

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF SEALED SOURCE
(AMENDED IN ITS ENTIRETY)

NO: TX-167-S-102-S

DATE: May 13, 2011

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SOURCE TYPE: Foil Source

MODEL: AMM.1001, AMM.1001D, AMM.1001H, AMM

DISTRIBUTOR: BRK Brands, Inc.
25 Spur Drive
El Paso, Texas 79906

MANUFACTURER: Shenzhen CICAM
Manufacturing Company Ltd.
Building 11, Wanxia Industry Garden
Tongfuyu Industry District
Shajing Street, Baoan District
Shenzhen, China 518067

<u>ISOTOPE:</u>	<u>MAXIMUM ACTIVITY:</u>	<u>MODEL NUMBER:</u>
Americium-241	200 μCi (7.4 MBq) and 50 $\mu\text{Ci} / \text{cm}^2$ (1.85 MBq / cm^2)	AMM.1001, AMM.1001D, AMM.1001H
	1 millicurie (37 MBq) and 250 $\mu\text{Ci} / \text{cm}^2$ (9.25 MBq / cm^2)	AMM

LEAK TEST FREQUENCY: 3 months for foils greater than 10 μCi (370 kBq)

PRINCIPAL USE: (P) Ion Generators, Smoke Detectors

CUSTOM SOURCE: YES ____ NO X

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SOURCE TYPE: Foil Source

DESCRIPTION:

Model AMM.1001

The Model AMM.1001 primary foil consists of americium oxide uniformly distributed and sintered in a fine gold matrix at temperatures in excess of 1472°F (800°C). This matrix is further contained between layers of silver, gold, and palladium by hot forging. The result is a foil, which is typically 1 meter (39.34 in.) long and 4 centimeters (1.57 in.) wide. There are two primary foil designs whose dimensions depend on the particular choice of materials contained within the various layers and the target thickness of each layer.

Model AMM.1001 - Type 1

The target thickness of each layer and the overall thickness are: overall thickness = 0.155 - 0.256 mm (6.1 - 10.1 mils); silver substrate = 0.15 - 0.25 mm (5.9 - 9.8 mils); gold backing = 0.001 mm (39.4 microns); ²⁴¹Am/gold matrix = 0.002 mm (78.8 microns) and non-radioactive over-plate = 0.002 - 0.003 millimeters (79 - 118 microns). The over-plate is comprised of gold, gold & palladium alloy, gold/palladium laminate, or palladium.

Model AMM.1001 - Type 2

The Type 2 primary foil uses the same layering concept as Type 1. However, in Type 2, there are more layers and there is a variation in the thickness of the over-plate, matrix, and silver substrate layers as well as over-plate components. The target thickness of each layer and the overall thickness are: overall thickness = 0.15 - 0.25 mm (5.9 - 9.8 mils); gold alloy backing = \pm 0.0005 mm (19.7 microns); silver substrate = \pm 0.2 mm (7.9 mils); gold alloy backing = \pm 0.0005 mm (19.7 microns); ²⁴¹Am/gold matrix = \pm 0.0005 mm (19.7 microns); gold alloy over-plate = \pm 0.0002 mm (7.9 microns); palladium over-plate = \pm 0.0018 mm (71 microns).

The primary foil (Type 1 or 2) is used to fabricate secondary foil sources by using various dies to punch a specific size and shape of secondary foil.

Model AMM.1001D

The Model AMM.1001D is manufactured by power rolling two AMM.1001 Type 1 primary foils back-to-back to produce a primary double sided foil with an overall thickness of approximately 0.38 mm (15 mils). The layers of the double sided foil are hot forged together prior to rolling with one active insert on either side of the silver block. Each foil side has an over-plate of either gold/palladium alloy or palladium with a thickness of approximately 0.002 mm (79 microns).

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DESCRIPTION (Cont.):

Model AMM.1001H

The Model AMM.1001H consists of Model AMM.1001 or AMM.1001D discs (or similarly-shaped foils) mounted into a holder which is constructed of tin plated brass or stainless steel. The mounting is done by either rolling or by staking the edge of the holder so that the outer edges of the foil discs are not exposed.

Model AMM

The Model AMM.foil consists of americium oxide uniformly distributed and sintered in a fine gold matrix at temperatures in excess of 1472°F (800°C). It is further contained by a hot forging process between layers of gold, gold palladium alloy, or palladium. The laminate is mounted, again by hot forging, onto a supporting substrate of silver, gold, palladium, or any combination of those three metals alloyed together. The metal layers, now continuously welded, are extended in area by means of a power rolling mill to give the required active and overall areas. The rolled foil may be distributed over the whole area of the foil piece.

LABELING:

The source foils are transferred to device manufacturers in containers which are labeled with the model number, trefoil, isotope, the BRK Brands, Inc. name or logo, the batch number, and the quantity of secondary source foils or source assemblies in the container.

Each source shipment is accompanied with a Test Report listing the model number, nuclide, activity assay results, a reference date, batch number, leak test results, and other pertinent information. The sources are distributed with 'Handling Instructions for Radiation Sources'.

DIAGRAM:

Attachment 1 - Model 1001 Type 1 primary foil

Attachment 2 - Typical secondary strip

Attachment 3 - Typical secondary disc source punched from a Type 1 primary foil

Attachment 4 - Typical secondary disc source punched from a Type 2 primary foil

Attachment 5 - Model AMM.1001D

Attachments 6 through 9 - Typical Model AMM.1001H sealed source / holder assemblies

Attachment 10 - Model AMM

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CONDITIONS OF NORMAL USE:

The Models AMM.1001, AMM.1001D, and AMM.1001H foils sources are designed for use in ionization smoke detectors. The sources will be used in industrial and residential environments. The normal conditions of use should not exceed the ANSI performance classification of C64444. The foil sources are not designed for use in corrosive environments and cyclic thermal and mechanical conditions must be avoided. The Model AMM foil source is intended for use as an alpha particle emitter in ionization chambers and related devices located in industrial and military environments which have been granted a specific approval by a licensing authority.

The recommended working life of the Model AMM.1001 (AMM.1001D and AMM.1001H inclusive) foil sources is 10 years and 15 years for Model AMM; after which the user should arrange for the foil source to be inspected and assessed by a qualified authority to extend its working life, or dispose of the product through a suitable disposal route.

PROTOTYPE TESTING:

Prototype Models AMM.1001, AMM.1001D secondary foils and AMM.1001H source assemblies have been tested to conditions described by ANSI standard N5.10-1968, ANSI N542-1977, and ISO 2919, and the classification of C64444 was demonstrated. Results of wipe tests of the tested foils for all models were acceptable to less than 0.005 μCi (185 Bq).

The following additional tests were also performed on Model AMM.1001 foils:

1. Immersion in water of prototype foils for 3 weeks at room temperature; less than 0.001 μCi (37 Bq) per foil loaded at maximum activity was found in the water.
2. Immersion in 0.1 N hydrochloric acid for 24 hours at room temperature; less than 0.004 μCi (156 Bq) activity was detected in the solution.
3. Foils were subjected to tests in moist air, dry air, sulfur dioxide, ammonia vapor, and hydrochloric acid vapor. Less than 0.005 μCi (185 Bq) of contamination was detected in each case.
4. Foils were subjected to repetitive wipe tests (5000X). All single wipes were less than 0.005 μCi (185 Bq) of removable contamination.
5. Shelf-life tests of foils with 50 $\mu\text{Ci} / \text{cm}^2$ loading show no deleterious aging effects after 6 years.
6. Application of solder (used in printed circuit boards of smoke detectors) resulted in less than 0.005 μCi (185 Bq) of detectable contamination.

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PROTOTYPE TESTING (Cont.):

7. Foils and mounted foils have been subjected to ozone at 0.75 ppm for a period of 60 days and salt spray for 16 days without deleterious results.

Prototype Model AMM sources containing up to $460 \mu\text{Ci}/\text{cm}^2$ ($17.0 \text{ MBq}/\text{cm}^2$) have been tested according to the requirements in ANSI N542-1977 and ISO 2919 and have qualified for performance classification C64344. Additional testing on closely related products has been completed and has been documented in the technical report # 379 dated September 1975 and entitled "Integrity Testing of Alpha Foil Used in the Ionization Chamber Smoke Detectors" which is on file with the Agency.

A summary of the Model AMM testing is as follows:

1. The product has been approved as Special Form material by the United Kingdom Department of the Environment.
2. Two batches of five samples with activities up to $200 \mu\text{Ci}/\text{cm}^2$ ($7.4 \text{ MBq}/\text{cm}^2$) were subjected to high humidity atmospheres containing 1% sulphur dioxide for a period of 16 days. Wipe tests of the foil surface after testing produced results of between 3 nCi (111 Bq) and 28 nCi (1.04 kBq) from each sample. Immersion testing led to the removal of between 1 nCi (37 Bq) and 15 nCi (555 Bq) from each source.
3. Two batches of ten samples with activities up to $200 \mu\text{Ci}/\text{cm}^2$ ($7.4 \text{ MBq}/\text{cm}^2$) were subjected to an atmosphere maintained at 113°F (45°C) with high humidity and high sulphur dioxide and hydrogen sulphide concentration for two periods of 8 days. Wipe tests of the foil surface after testing produced results of between 0.5 nCi (18.5 Bq) and 105 nCi (3.89 kBq) from each sample. Immersion testing led to the removal of between 0.1 nCi (3.7 Bq) and 16.2 nCi (599.4 Bq) from each source.

NOTE: These severe corrosion tests were conducted on source foils containing 25 (925 kBq) and $75 \mu\text{Ci}$ (2.78 MBq) of activity and the tests resulted in removable contamination of less than 1 percent.

4. Two batches of ten samples with activities of 25 (925 kBq) and $75 \mu\text{Ci}$ (2.78 MBq) or up to $200 \mu\text{Ci}/\text{cm}^2$ ($7.4 \text{ MBq}/\text{cm}^2$) were subjected to an environment in which they were sprayed intermittently with artificial sea water for a period of 16 days. Wipe tests of the foil surface after testing produced results of between 0.17 nCi (6.29 kBq) and 4.1 nCi (151.7 kBq) from each sample. Immersion testing led to the removal of between 0.002 nCi (74 mBq) and 0.42 nCi (15.54 Bq) from each source.

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PROTOTYPE TESTING (Cont.):

5. A batch of ten samples each containing 75 μCi (2.78 MBq) and 200 $\mu\text{Ci}/\text{cm}^2$ (7.4 MBq/ cm^2) was subjected to immersion in 0.1 N hydrochloric acid at 99°F (37.5°C) for 4 hours. The amount of activity leached out was measured and the sources were wipe and immersion tested. This body fluid test was repeated on the same sources after a period of 17 days and in every case, the amount of activity leached out was reduced from 118 (4.37 kBq) - 209 nCi (7.73 kBq) to 27 (999 Bq) - 44 nCi (1.63 kBq). Wipe tests of the foil surface after testing produced results of between 0.43 nCi (15.91 Bq) and 0.58 nCi (21.46 Bq) and immersion testing removed between 0.06 nCi (2.22 Bq) and 0.10 nCi (3.7 Bq) from each source. The greatest amount of activity seen to leach from any source during either test was 0.25 percent of the source activity.
6. Samples of radioactive foil loaded at 100 $\mu\text{Ci}/\text{cm}^2$ (3.7 MBq/ cm^2) were exposed to abrasion by silicon carbide particles until considerable contamination became evident and the conclusion was reached that the degree of abrasion to be expected in a normal working environment would lead to considerably less than 5 nCi (185 Bq) of contamination based on a wipe test or immersion test.
7. As part of the test procedure involved in assessing the sources to the criteria outlined in ANSI N542-1977, samples of sources containing 460 $\mu\text{Ci}/\text{cm}^2$ (17.02 MBq) have passed wipe and immersion tests at the 5 nCi (185 Bq) level after being held at a temperature of 1472°F (800°C) for one hour. However, further testing at even higher temperatures has been conducted to determine the likely effects of exposure to the conditions encountered in major fires, and the conclusions to be drawn are that foils loaded to 125 $\mu\text{Ci}/\text{cm}^2$ (4.63 MBq) releases less than 0.01 percent of its radioactive content when held at a temperature of 2192°F (1200°C) for ten minutes. However, the results also highlight the fact that it is necessary to consider the nature of other materials (e.g., tin) which may be in close proximity to the source. In the event that these very high temperatures should occur, the ^{241}Am may alloy with its immediate surroundings, possibly leading to a greater release of activity.

EXTERNAL RADIATION LEVELS:

QSA Global Incorporated (see MA-1059-S-174-S) has calculated the following radiation exposure rates for a 1 mCi (37 MBq) source:

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EXTERNAL RADIATION LEVELS (Cont.):

Distance		Dose Rate	
cm	in	$\mu\text{Sv/h}$	mR/h
5	1.97	1260	126
30	11.8	34.9	3.49
100	39.37	3.14	0.31

The calculations were performed using a specific gamma ray constant of $3.14 \mu\text{Sv/hr/mCi}$ at 1 meter; from the Health Physics and Radiological Health Handbook, Revised Edition, 1992.

QUALITY ASSURANCE AND CONTROL:

Sources are manufactured and distributed in accordance with a Quality Assurance program of **BRK Brands, Inc.** that is in compliance with the requirements of ISO 9001:2008. For operations performed by vendors, these actions are controlled to BRK Brands, Inc. specifications through the Quality Assurance programs.

BRK Brands, Inc. (El Paso) has committed to a procedure for receiving radioactive foils from the manufacturer that includes conducting appropriate contamination surveys. Following verification of no contamination and interim storage, the radioactive foils are shipped directly to Electronica BRK de Mexico in Juarez, Chihuahua, Mexico. Electronica BRK de Mexico assembles smoke detectors using the foil sources for BRK Brands, Inc. (First Alert).

Electronica BRK de Mexico maintains a ISO 9001:2008 certified quality assurance and control program. Their Quality System Requirements Manual is predicated on product performance verification through in-process inspections focused on the manufacture of the BRK Brands, Inc. Model 1000J Series smoke detector (NR-0167-D-101-E). Though focused on smoke detector manufacture, the program does establish adequate measures for resource (e.g., radioactive foil sources) quality assurance. A copy of this program is on file with Texas Department of State Health Services.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

- The foil sources shall only be distributed to persons specifically licensed by the Agency, the U.S. Nuclear Regulatory Commission, or an Agreement State.

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LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE (Cont.):

- Handling, storage, use, transfer, and disposal: to be determined by the licensing authority.
- The foil sources with activity greater than 0.37 MBq (10 μ Ci) shall be leak tested at intervals not to exceed 3 months using techniques capable of detecting 185 Bq (0.005 μ Ci) of removable contamination.
- The foil sources shall not be exposed to environments which exceed their ANSI N43.6-1997 classification.
- Users of these foil sources should avoid source contact with corrosive powders such as polyvinylchloride (PVC); prolonged contact of sources with organic solvents such as methanol or acetone; or use in cyclic thermal or mechanical conditions.
- This registration certificate and the information contained within the references shall not be changed without the written consent of the Texas Department of State Health Services.

SAFETY ANALYSIS SUMMARY:

Based on our review of the Models AMM.1001, AMM.1001D, AMM.1001H, and AMM foil sources, their ANSI classifications, and the information and test data cited below, **we continue to** conclude that the foil sources are acceptable for licensing purposes.

Furthermore, we **continue to** conclude that these foil sources would be expected to maintain their containment integrity for normal conditions of use and accidental conditions which might occur during uses specified in this certificate.

REFERENCES:

The following supporting documents for the models AMM, AMM.1001, AMM.1001D, and AMM.1001H foil sources are hereby incorporated by reference and are made part of this registry document.

- Amersham letters dated March 18, 1971, November 4, 1974, November 8, 1974, March 10, 1975, September 20, 1979, March 15, 1995, June 6, 1997, October 23, 1997, November 24, 1997, November 13, 1998, August 13, 1999, September 30, 1999, and October 28, 1999, with enclosures thereto.
- Amersham Corporation letters dated January 11, 1982 and January 28, 1982 with enclosures thereto.

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SOURCE TYPE: Foil Source

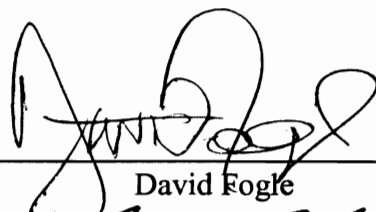
REFERENCES (Cont.):

- AEA Technology letter dated December 2, 1999 with enclosures thereto.
- QSA Global letters dated November 23, 2005 and March 14, 2006, with enclosures thereto.
- BRK Brands, Inc. letter dated January 19, 2011, with enclosure thereto.
- QSA Global, Inc. letter dated January 27, 2011.
- BRK Brands, Inc. letters dated March 11, 2011, with enclosures thereto.
- **QSA Global, Inc. letter dated March 31, 2011.**
- **BRK Brands, Inc. electronic mail dated May 4, 2011.**

ISSUING AGENCY:

Radiation Safety Licensing Branch
Texas Department of State Health Services

Date May 13, 2011

Reviewer 
David Fogle

Date May 13, 2011

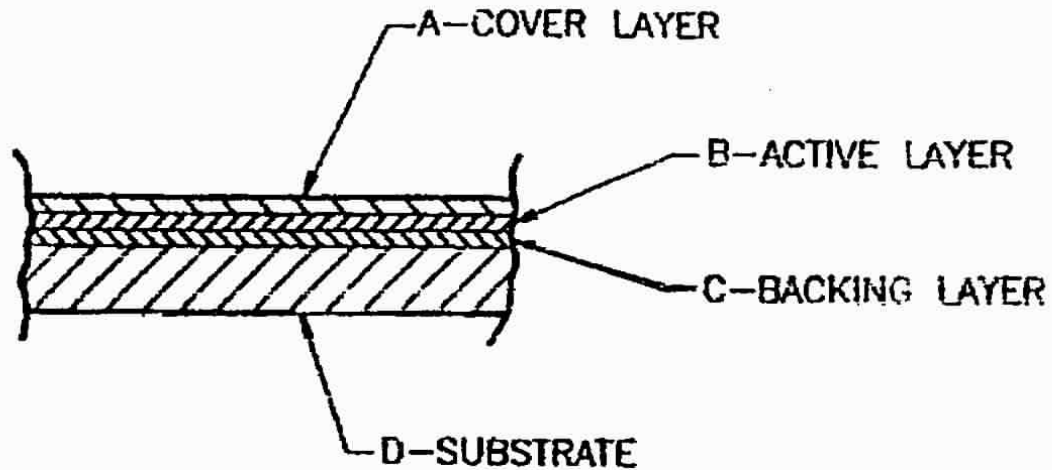
Concurrence 
Ray Fleming

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SECTION OF ACTIVE AREA

A-GOLD OR GOLD PALLADIUM ALLOY OR GOLD
PALLADIUM LAMINATE (Pd ON SURFACE) 0.002 OR 0.003mm

B-AMERICIUM OXIDE PLUS GOLD 0.002mm

C-GOLD 0.001mm

D-SILVER 0.15-0.25mm

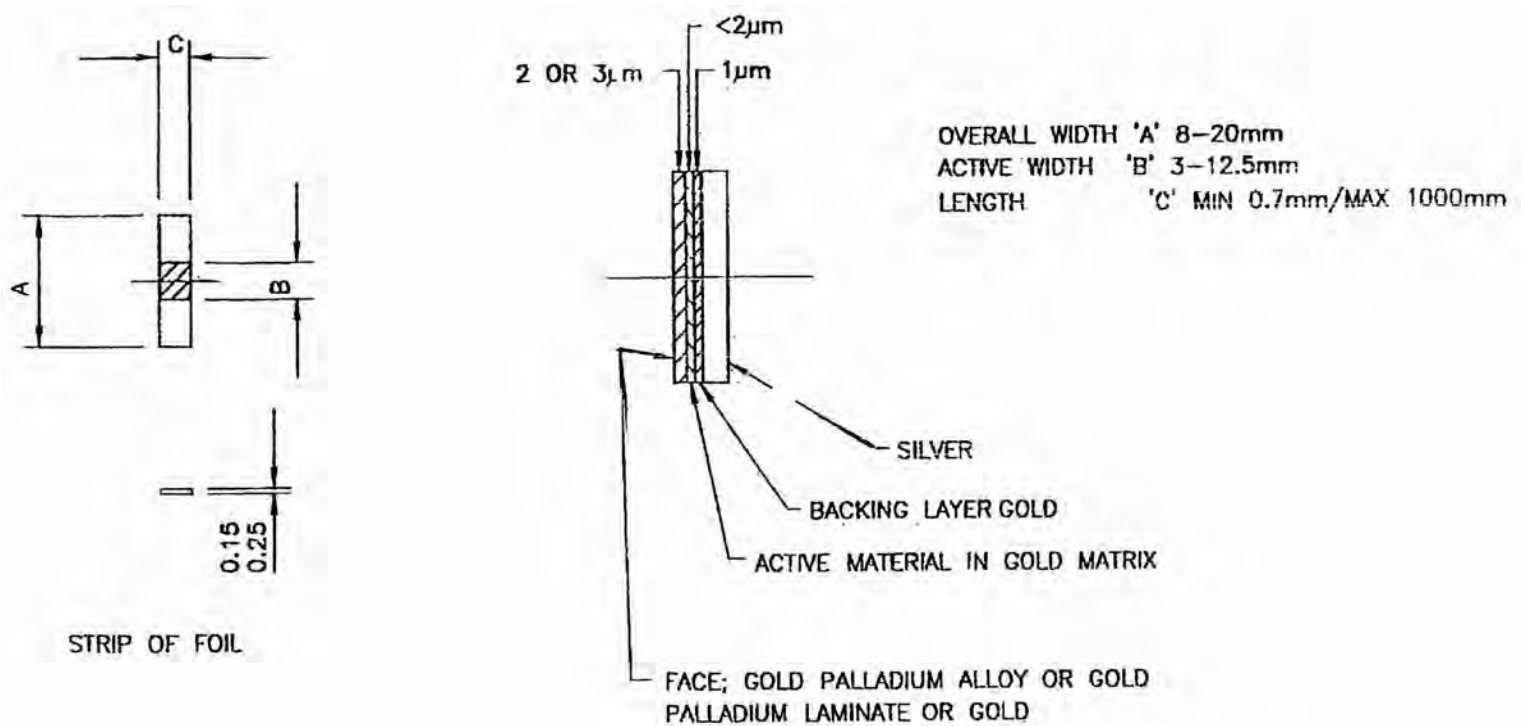
Model AMM.1001 Type 1 Primary Foil

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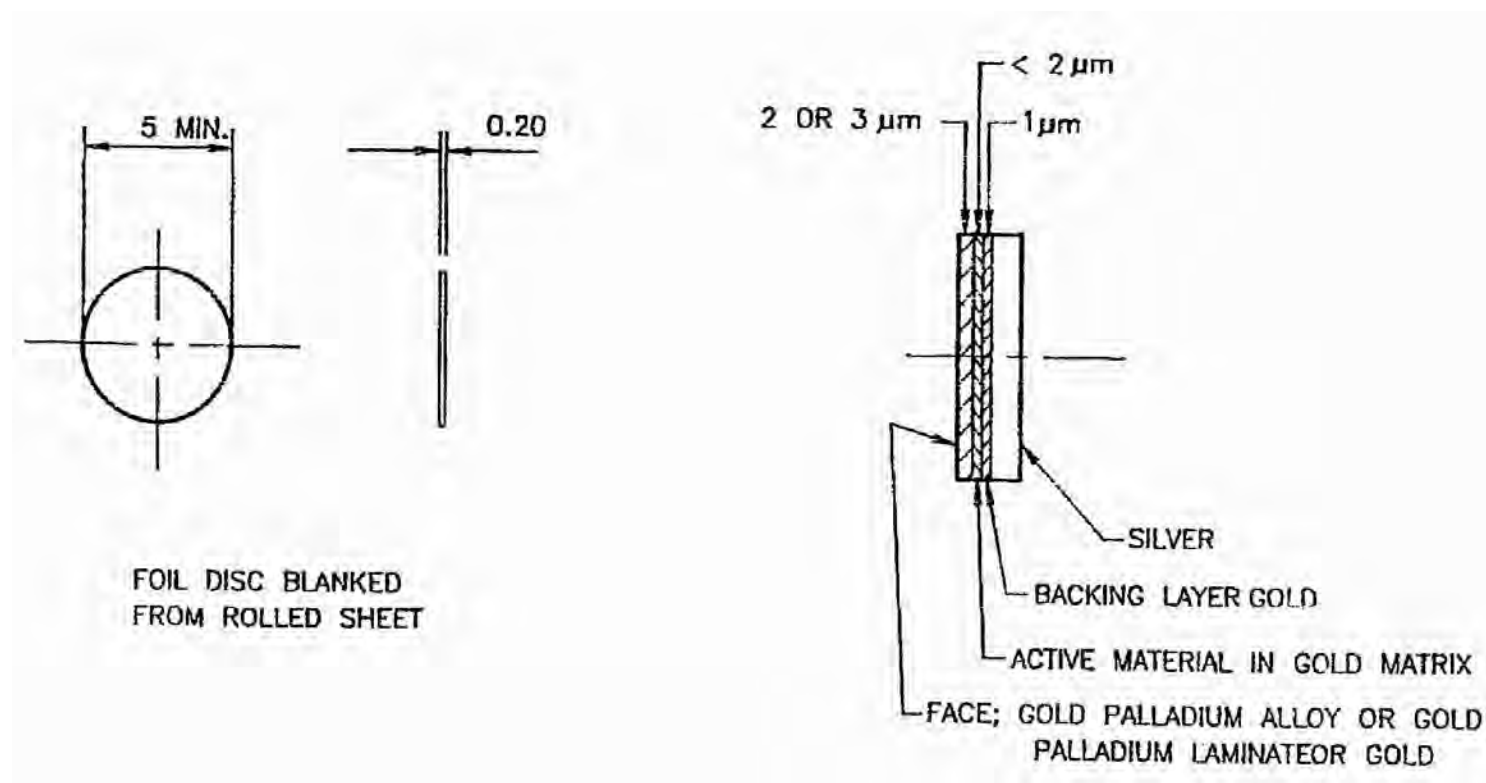
Typical Secondary Strip

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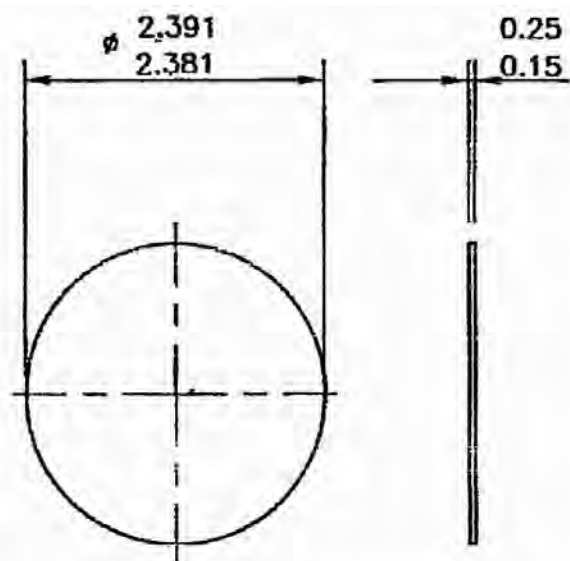
Typical Secondary Disc Source
(punched from a Type 1 primary foil)

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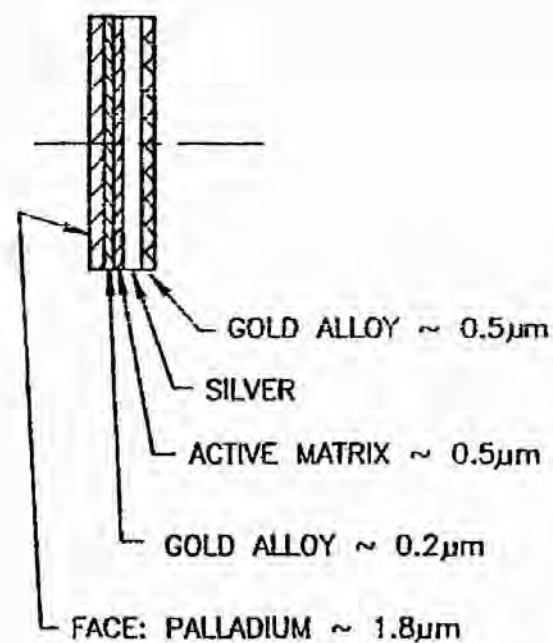
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FOIL DISC BLANKED
FROM ROLLED SHEET



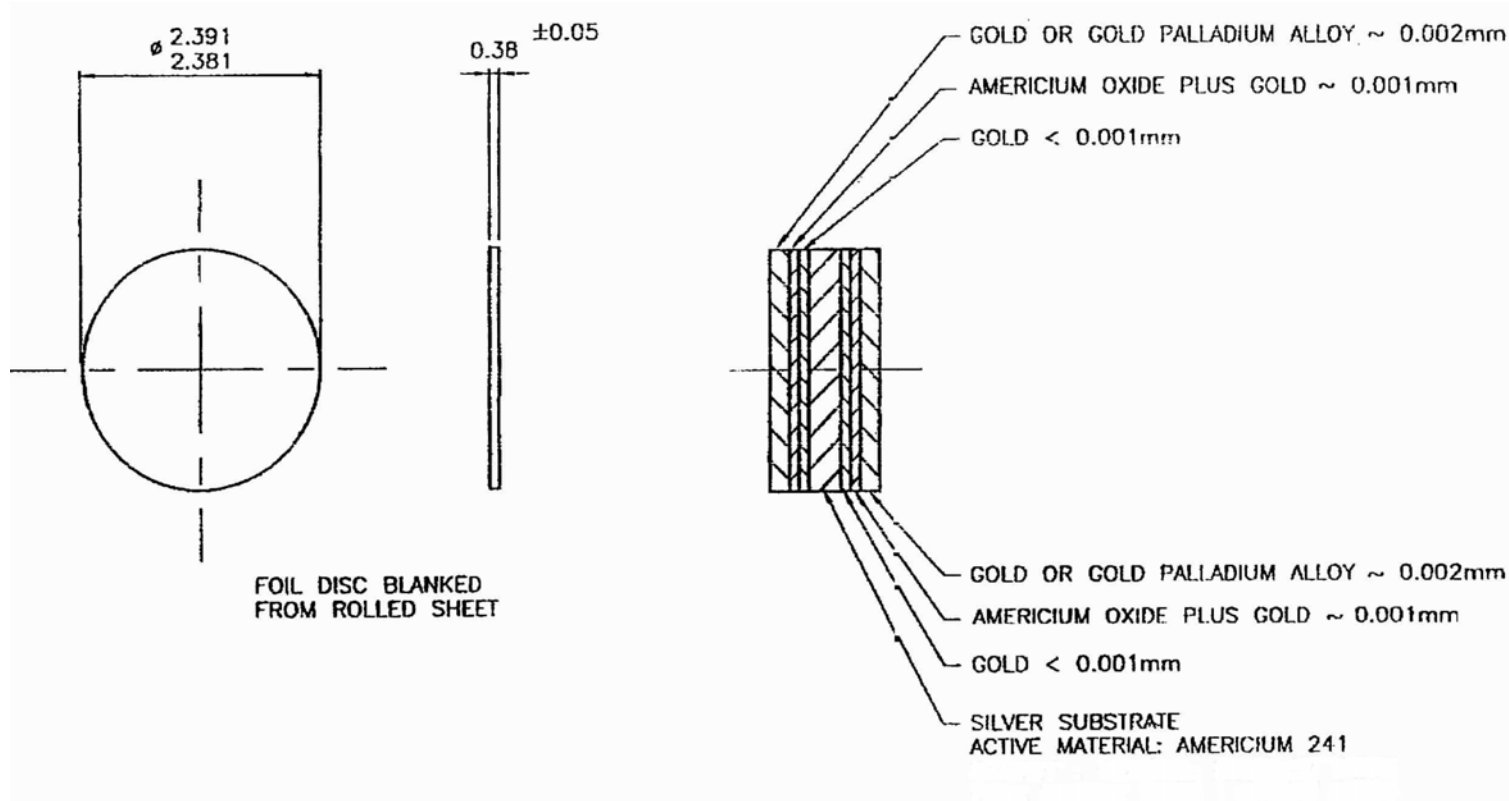
Typical Secondary Disc Source
(punched from a Type 2 primary foil)

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Typical Model AMM.1001D

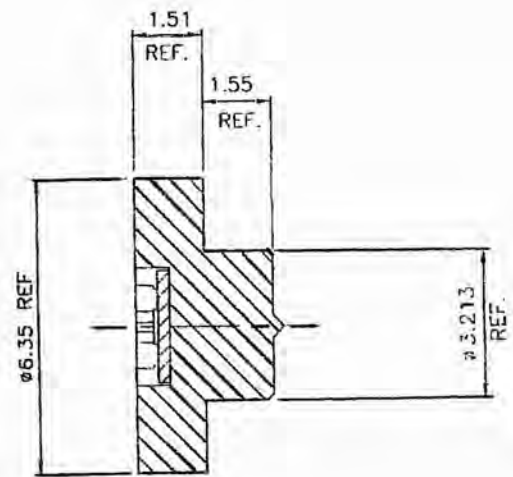
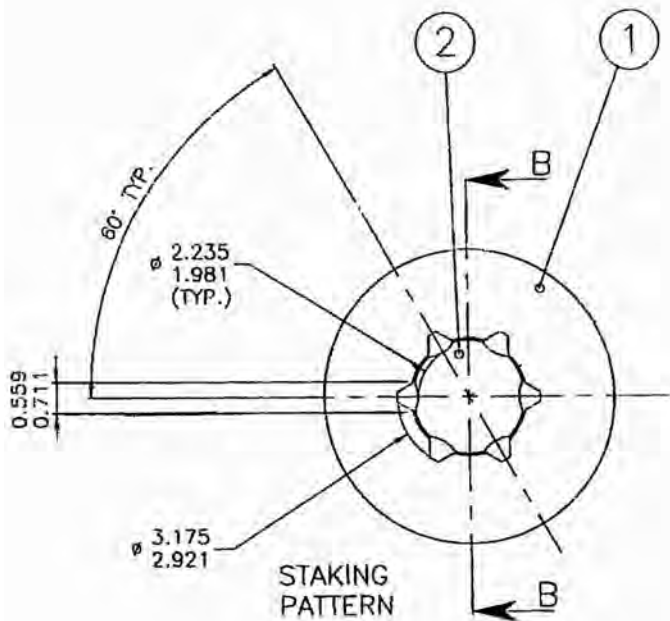
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ITEM	DESCRIPTION
1	SOURCE HOLDER
2	ALPHA FOIL DISC



SECTION B-B

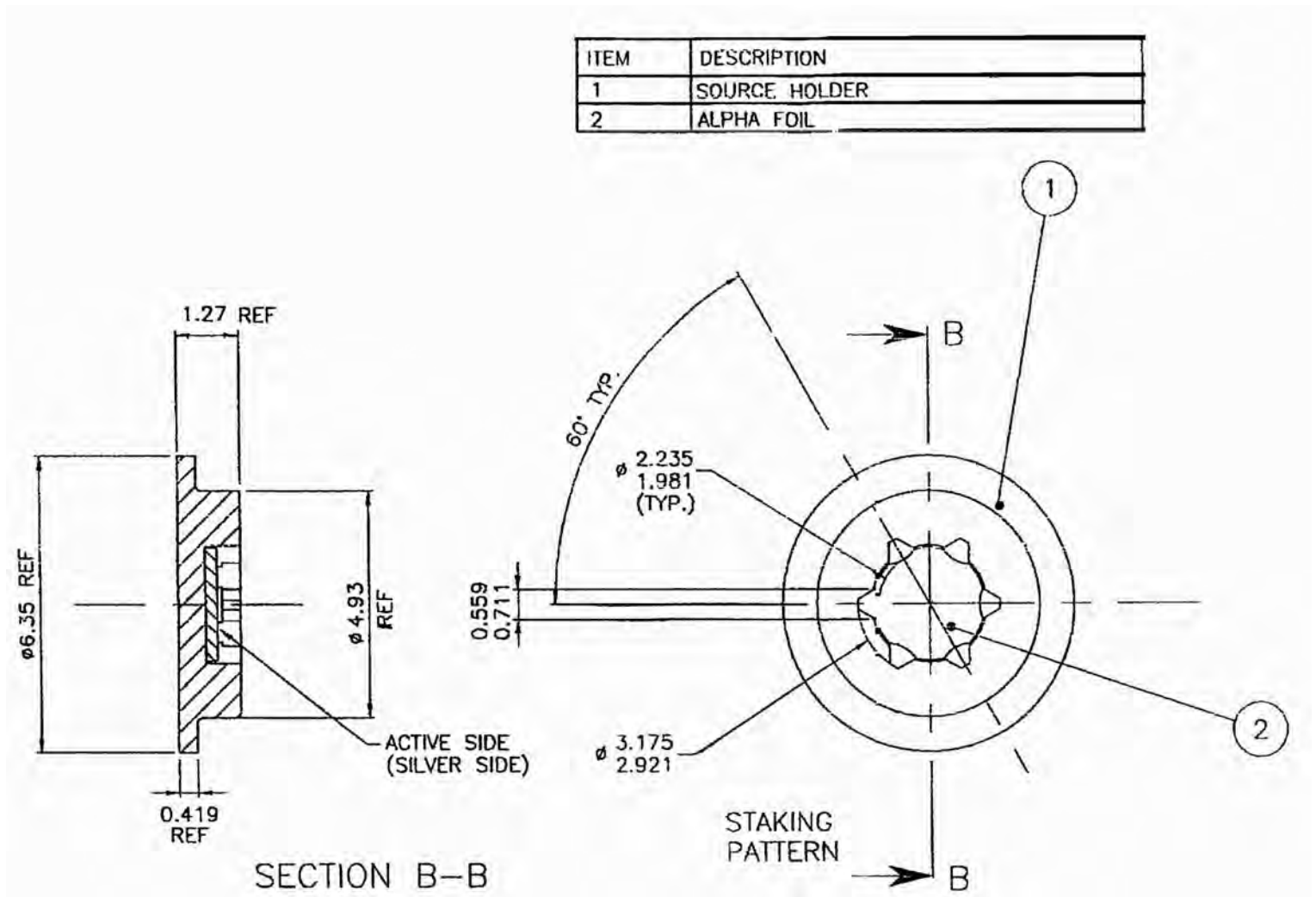
Typical Model AMM.1001H Source Assembly

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Typical Model AMM.1001H Source Assembly

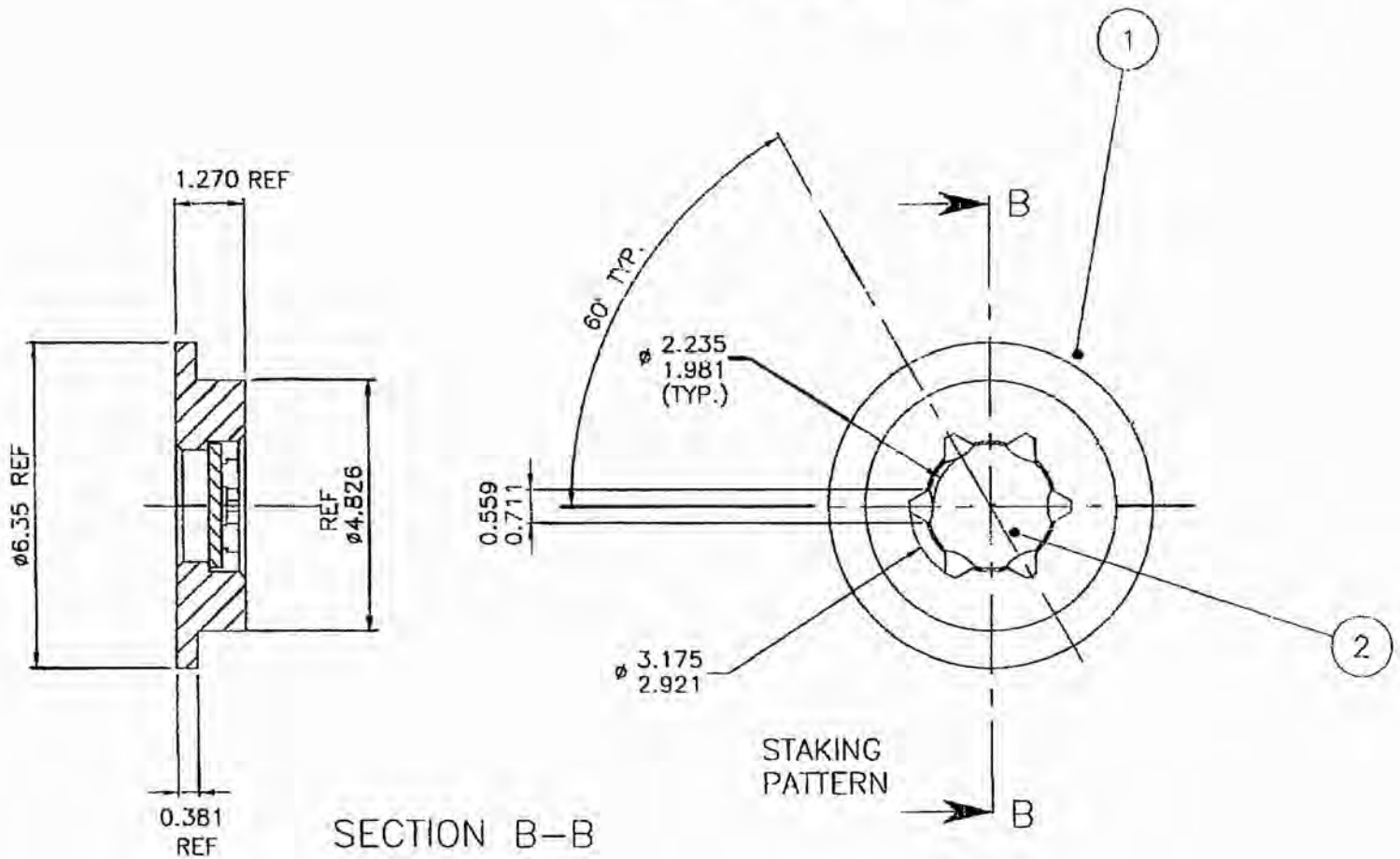
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
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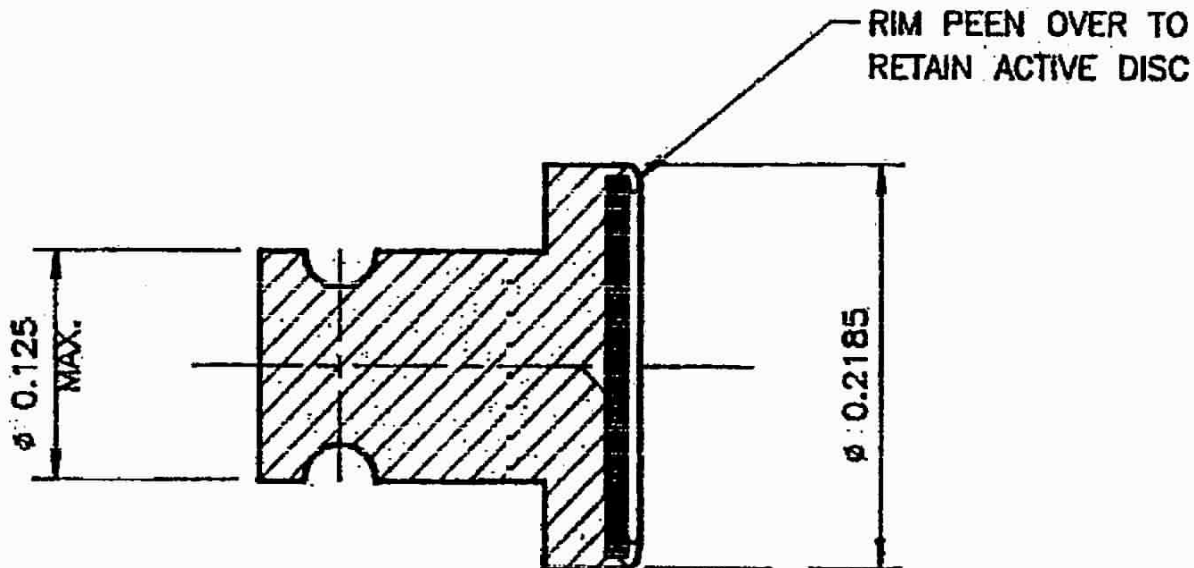
ITEM	DESCRIPTION
1	SOURCE HOLDER
2	ALPHA FOIL DISC (DOUBLE SIDED)



Typical Model AMM.1001H Source Assembly

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Item	Description	Material
1	HOLDER	SEE TABLE
2	ACTIVE FOIL DISC Am241	



X No.	MATERIAL
X268/1	BRASS TIN PLATED
X268/2	MONEL TIN PLATED
X268/3	STAIN.STL.

(AMENDED IN ITS ENTIRETY)

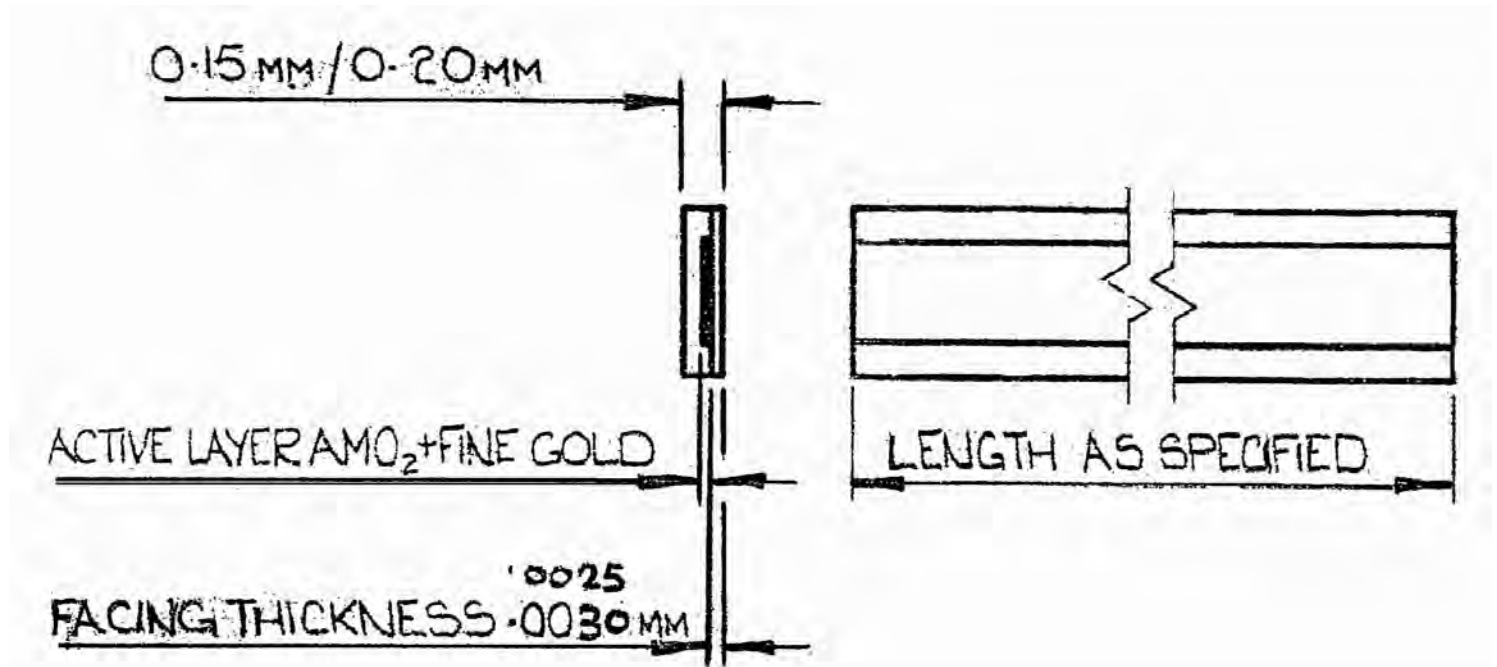
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Typical Model AMM.1001H Source Assembly

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MODEL AMM FOIL SOURCE