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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

Attn.: Mr. Bernard White

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

Dear Mr. White,

I am writing as we discussed last month to correct some errors your reviewer identified in our consolidated application dated October 29, 1992. The corrections have been made in the attached pages.

I believe these corrections to be totally responsive to our discussion. If you disagree, or require additional information, please advise accordingly. Otherwise, please substitute the pages transmitted herein for those in the previous submittal.

Thank you again for your attention to this matter.

Bill Ransohoff
Neutron Products inc
Director of Operations

NMSS01

representative recent shipments with the existing package. These provide a base for comparison with the new package. The design guidelines for the new package are a maximum dose rate of 100 mr./hr. at the accessible surface of the package and 10 mr./hr. at a distance of one meter from the surface of the package for normal conditions of transport. These are the values listed in Table 5.1.2.

A comparison of the radial gamma ray attenuation between the new and existing inner container is detailed in Appendix 5.4.1. On a comparative basis, the new container will permit an increase of 54 percent in source strength for the same cask surface dose. This factor, along with the initial shielding design margin of the casks, as shown in Table 5.1.1, provides a satisfactory 15,000 curie operating limit for cobalt-60. This is further supported by a surface and one meter distant dose rate for the package calculated to be 104 mr/hr and 14 mr/hr, respectively, for a contained 15,000 curie source. This calculation is also included in Appendix 5.4.1. To the extent any dose rate exceeds the regulatory requirements for general transport, the package would be shipped in accordance with the requirements of an exclusive use shipment (49 CFR 173.441).

The principal physical change to the drum of the new package has been to decrease the drum liner tube inside diameter from 2.82 to 2.56 inches, while maintaining the 0.095 inch tube wall thickness. In the radial direction, the change amounts to replacing 1/8 to 3/16 inches of steel and clearance with an equal thickness of lead. The change also reduces gamma streaming in the axial direction by factors calculated to be 1.8 to 7.3, depending upon the source holder configuration. The supporting calculations are provided in Appendix 5.4.2.

The only other physical change to the new inner container that impacts shielding is the reduction in the outside diameter of the Shell Assembly Liner. The effect is to replace a 3/16 thickness of steel with an equivalent amount of lead. The principal influence is an increase in radial attenuation. This factor has been included in the calculations shown in Appendix 5.4.1.

Subsequent to the calculations and comparisons described above, a package incorporating the new inner container carrying a 6,650 curie source was radiation surveyed. The results are provided in Appendix 5.4.3. As extrapolated to 15,000 curies, the package maximum surface reading would be 34 mr./hr., as compared with the design basis value of 100 mr./hr. and the 10 CFR 71.47 limit of 200 mr./hr. for general transport. At one meter distant, the level would be about one-third of the 10 mr./hr. general transport limit.

The change in shielding effectiveness under hypothetical accident conditions is due to shifting of the inner container with reference to the outer surface of the package as a consequence of the 30 foot drop. With a maximum estimated inner container shift of seven inches, the surface dose increases by a factor of 2 and the dose at 1 meter by about 25 percent. Both values are below the 10 CFR 71 limit of 1,000 mR/hr. at 1 meter for the hypothetical accident condition. There is no opportunity for any measurable shift of source or shielding within the inner container under the most severe free drop condition. Greater detail is provided in Appendix 5.4.4.

5.4.1 Radial Gamma Attenuation

The specific shielding arrangement within the drawer or holder placed in the drum chamber may vary. However, a comparison of radial (in the plane perpendicular to the axis of the drum) attenuation in the original with that of the new inner container can be made from the drum liner outward. This comparison, along with an overall calculation of dose rate for the new package in the radial direction, is presented in this appendix.

For both purposes a point source model was used. For the comparison, the attenuation from chamber wall to exterior of the inner container, $[I_o/I]_{S/TC}$ was taken as the product of the individual shielding components.

$[I_o/I]_{S/TC} = e^{\mu_n x_n} / B_n$, where B_n is the buildup factor, μ_n the linear attenuation coefficient, x_n the thickness of the shield component under consideration, and n designates the particular shielding material component.

Table 5.4.1.1 lists the input parameters for the calculation, as well as the results. The configuration is shown schematically in Figure 5.4.1.1. The constituent material attenuations are shown for each of the shielding component materials, as well as the total for both the original and new inner containers. The ratio of the new to the original cask attenuation is 1.54. Looked at in another way, for the same surface dose, the new cask would have to contain a source strength 54 percent greater. The original inner container was not considered shielding limited at 9,500 curies, so that no absolute level of source strength can be determined by this means. However, when applied to actual package measurements, such as those shown in Table 5.1.1, the package dose rates with a 15,000 curie source, would - depending on the particular source loading configuration - either qualify as an exclusive use shipment, or meet the requirements for general transport.

The dose rate at the package surface and at one meter distant were also calculated in the radial direction. The attenuation due to shielding inside of the source containing drum chamber and the small attenuation due to the over pack were combined with the S/TC attenuation shown in Table 5.4.1.1 to provide the total material attenuation of the packaging. The additional constituents, as well as the overall result, are presented in Table 5.4.1.2. The overall shielding attenuation, $[I_o/I]$ is 5.75×10^5. Combining this with the source dose rate relationship[1] in the absence of shielding

I_o = Dose rate at distance d, cm from C curie source
$= 5.2 \times 10^6 \, C \, E/d^2$ mr/hr.

where

C = 15,000 curies
E = Total gamma energy/disintegration = 2.5 MeV for cobalt-60
d (surface) = [(48.5/2) - 1.75] 2.54 = 57.2 cm
d (@ 1 meter) = 157.2 cm

[1] S. Glasstone, Principles of Nuclear Engineering, pg. 545

TABLE 5.4.1.1

CALCULATED RADIAL GAMMA ATTENUATION COMPARISON

Location (1) and New/Original Inner Container	Material and Thickness, in.	Linear Absorption Coefficient cm. -1	Buildup Factor (2)	Attenuation I_o/I (2)
1. Drum Liner	S.S (3)			
New	0.095	0.432	1.09	1.02
Original	Same as above			
2. Drum Shielding	Lead			
New	0.782	0.655	1.47	2.50
Original	0.625	0.655	1.40	2.02
3. Drum Casing	S.S.			
New	0.187	0.432	1.17	1.046
Original	0.219	0.432	1.20	1.056
4. Shell Liner	C.S. (3)			
New	0.187	0.424	1.17	1.044
Original	0.375	0.424	1.34	1.115
5. Shell Shielding	Lead			
New	7.69	0.655	4.75	7.63×10^4
Original	7.50	0.655	4.65	5.68×10^4
6. Shell	C.S.			
New	0.375	0.424	1.34	1.115
Original	Same as above			

S/TC Attenuation, π (New)	2.37×10^5
S/TC Attenuation, π (Original)	1.538×10^5
Ratio, π (New) / π (Original)	1.54

(1) Numbers keyed to locations shown in Figure 5.4.1.1

(2) Attenuation $I_o/I = e^{\mu_n x_n} / B_n$. Buildup factor based on point isotropic source. Radiological Health Handbook, pgs. 145-146)

(3) S.S. = stainless steel, C.S. = carbon steel.

TABLE 5.4.1.2

CALCULATED DOSE RATE FOR NEW PACKAGE

Location	Material and Thickness, in.	Linear Absorption Coefficient, cm. -1	Buildup Factor	Attenuation I_o/I
Source capsule	Tungsten alloy 0.437	0.944	1.47	1.94
Source chamber	Stainless steel 0.314	0.432	1.29	1.092
Source chamber to Inner container surface	From Table 5.4.1.1			2.37×10^5
Wooden protective jacket	Wood 6.0	0.0384	1.62	1.11
Steel shell	Carbon steel 0.107	0.424	1.10	1.032

Total material attenuation, source to package surface $(I_o/I) = 5.75 \times 10^5$

yields the following surface dose:

$$(5.2 \times 10^6)(15{,}000)(2.5)/(5.75 \times 10^5)(57.2)^2 = 104 \text{ mr./hr.}$$

The dose at 1 meter is:

$$(5.2 \times 10^6 \times 15{,}000)(2.5)/(5.75 \times 10^5)(157.2)^2 = 14 \text{ mr./hr.}$$

These values compare with 200 mr./hr. and 10 mr/hr., respectively, for normal shipment. The margin provided for surface dose rate appears adequate for slight changes in shielding, thickness, geometry, or calculational uncertainty. To the extent the 10 mr/hr at 1 m dose rate is exceeded, the package would be shipped exclusive use, as described in 49 CFR 173.441.

5.4.2 Axial Gamma Attenuation

Evaluation of the shielding in the direction parallel to the axis of the new inner container drum involves the source loading arrangement. The loading arrangement of a source in an international capsule is shown in Figure 4.3. This is representative and one of the more frequent loading arrangements. The 2.56 inch diameter drum chamber is fitted with a stainless steel sleeve having an outside diameter of 2.50 inches and an inside diameter of 2.060 inches. The capsule is placed within the sleeve and held in the axially central region of the drum with two tungsten alloy plugs, one on each side. The covers hold the entire assembly in place.

The arrangement in the original inner container is similar, except the drum chamber is 2.81 inches in diameter and a second sleeve of 0.095 wall thickness, surrounding the first is used to fill the space and center the source.

For both configurations the shielding arrangement in the axial direction is a plug of tungsten alloy 9.8 inches long and 2.03 inches in diameter (about twice the diameter of the source face) surrounded by an annulus of steel with either two or three narrow air gaps. This assembly, in turn, is surrounded by a matrix of lead. The arrangement is shown for the new drum in Figure 5.4.2.1.

Based on a point source, a simple calculation shows that for a shield thickness of 9.8 inches (the length of the plug and approximate distance from the source to the face of the shell assembly), the attenuation in tungsten alloy is of order of 10^{10}, that in lead of order 10^7, and in steel of order 10^4. With the highest leakage path being that through the annulus of steel, a comparative measure of attenuation between the new and the original arrangement can be made by treating the steel annulus as a streaming path. The annulus is thinner in the new arrangement. To determine the relative streaming, the following expression [(1)] for the ratio of entering to leaving gamma flux was used and taken as proportional to the corresponding dose rates:

[(1)] Source: T. Rockwell, Reactor Shielding Manual, pg. 293