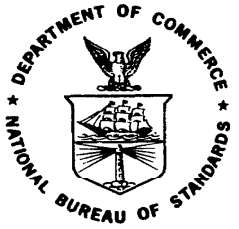


NBS SPECIAL PUBLICATION 260-57

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

Standard Reference Materials:

GUIDE TO UNITED STATES REFERENCE MATERIALS

Standard Reference Materials:
GUIDE TO UNITED STATES REFERENCE MATERIALS

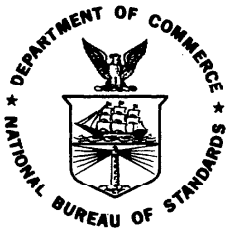
J. Paul Cali

Office of Standard Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234

and

Tomasz Plebanski

Polish Committee of Standardization
and Measures
Warsaw, Poland



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PREFACE

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

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

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

Office of Standard Reference Materials
National Bureau of Standards
Washington, D.C. 20234

J. Paul Cali, Chief
Office of Standard Reference Materials

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Standard Reference Materials:

GUIDE TO UNITED STATES REFERENCE MATERIALS

J. Paul Cali

Office of Standard Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234

and

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Polish Committee of Standardization
and Measures
Warsaw, Poland

Summarized is a list of reference materials produced and distributed by U.S. manufacturers, both public and private. Extensive tables are indexed by use to which reference materials may be put. Properties covered include: chemical composition (analytical chemical purposes), chemical composition (high purity), physical properties, engineering and technological properties, and biochemical properties. Names and addresses of 93 U.S. producers and/or distributors are included.

Key words: Measurement; reference materials; standardization; Standard Reference Materials.

GUIDE TO UNITED STATES REFERENCE MATERIALS

I. Background

In 1976, the Council Committee on Reference Materials (REMCO) of the International Organization for Standardization proposed as the term "reference materials" the following definition: "A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus or for the verification of a measurement method." "A certified reference material (CRM) is further defined as: "A RM accompanied by, or traceable to, a certificate stating the property value(s) concerned, issued by an organization, public or private, which is generally accepted as technically competent." A careful reading of this definition will lead the reader to the conclusion that a great many materials will rest comfortably under its umbrella. Thus, for an analytical chemist any pure chemical used to prepare what are usually called "standard solutions" can be considered to be a reference material. Simple devices, such as accurately calibrated optical filters, also are covered by this definition. Where to draw the line to exclude various chemicals or devices is somewhat arbitrary and no hard and fast rules have been developed to date. Weights used to calibrate or check balances are, e.g., <u>not</u> considered reference materials, even though they obviously fit the definition very well. For this reason then the reference materials listed herein are somewhat arbitrary. In fact, the inclusion or exclusion of a particular supplier's reference materials is first and foremost simply a function of whether or not he replied to our inquiry for information.

The current great interest in reference materials as an important means for helping to assure measurement compatibility in a wide variety of applications dates from 1969. In that year the National Bureau of Standards (NBS) and the International Committee on Weights and Measures (CIPM) cosponsored a meeting where the desirability of establishing a formal program internationally was explored. Representatives from 15 countries and 4 international agencies agreed unanimously that such a course of action would be desirable. The need for a central distributing agency for exchange of information on reference materials, preferably through an international agency was stressed. The CIPM was asked to assume this (and other) responsibilities. Subsequently however, the CIPM with regret had to decline due to a lack of resources and a misfit with regard to its scope. (1)

However, the matter was not dead for following the first large scale SRM Symposium held at NBS in 1973 - see reference (2), a meeting called by the International Organization for Legal Metrology was held to reactivate the matter. As a result of this meeting, attended by representatives of 12 countries and 7 international agencies, ISO subsequently agreed to provide secretariat services for international agencies interested in the exchange of information concerning reference materials.

Thus, ISO established REMCO in 1974 to coordinate reference material information exchange activities. Since one of the authors (J. P. Cali) is the U.S.-American National Standards Institute (ANSI) representative on REMCO, this report was prepared to provide information on reference material activity and availability in the U.S. for dissemination in international channels, as well as information of value to U.S. science, technology, and industry directly.

The other author (T. Plebanski) spent one year at NBS under a UNESCO fellowship studying RM's. With this work in place he helped gather, collate, and prepare for publication information on U.S. available reference materials. To this end, NBS contracted with him in 1974 to perform these functions.

II. Purpose of Guide

All measurement networks need to be compatible. By this we mean that producer and consumer, or regulator and those regulated, need to be able to measure the property(ies) of the same sample in such a way that, within agreed on limits of uncertainty, all obtain identical numerical values of the property(ies) under measurement. Cali, among others, has shown (see 3 or 4 e.g.) that when measurement systems are based on accuracy that measurement compatibility must logically ensue. However, to achieve accuracy in measurement, especially when the property under consideration is that of composition, five basic components of the measuring process need to be available or present (see, e.g., 5). One of these is reference materials and called at NBS for historical reasons Standard Reference Materials (SRM).

Thus, a knowledge of where to obtain reference materials is important. This then is the basic rationale and principal purpose for this guide.

III. Scope and Structure of Guide

Listed in the body of the report are over 17,000 reference materials. Of these approximately 7,200 fall into

the class "certified reference materials" (see Section IV, below). These 17,000 reference materials are either the direct product of or are distributed by the 93 U.S. companies and/or organizations who responded to the NBS request for information. The information supplied was primarily in the form of catalogues, product lists, etc.

Of the 17,000 reference materials listed, about 2,000 are produced in foreign countries, principally Japan and countries of Europe. There is, of course, considerable duplication among the reference materials. The duplication is especially strong in these classes: high purity elements and inorganic chemicals; spectrochemical mixtures, powders, and alloys; and, standard solutions and mixtures for atomic absorption calibration. We estimate there are listed approximately 10,000 different reference materials produced in the U.S.

No attempt has been made to make a quality assessment of either the producers or of their reference materials.

Two classes of reference materials have been listed: general reference materials (RM) and certified reference materials (CRM). These have been defined above. In attempting to decide whether a particular material was, in fact, suitable for use as a reference material, the general criteria listed by Cali in reference 6 were applied. Some of these criteria are: purity, homogeneity, stability, continuity of both supply and information, availability, and extent of certification process. Other factors considered were: (1) whether the producer states in his literature that his product is suitable for reference purposes (as calibrating material, e.g.); (2) whether the producer guarantees his product in some meaningful way; (3) whether useful technical information is supplied with his product (e.g., actual lot analysis); (4) by comparison of the same product from different sources; and/or, (5) by some evidence that traceability to national or international standards has been established. Thus, it is apparent that a considerable degree of subjective judgment was used by the authors. The ultimate test, of course, as to whether a particular material can serve usefully as a reference material must lie with the user.

The properties embodied in the reference materials are classified in five categories:

1. Chemical composition (Analytical RM) - multicomponent (usually) reference materials, often mixtures or solutions, used in chemical analytical systems. This class will include alloys, mixtures, natural materials, etc.

2. Chemical composition (High Purity RM) - single component (usually) reference materials of high purity used in chemical analytical systems. However, they may also serve for the realization or determination of other properties, e.g., physico-chemical, thermochemical, electrical, etc. Others, e.g., platinum, cesium, kryton serve as primary RM in defining international scales. These latter RM are certified for total purity of the main component and for trace impurities present.

3. Physical properties - reference materials characterized for optical, heat, radiation, etc. properties.

4. Engineering and technological properties - reference materials embodying properties as hardness, smoke density, etc.

5. Biochemical properties - reference materials of botanical, biological, clinical, bionuclear substances.

These categories are not necessarily mutually exclusive. Often RM's will be characterized for more than one property and thus will be found in the appropriate categories. E.g., some bionuclear RM's might be found in category(ies) 1, 3, and 5 if characterized for chemical composition, radioactivity, and biological activity.

Two tables are presented:

Table A: Index of Reference Materials. In this table are incorporated both matrices and properties of interest arranged in the five categories listed above. It would have been impractical to list individually every RM by chemical name or specific material. Therefore, we have tried to use classes or groups to lead the user to a supplier who can provide more specific information with regard to highly specific chemicals, matrices, or properties. In other words, the principal utility of this listing is to provide general guidance to the user to assist in shortening his search time and to make him aware of RM supplies he might otherwise have missed. Only in the catalogs of the various suppliers will be found the specific information usually required for the ultimate end-use.

Table B: Index of Suppliers. In this table we give the names and addresses of the suppliers who replied to our request for information. The addresses shown are those given by the supplier at the time his catalogues were delivered to NBS. Each is given a supplier number, an internal NBS file number, and the approximate number of RM's, either general or certified, produced or distributed.

IV. Disclaimer

In issuing this guide NBS makes no warranty, explicit or implied, that any RM listed will perform or not as claimed by the producer or distributor.† Neither does NBS, through the inclusion or exclusion of any RM producer or distributor, impute either directly or indirectly the technical, scientific, or economic value or worth of the RM's referenced. This guide is issued by NBS for information only to provide RM users or potential users to RM sources in the U.S. NBS, an agency of the U.S. Government, assumes no liability for damages resulting from the use or misuse of any of the information given in the guide or from use or misuse of the RM's referenced.

V. Updating of Guide

It is our intention to update the guide from time to time as interest and demand warrant. RM producers, suppliers, and distributors may send catalogues and pertinent information, together with suggestions to improve the usefulness of the guide to:

J. Paul Cali
Chief, Office of Standard
Reference Materials
Institute for Materials Research
National Bureau of Standards
Washington, D.C. 20234.

†Excepting RM's and CRM's directly produced by NBS itself (Supplier #86).

A. INDEX OF REFERENCE MATERIALS

Category 1: Chemical Composition - Analytical Reference Materials — Supplier No.

Category 2: Chemical Composition - High Purity Reference Materials

Category 3: Physical Property Reference Materials — Supplier No.

Category 4: Engineering and Technical Property Reference Materials

Category 5: Biochemical Reference Materials (including biological, bionuclear, clinical, drug and medical reference materials)

	Supplier No.
Agarose	17
Aminoacids	20, 23, 31, 41
Aminosugars	41
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Antisera	41
Barbiturates	13
Biochemicals conforming to NAS/NRC specifications	22, 44
Biological samples - reference electron probe standards	78
Blood cell counting and sizing - particle size standards	28
Bovine liver - analytical standard	86
Brain cerebroside hydrolyzates	13
Buffers	17, 41
Carbohydrates	13
Cholesterol	86
Cholesteryl esters	13
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Drugs	13, 20, 23
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Electron microscopy of biological materials	78
Electrophoresis	17
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- methyl esters	74
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Fatty alcohols	13
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Glutaraldehyde for electron microscopy of biological materials	78

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Supplier Number	NBS File #	Supplier	Number of CRM's	Number of RM's
1	72/97	Ace Scientific Supply Co., Inc. 1420 East Linden Avenue Linden, N. J. 07036		16
2	72/88	Airco Industrial Gases 575 Mountain Avenue Murray Hill, N. J. 07974	25	143
3	72/2	Air Products and Chemicals, Inc. Specialty Gas Department P. O. Box 538 Allentown, Pa. 18105	136	540
		Alfa Products--see Ventron Corp. Alfa Prod.		
4	72/4	Alpha Analytical Laboratories Division of Alpha Metals Inc. 56 Water Street Jersey City, N. J. 07304	180	117
5	72/5	Aluminum Company of America ALCOA Laboratories Alcoa Center, Pa. 15069	403	
6	72/7	American Petroleum Institute Standard Reference Materials Carnegie-Mellon University Schenley Park Pittsburgh, Pa. 15213	407	

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Supplier Number	NBS File #	Supplier	Number of CRM's	Number of RM's
7	72/8	American Smelting and Refining Company By-Product Sales 120 Broadway New York, N. Y. 10005		14
8	72/9	Amersham/Searle Corporation 2636 S. Clearbrook Drive Arlington Heights, IL 60005	145	622
9	72/126	Analytical Supplies Development Corp. 48 Notch Road Little Falls, N. J. 07424	45	
10	72/10	Angstrom, Inc. 678 E. Huron River Drive P. O. Box 248 Belleville, Michigan 48111	16	40
11	72/11	Apache Chemicals, Inc. P. O. Box 17 Rockford, IL 61105	70	307
12	72/12	Apex Smelting Company Division of Amax Aluminum Co., Inc. 2537 W. Taylor Street Chicago, IL 60612		62
13	72/13	Applied Science Laboratories, Inc. P. O. Box 440 State College, Pa. 16801		265

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Supplier Number	NBS File #	Supplier	Number of CRM's	Number of RM's
14	72/14	Arro Laboratories, Inc. P. O. Box 686 Caton Farm Road Joliet, Ill. 60434	45	72
15	72/15	Atomergic Chemetals Company Division of Gallard-Schlesinger Mfg. Corp. 584 Mineola Avenue, Carle Place Long Island, N. Y. 11514	6	220
16	72/78	Baird-Atomic, Inc. 125 Middlesex Turnpike Bedford, Mass. 01730	176	
		Baker--See J. T. Baker Company		
17	72/112	Bio-Rad Laboratories 32nd and Griffin Avenue Richmond, Calif. 94804		46
18	72/111	Bradford Scientific, Inc. P. O. Box 275 Marblehead, Mass. 01945	15	226
19	72/16	Brammer Standard Company 213 Essex Knoll Drive Coraopolis, Pa. 15108	548	613
20	72/110	Brinkmann Instruments, Inc. Cantiague Road Westbury, N. Y. 11590		5

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21	72/84	Burdick and Jackson Laboratories 1953 South Harvey Street Muskegon, Michigan 49442		42
		Bureau of Mines--See U.S. Dept. of the Interior		
22	72/82	Calbiochem 109 North Torrey Pines Road LaJolla, Calif. 92037		39
23	72/131&142	California Bionuclear Corporation 7654 San Fernando Road Sun Valley, Calif. 91352	463	
24	72/17	Cannon Instrument Company P. O. Box 16 State College, Pa. 16801	29	
		Cargille--See R. P. Cargille		
25	72/87	Columbia Scientific Industries 11950 Jollyville Road P. O. Box 9908 Austin, Tx. 78766	752	30
26	72/118	Cominco American, Inc. Building 101 Spokane Industrial Park Spokane, Washington 99216		19

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27	72/18	Continental Oil Company Conostan Division P. O. Box 1267 Ponca City, Oklahoma 74601	52	1
28	72/90	Duke Scientific Corporation 445 Sherman Avenue Palo Alto, Calif. 94306	33	65
29	72/19	Eastman Kodak Company Eastman Organic Chemicals Rochester, N. Y. 14650	6	235
30	72/21	Electronic Space Products, Inc. 854 S. Robertson Blvd. Los Angeles, Calif. 90035	240	1128
31	72/109	EM Laboratories, Inc. 500 Executive Boulevard Elmsford, N. Y. 10523		10
32	72/23	ESCO Corporation 2141 N.W. 25th Ave. Portland, Oregon 97210	1	62
		Fisher--See Jarrel-Ash Division		
33	72/24	F&J Scientific 79 Far Horizon Drive Monroe, Conn. 06468		230

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34	72/25	Foote Mineral Company Route 100 Exton, Pa. 19341	1	8
		Frederick Smith--See G. Frederick Smith		
35	72/26	Gallard Schlesinger Chemical Manufacturing Corporation 584 Mineola Avenue Carle Place, N. Y. 11514		91
36	72/81	General Graphites, Inc. First and Monroe Streets Bay City, Michigan 48706	53	7
37	72/28	G. Frederick Smith Chemical Company P. O. Box 23344 Columbus, Ohio 43223	68	17
38	72/29	Glidden-Durkee Division of SCM Corporation Metals Group P. O. Box 217 Johnstown, Pa. 15907	1	
39	72/30	Handy & Harman Fairfield Plant 1770 Kings Hwy. Fairfield, Conn. 06430	2	

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		Harshaw--See the Harshaw Chemical Company		
40	72/32	Huntington Alloys, Inc. Huntington, West Virginia 25720		32
41	72/114	ICN Life Sciences Group 26201 Miles Road Cleveland, Ohio 44128	114	461
42	72/92	Janos Optical Corporation Route 35 Townshend, Vermont 05353		276
43	72/35	Jarrel-Ash Division, Fisher Scientific Company Spectrographic Supplies Section 590 Lincoln Street Route 128 Waltham, Mass. 02154	225	23
44	72/37	J. T. Baker Chemical Company 222 Red School Lane Phillipsburg, N. J. 08865	130	818
45	72/105	Kawecki Berylco Industries, Inc. 220 East 42nd Street New York, N. Y. 10017		8

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46	72/117	Lachat Chemicals, Inc. 1350 W. Meguon Road Meguon, Wisconsin 53092		44
47	72/80	LaPine Scientific Company 6001 South Knox Avenue Chicago, Ill. 60629		57
48	72/95	Leco Corporation 3000 Lakeview Avenue St. Joseph, Michigan 49085	137	30
		Linde--See Union Carbide Corporation, Linde Division		
		London Company--See The London Company		
49	72/43	Materials Research Corporation Orangeburg, N. Y. 10962	56	160
50	72/100	Metals Research Instrument Corporation 40 Robert Pitt Drive Monsey, N. Y. 10952	83	71
51	72/128	Miles Laboratories, Inc. Research Division Elkhart, Indiana 46514	20	31

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		Mineral--See U.S. Mineral and Chemical Co.		
52	72/45	Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Missouri 63166		3
53	72/47	Nanogens--Analytical Specialists P. O. Box 1025 Watsonville, Calif. 95076		171
		National Bureau of Standards--See U.S. Department of Commerce		
54	72/49	National Spectrographic Laboratories, Inc. 19500 South Miles Road Cleveland, Ohio 44128	109	
		New Brunswick Laboratory--See United States Department of Energy		
55	72/51	New England Nuclear Corporation 549 Albany Street Boston, Mass. 02118	121	168
56	72/98-46	NL Industries, Inc. Spectrographic Laboratory 2700 South Indiana Street Los Angeles, Calif. 90023	59	

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58	72/129	Nuclepore Corporation 7035 Commerce Circle Pleasanton, Calif. 94566		39
		Nucor Corporation--See Research Chemicals, Div. of Nucor Corp.		
59	72/91	Ortec, Inc. 100 Midland Road Oak Ridge, Tenn. 37830	2	
60	72/96	Pfaltz & Bauer, Inc. 375 Fairfield Avenue Stamford, Conn. 06902	31	121
61	72/52	Phillips Petroleum Company Special Products Division Bartlesville, Oklahoma 74004	124	24
62	72/86	Polyscience Corporation 6366 Gross Point Road Niles, Illinois 60648	16	34

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63	72/119	Research Chemicals Division of Nucor Corp. P. O. Box 14588 Phoenix, Arizona 85063		32
64	72/99	Research Organic/Inorganic Chemical Corp. 11686 Sheldon Street Sun Valley, Calif. 91352	148	140
65	72/54	R. P. Cargille Laboratories, Inc. Cargille Scientific Inc. Cedar Grove, N. J. 07009		251
66	72/134	Rutherford Research Products Company Box 249 Rutherford, N. J. 07070	8	
67	72/55	Sawyer Research Products, Inc. 35400 Lakeland Boulevard Eastlake, Ohio 44094	24	
68	72/56	Scientific Gas Products, Inc. 513 Raritan Center Edison, N. J. 08817	24+ numerous	

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69	72/57	Sensorex 17502 Armstrong Ave. Irvine, Calif. 92705		46
70	72/135	Service Physical Testers Division of Service Diamond Tool Co. 6169 Lakeshore Road Port Huron, Michigan 18060	1+ numerous	
71	72/121	Sigmund Cohn Corporation 121 So. Columbus Ave. Mount Vernon, N. Y. 10553		2
72	72/58	Smith and Underwood Laboratories 1023 Troy Court Troy, Michigan 48084		55
73	72/59	Spex Industries, Inc. 3880 Park Avenue Metuchen, N. J. 08840	145	299
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76	72/31	The Harshaw Chemical Company Crystal and Electronic Products Development 6801 Cochran Road Solon, Ohio 44139	51	11
77	72/65	The London Company 811 Sharon Drive Cleveland, Ohio 44145	2	14
78	72/85	Tousimis Research Corporation P. O. Box 2189 Rockville, Md. 20852	12	20
79	72/108	Twin City Testing Corporation 107-111 Goundry Street N. Tonawanda, N. Y. 14120		
80	72/66	Ultra Carbon Corporation First and North Madison Streets Bay City, Michigan 48706	12	154

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82	72/67	Union Carbide Corporation Chemicals & Plastics P. O. Box 8361 South Charleston, W. Va. 25303	2	2
83	72/115	Union Carbide Corporation Linde Division P. O. Box 372 51 Cragwood Road South Plainfield, N. J. 07080		12
84	72/68	Union Carbide Corporation Nuclear Division P. O. Box P Oak Ridge, Tenn. 37830		135
85	72/70	U. S. Department of Energy New Brunswick Laboratory P. O. Box 150 New Brunswick, N. J. 08903	20	
86	72/76	U. S. Department of Commerce National Bureau of Standards Office of Standard Reference Materials Washington, D. C. 20234	904	17

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88	72/69	U. S. Mineral and Chemical Corporation 129 Hudson Street New York, N. Y. 10013	251	
89	72/79	U. S. Steel Corporation 600 Grant Street Pittsburgh, Pa. 15230	35	
90	72/127	Var-Lac-Oid Chemical Company 666 South Front Street Elizabeth, N. J. 07202		59
91	72/74	Ventron Corporation Alfa Products 152 Andover Street Danver, Mass. 01923	232	236

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93	72/83	Wilks Scientific Corporation P. O. Box 449 So. Norwalk, Conn. 06856	___	109

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(1) Astin, A. V., Report on the Symposium on an International Standard Reference Materials Program, *Metrologia*, 6, 33 (1970).

(2) Seward, R. W. (ed.), Standard Reference Materials and Meaningful Measurements, *NBS Spec. Publ. 408* (1975).

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N O T E S