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9 February 2012

Document Control Desk
Director
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Certificate No. 9215, Rev. 10
Package ID No. USA/9215/B(U)

To whom it may concern,

I am writing to request that the activity limit for special form cesium-137 sources in our USA/9215/B(U) package be increased from 600 Ci to 20,600 Ci.

The intent of this letter is to convincingly demonstrate that the radiation and heat loads to be bourne by the package would not be any higher when loaded with cesium-137 sources than when loaded with cobalt-60 sources for which the package is currently approved. It is our understanding that such a demonstration would satisfy the requirements of 10CFR71.19(d)(1), which governs modifications of the authorized contents of previously approved packages such as ours.

Background

Until 2010, the above referenced package was used exclusively for the transport of cobalt-60. In 2010, we participated in an IAEA project to repatriate sources from Uruguay which involved the shipment of 12 cobalt-60 teletherapy sources, 15 cobalt-60 irradiator sources and one 550 Ci cesium-137 source. In order to complete the project, we requested authorization from NRC to ship the cesium-137 source, and - after review - NRC modified the Certificate of Compliance accordingly.

The cesium-137 shipment from Uruguay was delayed for other reasons until mid 2011, when it was completed without incident.

I have enclosed the NRC Safety Evaluation Report from the previous modification.

As technical justification for this request, I have attached a thermal evaluation and a shielding

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evaluation. In the attachments, I have also addressed questions which arose during the course of the previous certificate modification.

Current Request

Our current request is motivated by potential pending source transfers for commercial and research applications. Neutron Products has been contacted to see if we would consider requesting a modification to the certificate for our 9215 package so that it could be used for the shipment of special form Cs-137 sources with activities substantially higher than 600 Ci.

In addition, from time to time, there are Off-Site Source Recovery Program ("OSRP") removal jobs involving quantities of cesium-137 in excess of our 600 Ci certificate limit. It is our understanding that there is a very limited number of qualified bidders for such projects, and an increase in our cesium limit would enable us to compete for such work, thereby potentially reducing the expenditure of taxpayer dollars without adversely affecting safety.

The cobalt-60 activity limits for the three different drawer configurations of the 9215 package are 6,300 Ci, 9,500 Ci and 15,000 Ci. We have taken the lowest activity limit (6,300 Ci of cobalt-60) and determined that, from a thermal loading standpoint, that activity is equivalent to 20,600 Ci of Cs-137. From a shielding standpoint, 6,300 Ci of cobalt-60 is equivalent to 23,800 Ci of Cs-137. Our request is for the activity limit of Cs-137 to be increased to 20,600 Ci for all three of our drum configurations. While this requested increase in the authorized Cs-137 activity is significantly less than could be justified by the full design capacity of the package (equivalent to 15,000 Ci of cobalt-60), we believe that it will be sufficient to enable us to accomplish the prospective commercial transfers and to bid on future OSRP jobs.

Technical Evaluation

We have included both thermal and shielding calculations as separate attachments to this request. The calculations are similar to our previous request, but have been somewhat refined and some additional detail has been added in response to the NRC review of our previous request.

We anticipate that some of the shipments which would result from the granting of this request would be exclusive use shipments.

The attachments demonstrate that 20,600 Ci of special form cesium-137 is within the bounds of the current thermal and shielding capabilities of the package.

Conclusion

In considering this request, we hope that the NRC will recognize the public benefit derived from

the improved ability of the effected licensees to ship and receive sources for research and commercial applications, as well as the fact that the introduction of additional competition in the OSRP bidding process is also in the public interest, provided that both of these worthy objectives can be accomplished without adversely impacting the safety of conducting such shipments. We submit that the thermal and shielding calculations support our request and we will do our best to assure that the use of the package for the shipment of higher activities of Cs-137 will be conducted in such a way as to provide the same wide margin of safety that has characterized the prior use of these packages.

Thank you for your consideration in this matter. If you have any questions, or require additional information, please advise.

Bill Ransohoff

Neutron Products inc
Director of Operations

cc: Kimberly J. Hardin

Addendum to Safety Analysis Report for Certificate of Compliance No. USA/9215/B(U) Concerning Authorization to Transport Special Form Cesium-137 Sources with Activity not to Exceed 762.2 TBq (20,600 Curies)

Shielding Evaluation

The shielding in the package is adequate for 15,000 Ci of cobalt-60. The design is governed by the requirement to shield the 1.17 MeV and 1.33 MeV gamma rays resulting from each cobalt-60 disintegration, for a total of 2.5 MeV. The decay of cesium-137 results in a single 0.662 MeV gamma ray. Thus, the photon decay energy of Cs-137 is approximately 26.5% that of Co-60 (0.662/2.5 = 0.265).

While the unshielded exposure rate from Cs-137 would be approximately 26.5% of the exposure rate from an equal activity of Co-60 (in the same source configuration), the *shielded* exposure rate would be even less due to the much greater attenuation of the lower energy Cs-137 radiation, even accounting for its relatively greater buildup contribution from Compton scatter. Consequently, the use of an activity equivalence percentage of 26.5% is conservative for radiation safety evaluation purposes.

The current package has three different drum configurations, one of which is authorized for 6,300 Ci Co-60. The other two are authorized for higher activities (9,500 Ci Co-60 and 15,000 Ci Co-60). This request is for an activity of Cs-137 equivalent to 6,300 Ci of Co-60 to be authorized for transportation in any of the three drum configurations.

6,300 Ci / 0.265 = 23,800 Ci Cs-137

The package is currently used for sources of various geometries, with various source holder configurations based upon the manufacturer of the source and its intended use. As necessary, shield plugs and spacers made of lead, steel or tungsten alloys are utilized to restrict movement of the source and to ensure that regulatory dose rate limits are not exceeded. Adequate shield plugs will be used for the transport of cesium-137 sources, just as they are for the transport of cobalt-60 sources.

Conclusion

For all three drum configurations, the package is authorized for at least 6,300 Ci of cobalt-60, which - from a shielding standpoint - is equivalent to 23,800 Ci of Cs-137, so that the current request for use of the package for up to 20,600 Ci of Cs-137 is within the bounds of the current authorization. Our request is for less than 23,800 Ci because consideration of heat load is the limiting factor, as can be seen from the companion addendum which addresses the thermal evaluation.

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Addendum to Safety Analysis Report for Certificate of Compliance No. USA/9215/B(U) Concerning Authorization to Transport Special Form Cesium-137 Sources with Activity not to Exceed 762.2 TBq (20,600 Curies)

Thermal Evaluation

Summary

The current package has three different drum configurations, one of which is authorized for 6,300 Ci Co-60. The other two are authorized for higher activities (9,500 Ci Co-60 and 15,000 Ci Co-60). This request is for an activity of Cs-137 equivalent to 6,300 Ci of Co-60 to be authorized for transportation in any of the three drum configurations.

The heat generation design basis of the package is 240 watts, which corresponds to the decay heat of approximately 15,000 Ci of cobalt-60.

Supporting Calculations

Cobalt-60 decays by beta decay to a stable isotope of nickel. With each disintegration, there are two photons released. The energies are as follows:

$\beta_{avg} = 0.096$ MeV

$\gamma_1 = 1.173$ MeV

$\gamma_2 = 1.332$ MeV

TOTAL = 2.6 MeV / Co-60 disintegration

It follows that:

$$1 \text{ Ci Co-60} = (3.7 \times 10^{10} \text{ dps}) \times (2.6 \text{ MeV/d}) = 9.6 \times 10^{10} \text{ MeV/s}$$

$$= (9.6 \times 10^{10} \text{ MeV/s}) \times (1.6 \times 10^{-13} \text{ J/MeV})$$

$$= 0.0154 \text{ J/s}$$

$$= 0.0154 \text{W}$$

Maximum heat load for the current authorization of 15,000 Ci of cobalt-60:

$(0.0154 \text{ W/Ci}) \times (15{,}000 \text{ Ci}) = 231 \text{ W}$

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Heat load of 6,300 Ci of cobalt-60:

(0.0154 W/Ci) x (6,300 Ci) = 97 W

As explained in detail below, the decay heat for cesium-137 is 0.797 MeV/disintegration. Using the same conversion calculations shown above for cobalt-60 demonstrates that 0.797 MeV/disintegration is equivalent to 0.0047 W/Ci Cs-137.

The activity of Cs-137 with a heat load equivalent to the maximum package loading of 15,000 Ci of cobalt 60 is:

231 W / 0.0047 W/Ci = **49,100 Ci**

The activity of Cs-137 with a heat load equivalent to 6,300 Ci of cobalt-60 (which is the subject of this request) is:

97 W / 0.0047 W/Ci = **20,600 Ci**

Discussion of Decay Heat of Cs-137

The decay of Cs-137 takes two distinct routes. One of them (which occurs about 5.4% of the time) is a direct beta decay to the ground state of barium-137, with no accompanying gamma. The maximum beta energy for this decay is 1.173 MeV. The average beta energy for this route is 0.415 MeV.

Most of the time (94.6%) the beta decay is actually to an isomer of Ba-137, called Ba-137m. The maximum energy for this beta is 0.512 MeV, while the average energy is 0.157 MeV. The Ba-137m then quickly decays (half life of about 2.6 minutes) by isomeric transfer to the stable Ba-137. When it does so, it also releases various electrons and gamma rays, the dominant one of which is the 0.662 MeV gamma.

So, the total decay heat for Cs-137 is:

0.054(0.415 MeV) + 0.946(0.157 MeV + 0.662 MeV) = 0.797 MeV/disintegration

In determining the proper decay heat to use, it is important to address the following question:

> "If the decay of Cs-137 results in even a single beta decay out of a billion which has an energy of 1.173 MeV, then that means that the difference between the ground states of Cs-137 and Ba-137 must be 1.173 MeV. How, then, can one use any value less than that to calculate decay heat?"

This is a problem which exists for all isotopes which beta decay because each such isotope has a maximum beta decay energy and an average, and there is quite a broad distribution of beta energies for each isotope. Meanwhile, each isotope has a signature gamma energy, which does not vary. When scientists first recognized this problem several decades ago, they concluded that there must be some other form of energy being released which they simply could not measure and they postulated the existence of what is now known as the antineutrino, whose existence was subsequently confirmed many years later. The antineutrino has infinitesmal mass and has virtually no interaction with matter, so its energy would not be deposited in the shielding of the cask and, therefore, should not be considered in decay heat calculations.

Thus, it is appropriate to use the average beta energies, instead of the maximum beta energies, when performing decay heat calculations.

Conclusion

For all three drum configurations, the package is authorized for at least 6,300 Ci of cobalt-60, which - from a decay heat standpoint - is equivalent to 20,600 Ci of Cs-137, so that the current request for use of the package for up to 20,600 Ci of Cs-137 is within the bounds of the current authorization. As the current certificate authorizes the package for heat loads equivalent to 49,100 Ci of Cs-137, this request has a considerable margin for safety.

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

SAFETY EVALUATION REPORT
Docket No. 71-9215
Model No. NPI-20WC-6 MkII Package
Certificate of Compliance No. 9215
Revision No. 10

SUMMARY

By application dated April 8, 2010, Neutron Products, Inc., requested an amendment to Certificate of Compliance (CoC) No. 9215 for the Model No. NPI-20WC-6 MkII package. The applicant specifically requested allowance to add Cesium-137 as a new content to the CoC as a sealed source which meets the requirements of a special form radioactive material.

EVALUATION

Thermal Evaluation

The staff reviewed the request for the CoC No. 9215 to transport a special form Cesium-137 source with an activity not to exceed 22.2 Tbq (600 Curies), which corresponds to 3.1 watts. The package was originally designed for special form sources with higher activity, including Cobalt-60 with an activity not to exceed 15,000 Curies, which corresponds to 231 watts. Therefore, the proposed content is bounded by the approved original heat source.

Based on staff review, the staff finds reasonable assurance that the USA/9215/B(U) package design meets the thermal performance requirements set forth in 10 CFR Part 71.

Shielding Evaluation

NRC staff reviewed the applicant's submittal, the applicant's SAR (ML092180416), the above referenced drawings, the current CoC (ML080970006), and the Rev. 0 Safety Analysis Report (SER) (ML030100087). NRC staff reviewed the configurations shown in item 5 of Drawing No. 240122, sheet 1 of 2, Rev. H (ML022800515), and item 4 of Drawing No. 240122, sheet 2 of 2, Rev. H (ML022800529). NRC staff finds that these package configurations are already approved for 15,000 and 9,500 Curies of Cobalt-60 (^{60}Co), respectively. During radioactive decay of ^{60}Co two gamma rays are emitted with energies of 1.17 and 1.33 MeV. During radioactive decay of ^{137}Cs one gamma ray is emitted with an energy of 0.6617 MeV. So ^{60}Co emits two gamma rays that each has roughly twice the energy as the single gamma ray emitted by ^{137}Cs. This strongly suggests that ^{137}Cs is bounded by ^{60}Co. To confirm this staff performed dose rate calculations for shielded and unshielded ^{137}Cs and ^{60}Co point sources. Additional calculations were performed for a 600 Ci ^{137}Cs line source to represent a pencil source. The results of these calculations confirmed the applicant's argument that ^{137}Cs is bounded by ^{60}Co; and that a 600 Ci ^{137}Cs source does not violate the limits under normal conditions of transport or hypothetical accident conditions.

Based on a review of the representation within the application and independent calculations, staff finds reasonable assurance that a package with 600 Ci of ^{137}Cs meets the radiation limits

of Part 71, provided it is in the configurations specified in the CoC Rev. 9, Sections 5(b)(2)(i) and (ii); and provided that the applicant uses at least 2 inches of Lead or Tungsten, or 3 inches of steel as axial shielding material in the drum assembly. This is in addition to the shielding that is already part of the shipping/transfer cask (S/TC) and S/TC cover. The shielding material may be part of the plugs and spacers or part of the source drawer, but must be inserted between the source and the S/TC cover.

CONCLUSION

Condition No. 5(b) of the certificate was revised to add Cesium-137 as a new content - as sealed sources which meet the requirements of special form radioactive material, with a maximum activity not to exceed 600 curies and maximum decay heat not to exceed 3.1 watts. Condition No. 10 was added to ensure Cesium-137 and Cobalt-60 sources are not shipped together in the same package. Condition No. 12 of the certificate was revised which authorizes use of the previous revision of the certificate for a period of approximately one year.

These changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9215, Revision No. 10,
on May 13, 2010