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memorandum

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

SUBJECT: **Special Form Documentation for Am-241 Foil Sources used in Smoke Detectors and Other Gas Ionization Devices**

SCOPE

The purpose of this memo is to characterize sealed radioactive Am-241 sources used in ion chamber smoke detectors as special form radioactive material with the goal of achieving shipment, consolidation, interim storage, and final disposition at WIPP. We will examine some of the special form documentation available for foil sources found in the US.

PROBLEM

The two major suppliers of Am-241 smoke detector foils, NRD and QSA-Global, have historically characterized their laminated metal foil sealed sources as DOT special form radioactive material. NRD Inc. has a current Certificate of Competent Authority (COCA) maintaining that special form status for their foils (USA/0036/S-96)[1]. QSA-Global (formerly AEA Technology, Amersham, and TRC) allowed their most recent Am-241 foil COCA (GB/396/S-96) to expire as of April 30, 2006. By consolidating the information available from these two manufacturers of smoke detector we intend to demonstrate that all smoke detector foils in the US meet the DOT requirements for special form radioactive material. This document will serve as documentation for US DOT domestic self-certification.

BACKGROUND

Metal foil sources containing radium became available as a source of alpha radiation in the early 1950's. These laminated and rolled foils were used as alpha particles sources in early ion chamber smoke detectors and other devices. In the late 1960's less expensive Am-241 became available as alpha particle emitting metal foil. The availability of Am-241 and inexpensive electronics caused sales of residential smoke detectors to grow exponentially in the 1976-1978 time frame, exceeding 14 million units in 1978[2]. All US distributed devices incorporating Am-241 foils are documented for Acceptable Knowledge purposes in LANL memo N3-2010-137 dated April 18, 2010.

NRD FOILS

Setting up business in 1969, Nuclear Radiation and Development Inc. (NRD) used a foil manufacturing process identical to that used for US Radium Corp Lab model 204-1A (rev. 2) foils[3]. The US Radium Corp radium foils were not tested to determine their special form character, since they predated that DOT requirement. However, NRD did test the foils produced using that process and made appropriate application to DOT for a COCA. NRD metal foils containing Am-241 consisted of laminated layers of gold, gold/Am-241, gold/silver, and silver metal. NRD Inc. drawing number 92A071 (drawing NRD model A-001 americium foils are characterized as special form radioactive material under US DOT COCA USA/0036/S. This revision of expires 1/31/2019. NRD americium foil activity is conservatively limited to 92 μCi/cm^2 or less in the DOT COCA, as compared to 250

[1] US DOT COCA: USA/0036/S-96
[2] Environmental Assessment of Ionization Chamber Smoke Detectors Containing Am-241, NUREG/CR-1156, October, 1979, R. Belanger, D.W. Buckley, J.B. Swensen (see Attachment B).
[3] NRC Sealed Source & Device Registry No. NY-0502-S-101-U, NRD Model A-001 Foil Source.

$\mu Ci/cm^2$ in the SSDR. The description of the NRD smoke detector foils is consistent with that description in the SSDR:

> ***NRD Source Description***
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> *This special form material is a laminated metallic foil of silver, gold, and americium dioxide, as shown on NRD Inc. drawing number 92A071. The foil may be single or double sided. The single foil consists of successive layers of plating, gold, Am-241 and gold, gold silver and flash plating for identification. In the double foil the flash plating is replaced by gold, Am-241 and gold, gold, and plating. The plating is yellow gold, white gold, or palladium. During transport the material may be in the form of free foils, or secured in a variety of holders or mounts.*[4]

AMERSHAM FOILS

QSA-Global Inc. is the current name of a line of companies selling radioactive sealed sources. These companies start with the UK-AEA, Harewell isotope facility that was transformed into a Crown Corporation dba The Radiochemical Center (TRC) in 1971. TRC became Amersham plc, which later became Nycomed-Amersham (1996), then Amersham International. In 2004, Amersham was acquired by General Electric Corp and incorporated into GE Healthcare business segment. GE created a new business entity through which to sell sources, AEA Technology (2004), which became known as QSA- Global Inc. (2009). The actual americium foil manufacturing process was transferred to a joint venture with Shenzhen CIC-QSA-Global Manufacturing Company Ltd., Nantou Guankou, Nanshan District Shenzhen, China, in 2004 which continued using the same Amersham equipment and processes for foil production[5].

Amersham model AMM americium foil sources were originally characterized by TRC in a test report from Sept. 1975, *Integrity Testing of Alpha Foil Used in Ionization Chamber Detectors*. This testing formed the basis of all UK and US DOT applications for Certificates of Competent Authority asserting that these alpha foils were in fact special form radioactive material.

> ***TRC/Amersham Source Description***
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> *The radionuclide (either) as americium oxide AmO_2, plutonium, or radium sulphate is uniformly mixed with gold, formed into a briquette and sintered at (temperatures) above 800°C. The briquette is then mounted between a backing of silver (foil) and a front cover of gold or gold/palladium alloy and sealed by hot forging.*
>
> *The composite metal briquette is cold rolled in several stages to give the required active and overall areas. During this process the front cover is reduced in thickness to 0.002-0.003 mm and the metal layers arte consolidated to produce a single strip of metal approximately 0.2 mm thick. The metal strips have an overall width typically 20 mm and the active material is confined to a central zone usually 3 or 12.5 mm. Details of the general construction is shown in fig. 2. The foils are normally produced in one metre lengths and are sub-divided by cutting strips or punching out small pieces to produce the sources used in smoke detectors.*[6]

Comparison of NRD and QSA Foils

NRD and Amersham metal foils containing Am-241 are fabricated in very similar processes, starting with a briquette of gold/americium oxide mixture sintered at temperatures in excess of 800°C. The briquette is rolled into increasingly thinner sheets on a silver metal backing with gold or palladium overlays. Comparison of enclosures D & G, show the many layers of each design intended to keep both designs safe from mechanical, chemical, and thermal attacks. The major difference in these two processes is the use of palladium instead of gold for some lamination layers in the Amersham process.

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[4] NRD Inc. drawing number 92A071 in US DOT COCA: USA/0036/S.
[5] NRC SSDR: Model AMM Foil Source, MA-1059-S-174-S.
[6] TRC Report No. 379, *Integrity Testing of Alpha Foil Used in Ionization Chamber Smoke Detectors*, E.G. Hall and D.G. Hunt, Sept. 1975.

The NRC and Amersham foils were both tested to determine their special form character for DOT purposes. Both foils passed the DOT special form tests and were issued a COCA. The NRD COCA (USA/0036/S-96) is still current for international shipments. The QSA COCA was allowed to expire in 2006, meaning that those foils could no longer be shipped internationally as Type A packages in quantities greater than 27 mCi (A_2). If QSA foils are shipped as special form radioactive material within the US, shippers may self-certify that the QSA foils meet the requirements of 49 CFR 173.469, "Tests for special form Class 7 (radioactive) materials."

CONCLUSION

Based on this engineering evaluation, alpha-emitting foils incorporating Am-241 manufactured by either NRD or QSA-Global and any others manufactured using similar processes, can be characterized as special form radioactive material in the US. This has been established by the existence of a current COCA for NRD foils and a complete test report for Amersham (QSA-Global) foils described herein and in the supporting documentation.