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

January 12, 2017

Mr. Richard W. Boyle
Radioactive Materials Branch
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

SUBJECT: CERTIFICATE OF APPROVAL NO. CDN/2048/B(U)F FOR THE MODEL NO. F-257 (SERIAL NO. 2) PACKAGE

Dear Mr. Boyle:

This is in response to your letter dated September 8, 2016, requesting our assistance in evaluating the Model No. F-257 (Serial No. 2) transport package, authorized by Canadian Certificate of Approval No. CDN/2048/B(U)F, Revision 9.

Based upon our review, the statements and representations contained in the application and in the "Model No. F-257 Shipping Flask: Safety Analysis Report," and for the reasons stated in the enclosed Safety Evaluation Report, we recommend revalidation of Canadian Certificate of Approval No. CDN/2048/B(U)F, Revision 9, for the Model No. F-257 (Serial No. 2) package, with the following additional conditions:

(A) Total Package Weight: 6,960 pounds

(B) Contents:

Transport of the University of Alberta SLOWPOKE-2 research reaction core is authorized, consistent with the following specifications:

Type, Form, and Maximum Quantity of Material per Package

Type of Nuclear Reactor Assemblies:	SLOWPOKE – 2
Fuel Element Type:	Pin
Maximum mass of assembly	5059.6 grams
Maximum number of fuel elements per package:	297 fuel pins
Maximum fuel element length:	22.83 cm
Maximum fuel element outer diameter:	0.61 cm
Maximum decay heat per package:	1 watt
Maximum initial enrichment, weight percent U-235:	93.19%
Maximum initial mass, U-235:	831.16 grams
Maximum initial mass, Uranium:	892 grams
Maximum burnup Kwh / fuel core:	122,000
Minimum cooling time:	14 days

(B) Minimum Transport Index for Criticality Control: 100

(C) Periodic Leakage Test:

Completion of a periodic leakage test in accordance with ANSI N14.5, to verify a leakage rate not to exceed 1 X 10^{-7} std-cm^3/s within one year prior to shipment.

If you have any questions regarding this matter, please contact me or Huda Akhavannik of my staff at (301) 415-5253.

Sincerely,

/RA/

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

Docket No. 71-3054
TAC No. L25153

Enclosure: Safety Evaluation Report

(B) Minimum Transport Index for Criticality Control: 100

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DATE	12/02/16	12/07/16	12/02/16	12/06/16	1/10/16	1/10/16	12/22/16	01/12/17

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SAFETY EVALUATION REPORT
Docket No. 71-3054
Model No. F-257 Package (Serial No. 2)
Certificate of Approval No. CDN/2048/B(U)F
Revision 9

SUMMARY

By letter dated September 8, 2016, the U.S. Department of Transportation (DOT) requested review and recommendation regarding revalidation of Canadian Certificate of Approval No. CDN/2048/B(U)F, Revision 9, for the Model No. F-257 (Serial No. 2) package. DOT provided the following documents with its letter dated September 8, 2016:

1. Canadian Competent Authority Certificate of Approval No. CDN/2048/B(U)F, Revision 9, dated July 29, 2016.
2. Safety Analysis Report (SAR) on Model No. F-257 Shipping Flask, dated February 1986, Atomic Energy of Canada Limited (AECL).
3. United States Department of Energy Spent Nuclear Fuel Acceptance Criteria, dated August 30, 2016.
4. UASF Decommissioning Out-Of-Core Criticality Safety Assessment, dated August 9, 2016.
5. UASF Decommissioning Radiation Physics Assessment, dated August 19, 2016.

Separately, the DOT provided an update to the, “United States Department of Energy Spent Nuclear Fuel Acceptance Criteria,” dated December 22, 2016.

The NRC has reviewed and recommended revalidation to the DOT on two different occasions with respect to this package. Both times, the package contained SLOWPOKE-2 research reactor cores with slightly different characteristics. The first recommendation of revalidation to the DOT was in a letter dated March 29, 2000 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML003698735) and the second recommendation of revalidation to the DOT was in a letter dated February 14, 2011 (ADAMS Accession No. ML110450346.) Staff used the previous safety findings in those reviews, in addition to the application material provided to staff from the DOT, to evaluate their recommendation for this revalidation request.

Based on the statements and representations in the information provided by DOT and AECL, the staff recommends that Certificate of Approval No. CDN/2048/B(U)F, Revision 9, dated July 29, 2016, be revalidated for the contents listed below (see Contents).

1.0 GENERAL INFORMATION

The packaging consists of an inner container (flask) and an impact limiting fire shield overpack. The inner container is a stainless steel encased lead cylinder, with a removable top plug attached by eight 5/8-inch diameter bolts. The container is sealed by a silicone O-ring. The

overpack consists of a capped, double carbon-steel wall cylinder mounted on a disk base. External fins are welded to the outer skin to provide heat transfer and impact energy absorption. Lifting lugs are integral with four of the heat transfer fins. The cylinder is attached to the base disk by eight 1-inch diameter bolts.
The inner container is mounted on the disk of the overpack by four steel brackets and eight 3/4-inch diameter bolts. The overall dimensions of the overpack are approximately 60-inches high by 49.5-inches diameter.

1.1 Contents

Transport of the University of Alberta SLOWPOKE-2 Facility Reactor (UASF) core is authorized, consistent with the following specifications:

(A) Total Package Weight: 6,960 pounds

(B) Contents:

Transport of the University of Alberta SLOWPOKE-2 research reaction core is authorized, consistent with the following specifications:

Type, Form, and Maximum Quantity of Material per Package

Type of Nuclear Reactor Assemblies:	SLOWPOKE – 2
Fuel Element Type:	Pin
Maximum mass of assembly	5059.6 grams
Maximum number of fuel elements per package:	297 fuel pins
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Maximum initial mass, Uranium:	892 grams
Maximum burnup Kwh / fuel core:	122,000
Minimum cooling time:	14 days

(B) Minimum Transport Index for Criticality Control: 100

(C) Periodic Leakage Test:

Completion of a periodic leakage test in accordance with ANSI N14.5, to verify a leakage rate not to exceed 1 X 10^{-7} std-cm^3/s within one year prior to shipment.

3.0 THERMAL

The applicant stated in Section 5.1.2 of the, “UASF Decommissioning Radiation Physics Assessment,” report that the Model No. F-257 package is to be used for transport of a UASF core. The UASF core is within the Model No. F-257 package with a heat load limit of 1 Watt after a-14 day cooling period.

The staff reviewed the, “UASF Decommissioning Radiation Physics Assessment,” report and determined that the previous normal conditions of transportation (NCT) and hypothetical

accident conditions (HAC) thermal analyses, previously recommended for revalidation by NRC, are still valid for this revalidation and there is no significant impact or change to the heat removal capability of the Model No. F-257 package because the package thermal configuration remains unchanged and the maximum heat load is still equal to or less than 1 watt with a cooling period of 14 days.

The staff also finds that the Model No. F-257 package, loaded with the UASF core, will not result in over-pressurization due to its low heat load limit of 1 watt.

5.0 SHIELDING

The UASF is a 20-kW pool type reactor with a light water moderator, 93% enriched uranium core. The core is surrounded by a beryllium reflector and is cooled by natural convection of the moderator water. The source term of previously approved Dalhousie University reactor with operating history 313,060 kWh, which is equivalent to 156,530 flux-hours at 10^{11} n/cm2/s flux, is a factor of 2.6 higher than the UASF operating history (61,000 hours at 10^{11} n/cm2/s flux). From this value, staff calculated the burnup to be 122,000 kWh.

Also the previous revalidation for the Model No. F-257 package approved by the staff was for transport of the University of Toronto SLOWPOKE-2 core, which had a total burnup higher than the UASF core of 297,208 kWh and 11.5 cooling days. The following documents the staff's evaluation of the change in the source term from the previous revalidations.

The Model No. F-257 package is designed to transport a SLOWPOKE-2 research reactor core. The shielding evaluation provided in the, "UASF Decommissioning Radiation Physics Assessment," report was performed with MCNP code and SCALE code to determine the radiation source terms for UASF reactor. The MCNP model includes the core, beryllium reflectors, and pool floor and evaluates the irradiation fluxes in the core, reflector and the pool.

The design basis source term for the UASF core fuel assumes a total core loading of 830 g U-235 (300 pins), an irradiation history of 2 kW for 5 years followed by 20 kW for 10 hours, and a cooling time of 11.5 days. Table 5.7 of the, "UASF Decommissioning Radiation Physics Assessment," report evaluates the following maximum external dose rates for the SLOWPOKE-2 Model No. F-257 package (including the fire/crush shield) during NCT:

Parameter Location Dose Rate	**(μSv/h)**	**mrem/hr**
Gamma dose rate near contact with the flask proper	130	13
Near contact with the fire shield	13	1.3
1 m from the flask proper	7	0.7
1 m from the fire shield	2	0.2
Neutron dose rate near contact with flask	4E-04	4E-05
Near contact with fire shield	6E-05	6E-06

Under the 1973 version of IAEA that the applicant is licensed, Section 508 does not require a 2 m reading, which is now required under the current IAEA regulations. The package can have a dose of up to 1000 mrem/hr at the surface. If it exceeds 200 mrem/hr at the surface, or if the transport index exceeds 10, then the package is shipped exclusive use.

The staff independently verified the applicant's conclusion by calculating a source term for the UASF fuel using SCALE 6.1. The staff agrees that the UASF fuel is bounded by the design basis fuel in the SAR. Furthermore, the staff performed a MCNP shielding evaluation of the package with the UASF fuel and found that the calculated dose rates around the package are well below those completed as part of staff confirmatory review in the previous revalidation for the University of Toronto SLOWPOKE-2 core. Therefore, staff concludes that the UASF is bounded by the previous evaluation of University of Toronto SLOWPOKE-2.

The staff concludes that the shielding analyses demonstrated that the external dose rates for the package, containing the UASF core with a total over 27 years with the reactor operating for ~61,000 hours, meets the requirements of IAEA Safety Series No. 6, 1973 Revised Edition (As Amended).

6.0 CRITICALITY

The Model No. F-257 package is to be used for the transport of the UASF core. The contents of the current UASF core are bounded by a previously approved supplemental criticality analysis. Staff had previously approved supplemental criticality analysis provided by the applicant which evaluated a single package under both NCT and HAC (ADAMS Accession No. ML003724099). The contents of supplemental Model No. F-257 package analysis were modeled as a full SLOWPOKE-2 reactor core consisting of 342 fuel pins, 957.6 grams of U-235, and an initial enrichment of 93.5 wt.% U-235. The current UASF core planned for transport contains 297 fuel pins, a maximum 831.16 grams of U-235, and a maximum initial enrichment of 93.19 weight-percent U-235. Therefore, as demonstrated by the previous revalidation in 2000, the staff concludes that the UASF core can be safety transported in adherence the requirements of IAEA Safety Series No. 6, 1973 Revised Edition (As Amended).

CONCLUSION

Based on the statements and representations contained in the documents referenced above (see SUMMARY), and the conditions listed above (see Contents), the staff concludes that the Model No. F-257 (Serial No. 2) package meets the requirements of IAEA Safety Series No. 6, 1973 Revised Edition (As Amended).

Issued with letter to R. Boyle, Department of Transportation,
on January 12, 2017.