February 14, 2011

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 October 20, 2010, 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 7.

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 7, for the Model No. F-257 (Serial No. 2) package, with the following additional conditions:

(A) Contents:

Transport of the Dalhousie University 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 contents:	5234 grams
Maximum number of fuel elements per package:	297 fuel pins
Maximum fuel element length:	22 cm
Maximum fuel element outer diameter:	0.61 cm
Maximum decay heat per package:	1 watt
Maximum initial enrichment, weight percent U-235:	93.5%
Maximum initial mass, U-235:	825 grams
Maximum initial mass, Uranium:	886 grams
Maximum burnup Kwh / fuel core:	313,000

Minimum cooling time: 530 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) 492-3273.

Sincerely,

/RA/

Michele Sampson, Acting Branch Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-3054
TAC No. L24482

Enclosure: Safety Evaluation Report

(B) Minimum Transport Index for Criticality Control: 100

(C) Periodic Leakage Test:

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Docket No. 71-3054
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Enclosure: Safety Evaluation Report
Distribution: HAkhavannik, RParkhill, CHrabal, MDeBose, DJackson, MRahimi, MSampson, BWhite
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NAME	HAkhavannik	RParkhill	CHrabal	MDeBose	RParkhill on behalf of DJackson (email)	MRahimi (email)	MSampson
DATE	02/08 /11	02 /09 /11	02/10 /11	02 /09 /11	02/10 /11	02/11 /11	02/14 /11

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 7

SUMMARY

By letter dated October 20, 2010, 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 7, for the Model No. F-257 (Serial No. 2) package. DOT provided the following documents with its letter dated October 20, 2010:

1. Canadian Competent Authority Certificate of Approval No. CDN/2048/B(U)F, Revision 7, dated August 20, 2008.
2. Safety Analysis Report (SAR) on Model No. F-257 Shipping Flask, dated February 1986, Atomic Energy of Canada Limited.
3. United States Department of Energy Spent Nuclear Fuel Acceptance Criteria, dated July 27, 2010.
4. Operating Procedure on Preparation for Shipment of the F-257 Transport Package, dated September 2004.
5. Drawing No. SLWPKE-F125701-4, dated November 2004.

DOT provided the following documents separately dated October 22, 2010, and December 16, 2010:

1. AECL Memo on Decay Heat Calculations for the Dalhousie University SLOWPOKE–2 Reactor (DUSR), dated April 13, 2010.
2. Response to Request for Additional Information dated December 7, 2010.

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 7, dated August 20, 2008, be revalidated for the contents listed below (see Contents).

1.0 GENERAL INFORMATION

1.1 Packaging

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, with a gross weight of the flask and overpack of 3160 kg.

1.2 Contents

Transport of the Dalhousie University SLOWPOKE-2 research reactor 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 contents:	5234 grams
Maximum number of fuel elements per package:	297 fuel pins
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Maximum initial enrichment, weight percent U-235:	93.5%
Maximum initial mass, U-235:	825 grams
Maximum initial mass, Uranium:	886 grams
Maximum burnup Kwh / fuel core:	313,000
Minimum cooling time:	530 days

Transport Index for Criticality Control

Minimum Transport Index to be shown on label for nuclear criticality control:	100

3.0 THERMAL

The F-257 package is to be used for the transport of a reactor core from a SLOWPOKE-2 research reactor from Dalhousie University. The previously authorized content for the F-257 package from the University of Toronto was limited to a decay heat load of one watt. The Dalhousie reactor has been shut down for more than 2 years which results in a decay heat loading of less than one watt. However, the Dalhousie reactor core will have safety tests performed for a period of 4 or 8 hours of reactor operation prior to its shipment. These safety tests result in heat loads exceeding one watt during the testing period but evidence provided by the applicant demonstrates that this heat load will reduce to less than one watt after only one day cooling due to the relatively fast decay of the short lived fission products resulting from the short operation period.

Therefore, the staff concludes that the Dalhousie University reactor core for the SLOWPOKE-2 research reactor can be safely transported in accordance with IAEA standards provided it is limited to a total decay heat loading of less than 1 watt which is in accordance with the previous revalidation in 2000.

5.0 SHIELDING

The applicant requests a revalidation of the Certificate of Compliance for the Model No. F-257 package to transport the SLOWPOKE-2 research reactor core from Dalhousie University in Canada. The Dalhousie University SLOWPOKE-2 Reactor (DUSR) fuel contains 822 g U-235 and has an associated source term from an irradiation history with a total burnup exceeding ~313,000 kWh over 23 years with the reactor operating for ~40,000 hours. The previous revalidation for the F-257 package approved by the staff was for transport of the University of Toronto SLOWPOKE-2 core, which had a total burnup less than the DUSR of 297,208 kWh. The following documents the staff's evaluation of the change in the source term from the previous revalidation.

The Model No. F-257 package is designed to transport a SLOWPOKE-2 research reactor core. The shielding evaluation provided in SAR Appendix II was performed with hand calculations using shielding curves for mixed fission products. The design basis source term for the SLOWPOKE-2 fuel assumes a total core loading of 830 g U-235, an irradiation history of 2 kW for 5 years followed by 20 kW for 10 hours, and a minimum cooling time of 1 day. Given the high enrichment of the fuel, the neutron source is negligible. SAR Appendix II calculates the following maximum external dose rates for the Nordion F-257 package (including the fire/crush shield) during normal conditions of transport:

	Contact (mrem/hr)	1 meter (mrem/hr)
Sides	69	10.5*
Top	2.4	0.4
Bottom	30	3.2

*Note: The applicant is licensed to the 1973 version of the IAEA regulations (Regulations for the Safe Transport of Radioactive Material, 1973 Edition, Safety Series No. 6, IAEA, Vienna). Under this version, 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 package was subjected to the hypothetical accident conditions in accordance with the requirements of Safety Series 6, paragraph 542. Portions of the fire/crush shield were crushed following the testing but the fire/crush shield remained in place. The flask itself remained intact, but some lead slump was identified at the bottom of the package. The applicant demonstrated through a radiation shielding test in SAR Appendix VI that dose rates outside the package following accident conditions are higher than normal conditions, but still well below the limits of paragraph 542. The results at the bottom, which experienced the loss of shielding due to lead slump, were significantly less than the results at the sides of the package.

As part of its confirmatory review in the previous revalidation for the University of Toronto SLOWPOKE-2 core, the staff independently calculated the source term and shielding capabilities of the Nordion F-257 package containing design basis SLOWPOKE-2 fuel. The source term and shielding evaluation were performed using the SAS2H and SAS4 modules, respectively, of the SCALE 4.4 computer code. The staff's results were in good agreement with the results in SAR Appendix II.

As stated, the DUSR has a different source term than the previously revalidated University of Toronto SLOWPOKE-2 core. As part of the RAI response, the applicant demonstrated through calculations with ORIGEN-S and Microshield that the DUSR fuel is bounded by the design basis source term in the SAR. In addition, the gamma dose rates measured on contact and 1 m from the sides of the F-257 package are in good agreement with the calculated values. Because the dose rates on the sides of the package were significantly higher than the bottom in the SAR, even after assuming lead slump, the applicant only provided results for the sides in its RAI response. It should also be noted that while the overall burnup in the SAR is less than the

DUSR (87,800 kWh versus 313,000 kWh), the following conservative assumptions were made in the SAR: (1) no downtime was credited during operation of the core, and (2) a very short decay time following shutdown was assumed (1 day). These assumptions result in a higher fission product inventory and consequently more conservative dose rates that are significantly higher than the F-257 with the DUSR core.

The staff independently verified the applicant's conclusion by calculating a source term for the DUSR fuel using SAS2H. The staff agrees that the DUSR fuel is bounded by the design basis fuel in the SAR. Furthermore, the staff performed a SAS2H shielding evaluation of the package with the DUSR fuel and found that the calculated dose rates around the package are well below those presented in SAR Appendix II.

The staff concludes that the shielding analyses demonstrated that the external dose rates for the Nordion F-257 package, containing the DUSR research reactor with a total burnup exceeding ~313,000 kWh over 23 years with the reactor operating for ~40,000 hours, meets the limits in the IAEA regulation.

7.0 OPERATING PROCEDURES

The application included operating procedures for the package. The procedures include visual inspections of packaging components, reactor core loading procedures, an inner cavity purging procedure, closing the cavity, an assembly verification leak test, and radiation and contamination measurements.

In the previous revalidation in 2000, the applicant concluded, and staff agreed, that the low heat load of the University of Toronto SLOWPOKE-2 research reactor core will not result in excess cavity pressurization, if residual moisture were present, during shipment. Due to the same low heat load restrictions of the Dalhousie University SLOWPOKE-2 research reactor core, staff can conservatively make the same conclusion. The operating procedures have been used several times previously to transport SLOWPOKE-2 reactor cores within Canada. The staff concludes that the operating procedures meet the requirements of IAEA Safety Series No. 6.

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 February 14, 2011.