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

March 18, 2020

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

SUBJECT: AUTHORIZATION FOR SHIPMENTS USING THE MODEL NO. INNER HFIR UNIRRADIATED FUEL ELEMENT SHIPPING CONTAINER, AND OUTER HFIR UNIRRADIATED FUEL ELEMENT SHIPPING CONTAINER

Dear Dr. Shuler:

By letter dated March 5, 2020, you notified the U.S. Nuclear Regulatory Commission (NRC), in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 71.7 (b), of a potential non-conservative error in the hypothetical accident condition thermal analysis of the High Flux Isotope Reactor (HFIR) package design, Certificate of Compliance (CoC) No. 5797.

Based on our confirmatory review of your evaluation, the staff concurs that the package design continues to meet 10 CFR Part 71 requirements. The continued use of the package is authorized by the current CoC, Revision No. 20, without any additional condition. The NRC staff expects the corrections to the application to be submitted as part of an amendment request. This authorization is valid until July 31, 2020.

If you have any questions regarding this authorization, please contact Pierre Saverot of my staff at (301) 415-7505.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

/RA/

John McKirgan, Chief
Storage and Transportation Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-5797
EPID - L-2020-LLL-0003
Enclosure: Safety Evaluation Report

cc w/encl: R. Boyle, Department of Transportation

SUBJECT: AUTHORIZATION FOR SHIPMENTS USING THE MODEL NO. INNER HFIR UNIRRADIATED FUEL ELEMENT SHIPPING CONTAINER, AND OUTER HFIR UNIRRADIATED FUEL ELEMENT SHIPPING CONTAINER, DOCUMENT DATED:

DISTRIBUTION: SFST r/f ADimitriadis, RI; BDesai, RII; MKunowski, RIII; GWarnick, RIV

G:/SFST/Saverot/71-5797/Authorization Letter.doc

ADAMS Accession No.: ML20076C005

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UNITED STATES
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Safety Evaluation Report
U.S. Department of Energy
Docket No. 71-5797
Model No. Inner HFIR Unirradiated Fuel Element Shipping Container,
and Outer HFIR Unirradiated Fuel Element Shipping Container

BACKGROUND

During a recent review by the Oak Ridge National Laboratory (ORNL) of the Safety Analysis Report (SAR) of the Model No. Inner High Flux Isotope Reactor (HFIR) Unirradiated Fuel Element Shipping Container, and Outer HFIR Unirradiated Fuel Element Shipping Container (Docket No. 71-5797), non-conservative values were identified in association with the hypothetical accident conditions (HAC) thermal test damage conditions for side plates of both the inner and outer HFIR fuel elements.

The U.S. Department of Energy (DOE) suspended the use of the package and noted that this error applied to all prior shipments of licensed material in the Outer HFIR Unirradiated Fuel Element Shipping Container. However, the DOE does not believe the error is significant with respect to public health and safety or common defense and security.

EVALUATION

The ORNL HFIR Unirradiated Fuel Element Shipping Container is a Type B(U)F package, with contents described as U_3O_8-Al cermet, enriched up to 95% in U^{235}, and clad in aluminum. U^{234} and U^{236} have both a corresponding A_2 value of 6.0 x10^{-3} TBq, with the remaining U^{235} and U^{238} being unlimited with respect to A_2.

The ORNL identified that the pre-machined plate thickness was used, instead of the final thickness, in the analysis for the side plates of both the inner and outer HFIR fuel elements. As such, the reduced thickness increases both the exposure time to melt the fuel cladding and the fraction of exposed/unclad fuel, and consequently the A_2 results.

The ORNL performed a defense in depth evaluation of the necessary corrections to the side plate thickness and then used an initial temperature of 169°F, instead of the existing assumed initial condition of 70°F for normal conditions of transport (NCT). The ORNL explained that, with the elevated initial temperature, the erosion rate for the clad, or the side plate, changes from 1.80 to 1.90 in/hour. The inner element plate fuel-bearing section rate of consumption increases from 1.55 to 1.62 in/hour, while the outer element plate fuel-bearing section rate of consumption increases from 1.56 to 1.64 in/hour, with NCT conditions applied. The NCT condition does effectively increase the corrosion rate beyond what was presented in the SAR. Hence, as stated by the DOE in its March 5, 2020, letter, the error of the side plate increased exposed fuel-bearing material from 13% to approximately 24% for the outer element and the NCT adjustment was a contributor to melt of approximately 1.5%.

The outer fuel meat exposure time is significantly increased by the correction to the side plate thickness, but the actual fuel plate exposure only changes by 0.005 hours, when applying NCT conditions.

The revised thermal calculation results indicate that:

(a) the fraction of unclad fuel for the thinner plate (from 0.377 to 0.105 inch) of the inner fuel assembly is increased from 13% to 22% which is below the containment criteria limit of 40%. The ORNL noted that the 22% result is the effect from thinner plates and from using a 169°F initial condition. Using the same initial conditions than those in the current SAR, the damage change with the thinner plate (0.377 to 0.105 inch) results in a damage from 13% to approximately 20% for the inner fuel assembly, and

(b) the fraction of unclad fuel for the thinner plate (from 0.408 to 0.128 inch) of the outer fuel assembly is increased from 13% to 24% which is above the containment criteria limit of 16%. The 24% result is the effect from thinner plates and from using a 169°F initial condition. Using the same initial conditions than those in the current SAR, the damage change with the thinner plate (from 0.408 to 0.128 inch) results in a damage from 13% to approximately 23% for the outer fuel assembly.

Thus, the error is not safety significant with respect to public health and safety or common defense and security, and there is no loss of radioactive contents exceeding A_2 in one (1) week under HAC.

After performing a confirmatory analysis, the staff finds that:

- the numbers (e.g., A_2 values, specific activities, and content percentages of U^{234}, U^{235}, U^{236} and U^{238}) used in the revised calculation are consistent with the numbers listed in Tables in Part 71 Appendix A and are acceptable for the revised calculation,
- the increased fraction of unclad fuel to the inner fuel assembly from 13% to 22% is still in compliance with the HAC limit of 40% (maximum allowable damage),
- the increased fraction of unclad fuel to the outer fuel assembly from 13% to 24% (over the HAC limit of 16%) is still acceptable because the fraction of unclad fuel of 24% is below the criteria of 34.8% which corresponds to the limit of 10 CFR 71.51(a)(2). Therefore, the fraction of unclad fuel of 24% will not lead to any escape of radioactive material exceeding a total amount of A_2 in 1 week, and
- the result from the staff's confirmatory calculation matches very well with the results from the ORNL revised calculation.

CONCLUSIONS

Based on the statements and representations in the DOE letter dated March 5, 2020, the staff agrees that the continued use of the Model No. Inner HFIR Unirradiated Fuel Element Shipping Container, and Outer HFIR Unirradiated Fuel Element Shipping Container, under its current CoC, meets the requirements of 10 CFR Part 71.

Issued on March , 2020.