM 330; Copper Ore, Mill Tails - SRM 331 Copper Concentrate - SRM 332, and Molybdenum Concentrate - SRM 333, Nat. Bur. Stand. Spec. Publ. 260-xx (in press).
[2] W. R. Shields, Editor, Nat. Bur. Stand. Tech. Note 546, (1970).

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 688

Basalt Rock

This Standard Reference Material (SRM) is intended for use in evaluating the accuracy of analytical methods and instruments used in the analysis of geological type materials. SRM 688 is a finely powdered basalt rock that was obtained from a Cenozoic basalt flow near Jackpot, Nevada.

Certified Values of Constituents

The concentrations of the constituents were determined by methods that are widely used in the field of geological analysis and have a demonstrated accuracy. The values given are "certified" values, i.e., those values that were determined by either a definitive method, reference method, or by two or more independent methods, and "information" values that were determined by single or non-reference methods. The certified values are given in Table 1.

Table 1 Certified Values of Constituents

Constituent [1]	Content [2] wt (%)	Constituent [1]	Content [2] wt (μg/g)
Al_2O_3 [c,g]	17.36 ± 0.09	Cr [b,e]	332 ± 9
FeO [g]	7.64 ± 0.03	Rb [d]	1.91 ± 0.01
Fe_2O_3 [c,g] (Total Fe as Fe_2O_3)	10.35 ± 0.04	Sr [d]	169.2 ± 0.7
K_2O [b,d]	0.187 ± 0.008	Th [d]	0.33 ± 0.02
MnO [a,b,c]	0.167 ± 0.002	Pb [d]	3.3 ± 0.2
Na_2O [b,c,e]	2.15 ± 0.03		
P_2O_5 [a,c]	0.134 ± 0.003		
SiO_2 [c]	48.4 ± 0.1		
TiO_2 [a,b]	1.17 ± 0.01		

1. Methods of Analysis
   [a] Colorimetry
   [b] Emission spectrometry
   [c] Gravimetry
   [d] Isotope dilution mass spectrometry
   [e] Neutron activation analysis
   [f] Specific ion electrode potentiometry
   [g] Titrimetry
2. The estimated uncertainties of the certified values are based on judgment and represent an evaluation of the combined effects of method imprecision, possible systematic errors among methods and material variability of 250 mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

The overall direction and coordination of the technical measurements leading to certification were performed in the Inorganic Analytical Research Division, E. L. Garner, Chief.

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. E. Gills.

Washington, D.C. 20234
August 18, 1981

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

SUPPLEMENTAL INFORMATION

Preparation

The material was processed by the Colorado School of Mines, Golden, Colorado. Approximately 600 pounds of basalt rock were crushed, ground, and sieved to <200 mesh. The material was mixed in a cone blender to ensure homogeneity. The inhomogeneity was tested by taking random samples and analyzing for both major and minor constituents and was found to be $\leq 2\%$ relative.

Analysis

SRM 688 may pick up additional water on exposure to the atmosphere. Thus, exposure time should be kept to a minimum. Before analysis, it is recommended that the material be dried at 105 °C for 24 hours. Typical weight loss upon drying is approximately 0.2 percent.

The analysts and laboratories cooperating in the analytical program for certification were:

I. L. Barnes, M. J. Blackman, E. L. Garner, J. W. Gramlich, L. A. Machlan, L. J. Moore, and R. Zeisler of the Inorganic Analytical Research Division, National Bureau of Standards.

J. B. Bodkin, J. C DeVine, and N. H. Suhr of the Mineral Constitution Laboratories, The Pennsylvania State University, University Park, Pa.

S. S. Goldich of the Department of Geology, Northern Illinois University, Dekalb, Ill.

The constituents given in Table 2 are *not certified,* but are included for information only.

Table 2 Information Values

Constituent[1]	Content wt %	Constituent[1]	Content wt (μg/g)
CaO [c]	(12.17)	Ce [e]	(13.3)
CO_2 [f]	(0.05)	Co [e]	(49.7)
F [f]	(0.02)	Eu [e]	(1.07)
MgO [c]	(8.4)	Hf [e]	(1.6)
		Lu [e]	(0.34)
		Sc [e]	(38.1)
		Ba [b]	(200)
		V [b]	(250)
		Cu [b]	(96)
		Ni [b]	(150)
		Sm [e]	(2.79)
		Tb [e]	(0.448)
		U [d]	(0.37)
		Yb [e]	(2.09)
		Zn [e]	(58.0)

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 690

Iron Ore Concentrate (Canada)

(In Cooperation with the American Society for Testing and Materials)

This material is in the form of powder (<0.1 mm) for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

(Results based on samples dried for one hour at 105 °C.)

Constituent	Total Fe	SiO_2	Al_2O_3	P	S	TiO_2	MnO	CaO	MgO	Na_2O	K_2O
Certified[1] Value (wt. %)	66.85	3.71	0.18	0.011	0.003	0.022	0.23	0.20	0.18	0.003	0.0030
Estimated[2] Uncertainty	0.07	0.02	0.01	0.002	0.001	0.002	0.01	0.01	0.01	0.001	0.0005
Method[3] / Labs	$SnCl_2$ – $K_2Cr_2O_7$	$HClO_4$ Dehydration	Atomic Absorption	Photometric	Combustion-Titration	Photometric	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption
A	[a] 66.91	[b] 3.70	0.17	[c] 0.009	<0.005	[d] 0.021	0.24	0.20	0.17	0.0026	0.0030
B	66.88	3.76	.17	[c] .013	.003	[e] .026	.23	.20	.19	.004	.003
C	[f] 66.82	3.70	.19	.011	.006	[g] .024	[h] .23	[i] .19	[i] .19	[i] .0023	[i] .0034
D	66.85	3.73	[j] .18	-	-	[j] .021	.23	[j] .21	.18	.0028 [j] .0030	[j] .0029
E	66.83	[h] 3.69 3.73	[k] .20	.009	.002	[g] .022	.24	.21	.18	.002	.003

1. The certified value listed for a constituent is the *present best estimate* of the "true" value based on results of the cooperative analytical program for certification.
2. The 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 of 0.5 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determinations.)
3. A detailed description of many of the methods of analysis employed in the certification program for this SRM may be found in Part 12, Chemical Analysis of Metals and Metal Bearing Ores, Annual Book of ASTM Standards.

a H_2S reduction
b Sample fused in Na_2CO_3
c Alkali-molybdate method
d H_2O_2 photometric
e Atomic absorption
f Silver reductor
g Chromotropic acid photometric
h Photometric method
i Spectroscopic method
j Flame emission
k Chromazurol S photometric

Washington, D.C. 20234
October 24, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, ANALYSIS:

The iron ore powder concentrate material for this SRM was prepared in final powder form, minus 74 μm (200 mesh), by the Iron Ore Company of Canada, Labrador City, Newfoundland, Canada, through the courtesy of L. Rompré.

At NBS, the material was resieved and thoroughly blended.

Homogeneity testing of selected samples representative of the final lot was performed at NBS by R. K. Bell, Assistant Research Associate, ASTM-NBS Research Associate Program. The results for iron indicate that the material variability (0.5 g samples) is $\leq$ the method imprecision.

Chemical analyses for certification were performed in the following laboratories:

Bethlehem Steel Corporation, Homer Research Laboratories, Bethlehem, Pa., D. A. Flinchbaugh.
Inland Steel Company, Indiana Harbor Works, East Chicago, Indiana, J. E. Joyce.
Ledoux and Company, Teaneck, New Jersey, S. Kallman and C. L. Maul.
National Bureau of Standards, Center for Analytical Chemistry, Washington, D.C., T. C. Rains, T. J. Brady, J. D. Messman, and T. A. Rush and by R. K. Bell, ASTM Assistant Research Associate.
STELCO, The Steel Company of Canada, Ltd., Hilton Works, Hamilton, Ontario, Canada, O. P. Bhargava.

The overall direction and coordination of the technical measurements leading to certification were performed jointly by R. E. Michaelis, Office of Standard Reference Materials and by J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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 W. P. Reed.

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 691

Reduced Iron Oxide

(In cooperation with the American Society for Testing and Materials)

This Standard Reference Material (SRM) is intended for use in evaluating chemical methods and in calibrations associated with optical emission and x-ray spectrometric methods of analysis. SRM 691 is a finely powdered material (−200 mesh) and must be kept in a tightly sealed bottle when not in use. It is recommended that the material be stored in a desiccator over a suitable desiccant when not in use. Long term (>3 years) stability of this SRM has not been rigorously established. NBS will continue to monitor this material and any substantive changes will be reported to users.

The certified values given below in Table 1 are based on samples of at least 0.5 g, the minimum amount to be used for analysis. Non-certified values which are given for information only, are listed in Table 2.

Table 1

Constituent	Certified Value,[1] % by wt.	Estimated Uncertainty[2]	Constituent	Certified Value,[1] % by wt.	Estimated Uncertainty[2]
Iron (Total)	90.8	± 0.5	Copper	0.032	± 0.003
Iron (Metallic)[3]	84.6	.6	Cobalt	.030	.007
SiO_2	3.7	.2	Phosphorus	.006	.001
Al_2O_3	1.22	.07	Sulfur	.008	.001
TiO_2	0.27	.04	Carbon (Total)	.12	.03
CaO	.63	.03			
MnO	.043	.002			
MgO	.52	.02			
Na_2O	.186	.002			

1. The certified value listed for a constituent is the present best estimate of the "true" value based on the results of the cooperative program for certification.

2. The estimated uncertainty listed for a constituent 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 0.5 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

3. The metallic iron was determined by the ISO (Bromine-methanol) method.

The overall coordination of the technical measurements leading to certification was performed under the direction of J.I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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.E. Gills.

Washington, D.C. 20234
April 12, 1982

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, ANALYSIS:

The material for this SRM was provided by Allis-Chalmers, Reduction Systems Division, Milwaukee, Wis., courtesy of L.J. Wrangell. It was processed (crushed, ground, sieved, and mixed) at the Colorado School of Mines Research Institute, Golden, Colorado, under a contract to the National Bureau of Standards. The final product (−200 mesh) was blended at NBS.

Homogeneity testing of selected samples representative of the final lot was performed at Allis-Chalmers, L.J. Wrangell; at Ledoux & Co., Teaneck, New Jersey, by S. Kallmann; and at NBS by E.R. Deardorff.

Stability tests conducted over a seven-month period at NBS, during which samples were exposed to relative humidities of 75 and 90 percent at room temperature, indicated sufficient stability of the material for use as an SRM.

This material was packaged in a dry nitrogen atmosphere to prevent oxidation. If signs of oxidation are detected, please transmit this information to NBS for documentation into the monitoring program.

Cooperative analyses for certification were performed in the following laboratories:

Andrew S. McCreath & Son, Inc., Harrisburg, Pa.; F.A. Pennington, Jr., R.F. Eakin, G.L. Dobbs, J.C. Forney, and L.W. Richards.

Inland Steel Company, Indiana Harbor Works, East Chicago, Indiana; J.E. Joyce.

Institut de Recherches de la Siderurgie, Maizieres-les-Metz, France; G. Jecko.

Ledoux and Company, Teaneck, New Jersey; S. Kallmann.

National Bureau of Standards, Inorganic Analytical Research Division, C.G. Blundell, T.A. Butler, E.R. Deardorff, M.S. Epstein, R.M. Lindstrom, T.C. Rains, M. Sadjadi, and R.M. Stone.

United States Steel Corp., Research Laboratory, Monroeville, Pa.; J.D. Selvaggio, D.S. Shafferman, A.W. Fioravanti, D.G. Cunningham, K.G. Mikos, R.C. Cline, and H.S. Karp.

The values shown below are *not certified* since they are not based on the results of at least two independent laboratories or methods. These values are included for information only.

Table 2

Element	Content Wt. Percent	Element	Content µg/g
Cr	(0.03)	As	(14)
Ni	(.3)	Zn	(40)
K	(.06)	Pb	(<20)
		Cd	(< 5)
		Mo	(<20)
		Sn	(<10)
		N	(50)
		V	(135)

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 692

Iron Ore (Labrador)

(In Cooperation with the American Society for Testing and Materials)

This material is in the form of powder (<0.1mm) for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

(Results based on samples dried for one hour at 105 °C.)

Constituent	Total Fe	SiO_2	Al_2O_3	P	S	TiO_2	MnO	CaO	MgO	Na_2O	K_2O
Certified[1] Value (wt. %)	59.58	10.14	1.41	0.039	0.005	0.045	0.46	0.023	0.035	0.008	0.039
Estimated[2] Uncertainty	0.06	0.05	0.04	0.002	0.001	0.005	0.01	0.003	0.004	0.002	0.003
Method[3] / Labs	$SnCl_2$ – $K_2Cr_2O_7$	$HClO_4$ Dehydration	Atomic Absorption	Photometric	Combustion-Titration	Photometric	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption
A	[a] 59.55	[b] 10.09	1.40	[c] 0.039	<0.005	[d] 0.041	0.47	0.022	0.034	0.008	0.040
B	59.58	10.26	1.48	[c] .035	.004	[e] .05	.45	.02	.04	.005	.036
C	[f] 59.63 [f] 59.62	10.10	1.42	.040	.007	[g] .048	[h] .47	[i] .025	[j] .028	[i] .008	[j] .040 [i] .039
D	59.60	10.16	[j] 1.40	-	-	[j] .043	.47	[j] .021	.033	[j] .010 .009	[j] .041
E	59.50	[h] 10.12 10.05	[k] 1.41	.039	.004	[g] .050	.46	.01	.038	.008	.041
F	59.58	10.18	[l] 1.37 1.46	.040	.005	[g] .043	[h] .46	.026	.035	.008	.035

1. The certified value listed for a constituent is the *present best estimate* of the "true" value based on results of the cooperative analytical program for certification.

2. The 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 of 0.5 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determinations.)

3. A detailed description of many of the methods of analysis employed in the certification program for this SRM may be found in Part 12, Chemical Analysis of Metals and Metal Bearing Ores, Annual Book of ASTM Standards.

a H_2S reduction
b Sample fused in Na_2CO_3
c Alkali-molybdate method
d H_2O_2 photometric
e Atomic absorption
f Silver reductor
g Chromotropic acid photometric
h Photometric method
i Spectroscopic method
j Flame emission
k Chromazurol S photometric
l Mercury cathode-NH_4OH-Cupferron-$AlPO_4$

Washington, D.C. 20234
October 24, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, ANALYSIS:

The iron ore material for this SRM was prepared in final powder form, minus 74 μm (200 mesh), by the Bethlehem Steel Corporation, Bethlehem, Pa. through the courtesy of J. M. Karpinski.

At NBS, the material was resieved and thoroughly blended.

Homogeneity testing of selected samples representative of the final lot was performed at NBS by R. K. Bell, Assistant Research Associate, ASTM-NBS Research Associate Program. The results for iron indicate that the material variability (0.5 g samples) is $\leq$ the method imprecision.

Chemical analyses for certification were performed in the following laboratories:

Bethlehem Steel Corporation, Homer Research Laboratories, Bethlehem, Pa., D. A. Flinchbaugh.
Inland Steel Company, Indiana Harbor Works, East Chicago, Indiana, J. E. Joyce.
Ledoux and Company, Teaneck, New Jersey, S. Kallman and C. L. Maul.
National Bureau of Standards, Center for Analytical Chemistry, Washington, D.C., T. C. Rains, T. J. Brady, J. D. Messman, and T. A. Rush, and by R. K. Bell, ASTM Assistant Research Associate.
STELCO, The Steel Company of Canada, Ltd., Hilton Works, Hamilton, Ontario, Canada, O. P. Bhargava.
United States Steel Corporation, Research Laboratory, Monroeville, Pa., L. M. Melnick, J. D. Selvaggio, R. W. Cline, D. G. Cunningham, A. V. Fioravanti, J. R. Lucas II, C. W. Ponsonby, L. E. Povirk, D. Shafferman and R. J. Wargo.

The overall direction and coordination of the technical measurements leading to certification were performed jointly by R. E. Michaelis, Office of Standard Reference Materials, and by J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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 W. P. Reed.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 693

Iron Ore (Nimba)

(In Cooperation with the American Society for Testing and Materials)

This material is in the form of powder (<0.1mm) for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis.

(Results based on samples dried for one hour at 105 °C.)

Constituent	Total Fe	SiO_2	Al_2O_3	P	S	TiO_2	MnO	CaO	MgO	Na_2O	K_2O
Certified[1] Value (wt. %)	65.11	3.87	1.02	0.056	0.005	0.035	0.091	0.016	0.013	0.0028	0.0028
Estimated[2] Uncertainty	0.07	0.02	0.04	0.001	0.001	0.003	0.004	0.004	0.002	0.0005	0.0006
Method[3] / Labs	$SnCl_2$ – $K_2Cr_2O_7$	$HClO_4$ Dehydration	Atomic Absorption	Photometric	Combustion-Titration	Photometric	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption	Atomic Absorption
A	[a] 65.11	[b] 3.87	1.04	[c] 0.056	<0.005	[d] 0.034	0.094	0.016	0.013	0.0029	0.003
B	[e] 65.13 65.14	3.83	1.11	.055	.005	[f] .036	[g] .095	[h] .020	[h] .011	[h] .0023	[h] .003
C	65.10	3.89	[i] 1.06	-	-	[i] .032	.087	[i] .015	.012	[i] .0030 .0033	[i] .003
D	65.11	[g] 3.86 3.88	[j] 0.98	.056	.005	[f] .038	.090	.01	.015	.003	.003
E	65.09	3.87	[k] 0.98 1.06	.056	.007	[f] .033	[g] .091	.018	.015	.002	.002

1. The certified value listed for a constituent is the *present best estimate* of the "true" value based on results of the cooperative analytical program for certification.
2. The 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 of 0.5 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determinations.)
3. A detailed description of many of the methods of analysis employed in the certification program for this SRM may be found in Part 12, Chemical Analysis of Metals and Metal Bearing Ores, Annual Book of ASTM Standards.

a H_2S reduction
b Sample fused in Na_2CO_3
c Alkali-molybdate method
d H_2O_2 photometric
e Silver reductor
f Chromotropic acid photometric
g Photometric method
h Spectroscopic method
i Flame emission
j Chromazurol S photometric
k Mercury cathode-NH_4OH-Cupferron-$AlPO_4$

Washington, D.C. 20234
October 24, 1978

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

PLANNING, PREPARATION, TESTING, ANALYSIS:

The iron ore material for this SRM was prepared in final powder form, minus 74 μm (200 mesh), by the Bethlehem Steel Corporation, Bethlehem, Pa. through the courtesy of J. M. Karpinski.

At NBS, the material was resieved and thoroughly blended.

Homogeneity testing of selected samples representative of the final lot was performed at NBS by R. K. Bell, Assistant Research Associate, ASTM-NBS Research Associate Program. The results for iron indicate that the material variability (0.5 g samples) is $\leq$ the method imprecision.

Chemical analyses for certification were performed in the following laboratories:

Bethlehem Steel Corporation, Homer Research Laboratories, Bethlehem, Pa., D. A. Flinchbaugh.
Ledoux and Company, Teaneck, New Jersey, S. Kallman and C. L. Maul.
National Bureau of Standards, Center for Analytical Chemistry, Washington, D.C., T. C. Rains, T. J. Brady, J. D. Messman, and T. A. Rush, and by R. K. Bell, ASTM Assistant Research Associate.
STELCO, The Steel Company of Canada, Ltd., Hilton Works, Hamilton, Ontario, Canada, O. P. Bhargava.
United States Steel Corporation, Research Laboratory, Monroeville, Pa., L. M. Melnick, J. D. Selvaggio, R. W. Cline, D. G. Cunningham, A. V. Fioravanti, J. R. Lucas II, C. W. Ponsonby, L. E. Povirk, D. Shafferman and R. J. Wargo.

The overall direction and coordination of the technical measurements leading to certification were performed jointly by R. E. Michaelis, Office of Standard Reference Materials and by J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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 W. P. Reed.

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 696

Bauxite (Surinam)

(In Cooperation with the American Society for Testing and Materials)

(All analyses are based on samples dried 2 hours at 140 °C)

This material is in the form of fine powder (<0.08 mm) for use in checking chemical and instrumental methods of analyses.

Constituent	Certified Value[1] Percent, by weight	Estimated Uncertainty[2]
Al_2O_3	54.5	0.3
Fe_2O_3	8.70	.10
SiO_2	3.79	.10
TiO_2	2.64	.05
ZrO_2	0.14	.02
P_2O_5	.050	.006
V_2O_5	.072	.006
Cr_2O_3	.047	.003
CaO	.018	.002
MgO	.012	.003
MnO	.004	.001
ZnO	.0014	.0007
K_2O	.009	.003
SO_3	.21	.03
Loss on Ignition[3]	29.9	.2

[1]The certified value listed for a constituent is the *present best estimate* of the "true" value.

[2]The estimated uncertainty listed for a constituent 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 1.0 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

[3]Determined by igniting to constant weight at 1050 °C.

Washington, D.C. 20234
August 24, 1979

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

ADDITIONAL INFORMATION ON THE COMPOSITION

Elements other than those certified may be present in this material as indicated below. These are not certified but are given as additional information on the composition.

Constituent	Concentration, Percent by weight	Constituent	Concentration, Percent by weight
BaO	(0.004)	Co	(0.00009)
Na_2O	(0.007)	Hf	(0.0032)
Ce	(0.0041)	Sc	(0.0008)

The mineralogical composition of SRM 696 was determined by x-ray diffraction studies at the Geological Survey, U.S. Department of the Interior, Reston, Va., (J.W. Hosterman) to be 5% kaolinite, 80% gibbsite, 10% pyrite, and 5% anatase. These results are semiquantitative (to the nearest 5%).

PLANNING, PREPARATION, TESTING, ANALYSIS:

The material for this SRM was mined in Surinam, South America, and was provided by the Aluminum Company of America, Alcoa Technical Center, Pittsburgh, Pa., through the courtesy of H. B. Hartman. It was processed (crushed, ground, sieved, and mixed) at the Colorado School of Mines Research Institute under a contract with the National Bureau of Standards.

Homogeneity testing was performed at NBS by J.S. Maples and T.E. Gills.

Cooperative analyses for certification were performed in the following laboratories:

Aluminum Company of America, Alcoa Center, Pa., R. C. Obbink.

Aluminum Company of Canada, Ltd., Arvida Research Center, Arvida, Quebec, Canada, L. Girolami.

Andrew S. McCreath & Son, Inc., Harrisburg, Pa., F. A. Pennington, Jr., R. F. Eakin, and S. L. Miller.

General Refractories Co., U.S. Refractories Division, Research Center, Baltimore, Md., S. Banerjee.

Geological Survey, U.S. Department of the Interior, Reston, Va., H. J. Rose, Jr., and J. W. Hosterman.

Kaiser Aluminum and Chemical Corp., Center for Technology, Pleasanton, Calif., H. J. Seim, A. E. McLaughlin, D. F. G. Marten, A. Kermaninejad, R. C. Kinne, J. R. Skarset, J. Boruk, and U. Vogel.

National Bureau of Standards, Washington, D.C., R. K. Bell, ASTM-NBS Assistant Research Associate.

National-Southwire Aluminum Co., Hawesville, Ky., N. Robinson and E. Gotzy.

Ormet Corp., Burnside, La., W. L. Brown and A. D. Lafleur.

Reynolds Aluminum Co., Alumina Research Division, Bauxite, Ark., J. B. Ezell, Jr.

University of Kentucky, Institute for Mining and Minerals Research, Center for Energy Research Laboratory, Lexington, Ky., T. V. Rebagay.

The overall coordination of the technical measurements leading to certification were performed under the direction of J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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. E. Michaelis and R. Alvarez.

NBS Standard Reference Materials

BAUXITE SERIES

September 4, 1979

R. E. Michaelis and R. Alvarez, NBS Office of Standard Reference Materials
and
J. I. Shultz, ASTM Research Associate

The following table gives the values for four bauxite SRM's that are available in the form of fine powder (<0.08 mm) for use in chemical and instrumental methods of analysis. They are being issued as a culmination of a major Industry-ASTM-NBS cooperative program.

SRM No. Designation	69b Arkansas	696 Surinam	697 Dominican	698 Jamaican
Constituent		Percent by Weight		
Al_2O_3	48.8	54.5	45.8	48.2
Fe_2O_3	7.14	8.70	20.0	19.6
SiO_2	13.43	3.79	6.81	0.69
TiO_2	1.90	2.64	2.52	2.38
ZrO_2	0.29	0.14	0.065	0.061
P_2O_5	0.118	0.050	0.97	0.37
V_2O_5	0.028	0.072	0.063	0.064
Cr_2O_3	0.011	0.047	0.100	0.080
CaO	0.13	0.018	0.71	0.62
MgO	0.085	0.012	0.18	0.058
MnO	0.110	0.004	0.41	0.38
ZnO	0.0035	0.0014	0.037	0.029
BaO	(0.008)[a]	(0.004)	(0.015)	(0.008)
Na_2O	(0.025)	(0.007)	(0.036)	(0.015)
K_2O	0.068	0.009	0.062	0.010
SO_3	0.63	0.21	0.13	0.22
Loss on Ign.	27.2	29.9	22.1	27.3
Ce	(0.024)	(0.0041)	(0.069)	(0.030)
Co	(0.0001)	(0.00009)	(0.0013)	(0.0045)
Hf	(0.0063)	(0.0032)	(0.0014)	(0.0015)
Sc	(0.0008)	(0.0008)	(0.0058)	(0.0051)
Total	(100.0)	(100.1)	(100.1)	(100.1)

[a]Values in parenthesis are *not certified.*

The value listed for a certified constituent is the *present best estimate* of the "true" value based on the results of the analytical program for certification (10-12 laboratories). The individual certificates of analysis list the "estimated uncertainties" associated with the certified values (also listed is a semiquantitative mineralogical composition (±5%) as determined by x-ray diffraction studies at the U.S. Geological Survey).

Inquiries regarding the Bauxite SRM's 69b, 696, 697, and 698, should be directed to the Office of Standard Reference Materials, Chemistry Building, B311, National Bureau of Standards, Washington, D.C. 20234. (301) 921-2045.

George A. Uriano, Chief
Office of Standard Reference Materials

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 697

Bauxite (Dominican)

(In Cooperation with the American Society for Testing and Materials)

(All analyses are based on samples dried 2 hours at 140 °C)

This material is in the form of fine powder (<0.08 mm) for use in checking chemical and instrumental methods of analyses.

Constituent	Certified Value[1] Percent, by weight	Estimated Uncertainty[2]
Al_2O_3	45.8	0.2
Fe_2O_3	20.0	.2
SiO_2	6.81	.07
TiO_2	2.52	.05
ZrO_2	0.065	.007
P_2O_5	.97	.06
V_2O_5	.063	.005
Cr_2O_3	.100	.005
CaO	.71	.03
MgO	.18	.02
MnO	.41	.03
ZnO	.037	.003
K_2O	.062	.007
SO_3	.13	.03
Loss on Ignition[3]	22.1	.2

[1]The certified value listed for a constituent is the *present best estimate* of the "true" value.

[2]The estimated uncertainty listed for a constituent 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 1.0 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

[3]Determined by igniting to constant weight at 1050 °C.

Washington, D.C. 20234
August 24, 1979

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

ADDITIONAL INFORMATION ON THE COMPOSITION

Elements other than those certified may be present in this material as indicated below. These are not certified but are given as additional information on the composition.

Constituent	Concentration, Percent by weight	Constituent	Concentration, Percent by weight
BaO	(0.015)	Co	(0.0013)
Na_2O	(0.036)	Hf	(0.0014)
Ce	(0.069)	Sc	(0.0058)

The mineralogical composition of SRM 697 was determined by x-ray diffraction studies at the Geological Survey, U.S. Department of the Interior, Reston, Va., (J.W. Hosterman) to be 15% kaolinite, 50% gibbsite, 10% boehmite, 20% hematite, and 5% anatase. These results are semiquantitative (to the nearest 5%).

PLANNING, PREPARATION, TESTING, ANALYSIS:

The material for this SRM was mined in the Dominican Republic and was provided by the Aluminum Company of America, Alcoa Technical Center, Pittsburgh, Pa., through the courtesy of H. B. Hartman. It was processed (crushed, ground, sieved, and mixed) at the Colorado School of Mines Research Institute under a contract with the National Bureau of Standards.

Homogeneity testing was performed at NBS by J.S. Maples and T.E. Gills.

Cooperative analyses for certification were performed in the following laboratories:

Aluminum Company of America, Alcoa Center, Pa., R. C. Obbink.

Aluminum Company of Canada, Ltd., Arvida Research Center, Arvida, Quebec, Canada, L. Girolami.

Andrew S. McCreath & Son, Inc., Harrisburg, Pa., F. A. Pennington, Jr., R. F. Eakin, and S. L. Miller.

General Refractories Co., U.S. Refractories Division, Research Center, Baltimore, Md., S. Banerjee.

Geological Survey, U.S. Department of the Interior, Reston, Va., H. J. Rose, Jr., and J. W. Hosterman.

Kaiser Aluminum and Chemical Corp., Center for Technology, Pleasanton, Calif., H. J. Seim, A. E. McLaughlin, D. F. G. Marten, A. Kermaninejad, R. C. Kinne, J. R. Skarset, J. Boruk, and U. Vogel.

National Bureau of Standards, Washington, D.C., R. K. Bell, ASTM-NBS Assistant Research Associate.

National-Southwire Aluminum Co., Hawesville, Ky., N. Robinson and E. Gotzy.

Ormet Corp., Burnside, La., W. L. Brown and A. D. Lafleur.

Reynolds Aluminum Co., Alumina Research Division, Bauxite, Ark., J. B. Ezell, Jr.

University of Kentucky, Institute for Mining and Minerals Research, Center for Energy Research Laboratory, Lexington, Ky., T. V. Rebagay.

The overall coordination of the technical measurements leading to certification were performed under the direction of J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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. E. Michaelis and R. Alvarez.

NBS Standard Reference Materials

BAUXITE SERIES

September 4, 1979

R. E. Michaelis and R. Alvarez, NBS Office of Standard Reference Materials
and
J. I. Shultz, ASTM Research Associate

The following table gives the values for four bauxite SRM's that are available in the form of fine powder (<0.08 mm) for use in chemical and instrumental methods of analysis. They are being issued as a culmination of a major Industry-ASTM-NBS cooperative program.

SRM No. Designation	69b Arkansas	696 Surinam	697 Dominican	698 Jamaican
Constituent		Percent by Weight		
Al_2O_3	48.8	54.5	45.8	48.2
Fe_2O_3	7.14	8.70	20.0	19.6
SiO_2	13.43	3.79	6.81	0.69
TiO_2	1.90	2.64	2.52	2.38
ZrO_2	0.29	0.14	0.065	0.061
P_2O_5	0.118	0.050	0.97	0.37
V_2O_5	0.028	0.072	0.063	0.064
Cr_2O_3	0.011	0.047	0.100	0.080
CaO	0.13	0.018	0.71	0.62
MgO	0.085	0.012	0.18	0.058
MnO	0.110	0.004	0.41	0.38
ZnO	0.0035	0.0014	0.037	0.029
BaO	(0.008)[a]	(0.004)	(0.015)	(0.008)
Na_2O	(0.025)	(0.007)	(0.036)	(0.015)
K_2O	0.068	0.009	0.062	0.010
SO_3	0.63	0.21	0.13	0.22
Loss on Ign.	27.2	29.9	22.1	27.3
Ce	(0.024)	(0.0041)	(0.069)	(0.030)
Co	(0.0001)	(0.00009)	(0.0013)	(0.0045)
Hf	(0.0063)	(0.0032)	(0.0014)	(0.0015)
Sc	(0.0008)	(0.0008)	(0.0058)	(0.0051)
Total	(100.0)	(100.1)	(100.1)	(100.1)

[a]Values in parenthesis are *not certified.*

The value listed for a certified constituent is the *present best estimate* of the "true" value based on the results of the analytical program for certification (10-12 laboratories). The individual certificates of analysis list the "estimated uncertainties" associated with the certified values (also listed is a semiquantitative mineralogical composition (±5%) as determined by x-ray diffraction studies at the U.S. Geological Survey).

Inquiries regarding the Bauxite SRM's 69b, 696, 697, and 698, should be directed to the Office of Standard Reference Materials, Chemistry Building, B311, National Bureau of Standards, Washington, D.C. 20234. (301) 921-2045.

George A. Uriano, Chief
Office of Standard Reference Materials

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 698

Bauxite (Jamaican)

(In Cooperation with the American Society for Testing and Materials)

(All analyses are based on samples dried 2 hours at 140 °C)

This material is in the form of fine powder (<0.08 mm) for use in checking chemical and instrumental methods of analyses.

Constituent	Certified Value[1] Percent, by weight	Estimated Uncertainty[2]
Al_2O_3	48.2	0.4
Fe_2O_3	19.6	.2
SiO_2	0.69	.03
TiO_2	2.38	.07
ZrO_2	0.061	.009
P_2O_5	.37	.01
V_2O_5	.064	.005
Cr_2O_3	.080	.006
CaO	.62	.02
MgO	.058	.008
MnO	.38	.03
ZnO	.029	.002
K_2O	.010	.002
SO_3	.22	.03
Loss on Ignition[3]	27.3	.2

[1]The certified value listed for a constituent is the *present best estimate* of the "true" value.

[2]The estimated uncertainty listed for a constituent 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 1.0 g or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

[3]Determined by igniting to constant weight at 1050 °C.

Washington, D.C. 20234
August 24, 1979

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

ADDITIONAL INFORMATION ON THE COMPOSITION

Elements other than those certified may be present in this material as indicated below. These are not certified but are given as additional information on the composition.

Constituent	Concentration, Percent by weight	Constituent	Concentration, Percent by weight
BaO	(0.008)	Co	(0.0045)
Na_2O	(0.015)	Hf	(0.0015)
Ce	(0.030)	Sc	(0.0051)

The mineralogical composition of SRM 698 was determined by x-ray diffraction studies at the Geological Survey, U.S. Department of the Interior, Reston, Va., (J.W. Hosterman) to be 75% gibbsite, 20% hematite, and 5% anatase. These results are semiquantitative (to the nearest 5%).

PLANNING, PREPARATION, TESTING, ANALYSIS:

The material for this SRM was mined in Jamaica, and was provided by the Reynolds Metals Company, Bauxite, Arkansas, through the courtesy of J. B. Ezell, Jr. It was processed (crushed, ground, sieved, and mixed) at the Colorado School of Mines Research Institute under a contract with the National Bureau of Standards.

Homogeneity testing was performed at NBS by J.S. Maples and T.E. Gills.

Cooperative analyses for certification were performed in the following laboratories:

Aluminum Company of America, Alcoa Center, Pa., R. C. Obbink.

Aluminum Company of Canada, Ltd., Arvida Research Center, Arvida, Quebec, Canada, L. Girolami.

Andrew S. McCreath & Son, Inc., Harrisburg, Pa., F. A. Pennington, Jr., R. F. Eakin, and S. L. Miller.

General Refractories Co., U.S. Refractories Division, Research Center, Baltimore, Md., S. Banerjee.

Geological Survey, U.S. Department of the Interior, Reston, Va., H. J. Rose, Jr., and J. W. Hosterman.

Kaiser Aluminum and Chemical Corp., Center for Technology, Pleasanton, Calif., H. J. Seim, A. E. McLaughlin, D. F. G. Marten, A. Kermaninejad, R. C. Kinne, J. R. Skarset, J. Boruk, and U. Vogel.

National Bureau of Standards, Washington, D.C., R. K. Bell, ASTM-NBS Assistant Research Associate.

National-Southwire Aluminum Co., Hawesville, Ky., N. Robinson and E. Gotzy.

Ormet Corp., Burnside, La., W. L. Brown and A. D. Lafleur.

Reynolds Aluminum Co., Alumina Research Division, Bauxite, Ark., J. B. Ezell, Jr.

University of Kentucky, Institute for Mining and Minerals Research, Center for Energy Research Laboratory, Lexington, Ky., T. V. Rebagay.

The overall coordination of the technical measurements leading to certification were performed under the direction of J. I. Shultz, Research Associate, ASTM-NBS Research Associate Program.

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. E. Michaelis and R. Alvarez.

NBS Standard Reference Materials

BAUXITE SERIES

September 4, 1979

R. E. Michaelis and R. Alvarez, NBS Office of Standard Reference Materials
and
J. I. Shultz, ASTM Research Associate

The following table gives the values for four bauxite SRM's that are available in the form of fine powder (<0.08 mm) for use in chemical and instrumental methods of analysis. They are being issued as a culmination of a major Industry-ASTM-NBS cooperative program.

SRM No. Designation	69b Arkansas	696 Surinam	697 Dominican	698 Jamaican
Constituent		Percent by Weight		
Al_2O_3	48.8	54.5	45.8	48.2
Fe_2O_3	7.14	8.70	20.0	19.6
SiO_2	13.43	3.79	6.81	0.69
TiO_2	1.90	2.64	2.52	2.38
ZrO_2	0.29	0.14	0.065	0.061
P_2O_5	0.118	0.050	0.97	0.37
V_2O_5	0.028	0.072	0.063	0.064
Cr_2O_3	0.011	0.047	0.100	0.080
CaO	0.13	0.018	0.71	0.62
MgO	0.085	0.012	0.18	0.058
MnO	0.110	0.004	0.41	0.38
ZnO	0.0035	0.0014	0.037	0.029
BaO	(0.008)[a]	(0.004)	(0.015)	(0.008)
Na_2O	(0.025)	(0.007)	(0.036)	(0.015)
K_2O	0.068	0.009	0.062	0.010
SO_3	0.63	0.21	0.13	0.22
Loss on Ign.	27.2	29.9	22.1	27.3
Ce	(0.024)	(0.0041)	(0.069)	(0.030)
Co	(0.0001)	(0.00009)	(0.0013)	(0.0045)
Hf	(0.0063)	(0.0032)	(0.0014)	(0.0015)
Sc	(0.0008)	(0.0008)	(0.0058)	(0.0051)
Total	(100.0)	(100.1)	(100.1)	(100.1)

[a]Values in parenthesis are *not certified.*

The value listed for a certified constituent is the *present best estimate* of the "true" value based on the results of the analytical program for certification (10-12 laboratories). The individual certificates of analysis list the "estimated uncertainties" associated with the certified values (also listed is a semiquantitative mineralogical composition (±5%) as determined by x-ray diffraction studies at the U.S. Geological Survey).

Inquiries regarding the Bauxite SRM's 69b, 696, 697, and 698, should be directed to the Office of Standard Reference Materials, Chemistry Building, B311, National Bureau of Standards, Washington, D.C. 20234. (301) 921-2045.

George A. Uriano, Chief
Office of Standard Reference Materials

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 1632b

Trace Elements in Coal

(Bituminous)

This Standard Reference Material (SRM) is intended for use in the calibration of apparatus and the evaluation of techniques employed in the analysis of coal or similar materials. SRM 1632b is a bituminous coal with a nominal sulfur content of 1.9%. It is in the form of a fine powder (−60 mesh).

Certified Values of Constituent Elements: The certified values for the constituent elements are given in Table 1. The certified values are based on measurements using proven techniques and methods. Noncertified values are given in Table 2 and are provided for information only. These values are based on measurements made using a single technique or method. While no reason exists to suspect systematic bias in the information values, no attempt was made to determine if such a bias exists that is attributable to the technique and/or method used. A list of analytical techniques and methods used for the different analyses is given in Table 3. As part of its update certification program, NBS will periodically update many of these values to certification status.

Expiration of Certification: The certification of SRM 1632b will be valid up to 5 years from the purchase date. Should any of the certified constituents become invalid prior to that date, purchasers will be notified by NBS.

Use: This material should be vacuum dried at ambient temperature for 24 hours prior to use. The certified concentrations are reported on a "dry-weight" basis, thus the concentration determined on undried samples should be adjusted for the moisture content of the sample. Typical moisture loss using the drying procedure stated above is 1.3%.

A minimum sample size of 250 mg of the dried material is required for the certified values to be valid.

This SRM should be kept in its original bottle. It should not be exposed to intense source of radiation, including ultraviolet lamps or sunlight.

The statistical analysis of the certification data was performed by R.C. Paule of the National Measurement Laboratory.

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.E. Gills.

Gaithersburg, MD 20899
June 20, 1985

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

Source and Preparation of Material: The coal for this SRM was obtained from the Humphrey No. 7 mine and coal preparation plant of the Consolidation Coal Company, Christopher Coal Company Division, Osage, West Virginia. This mine produces bituminous coal with a sulfur content of 1.8 - 1.9 percent (dry basis). This coal was obtained from an underground mine that recovers coal from the Pittsburgh seam, which is considered the single most valuable and extensive coal seam in the United States.

Approximately 900 kg of the coal for SRM 1632b was oven dried prior to processing, in accordance with procedures outlined in ASTM D2013. The coal was reduced in size to −60 mesh and sieved prior to blending. The coal was then blended in a stainless steel cone blender (approximate capacity 0.85 cubic meter). After blending the coal was packaged in polyethylene-lined aluminum cans and was subsequently repackaged in fifty gram units.

Analysis

Major, Minor, and Trace Constituents: In general, the major, minor, and trace constituents were certified using two or more independent methods of analysis or two or more different laboratories. For those constituents that were determined using a single method, technique, or laboratory, the values are given for information only. (See Table 3).

Calorific Value: The calorific value was determined using measurements made in an isoperibol calorimeter, an isothermal calorimeter, and an adiabatic calorimeter at two different laboratories.

Moisture, Ash, and Volatile Matter: The moisture, ash, and volatile matter values were determined on measurements made using the standard ASTM methods, D3173, D3174, and D3175, respectively. In addition, commercial instruments commonly used for the determination of the parameters provided additional values.

Table 1. Certified Values of Constituent Elements

Major Constituents		Minor Constituents	
Elements	Content Wt. Percent	Elements	Content Wt. Percent
Carbon (Total)	78.11 ± 0.37[a]	Aluminum	0.855 ± 0.019
Hydrogen	5.07 ± 0.06	Calcium	0.204 ± 0.006
Nitrogen	1.56 ± 0.07	Iron	0.759 ± 0.045
Sulfur	1.89 ± 0.06	Magnesium	0.0383 ± 0.0008
Volatile matter	35.4 ± 1.1	Potassium	0.0748 ± 0.0028
		Sodium	0.0515 ± 0.0011
		Titanium	0.0454 ± 0.0017

Trace Constituents

Element	Content μg/g	Element	Content μg/g
Arsenic	3.72 ± 0.09	Manganese	12.4 ± 1.0
Barium	67.5 ± 2.1	Nickel	6.10 ± 0.27
Cadmium	0.0573 ± 0.0027	Rubidium	5.05 ± 0.11
Cobalt	2.29 ± 0.17	Selenium	1.29 ± 0.11
Copper	6.28 ± 0.30	Thorium	1.342 ± 0.036
Lead	3.67 ± 0.26	Uranium	0.436 ± 0.012
		Zinc	11.89 ± 0.78

Calorific Value[b,c]	Ash, wt.%
14005 ± 35 Btu/lb (32.57 ± 0.08 MJ kg^{-1})	6.79 ± 0.16

[a] The listed ± uncertainties for carbon, hydrogen, volatile matter, and calorific value are two standard deviations of the certified value. The listed ± uncertainties for all other constituents are two standard deviations for the certified values and include an allowance for minor sample heterogeneity. The observed sample variability was generally less than two percent of the constituent value.

[b] The calorific value (MJ kg^{-1}) may decrease upon aging or normal oxidation of the coals. NBS will continue to monitor this value and report any substantive change in the certified calorific value to the purchaser. The reference date for the calorific value is May 1985.

[c] The calorific value is determined as HHV2 (Higher Heating Value-Moisture Free).

Table 2. Noncertified Values for Constituent Elements

Trace Constituents

Element	Content μg/g	Element	Content μg/g
Antimony	(0.24)	Lithium	(10)
Bromine	(17)	Molybdenum	(0.9)
Cerium	(9)	Samarium	(0.87)
Cesium	(0.44)	Scandium	(1.9)
Chlorine	(1260)	Silicon, wt %	(1.4)
Chromium	(11)	Strontium	(102)
Europium	(0.17)	Tungsten	(0.48)
Hafnium	(0.43)	Vanadium	(14)
Lanthanum	(5.1)		

Table 3. Analytical Techniques and Methods Used for the Characterization of SRM 1632b

Method/ Element	A	B	C	D	E	F	G	H	I	J	K	L	M
Al			•	•								•	
As			•		•								
Ash Content							• 2		•				
Ba			•										
Br			•										
C (Total)							• 5	•	•		•		
Ca		•	•	•								•	
Cal Val									•	•			
Cd	•	•											
Ce			•										
Cl			•										
Co			•	•									
Cr			•										•
Cs			•										
Cu					•								•
Eu			•										
Fe	•		•									•	
H							• 5	•	•				
Hf			•										
K		•	•	•								•	
La			•										
Li				•									
Mg	•	•	•										
Mn			•	•									
Mo			•										
N							• 6						
Na			•	•									
Ni	•												•
Pb	•	•											
Rb		•	•	•									
S						•	• 4		•			•	
Sb			•										
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Se			•		c								
Si			•									•	
Sm			•										
Sr			•										
Th		•	•										
Ti			•	•								•	•
U		•	•										
V			•										•
Volatile Matter							• 3		•				
W			•										
Zn	•	•	•										

Analytical Methods

A. Atomic absorption spectrometry
B. Isotope dilution mass spectrometry
C. Instrumental neutron activation analysis
D. Flame emission spectrometry
E. Flameless atomic absorption spectrometry
F. Ion chromatography
G. ASTM Methods: (1)D3173, (2)D3174, (3)D3175, (4)D3177, (5)D3178, (6)D3179
H. Combustion coulometry
I. Commercial coal analyzers: moisture, ash, sulfur, Btu, volatile matter, carbon, hydrogen, nitrogen
J. Commercial calorimeter
K. Gas chromatography
L. X-ray fluorescence
M. Inductively coupled plasma emission spectrometry

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U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 1633a

Trace Elements in Coal Fly Ash

This Standard Reference Material is intended for use in the calibration of apparatus and methods used in analyses of coal fly ash and other materials with similar matrices for trace elements. This material should be dried to a constant weight before using. Recommended procedures for drying are: (1) drying for 24 hours at ambient temperature using a cold trap at or below -50 °C and a pressure not greater than 30 Pa (0.2 mm Hg); (2) drying in a desiccator over P_2O_5 or $Mg(ClO_4)_2$. When not in use, the material should be kept in a tightly sealed bottle. Long term (>3 years) stability of this SRM has not been rigorously established. NBS will continue to monitor this material and any substantive change will be reported to purchasers.

The certified values given below are based on at least a 250-mg sample of the dried material, the minimum amount that should be used for analysis.

Element[1]	Content[2]	Element	Content
	%		μg/g
Calcium[a,b,e]	1.11 ± 0.01	Mercury[a,c]	0.16 ± 0.01
Iron[a,b,c]	9.40 ± 0.10	Nickel[a,b,d,e]	127 ± 4
Potassium[a,b,e]	1.88 ± 0.06	Lead[b,d,e]	72.4 ± 0.4
Magnesium[a,b]	0.455 ± 0.010	Rubidium[a,b,c,e]	131 ± 2
Sodium[a,c]	0.17 ± 0.01	Selenium[a,c,g]	10.3 ± 0.6
Silicon[e,h]	22.8 ± 0.8	Strontium[a,e,f]	830 ± 30
	μg/g	Thorium[b,c]	24.7 ± 0.3
Arsenic[a,c]	145 ± 15	Thallium[b,g]	5.7 ± 0.2
Cadmium[b,c,d,g]	1.0 ± 0.15	Uranium[b]	10.2 ± 0.1
Chromium[a,b,c]	196 ± 6	Zinc[a,b,d,e,f]	220 ± 10
Copper[a,b,c]	118 ± 3		

1. **Methods of Analysis:**
   - [a] Atomic Absorption Spectrophotometry or Flame Emission Spectrometry
   - [b] Isotope Dilution Mass Spectrometry
   - [c] Neutron Activation
   - [d] Polarography
   - [e] X-ray Fluorescence Spectrometry
   - [f] Inductively Coupled Plasma Emission Spectrometry
   - [g] Isotope Dilution Spark Source Mass Spectrometry
   - [h] Gravimetry

2. The 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 of 250-mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

Washington, D.C. 20234
April 18, 1979

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

The overall direction and coordination of the analytical measurements leading to certification were performed in the Center for Analytical Chemistry under the chairmanship of L. A. Machlan.

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 W. P. Reed.

PREPARATION, TESTING, AND ANALYSIS

This fly ash material was supplied by a coal fired power plant and is a product of Pennsylvania and West Virginia coals. It was selected as a typical fly ash and is not intended as a fly ash from a specific coal or combustion process. The material was sieved through a # 170 sieve and blended for 2 hours in a Vee blender. The material was then removed and placed in a series of bulk containers from which specific samples were taken.

Twelve bottles were selected for homogeneity tests. These samples were analyzed for cobalt, chromium, europium, iron, scandium, and thorium by nondestructive neutron activation analysis. The observed standard deviations for both 50 and 250 mg samples were consistent with counting statistics indicating that the fly ash is homogeneous within ± 5% (relative) based on these elements. The homogeneity analyses were performed in the NBS Center for Analytical Chemistry by R. R. Greenburg and J. S. Maples. Analyses for the various elements were made in the NBS Center for Analytical Chemistry by the following analysts: J. R. Baldwin, T. J. Brady, E. R. Deardorff, M. G. Dias, L. P. Dunstan, M. S. Epstein, E. L. Garner, T E. Gills, C. A. Grabnegger, J. W. Gramlich, R. R. Greenberg, S. Hanamura, S. H. Harrison, E. F. Heald, H. M. Kingston, E. C. Kuehner, L. A. Machlan, E. J. Maienthal, J. S. Maples, J. D. Messman, L. J. Moore, P. J. Paulsen, P. A. Pella, T. C. Rains, K. J. R. Rosman, T. A. Rush, P. A. Sleeth, and R. L. Waters, Jr.

The following values are not certified because they are based on a non-reference method, or were not determined by two or more independent methods. They are included for information only.

Element	Content	Element	Content
	%		μg/g
Aluminum	14	Europium	4
Barium	0.15	Gallium	58
Titanium	0.8	Hafnium	7.6
	μg/g	Manganese	190
Beryllium	12	Molybdenum	29
Cerium	180	Antimony	7
Cobalt	46	Scandium	40
Cesium	11	Vanadium	300

U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate of Analysis

Standard Reference Material 1635

Trace Elements in Coal (Subbituminous)

This Standard Reference Material is intended for use in the calibration of apparatus and the evaluation of techniques employed in the trace element analysis of coal and similar materials. The material should be dried without heat to constant weight before use.

The recommended procedures for drying are either vacuum drying at ambient temperature for 24 hours, or freeze drying in which the drying chamber is kept at room temperature. The moisture content of this material is approximately 20%. Because of this moisture level, it is recommended that small individual samples be dried immediately before use. Drying of large samples may result in a violent discharge of water vapor and resultant loss of sample. When not in use, the material should be kept in a tightly sealed bottle and stored in a cool, dark place. Long-term (>1 year) stability of this SRM has not been rigorously established. NBS will continue to monitor this material and any substantive change will be reported to purchasers.

The certified values given below are based on at least a 250-mg sample of the dried material, the minimum amount that should be used for analysis.

Element[1]	Content, $\mu g/g$[2]	Element[1]	Content, $\mu g/g$[2]
Arsenic[a,b]	0.42 ± 0.15	Thorium[c,e]	0.62 ± 0.04
Cadmium[c,d,e]	0.03 ± 0.01	Uranium[c]	0.24 ± 0.02
Chromium[c,e]	2.5 ± 0.3	Vanadium[e,g]	5.2 ± 0.5
Copper[a,c,e]	3.6 ± 0.3	Zinc[c,d]	4.7 ± 0.5
Lead[c,d]	1.9 ± 0.2		
Manganese[a,e]	21.4 ± 1.5	Element[1]	Wt. %[2]
Nickel[c,d]	1.74 ± 0.10	Iron[c,d,e,f]	0.239 ± 0.005
Selenium[a,e]	0.9 ± 0.3	Sulfur[f,h]	0.33 ± 0.03

1. Methods of Analysis:
   a. Atomic Absorption Spectrometry
   b. Photon Activation
   c. Isotope Dilution Mass Spectrometry
   d. Polarography
   e. Neutron Activation
   f. Spectrophotometry
   g. Flame Emission Spectrometry
   h. Gravimetry
2. The 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 of 250-mg or more. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the determination of most constituents.)

The overall direction and coordination of the analytical measurements leading to this certificate were performed in the Analytical Chemistry Division under the chairmanship of L. J. Moore.

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 W. P. Reed.

Washington, D.C. 20234
August 22, 1979
(Revision of Certificate dated 1-23-78)

George A. Uriano
Office of Standard Reference Materials

(over)

PREPARATION, TESTING, and ANALYSIS

This material was prepared from one lot of subbituminous coal from the Eagle Mine of The Imperial Coal Company, Erie, Colorado. The material was ground and sieved thru a No. 65 (230 μm) sieve by the Colorado School of Mines Research Institute. The material was then blended in a V-type blender.

Samples for homogeneity testing were taken from the top, middle, and bottom of three bulk containers of coal, and analyzed by neutron activation analysis for sodium, scandium, chromium, iron, cobalt, lanthanum, cerium, and thorium. Replicate analyses of 250-mg samples indicated a homogeneity for these elements of $\pm 2.5\%$ (relative) except for chromium, which was homogeneous within counting statistics of $\pm 6\%$. The homogeneity measurements were performed in the NBS Analytical Chemistry Division by R. R. Greenberg. Certification analyses for the various elements were made in the NBS Analytical Chemistry Division by T. J. Brady, B. I. Diamondstone, L. P. Dunstan, M. S. Epstein, M. Gallorini, E. L. Garner, T. E. Gills, J. W. Gramlich, R. R. Greenberg, S. H. Harrison, G. M. Hyde, G. J. Lutz, L. A. Machlan, E. J. Maienthal, J. D. Messman, T. J. Murphy, and T. C. Rains.

The following values are *not certified* because they were based on a non-reference method, or were not determined by two or more independent methods. They are included for information only.

Element	Content (μg/g)
Antimony	(0.14)
Cerium	(3.6)
Cobalt	(0.65)
Europium	(0.06)
Gallium	(1.05)
Hafnium	(0.29)
Scandium	(0.63)
	(wt. %)
Aluminum	(0.32)
Sodium	(0.24)
Titanium	(0.02)

U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate of Analysis

Standard Reference Materials
2682, 2683, 2684 and 2685

Sulfur in Coal

These Standard Reference Materials (SRM's) are intended primarily for use as analytical standards for the determination of sulfur in coal. In addition to sulfur they are certified for their calorific value ($MJ \cdot Kg^{-1}$) and ash content. SRM's 2682-2685 each consists of a 50-g bottle of a different coal composition. Each material was ground to pass a 60-mesh sieve and homogenized. The certification of the materials for sulfur is based on at least a 250-mg sample of the dried material, the minimum amount that should be used for analysis (see drying instructions). The calorific values were determined by procedures recommended in standard ASTM methods (see references in Table 1). The certification data for the four different coals are given in Table 1 along with methods used for certification. Noncertified values for major and minor elements are given in Table 2. These values are provided for information only.

Notice to Users: These SRM's are sold individually rather than in sets; however, only one Certificate of Analysis is provided. Therefore, the user must be careful to use the data specific to the SRM being used.

The uncertainty of a certified value is expressed as two times the standard error and includes observed variability within and between measurement methods and any observed material heterogeneity. For the certified heating values the uncertainty also includes additional allowances for possible limited sample degradation due to aging or normal oxidation.

Certification analyses were performed by W.R. Kelly, W.F. Koch, P.J. Paulsen, and J.W. Stolz of the Inorganic Analytical Research Division and J.C. Colbert and D.R. Kirklin of the Chemical Thermodynamics Division.

Analyses for supplemental information were performed in the Inorganic Analytical Research Division by R. Fleming, R. Greenberg, and R.M. Lindstrom.

The statistical analysis of the certification data was performed by R.C. Paule of the National Measurement Laboratory.

The overall direction and coordination of the technical measurements leading to 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 these Standard Reference Materials were coordinated through the Office of Standard Reference Materials by T.E. Gills.

February 7, 1983
(Revision of Certificate dated 12-14-82)

(over)

George A. Uriano, Chief
Office of Standard Reference Materials

Table 1

Certified Values for SRM's 2682, 2683, 2684, and 2685

SRM No.	Coal Type	Sulfur[1,2,3] Wt. %	Furnace[4] Ash Wt. %	HHV2[5,6] $MJ \cdot Kg^{-1}$ ($BTU \cdot lb^{-1}$)
2682	Sub-bituminous	0.47 ± 0.03	6.37 ± 0.18	27.45 ± 0.56 (11800 ± 240)
2683	Bituminous	1.85 ± 0.06	6.85 ± 0.02	32.70 ± 0.14 (14060 ± 60)
2684	Bituminous	3.00 ± 0.13	11.09 ± 0.18	29.68 ± 0.47 (12760 ± 200)
2685	Bituminous	4.62 ± 0.18	16.53 ± 0.15	28.15 ± 0.42 (12100 ± 180)

[1] ASTM D3177 Standard Test Method for Total Sulfur in the Analysis Sample of Coal and Coke

[2] Ion Chromatography with Bomb Combustion

[3] Thermal Ionization Mass Spectrometry, Sealed Glass Tube Digestion

[4] ASTM D3174, Standard Test Method for Ash in the Analysis Sample of Coal and Coke

[5] ASTM D2015 Standard Test Method for Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter

[6] ASTM D3180 Standard Test Method for Calculating Coal and Coke Analyses from As-Determined to Different Bases
HHV2-(Higher Heating Value - Moisture Free)

Note: The calorific values ($MJ \cdot Kg^{-1}$) may decrease upon the aging or normal oxidation of the coals. NBS will continue to monitor these calorific values and report any substantive change to the purchaser. The uncertainty of the heating value includes an additional allowance of 0.12 $MJ \cdot Kg^{-1}$ for possible sample degradation. The reference date for the calorific data is October 1982.

PREPARATION AND TESTING

Approximately one ton of coal was obtained from each of four different coal mine locations. All coals were oven dried prior to processing in accordance with procedures outlined in ASTM D2013. At least 1000 pounds of each of the four coals were reduced in size to -60 mesh and screened prior to blending. Each of the -60 mesh coals was blended in a stainless steel cone blender (approximate capacity 0.85 cubic meter). The coals were then packaged into individual 50-g bottled units. Homogeneity testing was done on the bulk materials and 50-g bottled units. The homogeneity analyses were performed using x-ray fluorescence analysis. Replicate analyses indicated the material variability for sulfur to be within ± 2% (relative) for all four SRM's.

The homogeneity studies were performed by T.E. Gills and M. Watson of the Office of Standard Reference Materials and P.A. Pella of the Gas and Particulate Science Division.

ANALYSIS

Sulfur: The certified sulfur content is based upon the results of 3 independent methods of analysis: ion chromatography, gravimetry, and thermal ionization mass spectrometry. Agreement with the certified values was found using 2 additional independent techniques, prompt-gamma activation analysis and a combustion IR technique.

Calorific Value ($MJ \cdot Kg^{-1}$) and Ash Content: The certified values for the calorific values and ash contents were determined using measurements made in an adiabatic bomb calorimeter of the type used in commercial laboratories. This calorimeter is capable of reproducing determinations on benzoic acid to a precision of 0.07% (relative). This statement of precision was arrived at by averaging 5 calibrations made on the calorimeter using a benzoic acid standard that is traceable to the NBS SRM 39i, Benzoic Acid.

Major and Minor Elements: Analyses for major and minor elements were performed by thermal neutron activation analysis and neutron capture gamma-ray activation analysis. These values are not certified but are to be used for information only.

STABILITY

The long-term physical and chemical stability of these SRM's has not been rigorously established. However, NBS recommends that the material be stored in the tightly sealed bottle away from sunlight and intense sources of radiation. NBS will continue to monitor these materials and any substantive change in their certification will be reported to the purchaser.

INSTRUCTIONS FOR DRYING

The certification of sulfur in these SRM's is based upon a properly dried sample. The recommended procedures for drying are vacuum drying at ambient temperature for 24 hours or oven drying for 24 hours at 105 °C. Typical moisture loss using the recommended methods for drying are the following: SRM 2682, 18%; SRM 2683, 1.4%; SRM 2684, 3.6%; and SRM 2685, 1.8%.

SUPPLEMENTAL INFORMATION

The values listed below are based on measurements made using a single method or technique and are given for *information only*. While no reason exists to suspect systematic bias in these numbers, no attempt was made to determine if such bias attributable to the methods exists.

The analyses of SRM's 2682-2685 for major and minor elements were made using NBS SRM's 1632a and 1635, Trace Elements in Coal, as controls.

Table 2

Inorganic Constituents in SRM's 2682, 2683, 2684, and 2685

Mean Concentrations (μg/g) Unless Noted

Element/SRM	2682	2683	2684	2685
Al %	0.46	0.86	1.1	1.7
As	1.0	3.6	3.9	12
B	39	67	114	109
Ba	382	71	41	105
Br	3.7	17	11	5.6
C %	75	79	68	66
Ca %	1.1	0.20	0.44	0.52
Ce	10	9	12	18
Co	1.7	2.2	3.9	4.6
Cr	15	11	17	22
Cs	<0.1	0.4	1.2	1.3
Eu	0.17	0.18	0.23	0.36
Fe %	0.24	0.76	1.5	2.9
H %	4.7	5.0	4.8	4.6
Hf	0.60	0.42	0.57	0.91
K %	0.01	0.08	0.20	0.26
La	5.2	5.1	6.7	10
Mg %	0.2	0.05	0.08	0.1
Mn	26	13	36	41
N %	0.8	1.6	1.6	1.1
Na %	0.10	0.05	0.03	0.08
Rb	<2	5.3	15	17
Sb	0.19	0.28	0.35	0.36
Sc	1.5	1.9	2.7	3.7
Se	0.91	1.2	1.9	1.9
Sm	0.78	0.86	1.1	1.7
Th	1.5	1.4	2.0	2.7
Ti %	0.05	0.04	0.06	0.09
U	0.52	0.42	0.90	0.95
V	15	14	22	31
W	1.8	0.48	0.56	1.2
Zn	8.6	9.5	110	17

NBS Technical Publications

Periodical

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U.S. Department of Commerce
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