



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 29, 2015

Mr. Kevin Schehr
Vice President and General Manager
Source Production and Equipment Company, Inc.
113 Teal Street
St. Rose, LA 70087

SUBJECT: AUTHORIZATION FOR SHIPMENTS OF ADDITIONAL NUCLIDES USING THE
MODEL NO. 3977A PACKAGE

Dear Mr. Schehr:

As requested by the e-mail from Dr. Roy Parker dated December 20, 2015, as supplemented December 24, 2015, pursuant to Title 10 of the *Code of Federal Regulations* Part 71 (10 CFR), Certificate of Compliance (CoC) No. 9338 for the Model No. 3977A package is amended to authorize additional radionuclides resulting from the irradiation of the aluminum capsule housing, also known as "rabbit", in which the encapsulated Selenium-75 (Se-75) is shipped, as follows:

- (1) Authorization is for three shipments, from Oak Ridge National Laboratory to Source Production and Equipment Company, Inc. (SPEC), of 7,760 Ci of Se-75 within insert No. 3985, corresponding to Table 2 in CoC No. 9338, with additional contents as follows: irradiated aluminum rabbit as represented in Drawing No. X3E020977A583, Rev. B.
- (2) Prior to shipment, package dose rates shall be measured at all locations necessary to demonstrate compliance with 10 CFR 71.47. A 20% margin shall be applied to the measured dose rates to account for measurement uncertainties.
- (3) All other conditions of CoC No. 9338 shall remain the same.
- (4) This authorization shall expire on May 31, 2016.

If you have any questions regarding this authorization, please contact Pierre Saverot of my staff at (301) 415-7505.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

A handwritten signature in black ink, appearing to read "Steve Ruffin".

Steve Ruffin, Acting Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9338
TAC No. L25070

Enclosure: Safety Evaluation Report

cc w/encl: R. Boyle, Department of Transportation
J. Shuler, Department of Energy c/o L. F. Gelder



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SAFETY EVALUATION REPORT
Docket No. 71-9338
Model No. 3977A Package
Authorization for Three Shipments
Of Additional Radionuclides

BACKGROUND

On December 20, 2015 (Reference 1), as supplemented December 24, 2015 (Reference 2), Source Production and Equipment Company, Inc. (SPEC), submitted a request for authorization of a maximum of three shipments of Selenium-75 (Se-75) using the aluminum irradiation capsule, also known as "rabbit". The shipments are intended to be made in the Model No. 3977A package and with the insert corresponding to Table 2 in the Certificate of Compliance (CoC) No. 9338.

Oak Ridge HFIR irradiates Se targets for SPEC's use. During a recent irradiation, a problem developed with one of the Se targets, either in the form of a possible "leaker" or of a "damaged" target. As a result, SPEC requested Oak Ridge HFIR to ship the entire rabbit holding the targets to SPEC's facilities in St. Rose, LA. The shipments are intended to be made in the Model No. 3977A package, which includes Se targets as authorized contents. However, the "rabbit", now irradiated hardware, was not considered in the application for the Model No. 3977A package.

Staff found that the shielding analysis shows that the package meets normal and accident condition dose rates with the irradiated hardware added to the Se capsules.

EVALUATION

Table 2 of CoC No. 9338 currently authorizes the Model No. 3977A package to ship 461 TBq (12,500 Ci) of Se-75 (among other nuclides) within insert design No. 3985.

Se-75 is created by irradiating the stable isotope of Se-74. Due to a problem with one of the selenium targets, the customer (SPEC) requested the shipper to ship the entire "rabbit," holding the Se targets.

Although the Se-75 amount is authorized for shipment within the Model No. 3977A package, some of the radioactive materials in the activated aluminum rabbit were not included as authorized contents in CoC No. 9338. Therefore, SPEC requests authorization for shipment of the following radionuclides and amounts:

Nuclide	Curies (Ci)	Nuclide	Curies (Ci)	Nuclide	Curies (Ci)
Se-75	7.76E+03	Ca-45	9.56E-05	Se-73	1.43E-13
Cr-51	7.61E+00	Co-60	6.53E-05	Co-58m	2.78E-14
As-74	1.07E+00	Cu-67	4.52E-05	Ge-77	1.70E-16
Zn-65	4.53E-01	Co-58	4.50E-05	Zn-71m	2.42E-26
As-73	2.12E-01	Cu-64	9.63E-06	Br-80	1.14E-26
Fe-55	1.54E-01	Na-24	8.96E-06	Br-80m	1.07E-26
Ge-71	8.49E-02	Co-57	6.58E-06	Sc-44	4.38E-28
Fe-59	6.42E-02	Ca-47	2.10E-06	Pb-209	1.28E-32
As-76	6.17E-02	As-71	5.35E-07	Mn-56	7.06E-33
Mn-54	6.09E-03	Ga-72	1.62E-07	Ti-45	2.97E-33
As-77	4.84E-03	As-72	1.59E-07	Si-31	2.13E-34
Sc-48	2.81E-03	Zn-69	1.26E-07	Ni-65	2.33E-36
Sc-47	1.62E-03	Zn-69m	1.17E-07	Co-61	3.24E-58
Sc-46	1.13E-03	Se-79	2.53E-08	Ga-68	8.09E-83
V-49	5.17E-04	Ni-57	2.37E-08	Sc-49	3.58E-95
H-3	4.80E-04	Se-72	8.84E-09	Cr-49	3.52E-131
P-32	2.37E-04	Ge-69	5.91E-09	Zn-63	7.24E-143
Ni-63	1.13E-04	Br-82	2.21E-11	Ga-70	7.47E-253

The table above includes the activation products from the "rabbit". The staff reviewed Drawing No. X3E020977A583, Rev. B, "HFIR Irradiation Capsule, Selenium Capsule Housing," and noted that the capsule housing does not contain any significant steel or other materials that form activation products which are a concern for external doses.

The rabbit, which consists of aluminum and activated aluminum itself, is not a source of radioactive material as it quickly decays to a stable state. However, aluminum has impurities that can be activated into longer lived radio-isotopes that must be accounted for in the assessment of radiation hazards from activated aluminum.

The applicant stated that the aluminum rabbit is used for almost all smaller scale irradiations and that part of the documentation for irradiation is the certification of the stock materials used for the rabbits. The applicant also stated that the mass of the aluminum rabbit is determined for each irradiation specimen. However, the staff does not believe those assertions give any information on the impurities associated with the aluminum rabbit in this shipment, nor any information about the neutron flux that the aluminum rabbit has experienced in its lifetime. Therefore, the staff cannot determine that the impurities discussed above are specifically appropriate to represent the rabbit.

The staff reviewed a paper by R. Girardi, R. Pietra, "Neutron Activation Analysis of Aluminum, Determination of Gamma-Emitting Impurities with Long Half Lives," (Reference 3) that discusses the presence of impurities that give the most significant radiation hazards from activated aluminum. The staff found enough similarities between those in the list provided by the applicant and those in the paper referenced as Reference 3, to have confidence that these could in fact represent the radionuclide distribution from the activated aluminum impurities from the rabbit.

The main source of radiation of the shipment is Se-75. The applicant submitted some information stating that 7,760 Ci of Se-75 within the allowable configuration would produce a surface dose rate of 124 mrem/hr. The surface dose rate is the most limiting, as discussed in the staff's Safety Evaluation Report supporting CoC No. 9338, Revision 0. The applicant stated that the additional isotopes from the activated aluminum impurities would produce an additional 0.62 mrem/hr at the surface.

The staff performed an analysis using the Microshield 9.06 code. Since the current CoC allows for 12,500 Ci of Se-75, the staff evaluated the unshielded dose rate from all of the other nuclides in the above table and compared that to the unshielded dose rate of the remaining Se-75 (12,500 – 7,760 Ci = 4,740 Ci).

The staff evaluated the combined unshielded dose of all of the above nuclides with the exception of As-71, Se-72, Ge-69, Zn-71m, as these were not available in Microshield 9.06. The staff justifies the exclusion of these nuclides because all these nuclides have maximum curie limits less than 10^{-6} and therefore make a very small contribution when considering all of the nuclides in the table. The staff did not model all nuclides with curie limits below 10^{-20} as this number is so small that these nuclides are considered negligible. The staff found that the unshielded dose rate of all of the non Se-75 nuclides in the above table is negligible (about three orders of magnitude less) in comparison to that of the margin to the Se-75 limit (4,740 Ci). Thus, the applicant's analysis is reasonable.

The shipper will also perform pre-shipment dose rate measurements per the requirements of 10 CFR 71.87(j) to confirm that the package meets regulatory dose rate limits prior to shipment. This will give staff reasonable assurance that any gross miscalculation of aluminum activation would be in fact discovered prior to shipment.

Staff noted that testing of the Safkeg-HS-3977A package, under Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC), has demonstrated that the containment seals are leak-tight, while the structural analysis showed that there would be no permanent deformation of any of the containment system components. Thus, complete containment for all contents is ensured at all times even in case of contamination of the rabbit.

Based on the applicant's evaluation, the staff's evaluation, and the above pre-shipment measurement requirement, the staff has reasonable assurance that the shipment of the above nuclides meets the external dose rate limits in 10 CFR 71.47 and 10 CFR 71.51(a)(2).

CONDITIONS

The staff finds that the requested three shipments of 7,760 Ci of Se-75 within insert No. 3985, corresponding to Table 2 in CoC No. 9338, and with additional contents in the form of the irradiated aluminum rabbit as represented in Drawing No. X3E020977A583, Rev. B, meet regulatory dose rate limits in 10 CFR 71.47 and 10 CFR 71.51(a)(2), provided the following restrictions are met:

- (1) Prior to shipment, package dose rates shall be measured at all locations necessary to demonstrate compliance with 10 CFR 71.47. A 20% margin shall be applied to the measured dose rates to account for measurement uncertainties.

- (2) All other conditions of CoC No. 9338 shall remain the same.
- (3) This authorization is for a maximum of three shipments and shall expire on May 31, 2016.

CONCLUSIONS

Based on the statements and representations in the request dated December 20, 2015, as supplemented December 24, 2015, the staff agrees that the use by SPEC of the Model No. 3977A package meets the requirements of 10 CFR Part 71, subject to the conditions listed above.

Issued on December 29, 2015.

References

1. Email from Dr. Roy Parker to US NRC, "SPEC Request to Ship Additional Radionuclides in USA/9338/B(U)-96", December 20, 2015 (ADAMS Accession Nos. ML15357A241 and ML15357A239).
2. Email from Dr. Roy Parker to US NRC, "Urgent Croft Exception- SPEC Se-75 ORNL shipments", December 24, 2015 (ADAMS Accession No. ML15362A293)
3. R. Girardi, R. Pietra, "Neutron Activation Analysis of Aluminum, Determination of Gamma-Emitting Impurities with Long Half Lives," European Atomic Energy Community - EURATOM. Reprinted from "Analytical Chemistry", Vol. 35 - 1963, pages 173-177. Copyright 1963, by the American Chemical Society and reprinted by permission of the copyright owner.