



July 16, 1993

Dear Nuclear Professional:

Enclosed please find your new, completely revised, Isotope Products Laboratories' catalog. This catalog contains product descriptions and drawings of our most widely used products. For over twenty-six years IPL has been supplying a wide variety of standards and sources. IPL is known world-wide for providing custom standards and sources built to customer's unique specifications. IPL's expertise in the area of custom standards and sources is unparalleled in the industry.

As part of our on-going commitment to expand our product line we offer the following new products:

Multiline Simulated Gas Standards, Page 14  
Gadolinium-148 Alpha Sources, Page 18  
Hand and Foot Monitor Standards, Page 36  
Radiochromatography Reference Standards, Page 57  
Cesium-137 Line Sources, Page 59  
Germanium-68 Sources, Page 62  
Micropoint Beta Point Sources, Page 68  
High purity Gadolinium-153 Photon Sources, Page 73  
Ion Chamber Check Source Assembly, page 82

IPL supplies over eighty-five different nuclides in a wide variety of configurations. IPL participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology (NIST) in cooperation with the U.S. Council of Energy Awareness. Additionally, IPL follows NRC Regulatory Guide 4.15 and is approved to provide products to U.S. nuclear power plants.

We are proud to present this catalog to you as a source for technical information as well as a guide for products we manufacture. If you need more product information or pricing please call our Customer Service Department. We stand ready to provide you with quality products at competitive prices for all your nuclide requirements.

Thank you for making IPL a major, world-wide provider of radioactive standards and sources.

Sincerely,

Al Mandelblatt  
Director of Marketing and Sales

ENCLOSURE (2)

RADIOACTIVE SOURCES • DEVICES • NUCLIDES

*Corporate Offices*

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## EXEMPT QUANTITIES

Certain sources and materials listed in the IPL catalog are available as exempt quantities under applicable NRC or Agreement State regulations, and in individual quantities not greater than those specified in 10CFR 30.71 (Appendix B) or Agreement State quantity schedules. The following is a list of the sources in our current 1993 catalog that are available as exempt.

### Pages 8 through 11-Standard and Radionuclide Solutions

The nuclides listed on these pages, in sequential order through Po-210, and U-238, in the containers shown on page 7.

### Page 16-Radioactive Gas Standards (GS Series)

The nuclides listed are available in lecture bottles (figure 17-A).

### Page 18-Alpha Particle Standards (AF Series)

Catalog No. AF-210. Either 5 nCi or 0.1 uCi as Type A-1 disk or Type A-2 capsule.

### Page 22-Beta Particle Standards (BF Series)

All except catalog Nos. BF-032 and BF-022 as Type A disk or Type MF2 disk. *Sr 90 only up to .1 uCi*

### Page 25-Gamma and X-Ray Standards (GF Series)

✓ All except GF-227, GF-241, GF-007, GF-207, GF-057, GF-068, GF-226, GF-022, GF-228, GF-235, GF-NAT, and GF-088 as Type T tubes, Type R rods, D disk and M disk.

### Page 29-Planar Calibration Standards (EAB Series)

✓ Catalog items EAB-014 through EAB-210 are available as Model EAB-LB, PL, and FP style disk standards (see Fig 32D). EAB-230 through EAB-ML are not available as exempt.

### Page 34-Planar Calibration Standards (LDS Series)

Catalog items LDS-3 through LDS-204 will be available in either the Model 1620 or Model 1621 configuration

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ENCLOSURE (1)

RADIOACTIVE SOURCES • DEVICES • NUCLIDES



(see Fig 35-A). Catalog items LDS-230 et. seq. are not available as exempt.

Page 36-Hand and Foot Monitor Standards (LDS-HF)

All sources except Am-241 are available in the configuration shown in Fig 36-A.

Page 46-Mono-energetic (Conversion) Electron Sources (ME Series)

These catalog items are available in the MF-1 disk configuration.

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## MONO-ENERGETIC (CONVERSION) ELECTRON SOURCES (ME SERIES)

These sources are used as energy markers for the calibration of solid-state detectors and beta spectrometers. Sources are prepared by electrodeposition or evaporation of the radionuclide as a 0.2" (5.08 mm) diameter spot on very thin Mylar or nickel and protected by a 100-200  $\mu\text{g}/\text{cm}^2$  acrylic or gold coating. This assembly is stretched on a thin aluminum washer which in turn is mounted in an aluminum ring from which it can easily be removed (MF-1 mount).

Contained activity is supplied as a nominal value  $\pm 15\%$ . A NIST traceable calibration of the contained value will be provided on request.

Sources will be supplied uncovered at the written request of the customer. However, the general warranty is invalid for uncovered sources.

### STANDARD ACTIVITIES

1 $\mu\text{Ci}$	10 $\mu\text{Ci}$	100 $\mu\text{Ci}$
37 kBq	370 kBq	3.7 MBq

CATALOG NUMBER	NUCLIDE	HALF-LIFE	SUBSTRATE	METHOD OF PREPARATION	SIGNIFICANT ELECTRON ENERGIES (keV)
ME-133	Ba-133	10.5 y	Mylar (2)	Evaporation	5, 45, 75, 267, 320
ME-207	Bi-207	32.2 y	Nickel (3)	Electrodeposition	481, 975, 1047
ME-109	Cd-109	1.27 y	Nickel (3)	Electrodeposition	63, 85
ME-137	Cs-137	30 y	Mylar (2)	Evaporation	624, 656
ME-057	Co-57	272 d	Nickel (3)	Electrodeposition	7, 14, 115, 129
ME-113	Sn-113, In-113m (1)	115 d	Nickel (3)	Electrodeposition	20, 23, 364, 388
ME-119	Sn-119m	245 d	Nickel (3)	Electrodeposition	20, 23, 36, 62

(1) Sn-113 is available only as a 1  $\mu\text{Ci}$  (37 kBq) source.

(2) Mylar 0.9 mg/cm<sup>2</sup>

(3) Nickel 1-2 mg/cm<sup>2</sup>

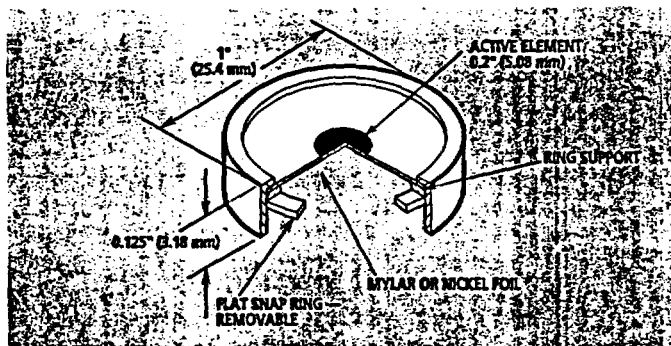


FIGURE 46-A — MF-1 DISK

## PLANAR CALIBRATION STANDARDS

### Hand and Foot Monitor Standards (LDS-HF)

This standard is designed for checking hand and foot monitors. The active element is prepared either by electrodeposition or by the incorporation of an insoluble complex of the nuclide into a thin polymeric surface to give a continuous, highly uniform active area. The holder is made from lucite and is designed to withstand rugged use. The Hand and Foot Monitor Standard is available with two different active areas: 10 cm x 10 cm and 10 cm x 15 cm.

IPL supplies this product as an alpha standard using Am-241. A beta standard is available using the following nuclides: C-14, Cl-36, Co-60, Sr-90/Y-90, Tl-204, or Pm-147. Other nuclides are available upon request.

The contained activity of these standards is traceable to NIST. The calibration accuracy is  $\pm 5\%$ . The uniformity of these standards is  $\pm 10\%$ .

The calibration of these standards follows the recommendations of ANSI / ISO 8769. These standards are calibrated for contained activity and for alpha or beta emissions.

EMISSION	NUCLIDE	10 cm X 10 cm PLATE				10 cm X 15 cm PLATE			
		ACTIVITY (TOTAL)		ACTIVITY		ACTIVITY (TOTAL)		ACTIVITY	
		nCi	Bq	pCi/cm <sup>2</sup>	Bq/cm <sup>2</sup>	nCi	Bq	pCi/cm <sup>2</sup>	Bq/cm <sup>2</sup>
Alpha	Am-241	1	37	10	0.37	1.5	55.5	10	0.37
		2	74	20	0.74	3.0	111	20	0.74
Beta	C-14	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4
	Cl-36	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4
	Co-60	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4
	Sr-90/Y-90	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4
	Pm-147	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4
	Tl-204	10	370	100	3.7	15	555	100	3.7
		20	740	200	7.4	30	1110	200	7.4

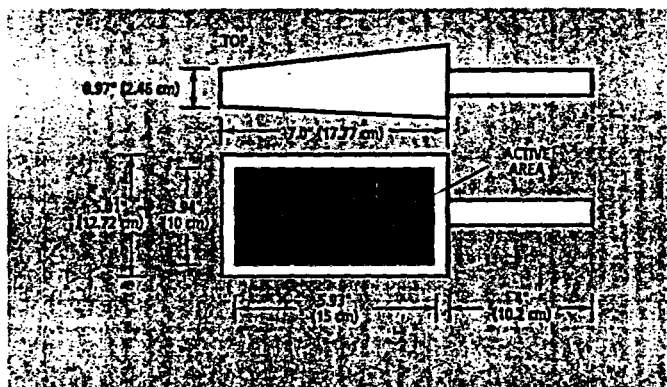


FIGURE 36-A — HAND AND FOOT MONITOR STANDARD

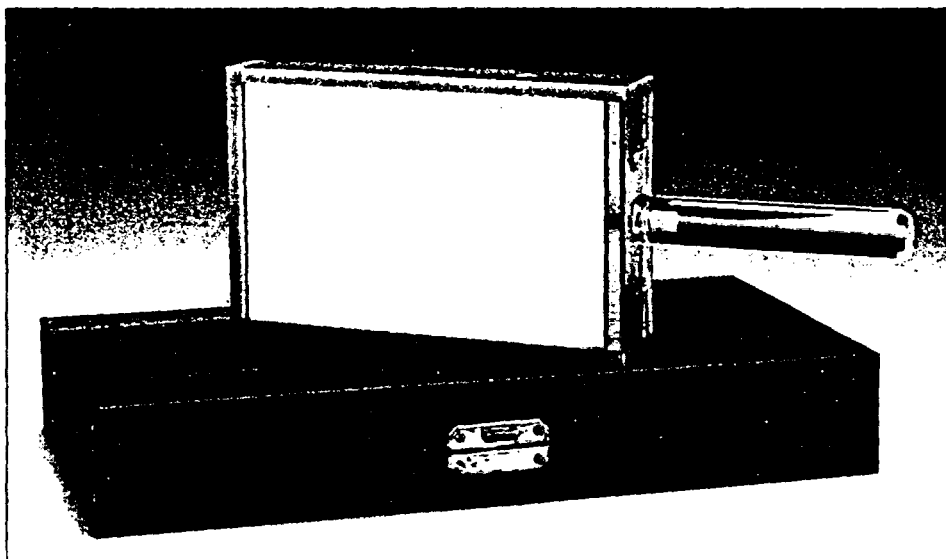


FIGURE 36-B —  
HAND AND FOOT MONITOR STANDARD

## PLANAR CALIBRATION STANDARDS

### Large Area Standards (LDS Series)

The Large Area Standards (LDS Series) are intended for the calibration of large area survey probes currently used for area and personnel monitoring

Two standard sizes are offered:

Model 1620 3.94" x 3.94" (100 mm x 100 mm) active area

Model 1621 3.94" x 5.91" (100 mm x 150 mm) active area

A comprehensive range of alpha and beta energies is listed in the table. Requirements for other nuclides, activity levels and geometries up to 8" x 12" (20 cm x 30.5 cm) can be accommodated on request.

Active elements are prepared by electroplating, by evaporative deposition, or by the incorporation of an insoluble complex of the nuclide into a thin polymeric surface. Standard activity is 1,000 dpm to 100,000 dpm (16.7 Bq to 1.67 kBq)

Several types of covers, e.g., polyimide film, mylar, acrylic, or no cover, are employed depending on the nature of the active deposit and the emitted energy. All alpha sources are supplied with a 100 - 200 µg/cm<sup>2</sup> acrylic or a 1 mg/cm<sup>2</sup> aluminized mylar cover. Alpha sources will be supplied uncovered at customer request. The general warranty does not apply to uncovered alpha standards or sources.

Electroplated standards are supplied on a nickel or ss backing plate. Standards employing polymeric membrane are supplied with a plastic backing plate.

CATALOG NUMBER	NUCLIDE	EMITTED ENERGY (keV) OR E <sub>α</sub> (keV)	OTHER SIGNIFICANT RADIATIONS
LDS-3	H-3	18.6	None
LDS-14	C-14	156	None
LDS-32	P-32(1)	225, 1710	None
LDS-36	Cl-36	1142	None
LDS-60	Co-60	1491	Gamma
LDS-90	Sr-90/Y-90(2)	546, 2282	None
LDS-99	Tc-99	294	None
LDS-129	I-129(3)	154	None
LDS-137	Cs-137	514, 1176	Gamma
LDS-147	Pm-147	225	None
LDS-204	Tl-204	763	None
LDS-230	Th-230	4621, 4688	None
LDS-232	Th-232	3952, 4010	None
LDS-235	U-235(4)	4215, 4597	Gamma
LDS-238 U	U-238(4)	4147, 4196	Gamma
LDS-238	Pu-238	5456, 5499	None
LDS-239	Pu-239	5105, 5143, 5156	None
LDS-241	Am-241	5388, 5443, 5486	Gamma

(1) Provided by Si-32 parent. A 15 mg/cm<sup>2</sup> Mylar or a 15 mg/cm<sup>2</sup> polyimide window absorbs approximately 60% of the Si-32 beta emissions.

(2) See note on Page 23 regarding Sr-90 sources.

(3) Simulates I-125. Refer to note on "Simulated I-125" standards on Page 25.

(4) Refer to chart on Page 19 for available activity levels.

All standards are supplied in a wooden storage box.

#### Calibration

The contained activity is certified in microcuries and becquerels and is NIST traceable ± 5%.

The emission rate in 2π is given on the certificate but is not normally a NIST traceable value.

In some cases NIST traceability may be available on special order. Note that the emission rate for a given energy spectrum is a function of detector geometry, gas composition, pressure, and material of construction, so that virtually every detector may have a different response.

To place an order:

**Phone 818 843-7000 - FAX 818 843-6168**

Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements

# PLANAR CALIBRATION STANDARDS

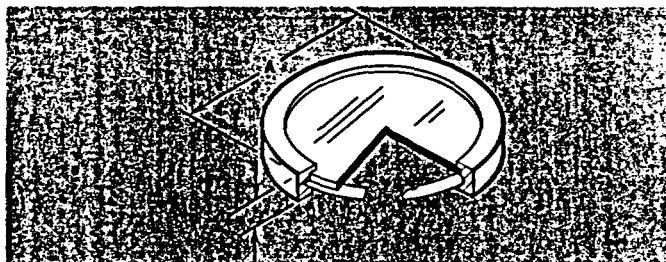


FIGURE 32-A — LB STYLE

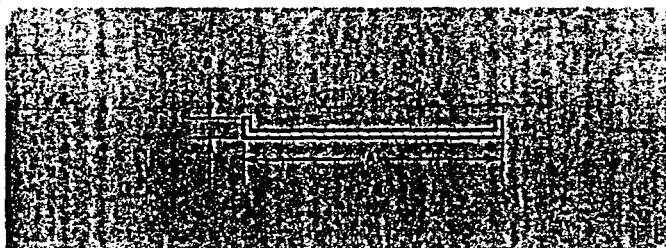


FIGURE 32-B — PL STYLE

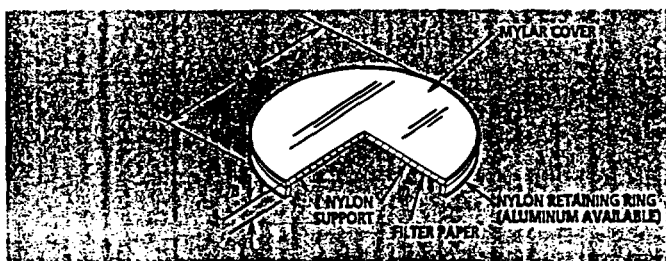


FIGURE 32-C — FP STYLE  
(NYLON RING AND DISK)

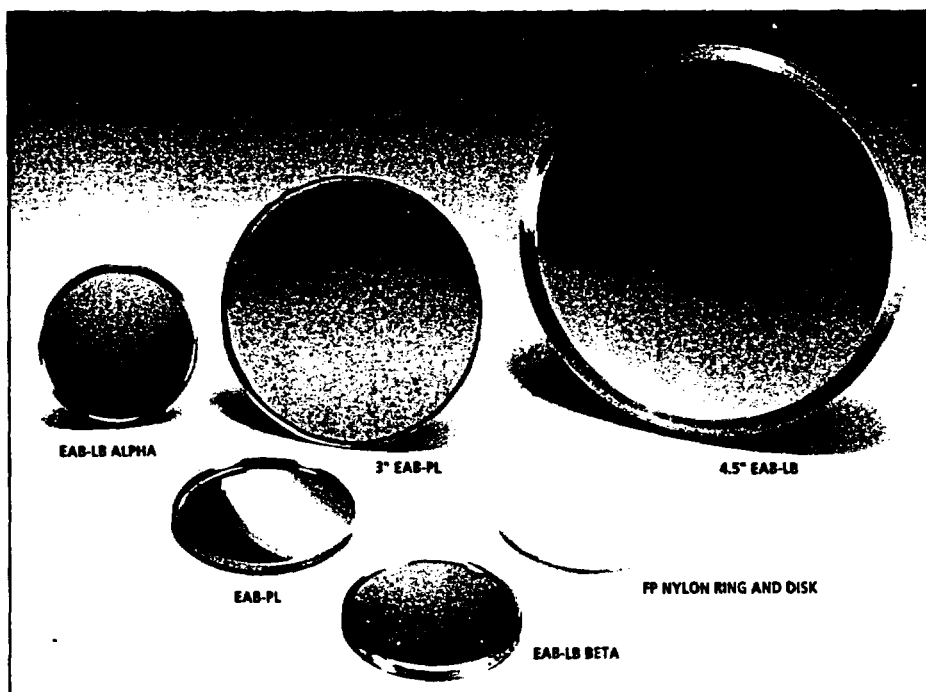


FIGURE 32-D — EAB PLANAR STANDARDS

## PLANAR CALIBRATION STANDARDS

EAB-LB RING AND DISK DIMENSIONS			
MODEL NUMBER (FIGURE 31-A)	OVERALL DIAMETER	ACTIVE DIAMETER	OVERALL THICKNESS
EAB-LB-1	1.85" (47.0 mm)	1.61" (41.0 mm)	0.125" (3.18 mm)
EAB-LB-2	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-LB-3 *	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)

\* Alpha standards in the 4.5" configuration are supplied with a 100-200  $\mu\text{g}/\text{cm}^2$  acrylic cover

Alpha standards are prepared by electrodeposition of the nuclide onto a nickel, stainless steel or silver foil that is then covered with 100  $\mu\text{g}/\text{cm}^2$  gold to prevent loss of alpha activity by recoil. Alpha standards will be supplied uncovered at customer request. The general

warranty does not apply to uncovered alpha standards.

Both alpha and beta standards are available in the configurations listed in the following tables. Other configurations are available on request.

### Planchet (EAB-PL)

These standards simulate cupped planchet samples and can be used as calibration or performance check standards.

Beta standards, with the exception of Tc-99, are prepared by electroplating, by evaporative deposition, or by the incorporation of an insoluble complex of the nuclide into a thin polymeric surface. Tc-99 standards are prepared by electrodeposition. Beta standards are covered with either an aluminized coating or with 1 mg/cm<sup>2</sup> or 9 mg/cm<sup>2</sup> polyimide film.

Alpha standards are prepared by electrodeposition of the nuclide onto a nickel, stainless steel or silver foil that is then covered with 100  $\mu\text{g}/\text{cm}^2$  gold to prevent loss of alpha activity by recoil. Alpha standards will be supplied uncovered at customer request. The general warranty does not apply to uncovered alpha standards.

In addition to the standard sizes listed below, a variety of other planchet configurations are available on request. Standards can also be prepared on customer supplied parts.

EAB-PL PLANCHET DIMENSIONS				
MODEL NUMBER (FIGURE 31-B)	OVERALL DIAMETER	ACTIVE DIAMETER	OVERALL THICKNESS	PLANCHET MATERIAL
EAB-PL-1	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)	Stainless Steel
EAB-PL-2 *	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)	Stainless Steel
EAB-PL-3	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)	Aluminum
EAB-PL-4	3.0" (76.2 mm)	2.77" (70.4 mm)	0.125" (3.18 mm)	Aluminum
EAB-PL-5*	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)	Aluminum

\* Alpha sources in the 4.5" configuration are supplied with a 100-200  $\mu\text{g}/\text{cm}^2$  acrylic cover.

To place an order  
**Phone 818 843-7000 - FAX 818 843-6168**  
 Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements



## GAMMA AND X-RAY STANDARDS (EG SERIES)

### Simulated Charcoal or Zeolite Gamma Cartridge Standards (EG-CH)

The activity is uniformly distributed between two polyimide films and placed under the screen of a 1" x 2.25" (25.4 mm X 57.2 mm) separable plastic charcoal cartridge (surface loaded). Uniform distribution of the nuclide in charcoal or zeolite is available on request.

Standard activity is 0.1  $\mu\text{Ci}$  (3.7 kBq).

NOTE I-125 and I-129 are available as surface loaded sources only. See "Simulated I-125" standards on Page 25.

### Radon-226 Canister Standard (EG-226C)

These standards are used to calibrate radioassay systems for measuring nanocuries of environmental radon in standard EPA charcoal canisters. The gamma spectrum above the Ra-226 gamma at 184 keV (4%) is identical with that of Rn-222 and its daughters.

The standard is prepared by uniform dispersion of a calibrated Ra-226 solution into the charcoal fill of a standard 1.5" x 4" (38.1 mm x 102 mm)

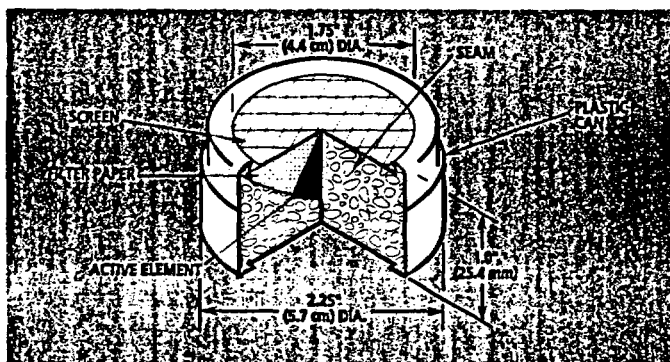


FIGURE 28-A — CHARCOAL CARTRIDGE

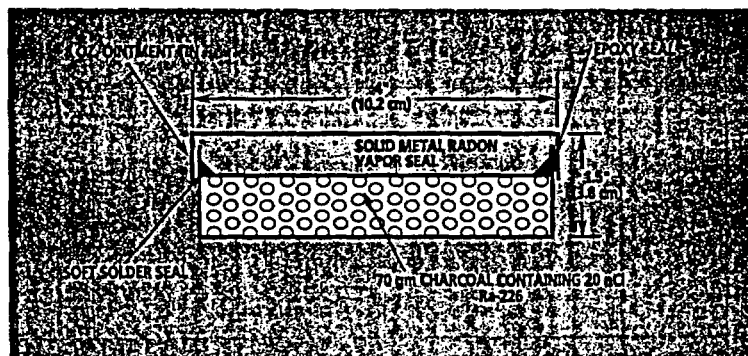


FIGURE 28-B — RADON CANISTER

canister, which is then sealed over the charcoal to define the charcoal volume and to prevent the escape of Rn-222 and its daughter products

The EG-226C is supplied with 20 nCi (740 Bq) Ra-226 and is NIST traceable. Calibration accuracy is within  $\pm 5\%$  of the stated value at the 99% confidence level. Other activities and canister sizes are available on request.

The EG-226C is usually kept in inventory to minimize delivery time on the catalog item.

The Rn-222 ( $T_{1/2} = 3.83$  d) and its daughters must be in equilibrium with the Ra-226 since their gamma radiations are used to calibrate the detection system. Radon standards purchased on a custom basis have a 60 day lead time for delivery to assure equilibrium between the Ra-226 and its daughters.

## GAMMA AND X-RAY STANDARDS (GF SERIES)

### Gamma Disk Set (GF-290-1 & GF-290-10)

This set consists of seven nuclides covering the energy range the energy range 80-1333 keV:

Ba-133, Cd-109, Co-57, Co-60, Cs-137, Mn-54 and Na-22

Available in both the D and M configurations, all sources in a set contain either 1  $\mu\text{Ci}$  (37 kBq) or 10  $\mu\text{Ci}$  (370 kBq). See Page 24 for dimensional information.

Catalog Number GF-290-1, 1  $\mu\text{Ci}$  (37 kBq)

Catalog Number GF-290-10, 10  $\mu\text{Ci}$  (370 kBq)

### Gamma Rod Sets and Gamma Tube Sets (GF-290 Series)

These sets contain the same nuclides supplied in the gamma disk sets, but in the Type R (rod) or Type T (tube) configurations. All sources in a set contain either 0.1  $\mu\text{Ci}$  (3.7 kBq) or 1  $\mu\text{Ci}$  (37 kBq).

Model Number GF-290R-01: 0.1  $\mu\text{Ci}$  (3.7 kBq)

Model Number GF-290R-1: 1  $\mu\text{Ci}$  (37 kBq)

Model Number GF-290T-01: 0.1  $\mu\text{Ci}$  (3.7 kBq)

Model Number GF-290T-1: 1  $\mu\text{Ci}$  (37 kBq)

See Page 59 for a listing of high intensity gamma standards suitable for portable instrument calibration and industrial applications.

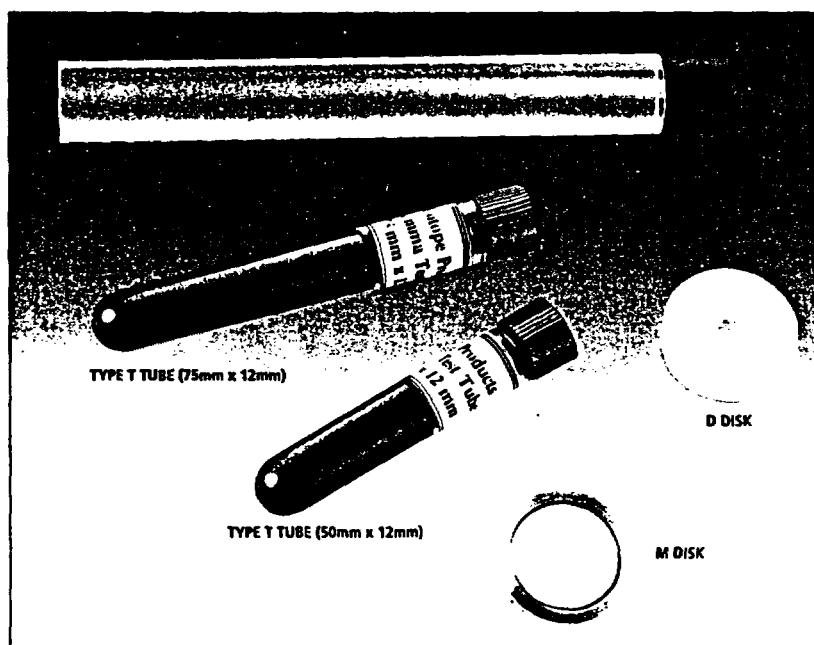


FIGURE 26-A — GAMMA STANDARDS

To place an order:

**Phone 818 843-7000 - FAX 818 843-6168**

Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements.

## GAMMA AND X-RAY STANDARDS (GF SERIES)

A wide range of gamma and x-ray standards for research and educational use are available in the energy range 5.9 to 2614 keV. All nuclides are available up to 100  $\mu\text{Ci}$  (3.7 MBq) to allow for the lower efficiencies of detection inherent in many instruments. Methods of calibration are described on Page 6.

Sources are available in the following four standard configurations. Custom configurations are available on request.

### Source Configurations:

#### Type D

The type D configuration is mainly used for checking the performance of G.M. and NaI(Tl) detectors. The type D disk is a 1" (25.4 mm) diameter by 0.25" (6.35 mm) thick disk constructed of high strength plastic. The active diameter is 0.197" (5.0 mm).

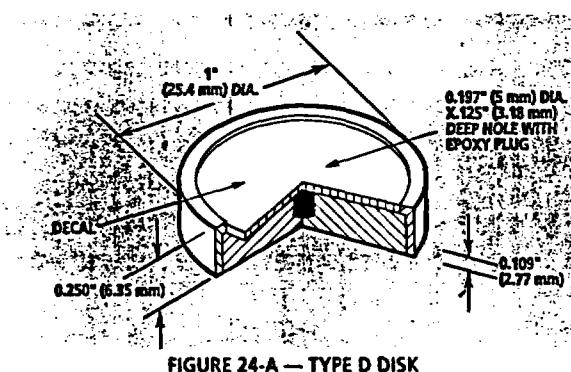


FIGURE 24-A — TYPE D DISK

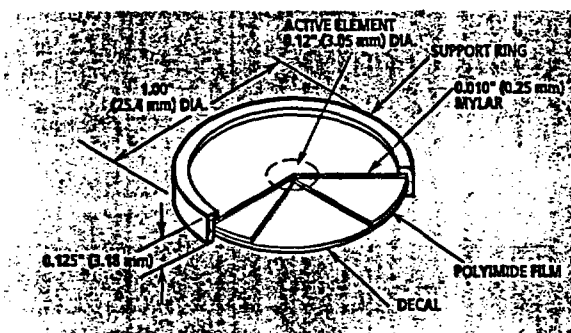


FIGURE 24-B — TYPE M DISK

#### Type M

The type M thin "scatterless" disk is used in applications involving high resolution solid state detectors. The activity is deposited on 9 mg/cm<sup>2</sup> polyimide and covered with a 0.010" (0.254 mm) aluminized Mylar foil. The source is supplied in a removable aluminum holder. In the holder the source has an overall diameter of 1" (25.4 mm) and a thickness of 0.125" (3.18 mm). Out of the holder the source is 0.937" (23.8 mm) in diameter with a thickness of approximately 0.030" (0.76 mm). The active diameter is 0.118" (3 mm).

#### Type R

The type R rod is used for calibrating well type NaI(Tl) detectors. It is constructed of high strength plastic 5" x

0.625" diameter (127 mm x 15.9 mm).

Alternate sizes, such as 5" x 0.5" diameter (127 mm x 12.7 mm) and 2.95" x 0.5" diameter (74.9 mm x 12.7 mm) are also available. The active diameter of the rod standard is 0.187" (4.75 mm).

#### Type T

The type T plastic test tube is used in clinical instrument calibrations. Each polypropylene tube contains 0.75 mL of active epoxy with the balance of the tube filled with cold epoxy. Tube sizes are 2.95" x 0.472" (75 mm x 12 mm) or 2.17" x 0.472" (55 mm x 12 mm).

Price includes traceability to NIST with  $\pm 2\%$  to  $\pm 5\%$  accuracy at the 99% confidence level.

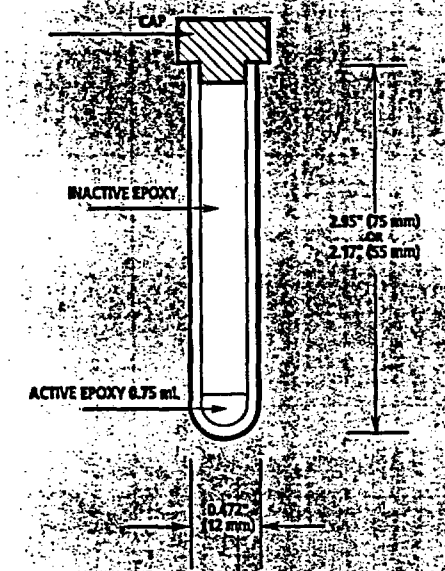


FIGURE 24-C — TYPE T TUBE

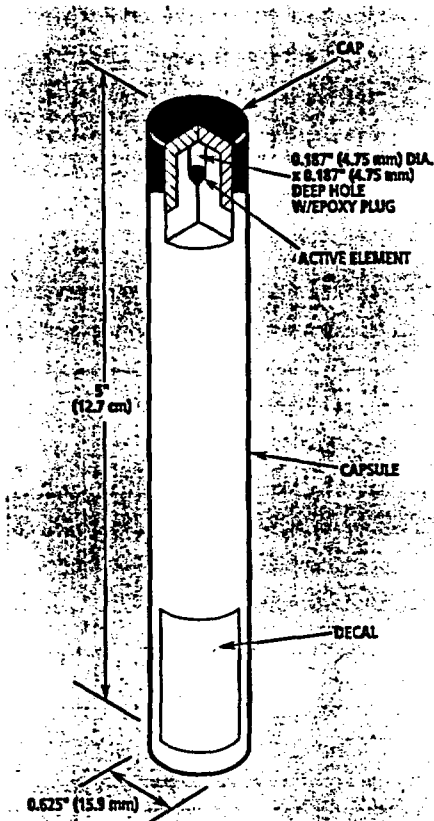


FIGURE 24-D — TYPE R ROD

### STANDARD ACTIVITIES

0.1 $\mu\text{Ci}$	1 $\mu\text{Ci}$	10 $\mu\text{Ci}$	100 $\mu\text{Ci}$
3.7 kBq	37 kBq	370 kBq	3.7 MBq

## BETA PARTICLE STANDARDS (BF SERIES)

A wide range of beta emitting nuclides are offered for counting room and educational uses. The two basic styles are:

### Source Configurations

#### Type A

The active material is uniformly distributed over the surface of a 0.937" (23.8 mm) diameter stainless steel foil and sealed in an aluminum mounting ring under a 0.9 mg/cm<sup>2</sup> aluminized Mylar window. The active diameter of the source is 0.866" (22 mm). Special absorbers may be included under the window to filter undesirable low energy radiation. This configuration is most useful for determining efficiencies of G.M. and windowless counters used for beta assaying evaporated liquid samples. The overall source diameter is 1" (25.4 mm) and is available in two thicknesses: 0.125" (3.18 mm) and 0.312" (7.93 mm). Specify the activity and thickness when ordering.

Certification of all BF Series sources includes both contained activity and 2 $\pi$  emission rate. Source configurations are electrically conductive on all surfaces to promote their use in windowless proportional detectors.

#### Type MF-2

This is a "scatterless" configuration in which the activity is applied as a 0.12" (3.05 mm) spot centered between two laminated 0.9 mg/cm<sup>2</sup> Mylar foils. The source is supplied in a removable aluminum holder. In the holder the source has an overall diameter of 1" (25.4 mm) and a thickness of 0.125" (3.18 mm). Out of the holder the source is 0.937" (23.8 mm) in diameter with a thickness of approximately 0.030" (0.76 mm).

### STANDARD ACTIVITIES

5 $\mu$ Ci	0.1 $\mu$ Ci	1 $\mu$ Ci
185 Bq	3.7 kBq	37 kBq

This configuration is most useful for the precise determination of G.M. and proportional counter efficiencies, and as an educational tool for the verification of the inverse square law, as well as demonstrating back-scatter phenomena.

Price includes traceability to NIST with  $\pm 2\%$  to  $\pm 5\%$  accuracy at the 99% confidence level.

Other configurations available on request.

1.85" (47 mm) and 4.5" (114 mm) diameter disk standards suitable for use with low background counting systems (Page 30).

3.94" x 3.94" (100 mm x 100 mm) distributed beta sources for instrument calibration and dose assessments (Pages 34 and 37).

CATALOG NUMBER	NUCLIDE	HALF-LIFE	SIGNIFICANT BETA ENERGIES (E <sub>max</sub> keV)	WINDOW THICKNESS (mg/cm <sup>2</sup> )
BF-210	Bismuth-210 (1) (Pb-210 parent)	22.3 y	1160	7.5 Aluminum
BF-014	Carbon-14	5730 y	156	0.9 Mylar
BF-137	Cesium-137	30.0 y	1175	0.9 Mylar
BF-036	Chlorine-36	3.01 x 10 <sup>5</sup> y	1142	0.9 Mylar
BF-060	Cobalt-60	5.27 y	1491	0.9 Mylar
BF-063	Nickel-63 (1)	100 y	66	none
BF-032	Silicon-32/ Phosphorus-32 (2)	104 y	225, 1710	13.7 Aluminum
BF-147	Promethium-147	2.63 y	225	0.9 Mylar
BF-106	Ruthenium-106 /Rhodium-106	1.02 y	39, 3540	0.9 Mylar
BF-022	Sodium-22	2.60 y	2842 (B+)	0.9 Mylar
BF-090	Strontium-90/ Yttrium-90 (3)	28.5 y	546, 2282	0.9 Mylar
BF-099	Technetium-99	2.13 x 10 <sup>5</sup> y	294	0.9 Mylar
BF-204	Thallium-204	3.78 y	763	0.9 Mylar

(1) NIST traceability is not offered for Ni-63 or Bi-210. Bi-210 can only be calibrated to  $\pm 10\%$  accuracy.

(2) This long-lived P-32 standard is the beta emitting P-32 daughter of the long-lived Silicon-32 parent. The standard mounting for this source is the A capsule with a 0.002" (0.051 mm) Al window. This window will absorb more than 60% of the Si-32 225 keV betas and less than 5% of the P-32 betas. Standards are prepared with the P-32 in equilibrium with the parent Si-32.

(3) See note on Page 23 regarding Sr-90 sources.

To place an order:

**Phone 818 843-7000 - FAX 818 843-6168**

Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements.

## ALPHA ABSORPTION DATA

Listed here are several graphs depicting tests performed by Isotope Products Laboratories to determine the degradation of the energy spectra caused by various thicknesses of nickel and titanium foils. These graphs should assist you in determining the correct foil thickness you require

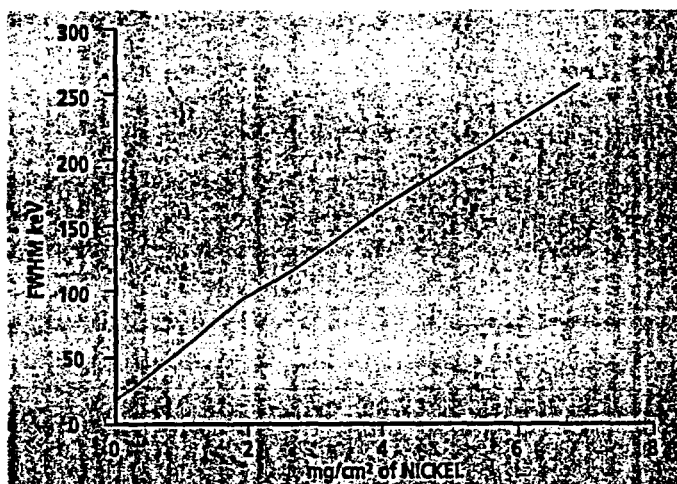


FIGURE 20-A — EFFECT OF NICKEL ON FWHM OF Am-241

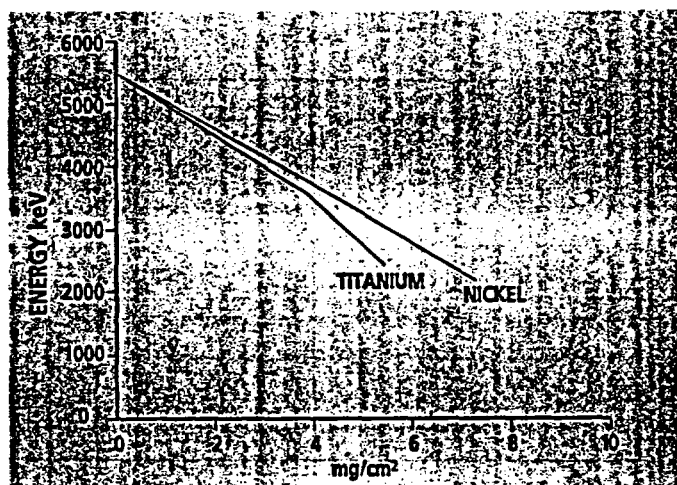


FIGURE 21-A — EFFECT OF NICKEL AND TITANIUM ON ENERGY OF Am-241

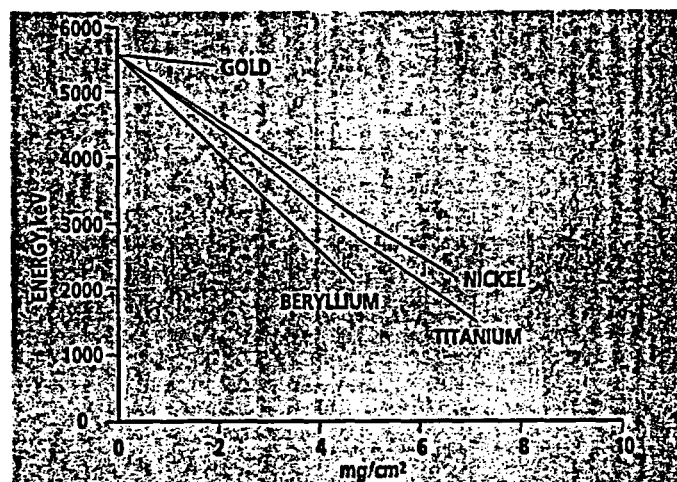


FIGURE 21-B — EFFECT OF VARIOUS METAL COVERS ON ENERGY OF Cm-244

## ALPHA PARTICLE STANDARDS (AF SERIES)

The majority of alpha standards listed below are spectroscopy grade and are suitable for the most exacting research requirements as well as for routine counting room applications.

Standards that emit Rn gas, most notably Th-230 and Ra-226, should not be used in gross alpha applications. Most sources are prepared by electrodeposition of the desired nuclide on a mirror finish platinum or platinum-clad nickel foil and are fixed to the surface by diffusion-bonding. These sources exhibit narrow line widths, generally less than 20 keV FWHM for high specific activity nuclides such as Po-210 and Am-241. Calibration methods are described on Page 6.

Even the lowest intensity uncovered alpha source may deteriorate with time, showing signs of removable activity as well as decreased spectral resolution. This is caused by the migration of the active material into the substrate and by the accumulation of dust and grime. For these reasons the source should be stored in a closed container when not in use. The inside of the container should be checked periodically for free activity. IPL considers the useful life of alpha sources with long half-lives to be between two and four years. We recommend a program of scheduled replacement for these sources.

All 1.0  $\mu\text{Ci}$  (37 kBq) alpha sources are supplied with a 50-100  $\mu\text{g}/\text{cm}^2$  gold cover. A gold cover on lower activities is available on request.

All activities of Ra-226, Ac-227, Th-228, and Cf-252 standards are supplied with the 50-100  $\mu\text{g}/\text{cm}^2$  gold cover which is sufficient to prevent loss of radioactive recoil daughter products. All activities of Po-210 are supplied with a

50  $\mu\text{g}/\text{cm}^2$  gold cover. These sources will be supplied uncovered at the written request of the customer. The general warranty does not apply to uncovered alpha standards or sources. See Page 20 for Alpha Absorption Data.

### Source Configurations

A-2: The source is permanently fixed in an aluminum holder 0.5" diameter x 0.250" high (12.7 mm x 6.35 mm). The active diameter is 0.197" (5.0 mm).

A-1: The source is permanently fixed in an aluminum holder 1" diameter x 0.125" high (25.4 mm x 3.18 mm). The active diameter is 0.197" (5.0 mm).

PM: The source is mounted in a removable plastic holder from which it can be separated for installation in a counting chamber or device. The holder is 1" diameter x 0.125" high (25.4 mm x 3.18 mm). The removable active foil is 0.438" (11.1 mm) in diameter with the active diameter 0.197" (5.0 mm). The foils are between 0.005" and 0.010" (0.127 mm and 0.254 mm) thick.

Sources are traceable to NIST with  $\pm 2\%$  to  $\pm 5\%$  accuracy at the 99% confidence level. AF Series standards are provided in a box suitable for daily use and long term storage.

Other activities are available on request.

### STANDARD ACTIVITIES

5 nCi	0.1 $\mu\text{Ci}$	1 $\mu\text{Ci}$
185 Bq	3.7 kBq	37 kBq

CATALOG NUMBER	NUCLIDE	HALF-LIFE	SIGNIFICANT ALPHA ENERGIES (keV)
AF-227	Actinium-227 (1)	21.8 y	4938-7451 (includes daughters)
AF-241	Americium-241	433 y	5388, 5443, 5486
AF-252	Californium-252	2.65 y	6076, 6118
AF-244	Curium-244	18.1 y	5763, 5805
AF-148	Gadolinium-148	75 y	3183
AF-237	Neptunium-237 (2)	$2.14 \times 10^6$ y	4640-4873
AF-208	Polonium-208	2.90 y	5116
AF-210	Polonium-210	138 d	5304
AF-238P	Plutonium-238	87.7 y	5456, 5499
AF-239	Plutonium-239	$2.41 \times 10^4$ y	5105, 5143, 5156
AF-226	Radium-226 (1) (4)	1,600 y	4601, 4784 Daughters 5489 thru 7687
AF-228	Thorium-228 (1) (5)	1.91 y	5341, 5423 Daughters 5449 thru 8784
AF-230	Thorium-230	$7.4 \times 10^4$ y	4621, 4688
AF-232	Thorium-232 (1) (2) (3)	$1.405 \times 10^{10}$ y	3952, 4010
AF-232U	Uranium-232 (1)	68.9 y	5264, 5320 Daughters 5341 thru 8784
AF-235	Uranium-235 (2) (3)	$7.04 \times 10^8$ y	4215-4597
AF-238U	Uranium-238 (2) (3)	$4.47 \times 10^9$ y	4147, 4196

(1) Not necessarily in equilibrium with daughters at time of shipment.

(2) These nuclides are not supplied as spectroscopy grade sources.

(3) The following table shows the maximum activities available for these nuclides.

(4) Radium-226 will leak Rn-222 gas

(5) Thorium-228 will leak Rn-220 gas

## RADIOACTIVE GAS STANDARDS (GS SERIES)

Radioactive gas standards are available in a compressed carrier gas suitable for tracer applications and the calibration of radiation detectors and effluent monitors. In general, all standards are available in concentrations from  $10^{-5}$  to  $10^2$   $\mu\text{Ci/cc}$  (0.37 Bq/cc to 3.7 MBq/cc) at STP in dry nitrogen carrier, enclosed in a 425 cc lecture bottle (DOT 3E 1800) containing 20 liters of gas. Calibration is typically within  $\pm 5\%$  of the stated concentration at the 99% confidence level and is NIST traceable. The following tables give the nuclear properties, the available concentration ranges and maximum uncertainties.

Each gas standard is accompanied by a certificate of calibration providing the concentration, total activity, uncertainties, calibration method, impurity analysis, carrier gas, gas pressure, volume and mass.

The lecture bottle is 14.25" high x 2" diameter (36.2 cm x 50.8 mm) and has a dual outlet brass valve. The external fitting is a 9/16" 18 UNF (CGA 170) fitting and the internal fitting is a 5/16" 32 female fitting (CGA 110). A combination regulator-flow meter with a 1/4" (6.35 mm) hose fitting is available at an additional charge. The lecture bottles are typically filled to approximately 800 psi providing 20 L of gas.

Custom activities, pressures, tank sizes and fittings are available on request. Lower calibration uncertainties at certain levels may be available. Carrier gases such as air, argon and methane are also available.

Standard delivery in most cases is 14 working days after receipt of order. Expedited delivery is available. Higher activities for Xe-127 and Xe-133 may require an additional seven days lead time. Contact the Sales Department for more information on expediting and exact delivery time.

CATALOG NO.	NUCLIDE	SIGNIFICANT RADIATIONS (keV)	HALF-LIFE	CHEMICAL FORM
GS-3	H-3	18.6 E <sub>max</sub> beta	12.33 y	Hydrogen Gas
GS-14	C-14	156 E <sub>max</sub> beta	5730 y	Carbon Dioxide Gas
GS-85	Kr-85	514 gamma (0.434%) 687 E <sub>max</sub> beta	10.72 y	Krypton Gas
GS-127	Xe-127	145 gamma (3.94%) 172 gamma (23.5%) 203 gamma (68%) 375 gamma (15.9%) 29-35 L K x-rays (87.7%)	36.41 d	Xenon Gas
GS-133	Xe-133	80.9 gamma (37.0%) 346 E <sub>max</sub> beta 30-36 Cs K x-ray (48.1%)	5.245 d	Xenon Gas

To place an order:

**Phone 818 843-7000 - FAX 818 843-6168**

Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements

## MULTILINE STANDARDS (ML SERIES)

### Multiline Solutions (7500)

Multiline solutions are available in 5 mL and 50 mL flame sealed glass ampules. The nuclide mixture is supplied in 2M HCl containing the appropriate amount of each carrier to prevent precipitation or adsorption on the glass walls. Additional ampule sizes are available on request.

### Multiline Point Standards (GF-ML)

The GF-ML is available with a 1" or 2" outside diameter. In both cases the activity is deposited as a 0.197" (5.00 mm) diameter spot in the center of the disk.

These configurations provide a convenient method to calibrate Ge and NaI(Tl) detectors for the analysis of soil and water samples, reactor coolants, air samples, and other environmental materials.

Customer supplied containers will be filled on request.

### Large Volume Multiline Standards (EG-LV-ML) and Multiline Marinelli Beaker Standards (EG-LVM-ML)

The LV-ML wide mouth polyethylene sample bottles are available in 250 mL, 500 mL, and 1000 mL. Additional sizes are available on request.

Series LVM-ML Marinelli Beakers, for both Ge and NaI(Tl) detectors, are available in 500 mL, 1000 mL, 2000 mL and 4000 mL. This configuration is useful where maximum efficiency is needed such as environmental samples.

In both series the radioactivity is uniformly dispersed in the matrix. Specify the series, matrix and container type and size. For the Marinelli Beakers, specify the detector type.

Three standard matrices are available

MATRIX	DENSITY (g/cc)	USE
Silicone*	1.0	water equivalent
Epoxy *	1.1	soil equivalent
Sand 50-70 mesh	2.5	soil equivalent
* Silicone densities from 0.75 to 1		
* Epoxies with densities from 1.0 g/cc to 3.5 g/cc are available on request		

The following are examples of customer-supplied materials that may also be used:

- Soil
- Vegetation
- Pulverized concrete

### Multiline Simulated Charcoal or Zeolite Cartridge (EG-CH-ML)

The activity is uniformly distributed between two polyimide films and placed under the screen of a 1" x 2.25" (25.4 mm X 57.2 mm) separable plastic charcoal cartridge (surface loaded). This configuration simulates a surface loaded charcoal cartridge.

### Simulated Gas Standards(SGS-ML)

Isotope Products' Simulated Gas Standard is used for the calibration of gamma-ray detectors for the counting of radioactive noble gases. IPL supplies a uniform, low density foam standard in many standard as well as custom configurations. These standards are available on a continual basis.

The nuclides employed in the Simulated Gas Standard is our nine-nuclide multiline gamma standard. Americium-241 can be added to allow efficiency determinations down to 60 keV. See Page 13 for more information on our nine-nuclide gamma standard. Standard activity is 1-5  $\mu$ Ci with higher activities on request. The foam matrix density is 0.04 g/cc. The Simulated Gas Standards are NIST traceable  $\pm 5\%$  at the 99% confidence level.

The Simulated Gas Standard can be supplied in following configurations

Gas Beakers of high impact polystyrene

SGS-ML-25 25 cc

SGS-ML-100 100 cc

SGS-ML-1L 1 Liter Germanium Standard  
Standard Ge-Li or  
Ge Detector  
3 x 3 NaI Detector

SGS-ML-4L 4 Liter Germanium Standard  
Standard Ge-Li or  
Ge Detector  
3 x 3 NaI Detector  
4 x 4 NaI Detector

Call Technical Customer Service for custom configurations or other nuclides

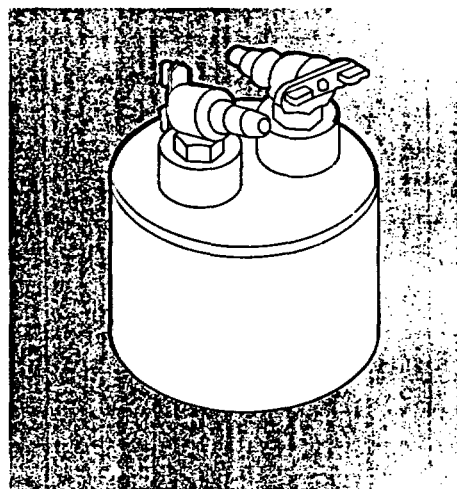


FIGURE 14-A — 100 CC SIMULATED GAS CONTAINER



## STANDARD AND RADIONUCLIDE SOLUTIONS

1

NUCLIDE	STANDARD SOLUTION CATALOG #	NOMINAL SOLUTION CATALOG #	TYPICAL UNCERTAINTY	CHEMICAL FORM
Gd-153	7153	6153	$\pm 4.0\%$	Gadolinium-153 Gadolinium Chloride in 0.1M HCl
Eu-154	7154	6154	$\pm 3.5\%$	Europium-154 Europium Chloride in 0.5M HCl
Eu-155	7155	6155	$\pm 3.7\%$	Europium-155 Europium Chloride in 0.5M HCl
Ho-166m	7166	6166	$\pm 3.5\%$	Holmium-166m Holmium Chloride in 0.1M HCl
Ta-182	7182	6182	$\pm 3.5\%$	Tantalum-182 Tantalum Nitrate in 4M HNO <sub>3</sub> + 0.2M HF
Ir-192	7192	6192	$\pm 3.5\%$	Iridium-192 Iridium Chloride in 0.1M HCl or Hexachloroiridate in H <sub>2</sub> O
Tl-204	7204	6204	$\pm 2.5\%$	Thallium-204 Thallium Chloride in 1M HCl
Bi-207	7207	6207	$\pm 3.5\%$	Bismuth-207 Bismuth Chloride in 4M HCl
Po-208	7208	6208	$\pm 2.5\%$	Polonium-208 Polonium Chloride in 2M HCl
Pb-210	7210	6210	$\pm 7.5\%$	Lead 210 Lead Nitrate in HNO <sub>3</sub>
Po-210	7310	6310	$\pm 2.5\%$	Polonium-210 Polonium in 2M HCl
Ra-226	7226	6226	$\pm 3.0\%$	Radium-226 Radium Nitrate in 1M HNO <sub>3</sub>
Ac-227	7227	6227	$\pm 3.5\%$	Actinium-227 Actinium Nitrate in 0.1M HNO <sub>3</sub>
Ra-228	7328	6328	$< 5\%$	Radium-228 Radium Nitrate in 1M HNO <sub>3</sub>
Th-228	7228	6228	$\pm 3.0\%$	Thorium-228 Thorium Nitrate in 0.1M HNO <sub>3</sub>
Th-229	7229	6229	$\pm 4.0\%$	Thorium-229 Thorium Nitrate in 0.1M HNO <sub>3</sub>
Th-230	7230	6230	$\pm 3.0\%$	Thorium-230 Thorium Nitrate in 0.1M HNO <sub>3</sub>
Th-232	7332	6332	$\pm 3.0\%$	Thorium-232 Thorium Nitrate in H <sub>2</sub> O
U-232	7232	6232	$\pm 3.0\%$	Uranium-232 Uranyl Chloride in 2M HCl
U-233	7233	6233	$\pm 3.0\%$	Uranium-233 Uranyl Nitrate in H <sub>2</sub> O
U-235	7235	6235	$\pm 3.5\%$	Uranium-235 Uranyl Nitrate in H <sub>2</sub> O

# STANDARD AND RADIONUCLIDE SOLUTIONS

NUCLIDE	STANDARD SOLUTION CATALOG #	NOMINAL SOLUTION CATALOG #	TYPICAL UNCERTAINTY	CHEMICAL FORM
H-3	7003	6003	±3.0%	Hydrogen-3 as H <sub>2</sub> O
Be-7	7007	6007	±3.5%	Beryllium-7 Beryllium Chloride in 1M HCl
C-14	7014	6014	±3.0%	Carbon-14 6014- Sodium Carbonate in H <sub>2</sub> O 7014- Benzoic Acid-Carboxyl-C-14 in NaOH
Na-22	7022	6022	±3.5%	Sodium-22 Sodium Chloride in H <sub>2</sub> O
Na-24	7024	6024	±3.5%	Sodium-24 Sodium Chloride in H <sub>2</sub> O
P-32	7032	6032	±3.0%	Phosphorus-32 Phosphoric Acid in 0.02M HCl
Si-32	7132	6132	±2.0%	Silicon-32 Sodium Silicate in 0.1M NaOH
Cl-36	7036	6036	±2.0%	Chlorine-36 Sodium Chloride in H <sub>2</sub> O
K-40	7040	6040	±4.0%	Potassium-40 Potassium Chloride in H <sub>2</sub> O
Ca-45	7045	6045	±3.5%	Calcium-45 Calcium Chloride in H <sub>2</sub> O
Cr-51	7051	6051	±3.5%	Chromium-51 Chromium Chloride in 0.1M HCl
Mn-54	7054	6054	±3.5%	Manganese-54 Manganese Chloride in 0.1M HCl
Fe-55	7055	6055	±4.0%	Iron-55 Ferric Chloride in 0.1M HCl
Co-57	7057	6057	±3.5%	Cobalt-57 Cobalt Chloride in 0.1M HCl Co-56 and Co-58 <0.2%
Co-58	7058	6058	±3.5%	Cobalt-58 Cobalt Chloride in 0.1M HCl
Fe-59	7059	6059	±3.5%	Iron-59 Ferric Chloride in 0.1M HCl
Co-60	7060	6060	±3.5%	Cobalt-60 Cobalt in 0.1M HCl
Ni-63	7063	6063	±2.5%	Nickel-63 Nickel Chloride in 0.1M HCl
Zn-65	7065	6065	±3.5%	Zinc-65 Zinc Chloride in 0.5M HCl
Ge-68	7068	6068	±4.0%	Germanium-68 Germanium Chloride in 0.5M HCl
Se-75	7075	6075	±3.5%	Selenium-75 Selenium Chloride in 0.1M HCl

## STANDARD AND RADIONUCLIDE SOLUTIONS

### Standard Solutions (7000 Series)

#### Accuracy:

Each nuclide is NIST Traceable and has an accuracy of  $\pm 2\%$  to  $\pm 5\%$  at the 99% confidence level.

#### Activity:

The solutions are available in a variety of activities from 0.1 to 100  $\mu\text{Ci}$  (3.7 kBq to 3.7 MBq).

#### Purity:

Radionuclidic purity is greater than 99% in most cases.

#### Packaging:

The solution is supplied in a 5 mL or a 50 mL flame-sealed ampule.

### Radionuclide Solutions (6000 Series)

#### Accuracy:

Each isotope has a nominal contained activity of  $\pm 15\%$ .

#### Activity:

Solutions are available in a variety of activities from 0.1 to 5 mCi (3.7 kBq to 185 MBq). Higher activities are available on request.

#### Purity:

Radionuclidic purity is greater than 99% in most cases.

#### Packaging:

Standard packaging is 5 mL of solution in a 10 mL serum vial or 1 mL in a 1 mL V-vial. Other packaging is available upon request.

#### All Solutions

Delivery: Most solutions are in stock and delivered in 10-14 days ARO. Expedited orders are available on request.

Carrier materials will be added when considered appropriate or on request.

STANDARD SOLUTIONS (7000 SERIES)				
1 $\mu\text{Ci}$	10 $\mu\text{Ci}$	100 $\mu\text{Ci}$	1 mCi	5 mCi
37 kBq	370 kBq	3.7 MBq	37 MBq	185 MBq

RADIONUCLIDE SOLUTIONS (6000 SERIES)			
0.1 $\mu\text{Ci}$	1 $\mu\text{Ci}$	10 $\mu\text{Ci}$	100 $\mu\text{Ci}$
3.7 kBq	37 kBq	370 kBq	3.7 MBq

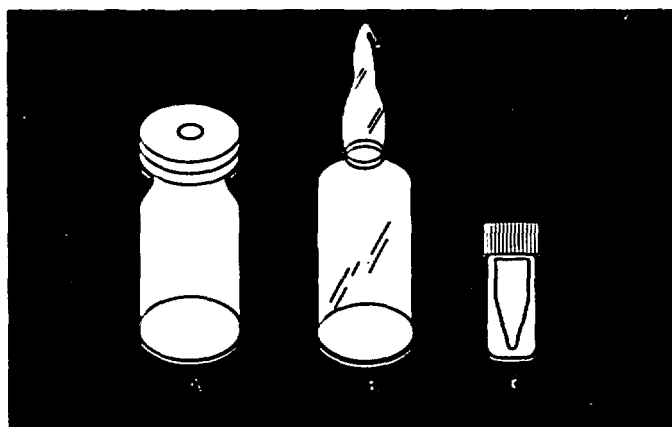


FIGURE 7-A — SERUM VIAL 10 mL

FIGURE 7-B — FLAME SEALED AMPULE 5 mL or 50 mL

FIGURE 7-C — V-VIAL 1 mL

## STANDARD AND RADIONUCLIDE SOLUTIONS

1

NUCLIDE	STANDARD SOLUTION CATALOG #	CHEMICAL SOLUTION CATALOG #	TYPICAL UNCERTAINTY	CHEMICAL FORM
Sr-85	7085	6085	±3.5%	Strontium-85 Strontium Chloride in 0.1M HCl
Y-88	7088	6088	±3.5%	Yttrium-88 Yttrium Chloride in 0.1M HCl
Sr-89	7089	6089	±2.5%	Strontium-89 Strontium Chloride in 0.1M HCl
Sr-90	7090	6090	±2.0%	Strontium-90 Strontium Chloride in 0.1M HCl
Zr-95	7095	6095	±3.5%	Zirconium-95 Zirconium Oxalate in 0.5M Oxalic Acid
Tc-99	7099	6099	±2.5%	Technetium-99 Ammonium Per technetate in H <sub>2</sub> O
Ru-103	7103	6103	±3.5%	Ruthenium-103 Ruthenium Chloride in 4M HCl
Ru-106	7106	6106	±3.5%	Ruthenium-106 Ruthenium Chloride in 4M HCl
Cd-109	7109	6109	±3.5%	Cadmium-109 Cadmium Chloride in 0.1M HCl
Ag-110m	7110	6110	±3.5%	Silver-110m Silver Nitrate in 0.1M HNO <sub>3</sub>
Sn-113	7113	6113	±3.5%	Tin-113 Hexachlorostannate (IV) in 6M HCl
Te-123m	7123	6123	±3.5%	Tellurium-123m Tellurous Acid in 4M HCl
I-125	7125	6125	±3.5%	Iodine-125 Sodium Iodide in 0.1M NaOH
Sb-125	7225	6225	±3.5%	Antimony-125 Antimony Chloride in 6M HCl
I-129	7129	6129	±3.0%	Iodine-129 Sodium Iodide in 0.1M NaOH
I-131	7131	6131	±2.5%	Iodine-131 Sodium Iodide in 0.1M HCl
Ba-133	7133	6133	±3.5%	Barium-133 Barium Chloride in 0.1M HCl
Cs-134	7134	6134	±3.5%	Cesium-134 Cesium Chloride in 0.1M HCl
Cs-137	7137	6137	±3.5%	Cesium-137 Cesium Chloride in 0.1M HCl
Pm-147	7147	6147	±2.0%	Promethium-147 Promethium Chloride in 0.1M HCl
Gd-148	7148	6148	±2.5%	Gadolinium-148 Gadolinium Chloride in 0.1M HCl
Eu-152	7152	6152	±3.5%	Europium-152 Europium Chloride in 0.1M HCl Eu-154 <2%

# STANDARD AND RADIONUCLIDE SOLUTIONS

NUCLIDE	STANDARD SOLUTION CATALOG #	NOMINAL SOLUTION CATALOG #	TYPICAL UNCERTAINTY	CHEMICAL FORM
Pu-236	7236	6236	±5.0%	Plutonium-236 Plutonium Nitrate in 4M HNO <sub>3</sub>
U-236	7336	6336	±3.0%	Uranium-236 Uranyl Nitrate in H <sub>2</sub> O
Np-237	7237	6237	±4.0%	Neptunium-237 Neptunium Nitrate in 4M HNO <sub>3</sub>
Pu-238	7238	6238	±2.5%	Plutonium-238 Plutonium Nitrate in 4M HNO <sub>3</sub>
U-238	7338	6338	±4.0%	Uranium-238 Uranyl Nitrate in H <sub>2</sub> O
Pu-239	7239	6239	±2.5%	Plutonium-239 Plutonium Nitrate in 4M HNO <sub>3</sub>
Pu-240	7240	6240	±2.5%	Plutonium-240 Plutonium Nitrate in 4M HNO <sub>3</sub>
Am-241	7241	6241	±2.5%	Americium-241 Americium Chloride in 1M HCl
Pu-241	7341	6341	±5.0%	Plutonium-241 Plutonium Nitrate in 4M HNO <sub>3</sub>
Pu-242	7242	6242	±5.0%	Plutonium-242 Plutonium Nitrate in 4M HNO <sub>3</sub>
Am-243	7243	6243	±3.5%	Americium-243 Americium Chloride in 1M HCl
Cm-244	7244	6244	±2.5%	Curium-244 Curium Nitrate in 0.1M HNO <sub>3</sub>
Cf-252	7252	6252	±5%	Californium-252 Californium Nitrate in 0.1M HNO <sub>3</sub>
Mixed Gamma	7500	—	±3.5%	Nine Nuclide Mixed Gamma Solution in 2M HCl

To place an order:

**Phone 818 843-7000 - FAX 818 843-6168**

Please include the catalog number, the capsule or configuration number, the nuclide, the activity and any NIST traceability requirements.

### MULTILINE STANDARDS (ML SERIES)

The nine-nuclide gamma standard, routinely used to establish efficiency curves for gamma spectrometers, covers an energy range from 88 keV to 1836 keV. As an option, Am-241 can be added to extend the calibration curve down to 60 keV. One (1)  $\mu\text{Ci}$  (37 kBq) of Am-241 emits 13,320 photons/sec. The component nuclides have been chosen to minimize peak interference, and the activity ratios have been selected to yield similar count rates in all major peaks on typical coaxial germanium detectors.

The multiline standard is NIST traceable with each component certified with an uncertainty better than  $\pm 5\%$  at the 99% confidence level. The multiline standards are prepared gravimetrically from calibrated solutions and then confirmed using a high purity germanium detector to insure the highest possible quality.

Multiline standards are made to order and are available on a year round basis in a variety of configurations described below. Standards can be supplied for special applications with nuclides, activities, containers and matrices manufactured to customer specifications.

NUCLIDE	GAMMA ENERGY (keV)	PHOTONS/SEC DECAY	PERCENT OF TOTAL ACTIVITY	TOTAL ACTIVITY IN FACT STANDARD	ACTIVITY (Bq)	APPROXIMATE PHOTONS/SEC PER Bq
Cd-109	88	0.036	28.7	0.287	10.6	380
Co-57	122 136.5	0.855 0.1069	1.10	0.011	0.407	350 44
Te-123m	159	0.84	1.4	0.014	0.518	440
Cr-51	320	0.0983	35.7	0.357	13.2	1300
Sn-113	392	0.64	5.2	0.052	1.92	1230
Sr-85	514	0.9927	6.6	0.066	2.44	2420
Cs-137	662	0.8521	4.8	0.048	1.78	1510
Co-60	1173 1332	0.999 0.999824	5.6	0.056	2.07	2070
Y-88	898 1836	0.927 0.9935	10.9	0.109	4.03	4030
OPTION Am-241	60	0.35	-	0.03	1.11	390

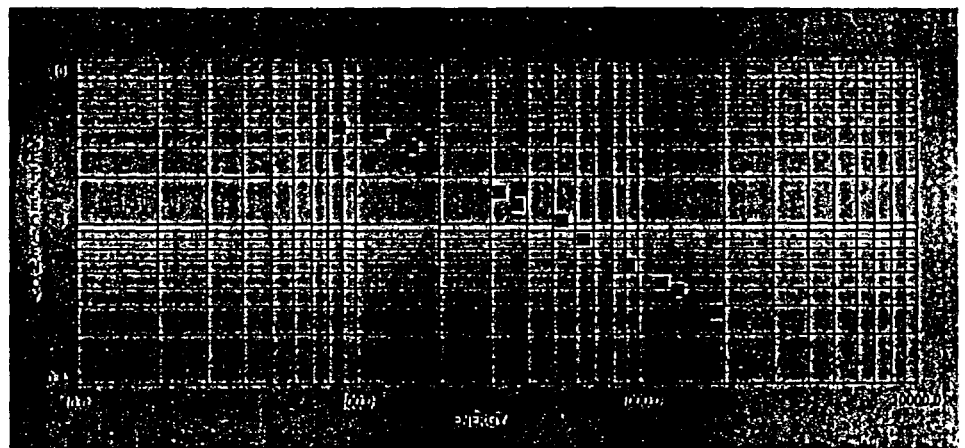


FIGURE 13-A — A TYPICAL GERMANIUM DETECTOR EFFICIENCY CURVE OBTAINED FOR A 500 mL MARINELLI BEAKER USING A 1  $\mu\text{Ci}$  MULTILINE STANDARD.

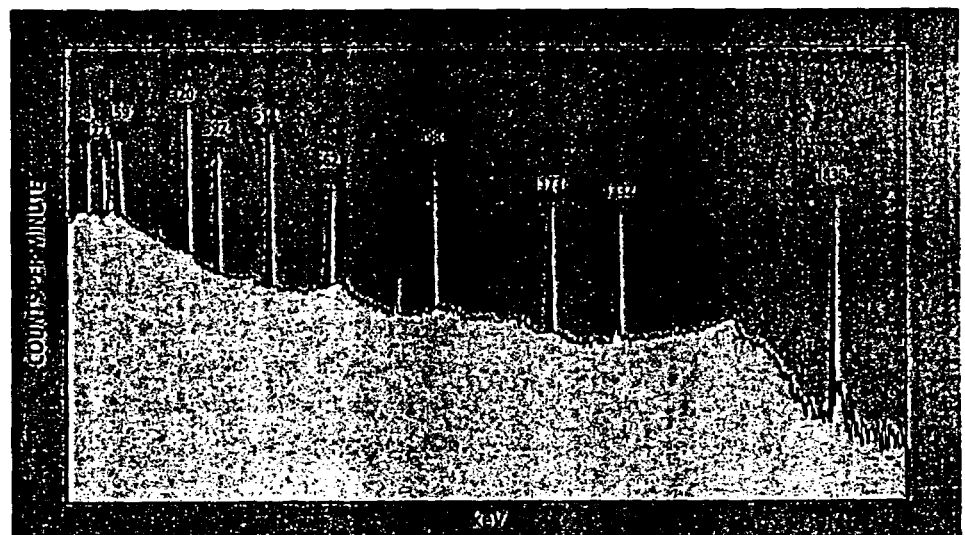


FIGURE 13-B — MULTILINE SPECTRUM OF A 5  $\mu\text{Ci}$  SOLUTION.

## MULTILINE STANDARDS (ML SERIES)

### Planar Multiline Calibration Standards

Three large area multiline configurations are available. In all cases the active elements are prepared by electroplating, by evaporative deposition, or by the incorporation of an insoluble complex of the nuclide into a thin polymeric surface.

### Ring and Disk (EAB-LB-ML)

EAB-LB disk standards are designed to check the performance and efficiency of low level counting systems such as proportional counters. The stainless steel disk containing the active element is surrounded by an aluminum ring which holds the window assembly in place.

### Planchet (EAB-PL-ML)

These sources simulate cupped planchet samples and can be used as calibration or performance check standards.

### Filter Paper (EAB-FP-ML)

Filter paper standards are designed to simulate surface smears and thus develop efficiencies for smear samples of similar construction. The standard mounts for the filter paper source are detailed on page 28.

### Tri-Nuclide Calibration Standards (TN Series)

This standard is a multiple energy gamma emitting standard consisting of Sb-125 ( $T_{1/2}=2.73$  y), Eu-154 ( $T_{1/2}=8.8$  y), and Eu-155 ( $T_{1/2}=4.96$  y). It is a relatively long lived gamma standard with many useful calibration points between 56 keV and 1597 keV.

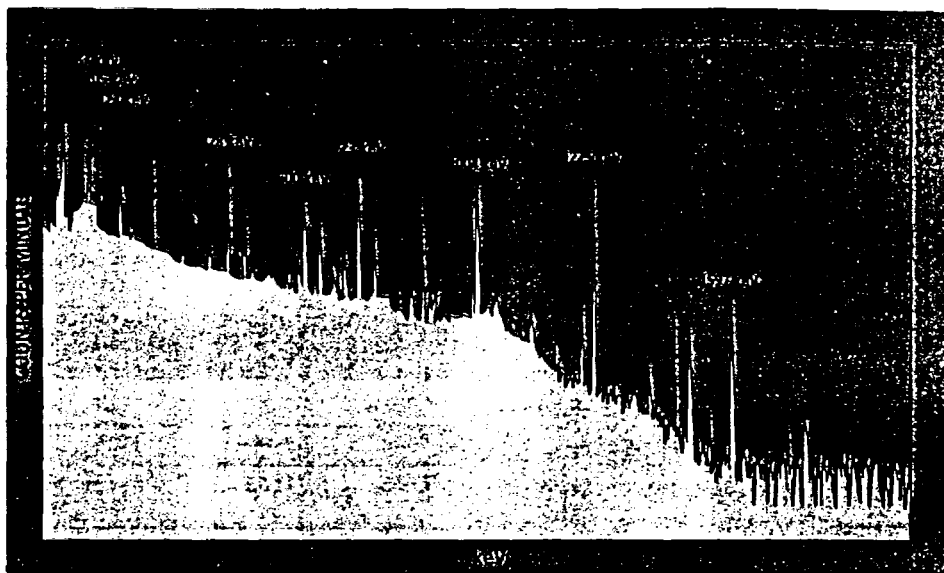


FIGURE 15-A — TRI-NUCLIDE SPECTRUM

While this standard does have the advantage of a longer useful life span when compared to the nine-nuclide mixed gamma standard, there are some disadvantages including cascade summing and spectral conflicts in photopeak emission rates.

The Tri-Nuclide Source is available as a nominal activity check source for various gamma energies, or as a NIST traceable gamma efficiency calibration standard in which the activity of each nuclide is certified to within  $\pm 5\%$  at the 99% confidence level. The Tri-Nuclide is available in the same configurations as the nine nuclide multiline standard described on Pages 13 and 15.



FIGURE 15-B — MULTILINE STANDARDS

# RADIOACTIVE GAS STANDARDS

CONCENTRATION $\mu\text{Ci}/\text{STP}$	TOTAL ACTIVITY IN 20 L	TOTAL ACTIVITY IN 20 L	H-3	CALIBRATION UNCERTAINTY AT 95% CONFIDENCE LEVEL			
				CS-137	K-85	CS-137	CS-137
$1 \times 10^{-5}$	0.2 $\mu\text{Ci}$	7.4 kBq	NA	NA	NA	$\pm 5\%$	$\pm 5\%$
$5 \times 10^{-5}$	1 $\mu\text{Ci}$	37 kBq	$\pm 7\%$	$\pm 7\%$	$\pm 7\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^{-4}$	2 $\mu\text{Ci}$	74 kBq	$\pm 7\%$	$\pm 7\%$	$\pm 7\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^{-4}$	10 $\mu\text{Ci}$	370 kBq	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^{-3}$	20 $\mu\text{Ci}$	740 kBq	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^{-3}$	100 $\mu\text{Ci}$	3.7 MBq	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^{-2}$	200 $\mu\text{Ci}$	7.4 MBq	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^{-2}$	1 mCi	37 MBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^{-1}$	2 mCi	74 MBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^{-1}$	10 mCi	370 MBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^0$	20 mCi	740 MBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^0$	100 mCi	3.7 GBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$1 \times 10^1$	200 mCi	7.4 GBq	$\pm 8\%$	$\pm 8\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
$5 \times 10^1$	1 Ci	37 GBq	NA	NA	$\pm 5\%$	NA	$\pm 5\%$
$1 \times 10^2$	2 Ci	74 GBq	NA	NA	$\pm 5\%$	NA	$\pm 5\%$
$1.5 \times 10^2$	3 Ci	111 GBq	NA	NA	$\pm 5\%$	NA	$\pm 5\%$
$2.5 \times 10^2^*$	5 Ci	185 GBq	NA	NA	$\pm 5\%$	NA	$\pm 5\%$
$5 \times 10^2^*$	10 Ci	370 GBq	NA	NA	$\pm 5\%$	NA	$\pm 5\%$

\* Requires a Type B container

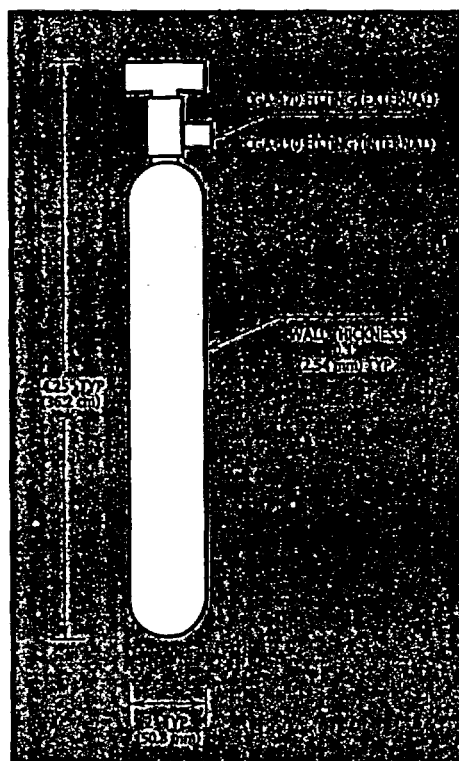


FIGURE 17-A — LECTURE BOTTLE

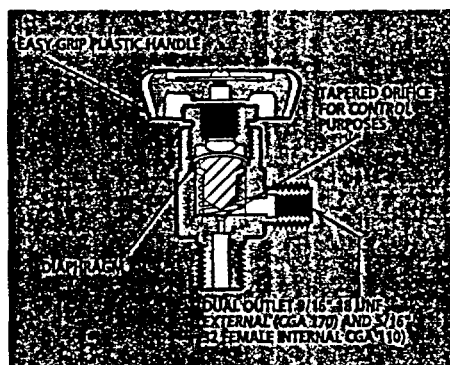


FIGURE 17-B — BRASS LECTURE BOTTLE VALVE



### Alpha Standard Set (AF-200)

Am-241 (0.1 µCi, 3.7 kBq), Th-228 (0.020 µCi, 0.74 kBq), Th-230 (0.020 µCi, 0.74 kBq). The sources are mounted in the A-1 configuration. (See description on Page 14)

MECHANICAL PROPERTIES FOR 1-2-3-4 AND 1-2-2-2								
CHARACTER PROPERTY	ACTIVE DIMENSIONS	MAXIMUM STRESS	1-2-3-4 STRESS	1-2-3-4 YIELD (ksi)	1-2-2-2 STRESS	1-2-2-2 YIELD (ksi)	1-2-2-2 STRAIN	1-2-2-2 YIELD (ksi)
A-2	0.197" 5.00 mm	0.196	1,000	0.425 (15.7)	150	0.0661 (2.45)	16.3	0.007 (0.26)
A-1	0.197" 5.00 mm	0.196	1,000	0.425 (15.7)	150	0.0661 (2.45)	16.3	0.007 (0.26)
PM	0.197" 5.00 mm	0.196	1,000	0.425 (15.7)	150	0.0661 (2.45)	16.3	0.007 (0.26)
LB	1.61" 41.0 mm	13.2	63,000	28.6 (1,058)	9,900	4.44 (164)	1000	0.48 (17.8)
PL	1.77" 45.0 mm	15.9	76,000	34.4 (1,273)	11,900	5.35 (198)	1300	6.58 (243)
FP (nylon)	1.77" 45.0 mm	3.0	14,000	6.49 (240)	2,200	1.00 (37.0)	240	0.109 (4.03)
LDS	3.94" x 3.94" 100 mm x 100 mm	100	480,000	216 (7,992)	75,000	33.6 (1,243)	8150	3.65 (135)

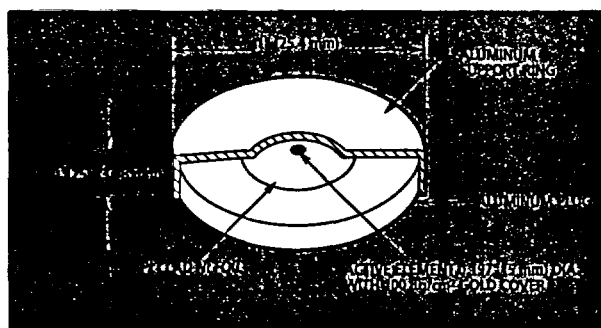
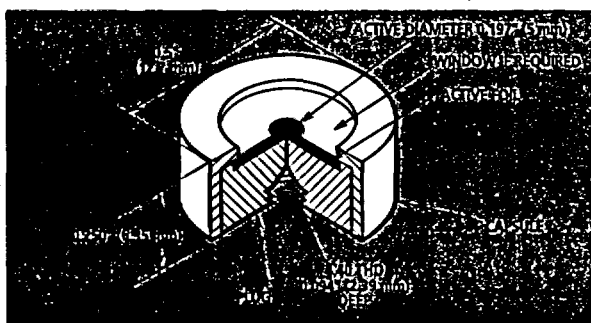
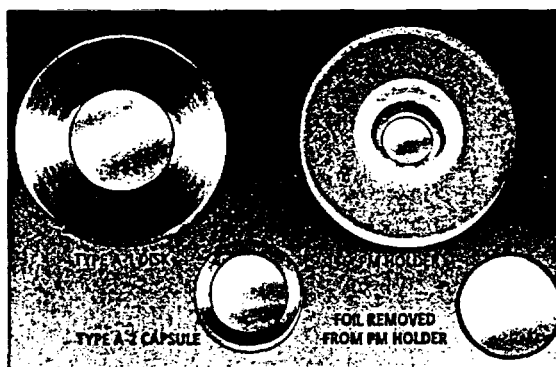


FIGURE 19-A — TYPE A-1 DISK



**FIGURE 19-B — TYPE A-2 CAPSULE**



**FIGURE 19-C — ALPHA STANDARDS**

## ALPHA PARTICLE STANDARDS (AF SERIES)

### Alpha Check Sources (AFSS)

The series AFSS check standard is a rugged source designed primarily for the calibration of portable alpha survey instruments in the plant or field.

The sources are prepared by electrodeposition of the desired nuclide to the surface of a 0.03" (0.76 mm) thick stainless steel disk followed by diffusion bonding at high temperature. They are provided without a cover. Sources are available up to 0.100  $\mu\text{Ci}$  (3.7 kBq).

The AFSS sources can be purchased as NIST traceable certified standards, with an uncertainty of  $\pm 5\%$  at the 99% confidence level, or as uncertified nominal check sources,  $\pm 15\%$ .

The following tables list the available nuclides and source dimensions:

### Composite Alpha Source (AF COMP)

The composite alpha source is designed to be used as an energy marker for alpha spectroscopy systems. Pu-239, Am-241 and Cm-244, 0.01  $\mu\text{Ci}$  (370 Bq) each, are electroplated onto a polished platinum foil. The active area is 0.197" (5.0 mm). The source is supplied uncovered. These nuclides provide alpha particles from approximately 5100 to 5800 keV and exhibit line widths typically less than 20 keV FWHM. This energy range is wide enough to provide a valid energy calibration for most alpha emitting nuclides.

The source, when purchased as a NIST traceable standard, can also be used to determine detector efficiencies for alpha particles. Total activity and individual activities are provided on the Certificate of Calibration.

The composite alpha source is available in the type A-2, A-1, and PM configurations as described on Page 18.

MODEL NUMBER	NUCLIDE
AFSS-230	Th-230
AFSS-238	Pu-238
AFSS-239	Pu-239
AFSS-241	Am-241

OVERALL DIAMETER IN		ACTIVE DIAMETER IN		DISK THICKNESS	
1"	25.4 mm	0.87"	22.1 mm	0.03"	0.762 mm
1.25"	31.8 mm	1"	25.4 mm	0.03"	0.762 mm
1.875"	47.6 mm	1.75"	44.5 mm	0.03"	0.762 mm
2"	50.8 mm	1.85"	47.0 mm	0.03"	0.762 mm
2.5"	63.5 mm	2"	50.8 mm	0.03"	0.762 mm

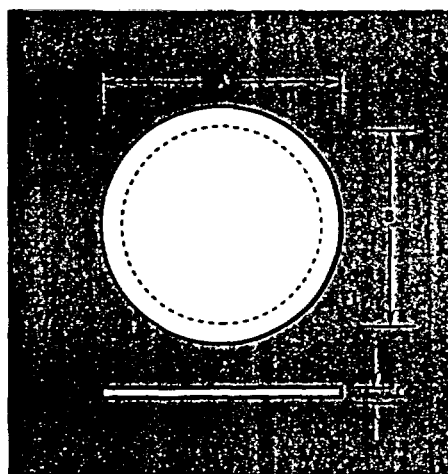


FIGURE 21-A — TYPE AFSS DISK

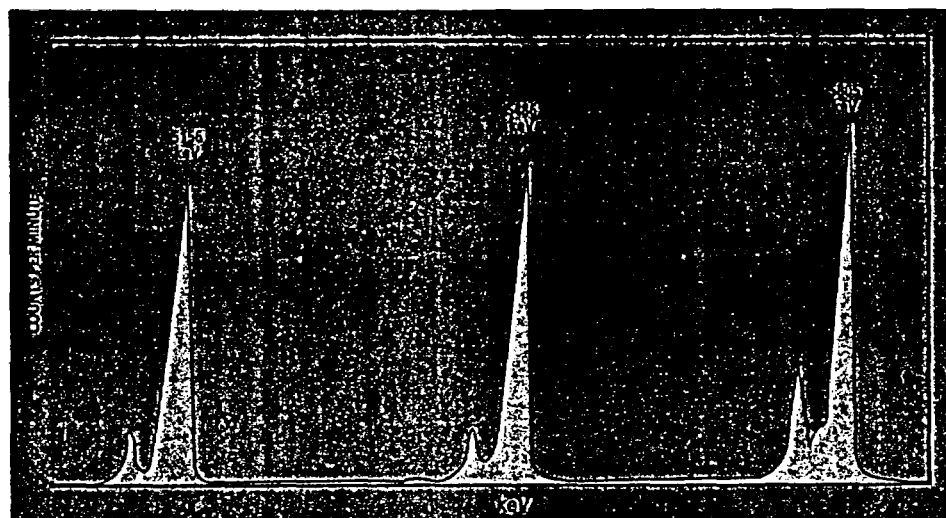


FIGURE 21B — COMPOSITE ALPHA SOURCE SPECTRUM  
Spectrum using silicon barrier detector

## BETA PARTICLE STANDARDS (BF SERIES)

### Beta Standards Set (BF-200)

This set consists of six nuclides covering the energy range 155-2282 keV (maximum):

C-14, Tc-99, Cl-36, Bi-210/Pb-210, Pm-147 and Sr-90/Y-90

The C-14 source contains 0.1  $\mu\text{Ci}$  (3.7 kBq).  
The other nuclides contain 0.01  $\mu\text{Ci}$  (370 Bq).  
The sources are Type A, 1" (25.4 mm) overall diameter and may be either 0.125" (3.18 mm) or 0.312" (7.93 mm) thick. Included in each set is an empty mount, two 0.9 mg/cm<sup>2</sup> aluminized Mylar absorbers, stainless steel planchets, and a Model 200C split source.

Model Number BF 200-1

(0.125", 3.18 mm thick)

Model Number BF 200-3

(0.312", 7.93 mm thick)

### Split Source Set (200C)

This source is for use in determining coincidence corrections for G.M. counters. It consists of two plastic half disks with a total overall diameter of 1" (25.4 mm). Each half-source contains a nominal 0.1  $\mu\text{Ci}$  (3.7 kBq) of Sr-90/Y-90. A blank half disk is included with each source.

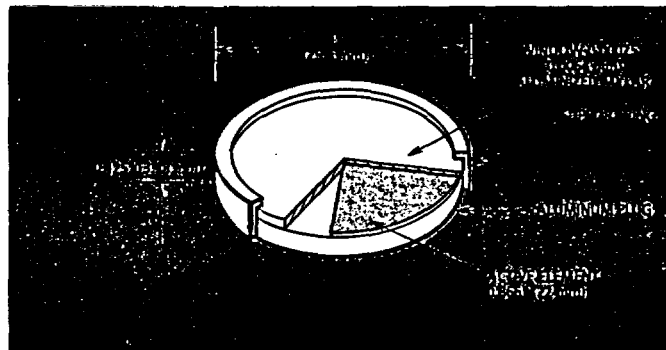


FIGURE 23-A — TYPE A DISK

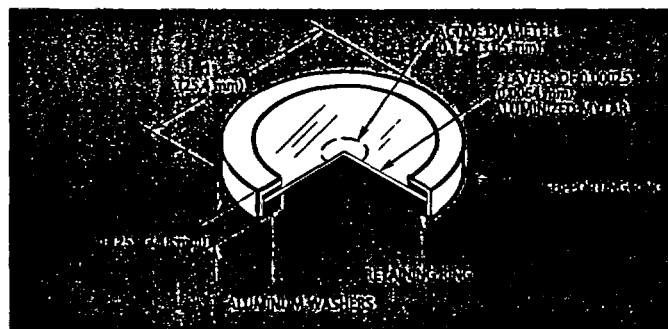


FIGURE 23-B — TYPE MF2 DISK



FIGURE 23-C —  
BETA STANDARDS

### Sr-90 SOURCES:

Sr-90 sources produced by Isotope Products Laboratories are certified as to the contained activity of the Sr-90 only. These sources, which are beta emitters, are in equilibrium with the Y-90 daughter. Thus, a 1  $\mu\text{Ci}$  (37 kBq) Sr-90 source also has 1  $\mu\text{Ci}$  (37 kBq) of Y-90. When comparing sources in similar geometries (i.e., similar backing, cover and source detector distance) good results should be obtained. Sr-90 has an average beta energy of 196 keV and Y-90 has an average beta energy of 934 keV, thus care must be taken when comparing sources of substantially different geometries since effects such as backscatter and window absorption must be considered.

# GAMMA AND X-RAY STANDARDS (GF SERIES)

Model	Isotope	Half-life	Major Photon Emissions (ray)
GF-227	Actinium-227	21.8 y	50-897, (includes daughters)
GF-241	Americium-241	433 y	60 (36%), 11-18 (39.5%) Np L x-rays
GF-125A	Antimony-125	2.73 y	428 (30.4%), 464 (10.5%), 60 (22.8%), 636 (11.3%), 19-32 (75.1%) Te K x-rays
GF-133	Barium-133	10.5 y	80 (34.2%), 303 (18.4%), 356 (62.2%), 30-36 (124%) Cs K x-rays
GF-007	Beryllium-7 (1)	53.3 d	478 (10.4%)
GF-207	Bismuth-207	32.2 y	570 (97.8%), 1063 (74.9%), 9-15 (32.5%) Pb L x-rays, 72-88 (74.8%) Pb K x-rays
GF-109	Cadmium-109	1.27 y	88 (3.8% from Ag 109m), 22-26 (9.8%) Ag K x-rays
GF-144	Cerium-144	285 d	134 (11.1%), 697 (1.3% from Pr-144), 35-41 (8.01%) Pr K x-rays
GF-134	Cesium-134	2.06 y	566 (23.8%), 605 (97.6%), 797 (94.1%)
GF-137	Cesium-137	30.0 y	662 (85.2% from Ba-137), 32-37 (7.12%) Ba K x-rays
GF-051	Chromium-51	27.7 d	320 (9.83%), 4.9-5.4 (21.6%) V K x-rays
GF-057	Cobalt-57	272 d	14 (9.54%), 122 (85.5%), 136.5 (10.7%), 6.4-7.1 (54.7%) Fe K x-rays
GF-058	Cobalt-58	70.9 d	511 (29.8%), 810 (99.5%), 6.4-7.1 (25.8%) Fe K x-rays
GF-060	Cobalt-60	5.27 y	1173 (100%), 1333 (100%)
GF-152	Europium-152	13.3 y	122-1408, 40-47 (74%) Sm x-rays
GF-154	Europium-154	8.8 y	58-1597, 42-50 (25.6%) Gd x-rays
GF-155	Europium-155	4.96 y	87 (34%), 105 (20.6%), 42-50 (24.0%) Gd K x-rays
GF-153	Gadolinium-153 (1)	242 d	97 (27.6%), 103 (19.6%), 40-49 (114%) Eu K x-rays
GF-068	Germanium-68 (8)	271 d	511 (178%), 1077 (3.0%) from Ga-68, 9.2-10.4 (43.9%) Ga K x-rays, 8.6-9.6 (4.6%) Zn K x-rays
GF-166	Holmium-166m	1200 y	81-1427, 48-58 (39.0%) Er K x-rays
GF-125	Iodine-125	60.1 d	35 (6.67%), 27-32 (141%) Te K x-rays
GF-129	Iodine-129 (2) (9)	1.5 x 10 <sup>7</sup> y	40 (7.5%), 29-35 (70.8%) Xe K x-rays
GF-055	Iron-55 (3)	2.73 y	5.8-6.5 (27.3%) Mn K x-rays
GF-059	Iron-59	44.5 d	1099 (56.5%), 1292 (43.2%)
GF-054	Manganese-54	312 d	835 (100%), 5.4-5.9 (24.5%) Cr K x-rays
GF-226	Radium-226 (7)	1600 y	47-2448 (includes daughters)
GF-106	Ruthenium-106 (1)	367 d	512 (20.7%), 622 (9.8%) from Rh-106
GF-075	Selenium-75	120 d	121 (17.3%), 136 (59.0%), 265 (59.2%), 280 (25.2%), 10.5-12.0 (55.6%) As K x-rays
GF-110	Silver-110m	250 d	447-1505
GF-131	Simulated I-131(4)	-5 y	356 (from Ba-133), 662 (from Cs-137/Ba-137)
GF-022	Sodium-22 (8)	2.60 y	511 (179%), 1275 (100%)
GF-085	Strontium-85	64.9 d	514 (99.3%), 13.3-15.3 (58.6%) Rb K x-rays
GF-228	Thorium-228 (7)	1.91 y	84-2614 (includes daughters)
GF-113	Tin-113	115 d	392 (64% from In-113m), 24-28 (97.8%) In K x-rays
GF-235	Uranium-235 (5)	7.0 x 10 <sup>8</sup> y	143(10.5%), 186 (53%), 90-105 (10.8%) Th K x-rays
GF-NAT	Uranium (6)	4.5 x 10 <sup>9</sup> y	26-2448 (includes daughters)
GF-088	Yttrium-88	107 d	898 (92.7%), 1836 (100%), 14.1-16.2 (60.1%) Sr K x-rays
GF-065	Zinc-65	244 d	1116 (50.8%), 8.0-8.9 (36.3%) Cu K x-rays
GF-095	Zirconium-95	64 d	724 (44.1%), 757 (54.5%)

- (1) Limited supply, inquire about availability.
- (2) I-129: Type D, R, or T configuration only.
- (3) Available in special type M configuration; 0.00025" (0.0064 mm) aluminized Mylar window with a 0.010" (0.254 mm) Mylar backing.
- (4) Simulated I-131: A mixture of Ba-133 and Cs-137 with a useful half-life of approximately 5 years.
- (5) Uranium (natural): See table on Page 15.
- (6) Uranium-235: See table on Page 15.
- (7) Ra-226 and Th-228 are only available in type D or R above 10 µCi (37 kBq)
- (8) Due to incomplete absorption of the positron in the type M window, annihilation may occur outside the source.
- (9) Calibrated in terms of its equivalence to massless point source.

## SIMULATED I-125 SOURCES

I-129 sources are frequently referred to as "simulated I-125 sources". I-129 does not in fact simulate I-125 well enough to use it to calibrate an I-125 counter. The equivalence of I-129 to I-125 will vary from one counter to another due to the differing photon energies. Isotope Products recommends the purchase of an I-125 standard for the initial instrument calibration. An I-129 source may then be used for a daily check of instrument response.

The energies and abundances of I-125 and I-129 x-rays and photons are:

	K x-rays (keV)	Gammas (keV)
I-125	(Te) 27-32 (141%)	35.5 (6.66%)
I-129	(Xe) 29-35 (70.8%)	39.6 (7.5%)

## LARGE VOLUME CALIBRATION STANDARDS (EG SERIES)

The Model EG Series standards offer a convenient method to calibrate Ge and NaI(Tl) detectors for the analysis of soil and water samples, reactor coolants, air samples, and other environmental materials.

Standard activity is 0.1  $\mu\text{Ci}$  (3.7 kBq).

Customer supplied containers will be filled on request.

### Large Volume Bottle Gamma Standards (EG-LVB)

Series LVB wide mouth polyethylene sample bottles are available in 250 mL, 500 mL, and 1000 mL. Additional sizes are available on request.

## Marinelli Gamma Standards (EG-LVM)

Series LVM Marinelli Beakers, for both Ge and NaI(Tl) detectors, are available in 500 mL, 1000 mL, 2000 mL and 4000 mL. This configuration is useful where maximum efficiency is needed such as environmental samples.

Three standard matrices are available for both series:

MATRIX	DENSITY (g/cc)	USE
Silicone <sup>+</sup>	1.0	water equivalent
Epoxy *	1.1	soil equivalent
Sand: 50-70 mesh	2.5	soil equivalent

<sup>+</sup> Silicone densities from 0.75 to 1 g/cc.

\*Epoxy with densities from 1.0 g/cc to 3.5 g/cc are available.

The following are examples of customer supplied materials that may also be used:

- Soil
- Vegetation
- Pulverized concrete

In both series the radioactivity is uniformly dispersed in the matrix. Specify the series, matrix and container type and size. For the Marinelli Beakers, specify the detector type.

NUCLIDES FOR LARGE VOLUME GAMMA STANDARDS		
CATALOG NUMBER	NUCLIDES	PRINCIPAL PHOTON EMISSIONS (keV)
EG-057	Co-57	14, 122, 136.5
EG-060	Co-60	1173, 1333
EG-125	I-125	35, 27-32 K x-rays
EG-129	I-129	40, 29-35 K x-rays
EG-131	Simulated I-131	356, 662
EG-133	Ba-133	80, 303, 356
EG-137	Cs-137	662
EG-ML	Multinuclide	See Page 13

Other nuclides or nuclide mixtures are available on request

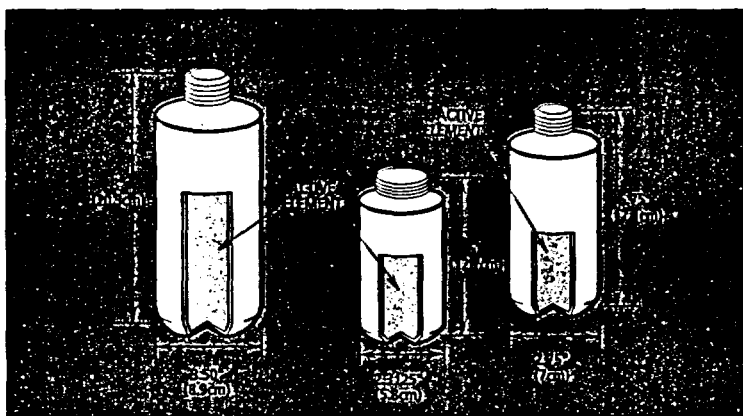


FIGURE 27-A — LARGE VOLUME CONTAINERS

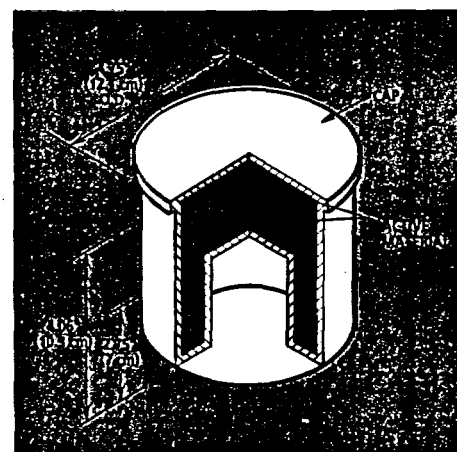


FIGURE 27-B — MARINELLI BEAKER

## PLANAR CALIBRATION STANDARDS

This series includes the Extended Alpha or Beta Standards (EAB) and the Large Decade Standards (LDS). These standards are used for the calibration of alpha, beta and wide area counters. EAB standards are typically disks and LDS standards are either large square or large rectangular standards. All standards are NIST traceable and provide good surface uniformity.

### EAB Series:

STANDARD NUMBER	NUCLIDE	EAB NUMBER (Area)	NOMINAL ACTIVITY	
			$\mu\text{Ci}$	Bq
EAB-014	C-14	156 $\beta$	0.0135	0.5
EAB-036	Cl-36	1142 $\beta$	0.0135	0.5
EAB-060	Co-60	1491 $\beta$	0.0135	0.5
EAB-090	Sr-90 Y-90 (1)	546 $\beta$ 2282	0.0135	0.5
EAB-099	Tc-99	294 $\beta$	0.0135	0.5
EAB-125	I-125 (2)	35, 27-32 K x-rays $\gamma$	0.0135	0.5
EAB-129	I-129 (3)	40, 29-35 K x-rays $\gamma$	0.0135	0.5
EAB-131	Sim-I-131	356, 662 $\gamma$	0.0135	0.5
EAB-137	Cs-137	514, 1175 $\beta$	0.0135	0.5
EAB-147	Pm-147	225 $\beta$	0.0135	0.5
EAB-204	Tl-204	763 $\beta$	0.0135	0.5
EAB-210	Po-210	5304 $\alpha$	0.0135	0.5
EAB-230	Th-230	4621, 4688 $\alpha$	0.0135	0.5
EAB-235	U-235 (4)	4215-4597 $\alpha$ (beta from Pa-231)	0.0135	0.5
EAB-238U	U-238 (4)	4147, 4196 (beta from Pa-234) $\alpha$	0.0135	0.5
EAB-239	Pu-239	5143, 5156 $\alpha$	0.0135	0.5
EAB-241	Am-241	5388, 5443, 5486 $\alpha$	0.0135	0.5
EAB-ML	Multiline Nine Isotope Gamma(5)	88 to 1836 $\gamma$	1-5	37-185

(1) see note on Page 23 regarding Sr-90/Y-90 sources

(2) maximum available activity is 0.200  $\mu\text{Ci}$  (7.4 kBq)

(3) See note on Page 25 regarding I-125 sources

(4) see table on Page 19 for maximum activity levels

(5) See Multiline Section on Page 13 for description of standard

\*Beta values are for  $E_{\text{max}}$

### Ring and Disk (EAB-LB)

EAB-LB disk standards are designed to check the performance and to determine the efficiency of low level counting systems such as proportional counters. The stainless steel disk containing the active element is surrounded by an aluminum ring which holds the window assembly in place. See Page 33.

Beta standards, with the exception of Tc-99, are prepared by electroplating, by evaporative deposition or by the incorporation of an insoluble complex of the nuclide into a thin polymeric surface. Tc-99 standards are prepared by electroplating. Beta standards are covered with either an aluminized coating or with 1 mg/cm<sup>2</sup> or 9 mg/cm<sup>2</sup> polyimide film.

## PLANAR CALIBRATION STANDARDS

### Filter Paper (EAB-FP)

Filter paper standards are designed to simulate surface smears and thus establish efficiencies for smear samples of similar construction. Since alpha and beta particles are easily attenuated by the filter paper, the actual surface emission may not appear to relate to the contained activity. Therefore, efficiencies derived with such standards have a large uncertainty caused by the inherent absorption. Filter paper standards are

most useful in establishing action levels for smear samples. The calibration certificate provides both the contained activity and the surface emission rate of the standard.

The standard mount for the filter paper source is on top of a 1.85" (47.0 mm), 2" (50.8 mm), or 4.5" (114 mm) diameter nylon disk with the assembly held in place by a nylon ring (Figure 33-C) or an aluminum ring (Figure 33-A).

Beta standards are covered with 0.9 mg/cm<sup>2</sup> Mylar. Alpha standards are covered with 100-200 µg/cm<sup>2</sup> of acrylic. In addition to the mounts described above the active filter paper can be mounted in any of the EAB-LB or EAB-PL configurations.

STANDARD NUMBER	STANDARD ASSEMBLY	DISK/FRAME DIAMETER (A)	DISK DIAMETER	OVERALL THICKNESS (B)
EAB-FP-1	Nylon ring and disk (Figure 33-C)	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-FP-2	Nylon ring and disk (Figure 33-C)	1.85" (47.0 mm)	1.61" (40.9 mm)	0.125" (3.18 mm)
EAB-FP-3	Nylon ring and disk (Figure 33-C)	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)
EAB-FP-4	Nylon disk and aluminum ring (Figure 33-C)	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-FP-5	Nylon disk and aluminum ring (Figure 33-C)	1.85" (47.0 mm)	1.61" (40.9 mm)	0.125" (3.18 mm)
EAB-FP-6	Nylon disk and aluminum ring (Figure 33-C)	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)
EAB-FP-7	LB Style with nylon disk and aluminum ring (Figure 33-A)	1.85" (47.0 mm)	1.61" (40.9 mm)	0.125" (3.18 mm)
EAB-FP-8	LB Style with nylon disk and aluminum ring (Figure 33-A)	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-FP-9	LB Style with nylon disk and aluminum ring (Figure 33-A)	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)
EAB-FP-10	LB style (Figure 33-A)	1.85" (47.0 mm)	1.61" (40.9 mm)	0.125" (3.18 mm)
EAB-FP-11	LB style (Figure 33-A)	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-FP-12	LB style (Figure 33-A)	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)
EAB-FP-13	PL style (Figure 33-B)	2.0" (50.8 mm)	1.77" (45.0 mm)	0.125" (3.18 mm)
EAB-FP-14 (1)	PL style (Figure 33-B)	3.0" (76.2 mm)	2.77" (70.4 mm)	0.125" (3.18 mm)
EAB-FP-15	PL style (Figure 33-B)	4.5" (114 mm)	4.0" (102 mm)	0.125" (3.18 mm)

(1) available in aluminum only

## PLANAR CALIBRATION STANDARDS

### Air Monitor Standard (AMS)

The air monitor standard is designed to be used in continuous air monitoring systems such as the Eberline AMS-3 Beta Particulate Air Monitor. The thin nylon backing allows the standard to be held in place after re-attaching the hub to the monitor.

The source simulates a surface-loaded filter paper. The disk backing is made of nylon and is covered with 1 mg/cm<sup>2</sup> of polyimide film. The edges of the Polyimide are sealed to the nylon disk to ensure the integrity of the standard. The standard has an overall diameter of 1.98" (50.3 mm) and a 1.65" (41.9 mm) active diameter. The contained activity of each source is 13.5 nCi (500 Bq). A certificate of calibration traceable to NIST is provided for each source. The uncertainty is  $\pm 5\%$  at the 99% confidence level. The 2x beta emission rate is also provided but is not NIST traceable.

The standard set consists of C-14, Cl-36, Co-60, Sr-90/Y-90, Tc-99 and Cs-137. Sources may also be purchased individually. Other nuclides and activities are available on request.

NUCLIDE	PRINCIPLE BETA EMISSIONS (E- <sup>-</sup> /CM <sup>2</sup> /HR)	CONTAINED ACTIVITY (nCi)	CONTAINED ACTIVITY (Bq)	LOSS THROUGH POLYIMIDE FILM (ESTIMATED)
C-14	156	13.5	500	65
Cl-36	1142	13.5	500	12
Co-60	1491	13.5	500	38
Cs-137	1175	13.5	500	28
Sr-90/Y-90 (1)	546, 2282	13.5	500	11.5
Tc-99	294	13.5	500	10
Ti-204	763	13.5	500	44
Pm-147	225	13.5	500	28

(1) See note regarding Sr-90/Y-90 sources on Page 23

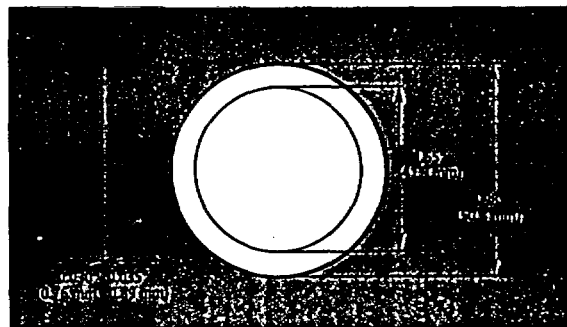


FIGURE 33-A — SERIES AMS DISK

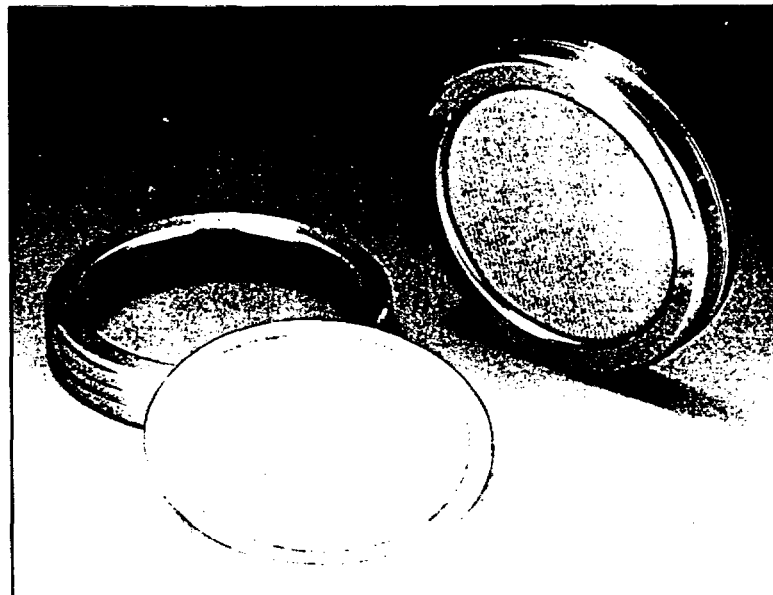


FIGURE 33-B — AMS STANDARD



## PLANAR CALIBRATION STANDARDS

### Standard Sets for Specialized Applications

#### Decade Standard Set (LDS-300)

Decade standards are designed to routinely check the tracking of G.M. and proportional counters from scale to scale. They may be supplied as an alpha, low energy beta, or high energy beta/gamma set.

Each set is supplied as 3 standards with activities at 1,000 dpm, 10,000 dpm and 100,000 dpm (16.7 Bq, 166.7 Bq and 1.67 kBq). Each source is NIST traceable  $\pm 5\%$ .

See table on Page 33 for available nuclides. Each set is supplied in a wooden box.

#### Surface Contamination Standard Set (LDS-100)

This set is designed to check the efficiencies of various radiation detectors used for surface monitoring in biomedical laboratories. These nuclides cover energies from 19-1710 keV  $E_{MAX}$ , the range of energies usually encountered in hospital and research laboratories. These standards are NIST traceable  $\pm 5\%$  on contained activity and are within  $\pm 20\%$  of the stated value except for H-3. H-3 standards are supplied -50+100% of the nominal value and are calibrated for beta output. The set contains four standards: H-3, C-14, P-32(1) and I-129.

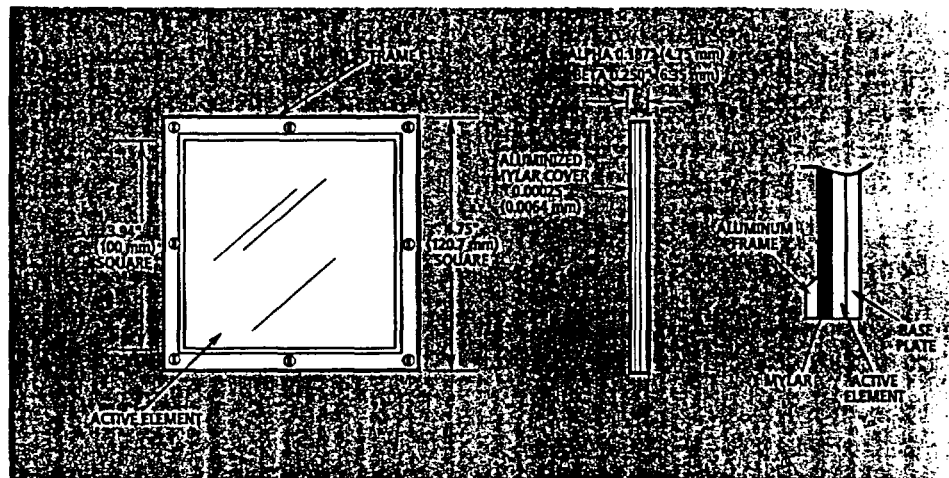


FIGURE 35-A — LDS PLANAR STANDARD

The standard size has an overall dimension of 4.75" x 4.75" (120.7 mm x 120.7 mm) and active dimension of 3.94" x 3.94" (100 mm x 100 mm).

These standards may also be purchased individually. The H-3, C-14 and I-129 are supplied as 0.1  $\mu\text{Ci}$  (3.7 kBq). The P-32 standard is supplied

as 0.01  $\mu\text{Ci}$  (0.37 kBq) (1). All standards are supplied in a wooden storage box.

#### Window Assemblies (LDS-W)

Window assemblies are available for field replacement of torn or punctured LDS parts. Specify Mylar or polyimide when placing the order.

Removal of the original window assembly may result in a loss of activity. Original calibration values are not valid once the window has been damaged or removed.

Damaged standards should be returned for evaluation. In most cases recalibration and recertification will be recommended. Contact Technical Customer Service for pricing information and instructions for returning standards.

(1) A 15 mg/cm<sup>2</sup> Mylar or a 15 mg/cm<sup>2</sup> polyimide window absorbs approximately 60% of the Si-32 beta emissions.

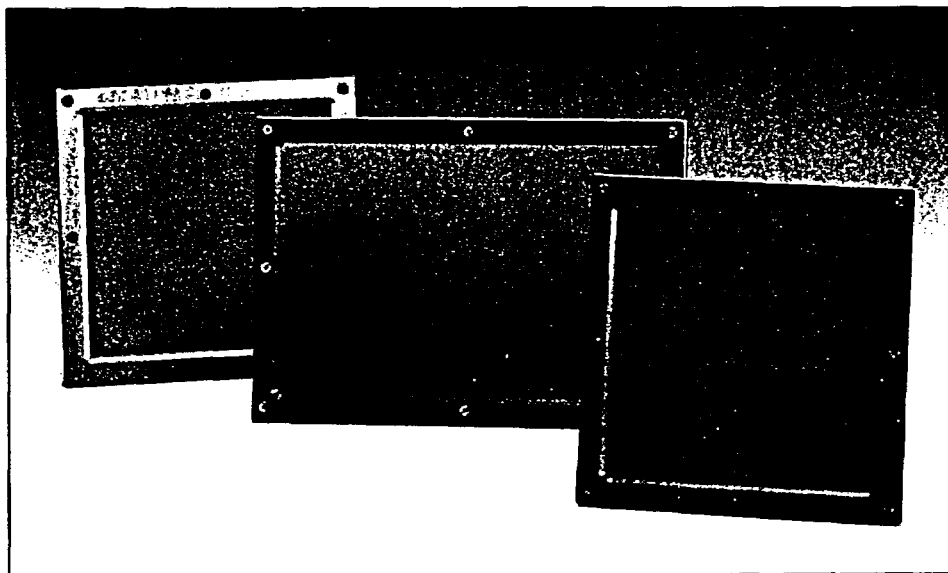


FIGURE 35-B — LDS STANDARDS

## PHOTON SOURCES (PHR SERIES)

The following group of nuclides covers a wide range of x-ray and gamma energies in a form convenient for calibrating solid-state counters. The normal configuration is an A-2 capsule fitted with a 0.010" (0.254 mm) beryllium window. Materials for construction are selected so that secondary radiations will cause minimum interference with those of primary interest. Unmounted foil elements are available in the type PM separable holder shown below. In this case a thin acrylic coating is applied replacing the beryllium window. Contained activity is supplied as a nominal value  $\pm 15\%$ . A NIST traceable calibration of the contained value and dose rate calibrations are available on request.

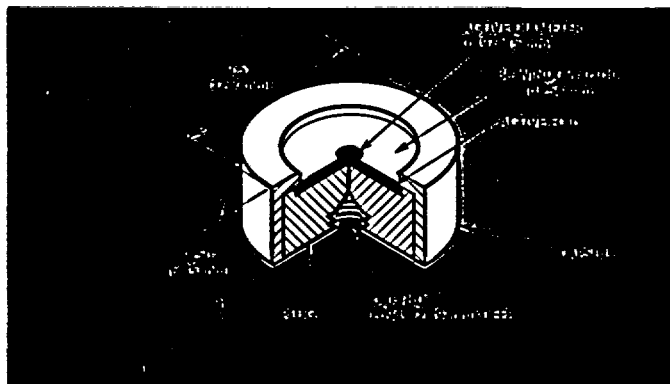


FIGURE 45-A — A-2 CAPSULE

STANDARD ACTIVITY			
10 $\mu$ Ci	100 $\mu$ Ci	500 $\mu$ Ci	1 mCi
370 kBq	3.7 MBq	18.5 MBq	37 MBq

CATALOG NUMBER	NUCLIDE	HAZARD	SHIELDING ENERGY (keV)	BACKING	WINDOW
PHR-241	Am-241	433 y	60, 18 Np L x-rays	Nickel	0.010" (0.254 mm) Be
PHR-207	Bi-207	32.2 y	569, 1063 75 Pb L x-rays	Nickel	0.010" (0.254 mm) Be
PHR-109	Cd-109	1.27 y	88, 22 Ag K x-rays	Silver	0.010" (0.254 mm) Be
PHR-244	Cm-244	18.1 y	13-16 Pu K x-rays	Platinum	0.010" (0.254 mm) Be
PHR-057	Co-57	272 d	14, 122, 136.5 6.4 Fe K x-rays	Nickel	0.010" (0.254 mm) Be
PHR-055	Fe-55	2.73 y	5.9 Mn K x-rays	Nickel	0.010" (0.254 mm) Be

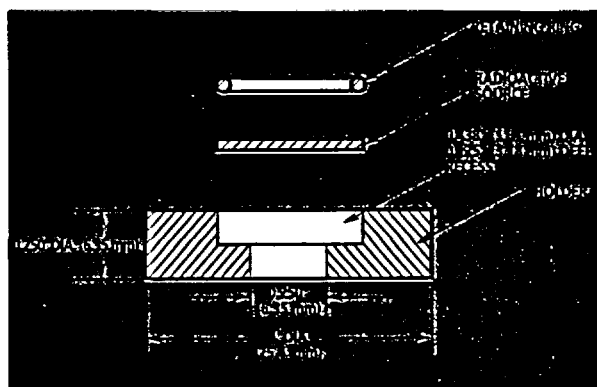


FIGURE 45-B — TYPE PM HOLDER