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Director
Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
US Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Mr. Chris Allen
Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards

Re: Supplemental Response to Second RAI
Docket No. 71-9215
EPID No. L-2017-LLA-0133

Dear Mr. Allen,

As we discussed by telephone, I am writing to supplement our reply to your Request for Additional Information dated January 30, 2019, which we received on March 15, 2019, and to which we initially replied on 5 April 2019.

Our initial reply included calculations based upon the source or sources being radially offset within the round cask through hole. Based upon our previous conversation, such a configuration will not be used going forward until after we have submitted additional information which will be the subject of a separate amendment request. This supplemental reply addresses sources which are radially centered in the round through holes, and sources which are offset in the square through holes, where the potential for rotation during transit or in accident conditions is not an issue.

The request from your second RAI states:

NMSS2D

"5.1 Provide additional information regarding the methodology and criteria used to determine whether source material is suitable to be loaded.

Staff analysis shows that a pencil source with the maximum activity limits in the CoC Condition 5(b) will not meet the dose rate requirements of Title 10 of the Code of Federal Regulations (10 CFR) 71.47(a). Although the applicant confirmed this in an RAI response (ADAMS Accession No. ML18218A429), the applicant did not provide separate analysis or measurements showing that a package which does not meet 71.47(a) will meet the requirements of 71.47(b). Therefore, the applicant needs to provide the criteria or the process by which the maximum activity that can be transported in a pencil source configuration is determined.

This information is necessary to determine compliance with 10 CFR 71.47."

1. Shielding Evaluation – Maximum Lengths for Cobalt-60 Certificate Activity Limits

As discussed in our initial response, the evaluation of whether or not a proposed source can be shipped in our package – from a shielding perspective – includes consideration of how the proposed source compares to sources previously shipped in the package and, to the extent previous experience is not applicable, a more detailed shielding evaluation. For that evaluation, we generally consider the proposed source to be several smaller point sources. The calculations are explained in some detail in the initial response, which discussion is not repeated here.

Before considering the theoretical maximum length for a source at the certificate limit for the package, it is useful to demonstrate that the evaluation method we use gives a reasonable approximation of survey data from actual shipments in the field.

Example

In March 2018, we shipped a cobalt-60 source containing 5290 Ci. It was 5.6" long and 0.772" in diameter. The -5 drum assembly from drawing 240122 was utilized.

The results of that evaluation and the actual survey data are:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	170	12	1.3
Actual	160	8	0.9

From this data, and others, we believe the evaluation to be a reasonable approximation of actual results from the field. The fact that the predicted values are generally a bit higher than

the actual measured values suggests that this approach is conservative. Had a source of the same dimensions, containing the certificate limit 15,000 Ci been shipped instead, we would have expected the dose rates to be higher by nearly a factor of three, or approximately 21 mR/hr at contact with the OP and a TI of 3, still well within regulatory limits for a routine shipment.

1.1 Theoretical 15,000 Ci Pencil Source for -5 Drum Assembly

Using the same evaluation technique, and continuing with the -5 drum assembly from the drawing, we can evaluate a theoretical 15,000 Ci cobalt-60 source of different lengths to establish a maximum length for this activity. A source measuring 11.625" in length would allow for 5" shield plugs on each side. For the purposes of this evaluation, materials of construction of the shield plugs to be used will be tungsten alloy, with a specific gravity of 17. Such an arrangement would give the following dose rates:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	28,000	1,400	130

Ignoring for a moment the occupational exposure issues presented by preparing such a shipment, this source could not be shipped in our package in accordance with the requirements of 10 CFR 71.47(b) because the 1 R/hr limit at contact with the package (OP) is exceeded.

Shortening the source by two inches, thereby adding an additional one inch of shielding on each side of the source reduces the predicted dose rates as follows:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	6,200	330	31

There are other dose rate requirements included in 10 CFR 71.47(b). Those are evaluated in the following example which has higher dose rates than those in this example. Accordingly, we submit that the 15,000 Ci limit for the -5 drum assembly should apply to lengths less than or equal to 9.625".

1.2 Theoretical 9,500 Ci Pencil Source for -4 Drum Assembly

The - 4 drum assembly from drawing 240122 is authorized for activities up to 9,500 Ci of cobalt-60. Performing a similar series of calculations on an 11.625" source in that drum assembly yields the following results:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	16,000	730	65

This shows that this source could be shipped in the 9215 package in accordance with the requirements of 10 CFR 71.47(b).

In order to evaluate compliance with 10 CFR 71.47(b)(4), it should be understood that the only regions of significant dose rate are those around the flanges of the endcaps. As a result, when loaded onto the transport vehicle, the package would be oriented such that the endcaps were pointing toward the front and rear of the vehicle, not toward the sides. Using the inverse square law from the center of the source (which is 2 feet from the surface of the OP):

$$(730 \text{ mR/hr}) * 2^2 / x^2 = 2 \text{ mR/hr}$$

Solving for x gives approximately 38 feet. Assuming 8 feet between the back of the tractor and the front of the trailer means that the package would have to be secured approximately 30 feet back in the trailer. For a typical 48 foot trailer, and taking into consideration the 4 feet occupied by the package itself, the other side of the package would be 14 feet from the end of the trailer. Using the inverse square law again:

$$(730 \text{ mR/hr}) * 2^2 / 14^2 = 15 \text{ mR/hr}$$

at the back doors of the trailer, which is well below the 200 mR/hr limit in 10 CFR 71.47(b)(2).

Regarding the 2 m from the vehicle limit of 10 mR/hr in 10 CFR 71.47(b)(3), the highest point would be behind the back doors of the trailer:

$$(730 \text{ mR/hr}) * 2^2 / (14+6.6)^2 = 7 \text{ mR/hr}$$

Based upon the foregoing evaluation, we submit that the 9500 Ci limit should apply to a cobalt-60 source less than or equal to 11.625" in length for the -4 drum assembly. One could argue whether or not it would be advisable to ship such a source in this configuration and, to be frank, we would have to have a very compelling reason to even consider such a shipment as it would require considerable effort and investment to manage the occupational exposures entailed in doing the work. That said, we believe that the foregoing demonstrates that such a source could be shipped in a compliant manner and that, as such, it should be authorized by the certificate.

1.3 Theoretical 6,000 Ci Pencil Source for -2 Drum Assembly

The - 2 drum assembly from drawing 240122 is authorized for activities up to 6,000 Ci of cobalt-60. Performing a similar series of calculations on an 11.625" source centered in that drum assembly yields the following results:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	11,000	500	45

These results are comparable to those discussed above, so that we may conclude that the -2 drum assembly is suitable for shipping cobalt-60 sources up to 11.625" in length at the maximum activity of 6,000 Ci.

2. Shielding Evaluation – Maximum Lengths for Cesium 137 Activity Limits

In practice, the longest sources we have shipped in the 9215 have been cesium source assemblies. For our package, the best way to shield these sources is to use the square drawer drum (the -2 drum assembly) and offset the source toward the center of the package.

One example was a source shipped in January 2018, which was 2454 Ci of cesium-137. The source was 15.94" long, and was attached to a tungsten rod which brought the total length of the assembly to 20", including a short length (3/8") of threaded rod attached to the end of the tungsten. The rod was typically used to handle and control the source. Because the source was being shipped for disposal, the short rod was no longer required for the use of the source. The certificate for the 9215 requires that at least 2" of shielding be used. Because the available length is only 21.625", we would not be able to ship the cesium source as it was configured. However, by grinding the short, small diameter threaded rod off of the end of the tungsten, the overall length of the source assembly was reduced to 19.625", which allowed us to use the required 2" shield plug on the end of the source that did not already have the tungsten attached.

In order that this type of activity not be confused with the recent events in Seattle, there was more than 3" of solid tungsten rod between the source and the short handling rod to be removed. In addition, the modification was performed by the manufacturer of the source assembly. As a result, there was no credible scenario in which this operation could jeopardize the integrity of the source.

The calculated dose rates were quite close to the actual results from the surveys:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Calculated	300	9.1	0.75
Actual	350	11	1

This example is instructive for two reasons. First, had a source of the same geometry containing the certificate maximum of 20,600 Ci of Cs-137 been shipped, the data above can be used to show that the TI for such a loading would have been:

(1 mR/hr) * (20,600)/(2454) = 8.4

In addition, the OP contact dose rate would have been approximately 92 mR/hr. Thus, the source could have been shipped in the package in accordance with 10 CFR 71.47(a).

Second, we have requested that the requirement to use at least 2" of axial shielding be removed from the certificate for sources such as this. This source, had it not been modified, would have used a 1.625" source plug instead of the full 2" plug currently required. Using an even shorter plug (1"), calculations show that the dose rates would be expected to be:

	Cask contact Dose rate (mR/hr)	OP contact dose rate (mR/hr)	TI
Predicted	4,300	99	8

Thus, a shipment in this configuration with an activity of 2454 Ci of Cs-137, with at least 1" of axial shielding would be in compliance with 10 CFR 71.47(a). For a 4,000 Ci source, the OP contact dose rate would be expected to be 160 mR/hr with a TI of 13. Such a shipment would meet the requirements of 10 CFR 71.47(b) by a comfortable margin. As a result, we request that the requirement to use at least 2" of axial shielding be reduced to 1" for shipments involving less than 4,000 Ci of Cs-137.

Additional Considerations

As you know, I have had a difficult time with this response primarily because I am concerned that the ultimate result is that the certificate is going to be made more restrictive. The fact of the matter is, however, that we do not ship 9.5" long 15,000 Ci sources in this package. Nor do we load the package such that the contact dose rate with the cask is on the order of 16 R/hr, or so that the contact dose rate with the overpack is on the order of 750 mR/hr. Nor do we make shipments with a TI of 65. All of these conditions are presented in the foregoing as if we do these things in the normal course of conducting our business. One point I would like to make in this response is that, even though we don't generally do any of those things, we currently have authorization to do them and that authorization gives us a wide margin of compliance when compared to the activities which we do routinely conduct. That wide margin is important to us and we would prefer that it remain intact.

Furthermore, as discussed in our initial response, the package has been used to ship a wide range of sources, both in commerce and in the removal of sources under the OSRP and IAEA programs. Some of these sources are standard, but many of them are not and there are

undoubtedly sources out there to be shipped that we do not even know about. To the extent a proposed shipment presents unusual challenges, those details – including shielding considerations - are evaluated on the merits prior to performing the work. I hope that these two responses have clarified how we evaluate the adequacy of the shielding provided by our package. We greatly appreciate the operational flexibility we have been afforded to date and believe that an approach can be devised which will enable you to satisfy your regulatory responsibilities and will at the same time allow us to maintain the operational flexibility we require.

Thank you for your patience. If I have missed the mark in this response, or if you require additional information, please let me know.

Thank you for your consideration.

Sincerely,

Bill Ransohoff
Neutron Products, Inc.
President