71-5753 PDR

Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, Tennessee 37830

November 14, 1979

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U. S. Nuclear Regulatory Commission
NMSS
Mail Section

U. S. Nuclear Regulatory Commission
ATTN: Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle & Material Safety
Washington, D. C. 20553

Gentlemen:

SAFETY ANALYSIS REPORT FOR PACKAGING FOR THE ORNL LOOP TRANSPORT CASK - REPORT ORNL/ENG/TM-11.

Reference is given to the subject SARP and to your Docket No. 71-5753.

In reply to the specific additional information which you requested, ORNL prepared the enclosed supplemental data. The data have been reviewed by the DOE-ORO Safety and Environmental Control Division and we fully concur with the conclusion.

We request your early review.

Sincerely,

William H. Travis

William H. Travis, Director
Safety & Environmental Control Division

MS-334:WAP

Enclosure:
Supplemental Data (9 copies)

cc w/encl.: T. H. Hardin, AD-46
D. M. Ross, G-135, HQ-GTN
cc w/o encl.: C. A. Keller, MS-30

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FEE EXEMPT

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Structural - We were not aware of any regulatory requirement for evaluation of packages at low service temperatures with respect to the free fall accidents. However, the cask will comply with the requirements of the regulations if subjected to the free fall accidents at -20°F. It was concluded that rupture of the outer shell was credible (see pages 99 and 132) as a result of the hypothetical accident at normal temperatures. It was postulated that the lead which melted would be lost and the resulting loss of shielding evaluated (see section 4.2). A catastrophic, cast iron type failure of the shell would not occur with materials in thickness range (.68" max thickness) employed in the loop cask at -20°F. This is because the cooling rate, after hot rolling, from the austenitizing temperature would be rapid enough to assure a microstructure which will exhibit adequate toughness at temperatures as low as -20°F. This fact is recognized by the ASME Code, Section III which does not require toughness testing for 5/8" and thinner materials (see paragraph NB 2311 a1). Also the probability of an impact accident followed by a fire at -20°F is very low.

Thermal - The damage from the impact (30 foot free fall and puncture) would be local in nature hence would not significantly affect the response of the cask to the thermal component of accident. The worst case "loss of shielding" was considered since the calculated loss from a side impact was greater than the combination corner impact and loss due to melting in the corner. It is noted that calculations show that melting is confined to the corner.

Containment - It should be recognized that the loop transport cask is a general purpose package which is used to transport a variety of material (see Section 0.2.3). Hence containment vessels are designed or existing vessels evaluated when the need arises. As stated in the SARP the primary containment vessels

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are designed in accordance with Section VIII of the ASME Code and DOT specification 2R (see Section 1.8). The inspections and tests required by the code are therefore a normal part of the fabrication. Routine inspections of the containment vessel are outlined on the ORNL Radioactive Materials Packaging Information form (see page 211 of the SARP) under the heading "Internal Container". Two typical containers were tested to demonstrate compliance with the impact tests (see section 3.3 and Appendix D). Calculations in the SARP demonstrate compliance with the other requirements of 10CFR, part 71.

Criticality - We have considered the effect of lead as a reflector on the contents of the subject cask. We found that for the proposed loadings of the cask there is no significant increase in the k-eff of the cask due to the presence of lead as a shielding material.

The analysis used the KENO IV Monte Carlo Criticality Code[1] with the Hansen-Roach cross-section sets.[2] This combination of code and cross sections meets the requirements of the American National Standard ANSI N16.11 on Validation of Calculational Methods for Nuclear Criticality Safety.

The cask was modeled as described in the SARP. It is known[3] that lead is a more effective reflector for systems having a high median energy of fission, thus rather than consider fissile materials "optimally moderated," the effect to be examined is emphasized if the fissile material is modeled as metal spaced in water to produce a k-eff larger than one may credibly expect. The metal was described as a rod having an 0.4-cm-diameter and a length of 1.7 m, resulting in a mass of 396 g U(93.2), or 388 g $^{233}U$ or 410 g $^{239}Pu$. The cask contained a loading of nine rods on 2.9 cm centers in a square matrix with and without water as a moderator. The results of the calculations appear in the following table. The cask was considered submerged.

Calculated k-eff for the ORNL Loop Transfer Cask for Various Fissile Materials

| Cask Loading Material | Mass, kg | Water in Cavity | k-eff | $\pm\sigma$ |
|---|---|---|---|---|
| U(93.2) | 3.6 | Yes | 0.463 | 0.007 |
| | | No | 0.083 | 0.002 |
| $^{233}U$ | 3.5 | Yes | 0.548 | 0.006 |
| | | No | 0.128 | 0.003 |
| $^{239}Pu$ | 3.7 | Yes | 0.484 | 0.006 |
| | | No | 0.131 | 0.003 |

Three additional calculations of the cask were performed with the U(93.2) loading. In one, the external reflector was removed and an $\infty \times \infty \times \infty$ array of packages was calculated. The resultant $k_\infty$ was 0.595 $\pm$ 0.010. The second was the same case but with the lead replaced by water giving a $k_\infty$ of 0.474 $\pm$ 0.006. The third was the same as the first entry of the table but having water in place of the lead in a single package. This gave a k-eff of 0.457 $\pm$ 0.005.

In summary, it is concluded that the lead is not a significant source of additional reactivity to the loaded cask and that the cask does satisfy the requirements of Fissile Class I package for its intended use.

REFERENCES


1. L. M. Petrie and N. F. Cross, KENO IV - An Improved Monte Carlo Criticality Program, ORNL-4938 (November 1975).
2. G. E. Hansen and W. R. Roach, Six and Sixteen Group Cross Sections for Fast and Intermediate Critical Assemblies, LAMS-2542 (1960).
3. H. C. Paxton, J. T. Thomas, D. Callihan, and E. B. Johnson, Critical Dimensions of Systems Containing $U^{235}$, $Pu^{239}$, and $U^{233}$, TID 7028 (June 1964).

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|---|---|---|---|---|
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| | | No | 0.083 | 0.002 |
| $^{233}U$ | 3.5 | Yes | 0.548 | 0.006 |
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