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memorandum

Nuclear Engineering and Nonproliferation Division
International Threat Reduction Group NEN-3
Off-Site Source Recovery Project (OSRP)

SUBJECT: AMMENDED - SPECIAL FORM CHARACTER OF MRC MODEL 2720-BT SERIES RADIOACTIVE SEALED SOURCES

Background

The following analysis was performed to assure by available documentation and engineering analysis that the model 2720-BT series of radioactive sealed sources, manufactured by Monsanto Research Corp. (MRC), meets the US Department of Transportation (USDOT) requirements for characterization as special form radioactive material. The original model 2720 series of capsules was characterized as special form under USDOT COCA USA/0043/S-96, and continues so under revision number 12. The MRC model 2720 series neutron sources were described as potentially containing Am-241 or Pu-238 oxides mixed with beryllium metal powder. The 2720-BT variants (2722-BT, 2723-BT, or 2724-BT) may contain Am-241 or Pu-238 oxides mixed with beryllium metal powder as well.

MRC manufactured model 2720 series sealed sources from 1970 to 1984, and earlier as the model MRC-N-SS-W-xxBe from 1961-1970 (ref. OSR-SF-002). The model 2720 had an A, B, and C sub-series are well documented in USNRC SSDR NR-882-S-816-S and all of whose special form character is documented in an engineering evaluation letter to the USDOT dated 12-10-1981. The model 2720-BT changed the basic capsule design by adding 0.25" of overall length to the outer capsule bottom head to allow the addition of a 0.25" deep threaded hole to the capsule. The BT designation stands for bottom threaded. The inner capsule design and manufacture is unchanged.

Since the only significant change is a thickening of the outer capsule bottom head by 0.25", that is then penetrated to an equal depth, that leaves the minimum capsule head thickness unchanged, thus the original pressure vessel evaluation of stresses in the capsule are unchanged.

Model 2720-BT Capsule Description

A comparison of the model 2720 series –BT variants with the original series reveals the following differences.

Source Model	Source Weight (g)	Outer Capsule							Max.
		ID (in.)	OD (in.)	W_t (in.)	OL (in.)	H_t (in.)	B_t (in.)	t_w (in.)	Act. (Ci)
2722-BT	21.8	0.407	0.500	0.047	0.950	0.100	0.350	0.024	1.0
2722-A	15.4	0.407	0.500	0.047	0.700	0.100	0.100	0.024	1.0
2723-BT	53.1	0.657	0.750	0.047	1.120	0.100	0.350	0.024	3.0
2723-A	38.6	0.657	0.750	0.047	0.870	0.100	0.100	0.024	3.0
2724-BT	96.6	0.907	1.000	0.047	1.370	0.100	0.350	0.024	5.0
2724-A	71.2	0.907	1.000	0.047	1.120	0.100	0.100	0.024	5.0

Highlighted values have changed from the original model 2720 series. Only the Overall length of the outer capsule, bottom head thickness of the outer capsule, and total weight of the capsule are changed, per the table.
The change in the capsule length by 0.25 inches strengthened the bottom outer capsule bottom head. The only significant change is that the three known –BT variants (2722-BT, 2723-BT, and 2724-BT) are slightly heavier 6.4, 14.5, and 25.8 grams, respectively.

Analysis
The special form capsule tests that would apply to the special form characterization of the MRC 2720-BT series capsules are; Impact, Percussion, Heat Test, and Immersion test. The only test that would be significantly affected by a small mass increase to the capsule is the Impact Test. The potential energy applied to the capsule by the Impact Test for the variants would be calculated as follows:

2722-BT, Potential Energy (PE_{Impact}) = 900 cm x (15.4 + 6.4 grams) = 19,620 cm-grams
2723-BT, Potential Energy (PE_{Impact}) = 900 cm x (38.6 + 14.5 grams) = 47,790 cm-grams
2724-BT, Potential Energy (PE_{Impact}) = 900 cm x (71.2 + 25.8 grams) = 86,940 cm-grams

For comparison the potential energy applied to the capsule by the Percussion test is as follows:
Potential Energy ($PE_{percussion}$) = 100 cm x 1,400 grams =140,000 cm-grams
A comparison of the different potential energies applied to the MRC 2722-BT through 2724-BT capsules indicates that the percussion test applies 610%, 190%, and 60% more energy to the capsules, respectively than the impact test. Since these capsules all passed the original Percussion testing it is my engineering judgement that the three 2720-BT variants represented here would have passed the 9 meter Impact test. Therefore it is my opinion that that since the MRC 2720 series of capsules were shown to be special form material (USA/0043/S-96), then the –BT variants are special form radioactive material as well.

Conclusion
Using the method of similarity special form equivalency can be established for source capsules by comparing them to similar sources of known manufacture. Therefore it is concluded that the method of similarity the 2720-BT variants are also special form material per 49CFR173.469, that the subject source capsules (2722-BT, 2723-BT, and 2724-BT) would meet special form criteria. Further analysis of the potential energies applied to the source capsules during testing by the Impact test and the Percussion test also supports this conclusion. This also applies to any and all of the three model 2720 series BT variants.

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