Department of Energy
Washington, DC 20585

March 5, 2020

Mr. John McKirgan, Chief
Storage and Transportation Licensing Branch
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Two White Flint North – Mail Stop 4 B34
11555 Rockville Pike
Rockville, MD 20852-2738

Dear John McKirgan:

This letter is the certificate holder's notification to NRC, in accordance with §71.7(b), of a non-conservative error in the Hypothetical Accident Condition (HAC) thermal analysis in Safety Analysis Report for Packaging: *ORNL HFIR Unirradiated Fuel Element Shipping Container, ORNL/TM-11656*, Revision 11, June 2018, for the HFIR Unirradiated Fuel Element Shipping Containers. This Type B(U)F package design is certified by NRC Certificate of Compliance No. 5797, Rev. 20 (Docket 71-5797).

During a recent review of the Safety Analysis Report (SAR), non-conservative values were identified in association with the HAC thermal test damage conditions for side plates of both the inner and outer HFIR fuel elements. The consequences of the error are a greater potential releasable inventory during HAC thermal due to greater damage to the fuel elements, and exceeding the HAC containment criteria for the Outer HFIR Container.

This error was discovered by the Oak Ridge National Laboratory (ORNL) on February 19, 2020 and reported to DOE on February 20, 2020. DOE contacted the HFIR registered users on February 20, 2020 to immediately suspend use of the package until further notice. DOE also confirmed at that time there were no shipments in progress. This error applies to all prior shipments of licensed material in the Outer HFIR Unirradiated Fuel Element Shipping Container; however, DOE does not believe the error is significant with respect to public health and safety or common defense and security.

The two dimensions used in error appear in SAR Chapter 3, Appendix B, page B-4 which indicates an outer side plate thickness of 0.408 inch for the outer fuel and on page B-8 which indicates 0.377 inch thickness for the outer side plate of the inner fuel element. The safety significance of the outer side plate thickness is that before heat from the HAC thermal test can begin to melt fuel plates, it must first melt through the outer side plate. The side plate dimensions used in Appendix B calculations are from fabrication drawings E-42125, Rev. J and E-42117, Rev. H. Appendix B should have used the final machined dimensions from Note 5 on the assembly drawing E-42126 Rev. N and E-42118, Rev R which require a minimum outer side plate thickness of 0.128 inch for the outer fuel element and 0.105 inch thickness for the outer side plate of the inner fuel element. The reduced thickness increases the exposure time to melt fuel plate cladding which causes the fraction of exposed fuel-bearing material to increase from 13 percent to approximately 24 percent for outer fuel

assembly and 22 percent for the inner fuel assembly. Noting the prior fuel melt analysis in SAR Chapter 3, Appendix B assumed an initial condition of 70°F, the above assessment for the fraction of fuel-bearing melt incorporates the initial condition of the maximum package NCT of 169°F as identified in Chapter 3, Section 3.4.2. The net effect of the NCT adjustment contributed approximately 1.5 percent to the fuel-bearing exposure result.

The only other instance in the SAR regarding the outer plate thickness is in Chapter 2, Appendix C, pages 5 and 6. The correct plate thicknesses were used for the geometry of the outer and inner fuel elements in the structural evaluation of the package.

The increased damage to the outer fuel element from 13 percent to 24 percent exceeds the HAC containment criteria in Chapter 4, Section 4.3.3., pages 4-7 and 4-8, of 16 percent (max. damage), which ensures compliance with §71.51(a)(2). The increased damage to the inner fuel element is still in compliance with the HAC containment criteria of 40 percent (max. damage). The inventory release fraction used in the SAR was a conservative approach based on an A_2 value of 0.1 Ci (U enriched 20% or greater) from an earlier edition of Table A-1 of Appendix A to Part 71 and the generic specific activity concentration of 9.1 x 10^{-5} Ci/g determination from Table A-4 of Appendix A to Part 71 for uranium enrichment weight percent greater than 95 (Chapter 4, page 4-3). However, a specific approach using the mixture and determining the percentage of the exposed fuel inventory in the outer fuel element is applied to the case for the revised fuel melt condition.

$$Fraction\ of\ unclad\ fuel * \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

The listed radioactive content percentages from the fuel specification are indicated in Chapter 1, page 1-4 as 1.010 percent for U-234, 0.389 percent U-236, and 93.164 percent for U-235. The content is U_3O_8 described as slow lung absorber with a corresponding A_2 value of 6.0 x 10^{-3} TBq for U-234 and U-236 (the remaining U-235 and U-238 are unlimited with respect to A_2). The U-235 loading of an outer fuel element is conservatively estimated as 6880 grams which corresponds to a total uranium loading of 7385 grams. Using the specific activities of 2.3 x 10^{-4} TBq/gram for U-234 and 2.4 x 10^{-6} TBq/gram for U-236 and the mass percentage of each contributor indicates the fraction of unclad fuel that is less than an A_2 value is 0.348 (34.8 percent of outer element uranium inventory).

$$0.348_{Fraction\ of\ unclad\ fuel} \leq \frac{1}{\frac{7385\ g(U) * ([2.3x10^{-4} * 0.0101]_{U234} + [2.4x10^{-6} * 0.00389]_{U236})TBq/g}{6.0x10^{-3}TBq}}$$

The corrected HAC thermal evaluation indicated that 24 percent of the cladding containment boundary for the fuel meat would be compromised and assumed released. The 24 percent of uncontained fuel meat is less than the allowable release fraction of 34.8 percent based on the regulatory release limit specified in 10CFR71.51(a)(2). Therefore, the package design continues to meet 10 CFR Part 71.

Based on the evaluation above, DOE requests NRC to continue to authorize of use of the package for shipment of licensed material in accordance with CoC 5797, Rev. 20, until July 31, 2020, while DOE prepares a simple amendment request to correct errors in the SAR. The package is needed at this time for shipment of fresh fuel loading for DOE HFIR.

If you have any questions or need more details please call at 301-903-5513 or james.shuler@em.doe.gov.

Dr. James M. Shuler

Manager, DOE Packaging Certification Program
U.S. Department of Energy
Office of Packaging and Transportation
EM-4.24, 270CC – Rm 3113
Washington, DC 20585

CC: ATTN: Document Control Desk
Director, Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Mr. Pierre M. Saverot, Project Manager
James C. Barnard, Jr., SC-OSO
Gregory J. Hirtz, ORNL