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Refer to: OSRP:00-04

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Re: Special Form Character of MRC-N-SS-W-AmBe Sealed Sources

Problem:

The Monsanto Research Corporation (MRC) sealed source Model Number MRC-N-SS-W-AmBe is commonly encountered in Off-site Source Recovery Project actions. There is a lack of historical documentation to identify this model as DOT "Special Form", since these sealed sources predate any requirement for special form testing. The purpose of this memo is to compare relevant characteristics of the MRC-N-SS-W-AmBe sealed sources with the MRC 2720A series, for which Special Form documentation is available. Information for this comparison was obtained from the following sources:

1) A 1968 catalogue reference to MRC drawing: MRC-N-SS-W-AmBe
2) MRC request to US DOT for CoC on MRC Models 2720-A, B, and C series dated 10 December 1981
3) A telephone conversation with Edward Janzow, a former production line supervisor with MRC during the production of both model series.

Background:

The origin of the problem is rooted in the MRC decision to use a model number of the form MRC-N-SS-W-AmBe, which is very descriptive, but does not differentiate amongst the different capsule sizes and types. According to my telephone conversation with Ed Janzow (9/28/99), MRC recognized this problem and moved to convert all MRC-N-SS-W-AmBe capsule designs to the MRC 2720-A series. MRC then generated a new model number and drawing for each capsule design.

The characteristics compared for these sources were capsule dimensions, curie content, source material origins, capsule material, welding procedures, welder training, and welding equipment.

Analysis:

Model MRC-N-SS-W-AmBe and Model 2720-A series capsule dimensions were compared. Table 3 shows the results of the comparison as the net difference between the relevant capsules. This evaluation excludes MRC Models 2721-A and 2727-A, for which there is no equivalent series member in the MRC-N-SS-W-AmBe models. Tables 1 and 2 contain the relevant capsule dimensions for each source series. Table 3 contains the observed difference between dimensions reported in Tables 1 and 2. The first observation of Table 3 clearly suggests that the two series are effectively identical in physical dimensions. The first

measurable difference noted in Table 3 is the length of the inner capsule which is about 0.020 inches longer for all but one model of the MRC 2720-A series. The Model 2726-A inner capsule is 0.180 inches shorter than its MRC-N-SS-W-AmBe equivalent. This difference in the length of the inner capsule is not significant. The other difference is in the activity limits, which are higher for the MRC 2720-A series. The difference in maximum americium content of the two sets of capsules indicates that the MRC 2720-A capsules could be loaded with significantly higher amounts of Am-241, with the exception of the 2728-A capsule which was limited to 8.1 Ci.

According to Edward Janzow, former production line supervisor at MRC, the source of activity for these AmBe sealed sources was the AEC (later ERDA & DOE). Mr. Jansow stated that the following characteristics did not change:

1) origins of the Am-241
2) characteristics of the beryllium metal
3) capsule material origins (304 SS)
4) welding procedures, welder training, and welding equipment

In fact, according to Mr. Jansow, the MRC-N-SS-W-AmBe source fabrication methodologies were used to establish the minimum weld thickness for the Model 2720-A series (0.024 inches).

The stress analysis of the MRC 2720-A series was conservative and well documented. Worst case analysis scenarios use the minimum capsule wall and head thickness, minimum internal volume, and no retention of gas in the solid phase. The weld design provides a minimum safety factor of at least 4. The maximum stress occurs in the seal weld joining capsule plug to body, which was analyzed using the minimum weld penetration area. The shear stress limited internal pressure (P_S) of the inner and outer source capsule weld area, in general, is the most limiting of the design analysis requirements. The only exception is the 2728-A capsule which is limited by the shear stress in the capsule head (P_H).

Summary:

1) The MRC 2720-A series sources are very well documented with respect to the ANSI N5.10-1968 characterization methodology, Special Form testing (49 CFR173.469) methodology, and detailed engineering stress analysis. This "Special Form" testing documentation for Model 2720-A capsules in on file with the U.S. DOT and the OSR Project Office at LANL, TA-46, Building 234.

2) MRC 2720-A series capsule construction is effectively identical to the MRC-N-SS-W-AmBe construction, with the exception of the dimensions of the inner capsules. A 0.020-inch shorter inner capsule was used in most of the MRC-N-SS-W-AmBe capsules as compared to the 2720-A capsules, making the MRC-N-SS-W-AmBe sources slightly stiffer structurally, although not significantly so. One 2720-A series inner capsule (2726-A) was 0.180 inch shorter than its MRC-N-SS-W-AmBe counterpart, however, this difference is not structurally significant.

3) The americium loading in the 2720-A series capsules is higher than in the MRC-N-SS-W-AmBe capsules with the exception of the 2728-A, which limited the curie content to 8.1 Ci. The corresponding MRC-N-SS-W-AmBe capsule was loaded to a maximum of 50 Ci.

Significant Observations:

1) The difference in inner capsule length is not a significant factor in evaluating either the ANSI or the Special Form equivalency, as this difference would not significantly change the mechanical strength of the MRC-N-SS-W-AmBe source capsules weld penetration or the plug thickness, which is the controlling limitation.

2) MRC-N-SS-W-AmBe capsules loaded with more activity than the corresponding 2720-A series capsules are not documented in terms of Special Form equivalency.

3) All MRC-N-SS-W-AmBe capsules, except the 1.5-inch OD capsules (2728-A) containing more than 8.1 Ci Am-241, will be treated as Special Form. Those MR-N-SS-W-AmBe capsules 1.5 inch in OD, containing more the 8.1 Ci Am-241, will be treated as normal form material for purposes of the US DOT.

Therefore, from this review we conclude that within the limitations specified in item (3) above, MRC-N-SS-W-AmBe source capsules are equivalent to special form capsules specified for the MRC 2720-A series capsules.

J.A. Tompkins, CHP
OSR Project Engineer

Attachment: As Stated

Cy: OSRP File

Table 1. MRC-N-SS-W-AmBe Capsule Dimensions

Activity Max. (Ci)	Inner ID (in)	Inner OD (in)	Inner wall thick (in)	Inner lgth (in)	Outer ID (in)	Outer OD (in)	Outer wall thick (in)	Outer lgth (in)
0.2	0.312	0.402	0.045	0.48	0.407	0.50	0.047	0.70
1.0	0.562	0.652	0.045	0.65	0.657	0.75	0.047	0.87
3	0.812	0.902	0.045	0.9	0.907	1.00	0.047	1.12
6	0.812	0.902	0.045	1.28	0.907	1.00	0.047	1.50
10	0.812	0.902	0.045	1.78	0.907	1.00	0.047	2.00
50	1.25	1.37	0.060	3.28	1.375	1.50	0.063	3.50

Table 2. MRC 2720 A Series Capsule Dimensions

Model	Activity* Max. (Ci)	Inner ID (in)	Inner OD (in)	Inner wall thick (in)	Inner lgth (in)	Outer ID (in)	Outer OD (in)	Outer wall thick (in)	Outer lgth (in)
2722 A	1.0	0.312	0.402	0.045	0.500	0.407	0.500	0.047	0.700
2723 A	3.0	0.562	0.652	0.045	0.670	0.657	0.750	0.047	0.870
2724 A	5.0	0.812	0.902	0.045	0.920	0.907	1.000	0.047	1.120
2725 A	8.5	0.812	0.902	0.045	1.300	0.907	1.000	0.047	1.500
2726 A	12.0	0.812	0.902	0.045	1.600	0.907	1.000	0.047	2.000
2728 A	8.1	1.250	1.370	0.060	3.300	1.375	1.500	0.063	3.500

* Depends on packing factor (pf), which is the fraction of the theoretical density achieved by compression of the source material in the source shell. Maximum activity is allowed for pf of 0.5.

Source is of the tube and plug design. Minimum weld thicknesses are 0.024" (2722-A - 2726-A) & 0.033" (2728-A).

Material 304 SS. Earliest drawings 9/5/69. Last Drawing Revision in set 8-28-75.

Table 3. Net Dimensional Difference, Models MRC 2720-A minus Models MRC-N-SS-W-AmBe

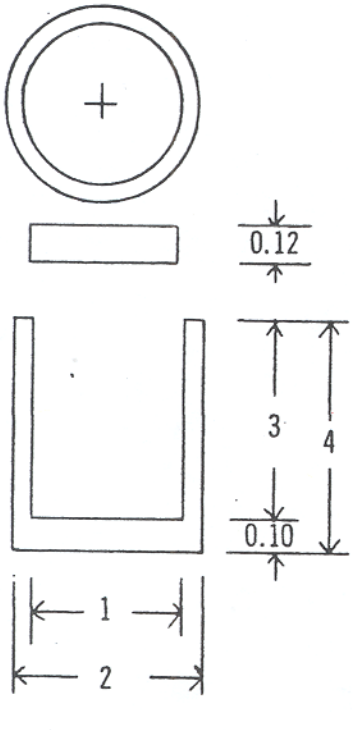
Model	Activity* Max. (Ci)	Inner ID (in)	Inner OD (in)	Inner wall thick (in)	Inner lgth (in)	Outer ID (in)	Outer OD (in)	Outer wall thick (in)	Outer lgth (in)
2722 A	0.8	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000
2723 A	2.0	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000
2724 A	2.0	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000
2725 A	2.5	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000
2726 A	2.0	0.000	0.000	0.000	-0.180	0.000	0.000	0.000	0.000
2728 A	-41.9	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000

* Model 2720-A series capsules are 0.020 inches longer in the inner capsule than MRC-N-SS-W-AmBe capsules, with the exception of the Model 2726-A, which is 0.180 inches shorter.

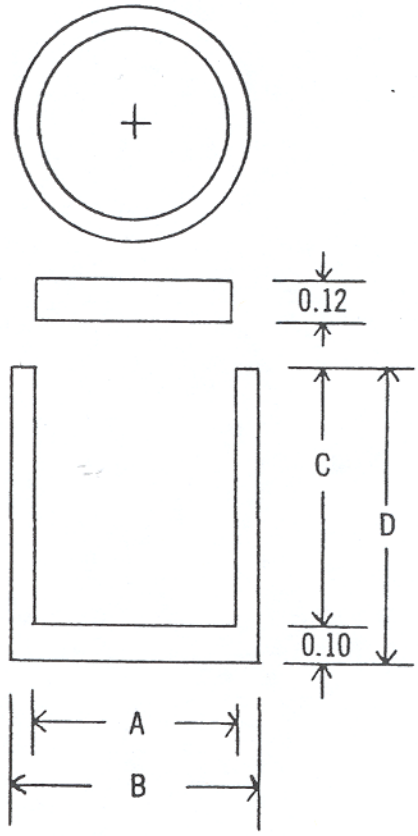
* Americium activities in the 2720-A series capsule are 0.8 to 2.0 Ci greater with the exception of the 2728-A, which is rated at 8.1 Ci as opposed to the largest of the MRC-N-SS-W-AmBe capsules which was rated at 10 to 50 Ci.

NOTES:
1. Make all closures by inert gas welding
2. Solid bottoms may be replaced by welded plugs
3. Ni, Ta, Steel may be substituted
4. Add 0.20 to length of outer containers if thread is desired
5. Leak test by pressurizing to 100 psi in helium and immersing in liquid.
6. All steel, Ni and Ta containers withstand 10,000 psi
7. Lengths and diameters may be altered without changing other specifications

INNER CONTAINER



OUTER CONTAINER



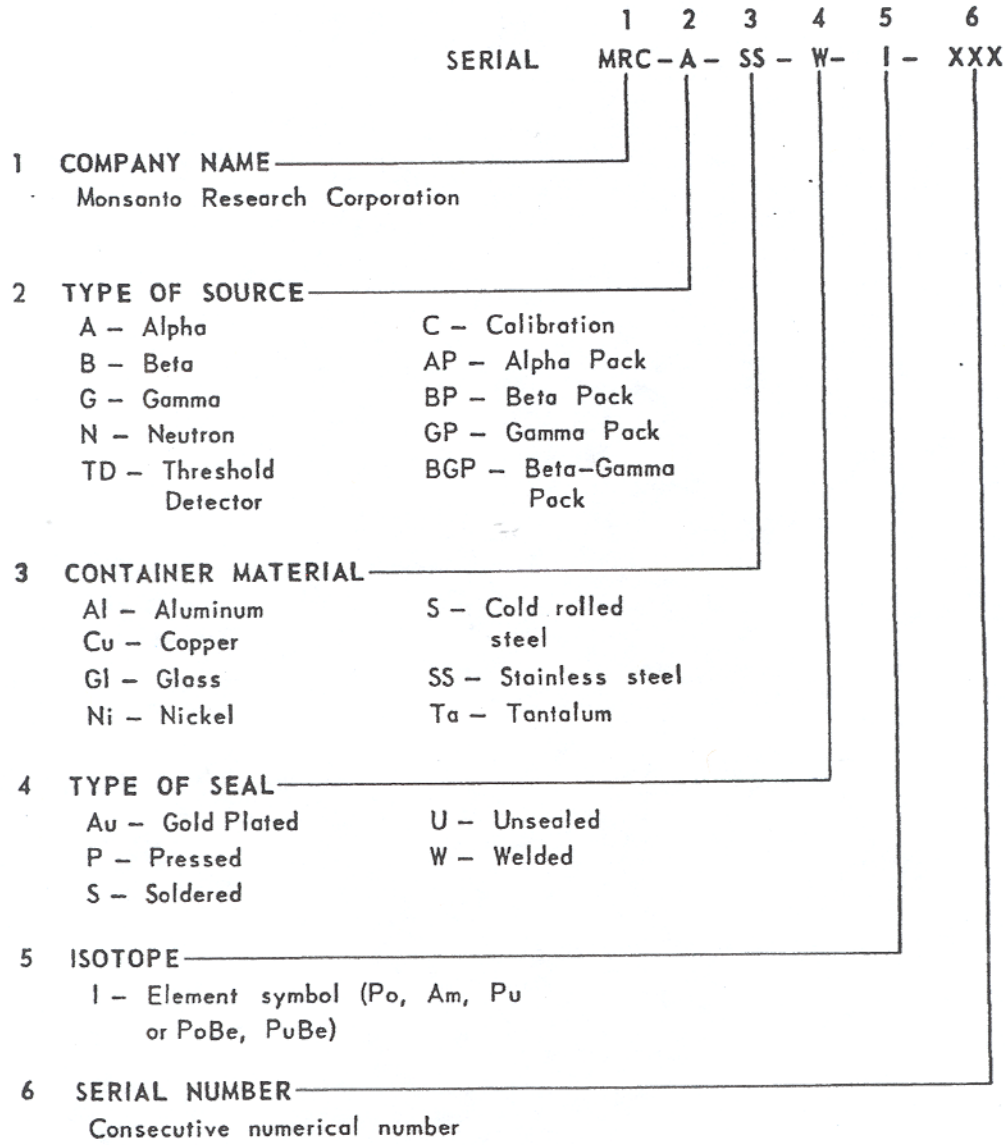
CURIE RANGE	DIMENSIONS PART NO.							
	1	2	3	4	A	B	C	D
0-0.2	0.312	0.402	0.38	0.48	0.407	0.50	0.60	0.70
0.2-1.0	0.562	0.652	0.55	0.65	0.657	0.75	0.77	0.87
1 - 3	0.812	0.902	0.78	0.90	0.907	1.00	1.02	1.12
3 - 6	0.812	0.902	1.18	1.28	0.907	1.00	1.40	1.50
6 - 10	0.812	0.902	1.68	1.78	0.907	1.00	1.90	2.00
10-50	1.25	1.37	3.18	3.28	1.375	1.50	3.40	3.50

MATERIAL – 304 STAINLESS STEEL
OTHER METALS ON REQUEST

Am Be
SOURCE CONTAINER
MODEL MRC–N–SS–W–Am Be

MONSANTO RESEARCH CORPORATION MODEL AND SERIAL NUMBERS

All MRC sources are numbered to identify the company, type of source, container material, type of seal, contained isotope, and serial number. MRC's identification numbers are made up of six characters:



EXAMPLE: MRC-N-SS-W-AmBe-401 designates a Monsanto Research Corporation neutron source, encapsulated in stainless steel, welded, with an americium-beryllium matrix, serial number 401.