614
223

GENERAL ELECTRIC

SPACE DIVISION

SPACE SYSTEMS ORGANIZATION

GENERAL ELECTRIC COMPANY . . . . . VALLEY FORGE SPACE CENTER
(MAIL: P. O. BOX 8555, PHILADELPHIA, PA. 19101), Phone 962-2000

23 February 1971

Mr. Robert Brinkman
Isotopes Branch
Division of Materials Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Brinkman:

Please amend AEC License #37-02006-05 to include an Americium 241 sealed source. This source, which will not exceed two curies, will be manufactured by the Amersham-Searle Corporation according to the specifications in the attached letter. The incorporation of the Americium as an oxide in the matrix should provide maximum protection against source leakage.

The source will be handled according to the procedures on file with License #37-02006-05. Contamination control will be the joint responsibility of the user and the Health Physicist and will include routine contamination surveys and quarterly leak tests. Radiation control is covered in the user's memo to the IRAG. Use of the source holder will keep exposures well below permissible limits. The source will be stored in a properly locked, posted and approved cabinet in a controlled area. Access to the source will be limited to approved users.

If there is any other information required for approval of this amendment, please contact me.

Sincerely,

Robert O McClintock

R. O. McClintock
Health Physicist

/atf
Attachment

E-10

20477

2636 S. CLEARBROOK DRIVE ARLINGTON HEIGHTS, ILLINOIS 60005 TELEX: 28-2452 TELEPHONE: (312) 593-6300

Amersham/Searle

AMERSHAM/SEARLE CORPORATION:
AN ACTIVITY OF G. D. SEARLE & CO. AND THE RADIOCHEMICAL CENTRE

February 19, 1971

Mr. Gezelunas
General Electric Company
Space Division
King of Prussia Park
P.O. Box 8439
Philadelphia, Pennsylvania 19101

Dear Mr. Gezelunas:

<u>1Ci Am241 Source, Model No. AMC4027</u>
(PO# 028 KS 0069)

I am writing to you to describe the construction of this source. I will forward the drawings immediately when they are made available.

The Am241 will be incorporated as oxide in an aluminum matrix inside a roll bonded aluminum foil. The overall thickness of this foil will be approximately 0.3mm with a window thickness of 0.15mm. The active diameter will be 23mm and the overall diameter 28mm. Liquid immersion tests and wipe tests will be carried out on this sealed source to a limit of 0.005μCi.

The active disc will be placed in our X93 stainless steel capsule which will be modified by removing the integral stainless steel window and replacing it with a 0.0004" titanium foil window. An epoxy adhesive will be used to attach this foil to the capsule.

Please let me know if you require any further information.

Yours sincerely,

Paul Duncombe
Marketing Manager
Radiation [illegible] Dept.

[illegible]

20477

GENERAL ELECTRIC
VALLEY FORGE SPACE CENTER
P.O. BOX 8555
PHILADELPHIA, PA. 19101

SPACE SYSTEMS

SUBJECT

COPIES: J. Guy
G. Huth
R. McClintock
Dr. R. Panaro

January 8, 1971

RECEIVED
JAN 11 1971
T. D. HANDLEY

IRAG Committee
c/o T. Handley
Room M1140
VFSTC

We would like to add a maximum of two curies of ^{241}Am to our AEC radioisotope license in the form of a commercially fabricated sealed source, identical to Amersham/Searle type 8X-93 with a 0.3 mm Al window (See Figure 1). The source would be loaded into the holder shown inFigure 2 by the source fabricators. The source holder is designed to reduce the dose at the holder face to much less than 1 mr/hr for a 2 Ci loading of ^{241}Am (See Appendix I). During storage, the maximum credible incident would occur if the source was exposed to high temperatures. The ^{241}Am as the oxide is incorporated in an enamel in this source type to reduce the effects of a capsule rupture. The source holder will be fabricated from stainless steel and would withstand short time temperatures in excess of 1000°C without significant damage. However sustained temperatures over approximately 230°C would result in the melting of the Sn shutter. The shutter to source distance is selected so that if the molten Sn flowed out of the source holder the exit hole resulting from this event would not directly "see" the source. To minimize the effects of this type of incident the source holder will be stored in a stainless steel canister in a locked box in a secured area when not in use.

The source is to be used to determine the effects of air and backscatter on the radiation spectrum under a variety of geometrical arrangements and distances.

GENERAL ELECTRIC

As part of the experimental regimen, the health physicist will be consulted and personnel radiation monitoring requirements and operating practices will be approved and/or specified by him before proceeding The dose rate expected due to the uncollided flux as a function of distance from the source at the source centerline with the shutter open is shown in Figure 3.

The undersigned is the principal investigator and the source will be under his direct supervision while in use or under the supervision of an individual approved by the health physicist.

Vincent L. Gelezunas

Vincent L. Gelezunas
Product Manager - Nuclear
Research
Space Technology Products
Room 8010 CC&F#8, Ext. 2553

jh

20477

APPENDIX I

CALCULATION OF THE RADIATION DOSE AT THE SURFACE OF THE ^{241}Am SOURCE HOLDER AS A FUNCTION OF HOLDER THICKNESS

The value of the uncollided flux at the centerline at a distance a from a uniformly distributed ^{241}Am disc source of radius R_o with a shield of thickness t between the source and the point under consideration is given by:

(1)
$$\phi = \frac{S_A}{2} \quad E_1 (\mu t) - E_1 \left[\mu t \ \frac{(a^2 + R_o^2)^{\frac{1}{2}}}{a} \right] *$$

where:

S_A = source strength per unit area, photons/cm^2-sec

μ = linear attenuation coefficient, cm^{-1}

$$E_1 (x) = \int_x^\infty \frac{e^{-u}}{u} \, du$$

Assume 1 Ci ^{241}Am source - Amersham/Searle Type X-93 and 60 keV photon yield = 0.36 photons/disintegration

R_o = 1.25 cm (See Figure 1)

Therefore

$$S_A = \frac{3.7 \times 10^{10} \times 0.36}{\pi (1.25)^2} = 2.7 \times 10^9 \ \frac{\gamma' s}{cm^2\text{-sec-Ci}}$$

This will be conservative since self-absorption by the source is neglected. Again for conservatism a is taken equal to t. The flux to dose conversion factor for 60 keV photons is $1.0 \times 10^4 \ \frac{\gamma}{cm^2\text{-sec}}$/1 mr/hr.** The shield is assumed to be iron at a density of 7.86 g/cm^3 and the mass attenuation coefficient at 60 keV is 0.96 cm^2/g.*** The results of the calculation are shown below:

* Theodore Rockwell III, "Reactor Shielding Design Manual" p. 348, Van Nostrand, Princeton, N.J. (1956)

** J. J. Fitzgerald et al, "Mathematical Theory of Radiation Dosimetry" p. 227, Gordon and Breach, New York (1967)

*** E. Storm & H. Israel, "Photon Cross Sections from 0.001 to 100 MeV for Elements 1 through 100" USAEC Report LA-3753 p. 200 Los Alamos Scientific Laboratory (1967)

t, cm	μt	ϕ (γ/cm^2-sec)	Surface Dose Rate, mR/hr
1.0	7.54	9.3×10^4	9.00
1.5	11.3	1.5×10^3	0.14
2.0	15.1	2.5×10^1	0.002

The following equation is used to calculate the Pb equivalent to Fe at 60 keV:

(2)

$$\frac{t_{Pb}}{t_{Fe}} = \frac{(\mu/\rho)_{Fe}}{(\mu/\rho)_{Pb}} \frac{\rho_{Fe}}{\rho_{Pb}} = \frac{0.96}{4.4} \quad \frac{7.86}{11.34} = 0.152$$

The minimum shield thickness then of iron equivalent was set at 1.5 cm to insure surface doses of less than 1 mr/hr. The equivalent Pb thickness would be 0.23 cm. The shutter will be fabricated to contain this minimum value of Pb. The shutter will be approximately 0.6 cm thick (Figure 2) which allows for a composite structure if found desirable experimentally.

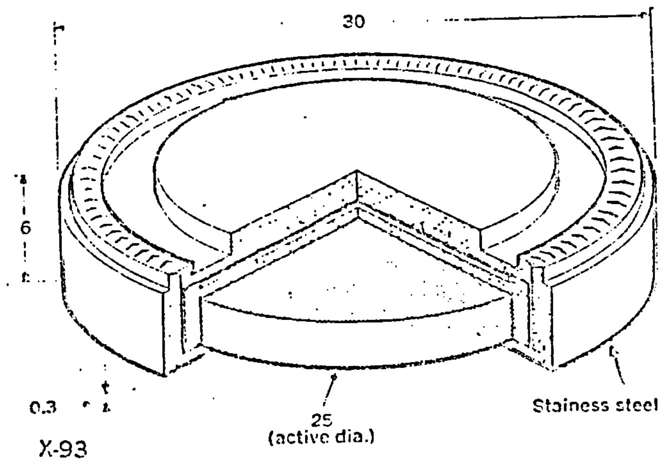
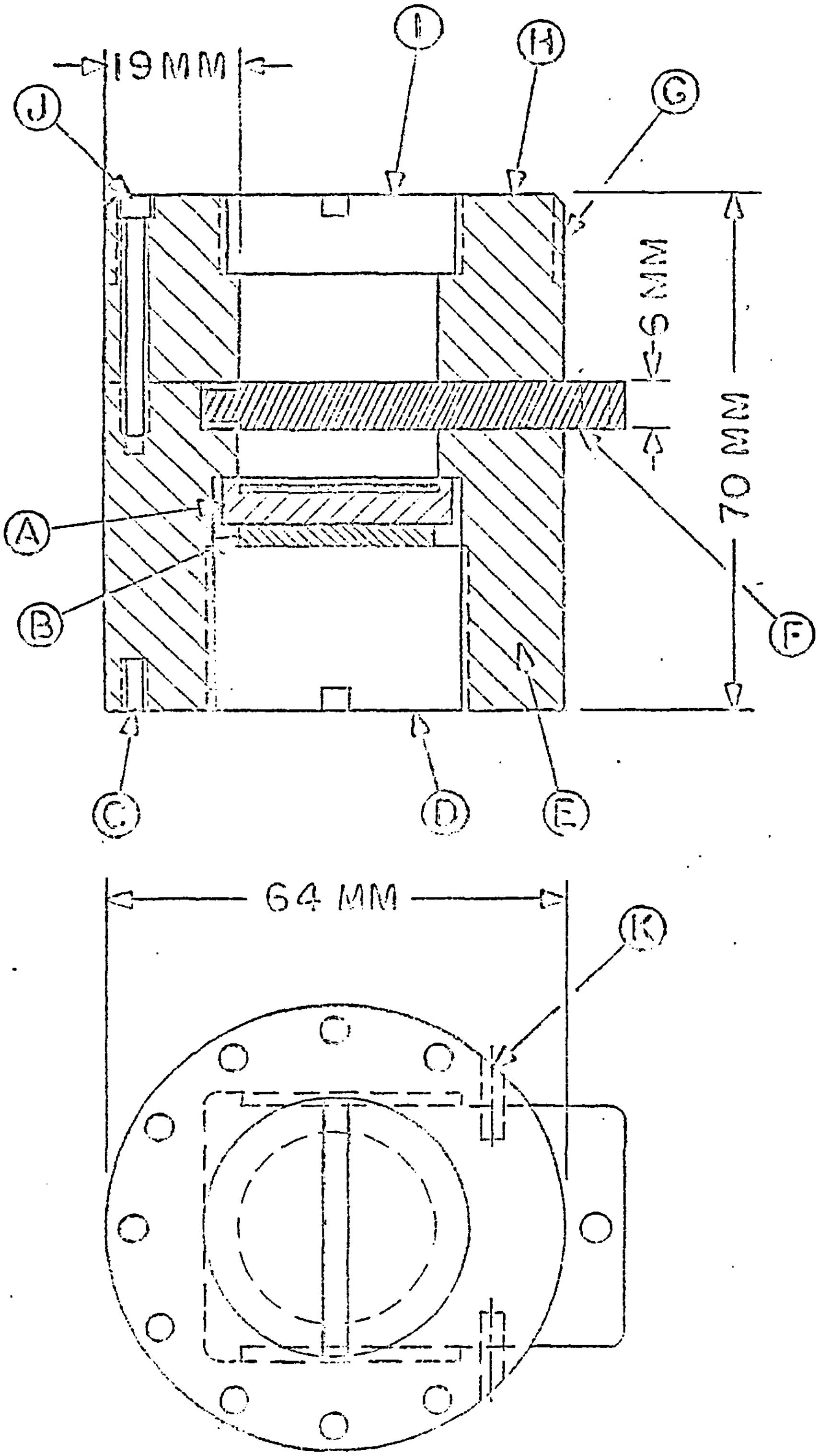


Figure 1. Amersham/Searle Type #X-93
Sealed Source for ^{241}Am
(Dimensions in millimeters)



KEY

A One curie ^{241}Am radiation source - Amersham/Searle X-93, with 0.3 mm Al windo
B 3 mm Pb shim
C Tapped holes for mounting source holder
D Retaining screw for radiation source
E Type 304SS source holder sub-assembly
F 6 mm thick manually operated Pb shutter
G Threads for collimator attachment
H Type 304SS source cap and shutter guide assembly
I Storage cap
J SS assembly bolts (nine-30° apart)
K Locking pins for shutter

FIGURE 2. Radiation Source Holder Assembly for ^{241}Am

SEMI-LOGARITHMIC 359-93

7 CYCLES X 50 DIVISIONS

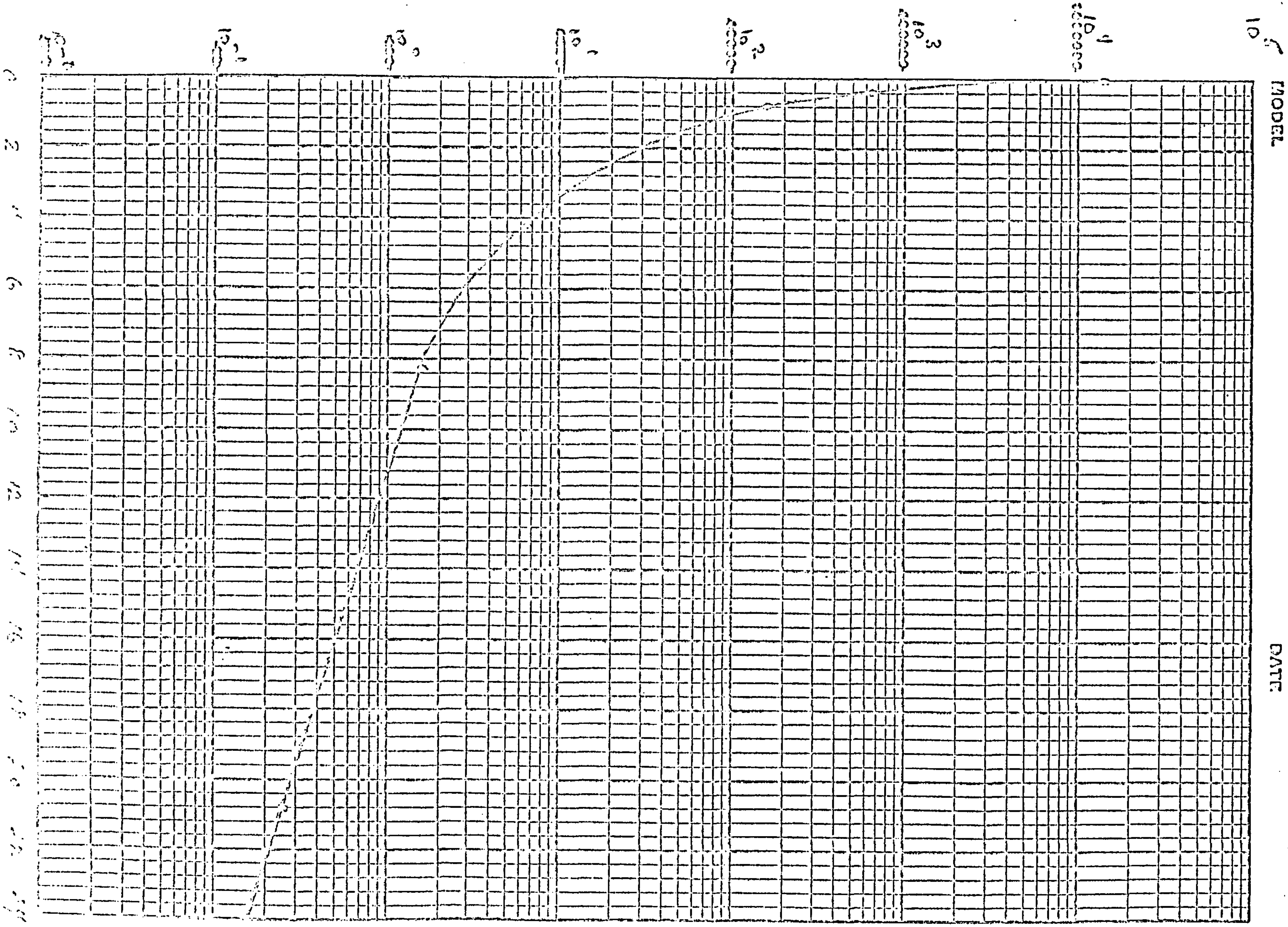


FIG. 3. DOSE RATE AS A FUNCTION OF DISTANCE FROM A ONE CURIE ^{241}Am SOURCE.

20477