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

May 5, 2015

Mr. Richard Boyle, Chief
Radioactive Materials Branch
Office of Hazardous Materials
Technology
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590

SUBJECT: REVALIDATION OF THE MODEL NO. ASPECT 12K PACKAGE, CANADIAN PACKAGE DESIGN CERTIFICATE NO. CDN/2091/B(U)-96, REV. 0

Dear Mr. Boyle:

This refers to your request dated November 25, 2014, for a recommendation concerning the revalidation of the Model No. ASPECT 12K package, Canadian Certificate of Approval No. CDN/2091/B(U)-96, Revision 0.

Based on our review, the statements and representations contained in the application, as supplemented, and for the reasons stated in the enclosed safety evaluation report, we recommend revalidation of Canadian Package Design Certificate No. CDN/2091/B(U)-96, Rev. 0, dated November 19, 2014.

If you have any questions regarding this matter, I may be contacted at (301) 415-7493 or you may contact Huda Akhavannik at (301) 415-5253.

Sincerely,

/RA/ B. H. White for

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

Docket No. 71-3087
TAC No. L24966

Enclosure: Safety Evaluation Report

cc: J. Shuler, Department of Energy, c/o L. F. Gelder

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SAFETY EVALUATION REPORT
Docket No. 71-3087
Model No. ASPECT 12K Package
Canadian Package Design Certificate No. CDN/2091/B(U)-96
Revision 0

Summary

The Department of Transportation (DOT) requested NRC's recommendation concerning the revalidation of the Model No. ASPECT 12K package, Canadian Package Design Certificate No. CDN/2091/B(U)-96, Rev. 0. The package is currently licensed under the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1) by the Canadian Competent Authority. The package is designed to transport special form sources of Iridium-192, Selenium-75, Ytterbium-169, Cesium-137, and Cobalt-60. The package is 394 mm in diameter and 547 mm high. The maximum total authorized gross mass of the package is 149 kg. The package consists of an outer container and the choice of three possible inner containers: maxiBulk, miniBulk, and 10-Channel. The inner container contains a depleted uranium (DU) shield which surrounds the cavity that houses the special form sources.

Based on the statements and representations in the application, as supplemented, the NRC recommends revalidation of the Canadian Package Design Certificate No. CDN/2091/B(U)-96, Rev. 0, for use in the United States.

1.0 General Information

1.1 Package Description

1.1.1 Packaging

The package is designed to transport special form sources of Iridium-192, Selenium – 75, Ytterbium – 169, Cesium – 137, and Cobalt - 60. These special form sources provide the primary containment for the package. The package is 394 mm in diameter and 547 mm high. The maximum total authorized gross mass of the package is 149 kg. The package consists of a 16-gallon drum outer container and the choice of three possible inner containers: maxiBulk, miniBulk, and 10-Channel.

The outer container drum can be either stainless steel or 18 gauge steel and is lined with a monolithic thermal ceramic insulator. The drum is closed using a 1.2 mm steel cover that is secured by a clamp ring fastened by means of a bolt. Additionally, four bolt tabs are welded to the underside of the cover which are engaged by M8 bolts through the side wall of the container. A tamper indicating seal, fabricated from either plastic or wire, is attached to the clamp ring. Two handles attached to the outer container function as lifting and tie-down devices. The insulating liner leaves a cavity, 181 mm in diameter and 286 mm long, to hold the inner container. The cavity is supported by a galvanized or stainless steel cylinder and contains an optional foam spacer. The package allows for other accessory equipment to be transported

in the volume between the monolithic thermal ceramic insulation liner and the drum cover, provided that the maximum authorized mass limit is satisfied.

The inner containers are cylindrical in shape and are fabricated from a stainless steel shell. The inner containers use depleted uranium, encased in stainless steel, as shielding. Copper and brass separate the depleted uranium from the stainless steel to preclude the possibility of the formation of an iron-uranium eutectic alloy.

The Maxibulk inner container is 170 mm in diameter and 250 mm in height. It weighs 79 kg including 69 kg of DU. It is made from a shell which is welded closed at bottom with a plate and at the top with a ring all made of 300 series stainless steel. The DU shield is inside the shell and separated from the plates and shell using brass. The cavity is lined with steel and closed with a steel encased DU lid using two M8 stainless steel screws. A separate cover made from a steel plate keeps the lid in place using four M8 screws. The cavity is 31.6 mm in diameter and 72.5 mm long.

The Minibulk inner container is 140 mm in diameter and 180 mm in height. It weighs 37 kg including 31 kg of DU. It is made from a shell which is welded closed at the bottom with a plate and at the top with a ring all made of 300 series stainless steel. The ring is closed using two separate lids. The internal lid is a stainless steel encased DU lid closed with two M8 stainless steel screws and the external lid is closed with four M8 screws. The DU shield is inside the shell and separated from the plates and shell using brass. The cavity is lined with steel and it is 23.6 mm in diameter and 40 mm long.

The 10-Channel inner container is 180 mm in diameter and 280 mm high. It weighs 60 kg, including 52 kg of DU. It is made from a shell which is welded closed at bottom with a plate and at the top with a conical structure all made of 300 series stainless steel. The DU shielding is inside the shell and separated from the plates and shell using brass. The DU shielding is made of two separate parts, the DU shield and the DU shield insert. Ten channels are made in the DU to hold copper plated stainless steel source tubes. The source assemblies are held in the tubes using source hold down caps. A lid made from 3 mm shells and plates covers the caps. The special form source capsules are incorporated into the source holders to form the source assemblies. Each channel is 213.2 mm long and its diameter varies from 9 mm at the top to 6.8 mm at bottom.

1.1.2 Contents

A description of the contents is provided in the safety analysis report (SAR) and coincides with the contents approved by the Canadian Package Design Certificate No. CDN/2091/B(U)-96, Rev. 0.

The package is designed to contain special form capsules.

The following table lists the maximum radioactive materials that may be transported in each package configuration:

Isotope	mW/Ci	MaxiBulk			MiniBulk			10-Channel		
		Max Activity		Decay heat	Max Activity		Decay heat	Max Activity		Decay heat
		TBq	Ci	W	TBq	Ci	W	TBq	Ci	W
Iridium-192	8.59	250	6750	58	81	2212	19	56	1500	13
Selenium-75	5.12	370	10000	51	370	10000	51	56	1500	8
Ytterbium-169	5.38	56	1500	8	56	1500	8	56	1500	8
Cesium-137	6.97	250	6750	47	5.6	150	1	-	-	-
Cobalt-60	16.7	0.022	0.6	0.01	0.003	0.08	0.001	-	-	-

1.2 Appendix (Engineering Drawings)

Staff reviewed the drawings and found them to provide sufficient detail to adequately describe the package.

1.3 Findings

The TS-R-1 regulations with respect to the general information of this cask are listed in the enclosed table.

Staff reviewed the findings of the Canadian competent authority as well as the application. Based on review of the statements and representations in the application, the staff concludes the design has been adequately described and evaluated to meet the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1).

2.0 Structural Evaluation

According to the applicant, the ASPECT 12K package is 394 mm in diameter and 547 mm high. The application further describes that the maximum total authorized gross mass of the package is 149 kg and contains one of three possible inner containers: the maxiBulk container, the miniBulk container, and the 10-Channel container. As described in the applicant supplied SAR:

- Each inner container is cylindrical in shape and is fabricated using a stainless steel shell and depleted uranium for shielding. The inner container is housed inside the outer container. The outer container consists of a monolithic thermal ceramic insulation liner within a steel drum.

- The steel drum is fabricated from minimum 18 gauge (1.2 mm thick) steel or stainless steel. The outer container is closed by means of a minimum 18 gauge (1.2 mm thick)

steel cover and secured by a clamp ring head closure. Four bolt tabs are welded to the underside of the cover, and these are fastened by M8-1.25 x 16 mm bolts through the side wall of the container.

The staff reviewed and verified the accuracy of these details in the general arrangement of the ASPECT 12K package as shown in the SAR Figures 1.1 through 1.5, and the descriptive assembly drawings as shown in Appendix 1.3. As shown in the descriptive assembly drawing in Appendix 2.12.5, the center of gravity of the package is located experimentally 280 mm from the bottom of the package along the cylindrical axis.

The package is designed to comply with the requirements of TS-R-1(1996 Revised). The structural issues relevant to this package and the ability of the package to meet these regulations are also noted in the enclosed table.

2.1 Structural Findings

Staff reviewed the findings of the Canadian competent authority as well as the application. Staff verified that appropriate calculations or analyses were performed and verified that the margins of safety provided reasonable assurance that the package would perform as intended.

Based on review of the statements and representations in the application, the staff concludes that the structural design has been adequately described and evaluated and that the package has adequate structural integrity to meet the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1).

2.2 Materials Evaluation

Packages will be fabricated in accordance with the engineering drawings shown in Appendix 1.3.2 of the SAR, and welding will be performed in accordance with the standards identified in Section 2.1.4 of the SAR.

The materials from which the package is fabricated, along with the contents of the package, will not cause significant chemical, galvanic, or other reaction among packaging components and package contents. Copper and brass are used to separate the depleted uranium from the stainless steel to preclude the possibility of the formation of an iron-uranium eutectic alloy at temperatures below the melting temperatures of the individual metals. The depleted uranium components are covered with copper foil where contact with stainless steel is possible.

Thermal requirements are met for the materials from which the package is fabricated. The minimum service temperature for all package components is less than or equal to -40°C. The maximum service temperatures of the package materials exceed the ambient upper temperature limits the package would be subjected to in service.

2.3 Materials Findings

The TS-R-1 regulations with materials issues relevant to this package are listed in the enclosed table. The ability of this package to meet these regulations is also noted in the table.

Based on review of the statements and representations in the application, the staff concludes that the materials aspects of the design have been adequately described and evaluated and the

package meets the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1).

3.0 Thermal Evaluation

The purpose of the thermal review is to verify that the package design satisfies the thermal safety requirements of the IAEA *Regulations for the Safe Transport of Radioactive Material*, TS-R-1, 1996 (Revised) edition. The staff review included the evaluation of the materials, drawings, assumptions and calculations listed in the thermal safety analysis portions of the revalidation request.

The package is designed for use in the transportation of special form non-fissile radioactive material by air, sea, road, or rail. The radioactive material is sealed in source capsules which act as the primary containment for the radioactive contents.

The application states that the package is a completely passive thermal device which has no mechanical cooling system; all cooling is through free convection and radiation. The decay heat load proposed by the applicant ranges from 0.001 W to 58.1 W depending on the radioactive content and the inner container used. The maximum heat source used in the evaluation is the maxiBulk container with 250 TBq (6,764 Ci) of Iridium-192 which the applicant states is conservatively assumed to generate 58.1 W of decay power.

CAE Associates conducted a thermal analysis of the ASPECT 12K using ANSYS CFD thermal simulation software. Aspect Technology Ltd. stated that the materials used in the package do not degrade at temperatures down to -40°C. The applicant has demonstrated that there is significant temperature margin for the package components. The smallest margin seen was 70.8°C for the insulation under hypothetical accident conditions (HAC). This margin is based on a temperature limit of 870°C which is the recommended service temperature and not the melting point of the insulation. The maximum temperature seen by the surface of the drum under normal conditions of transport (NCT) was 49.0°C which is close to the 50°C limit to be transported by air. The applicant has conservatively assumed that all decay energy is transformed into heat, when in actual use not all of the decay power would be completely deposited as heat in the source capsule. This provides an added margin of safety to the drum surface temperature provided by the applicant.

The staff confirmed that the maximum pressure within the Special Form Capsule, serving as the containment system, generated under HAC is 370 kPa. This creates a maximum stress within the capsule of 5.68 mPa which is less than 9% of the yield strength of the stainless steel capsule material under the same conditions. The staff verified that the maximum pressure in the package under HAC was 370 kPa. The applicant shows this pressure results in stresses less than 11% of the yield strength of the material. The pressures and stresses from much lower temperatures will be much less severe. The staff reviewed and confirmed that the analyses performed in the SAR to ensure the containment system will conform to design requirements and maintain integrity under this pressure. The external container is enclosed but not sealed so there will be no pressure build up in this container during NCT.

3.1 Thermal Findings

The staff finds that the ASPECT 12K meets the requirements for thermal performance outlined in IAEA TS-R-1 for the transportation of radioactive materials, and the staff has reasonable

assurance that the package will perform as designed for shipments made in accordance with the applicable Certificate of Compliance.

A summary of the TS-R-1 requirements related to the thermal performance ASPECT 12K package, along with the staff's findings, is provided in the table in the appendix.

5.0 Shielding Evaluation

The applicant did not perform a shielding analysis to confirm the adequacy of the ASPECT 12K package design. Instead, adequate shielding design was confirmed by actual measurements of radiation profiles from the prototype shield, and by actual measurements of resulting radiation levels after the numerous tests performed for NCT and HAC.

5.1 Shielding Findings

The staff reviewed the information presented in the SAR on the package design. A summary of the TS-R-1 requirements related to the shielding performance of the ASPECT 12K package, along with the staff's findings, is provided in the enclosed table.

7.0 Operating Procedures

Staff reviewed the operating procedures provided in the application and in the operating manual. The operating procedures include steps for preparing the package, loading the contents into the package, preparing for transport, unloading the contents, removing the contents, and preparing an empty package for transport. As part of these procedures, there are steps for checking the contamination of the package and performing radiation surveys. Staff verified that the procedures are adequate to satisfy the requirements of TS-R-1.

7.1 Findings

Based on review of the statements and representations in the application, the staff concludes the design has been adequately described and evaluated to meet the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1). A summary of the TS-R-1 requirements related to the operating procedures of the ASPECT 12K package, along with the staff's findings, is provided in the enclosed table.

8.0 Acceptance Tests and Maintenance Program

Staff reviewed the acceptance tests and maintenance program provided in the application and in the operating manual. Quarterly maintenance and annual inspections are performed on the package. The quarterly maintenance includes visual checks to the drum and other components that may require replacement. The annual maintenance checks for cracked welds, any contamination in the inner container lid and plug, and any damage. Staff verified that acceptance tests and maintenance completed are adequate to satisfy TS-R-1.

8.1 Findings

Based on review of the statements and representations in the application, the staff concludes the design has been adequately described and evaluated to meet the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1). A summary of the TS-R-1 requirements related to the maintenance and

acceptance of the ASPECT 12K package, along with the staff's findings, is provided in the enclosed table.

9.0 Quality Assurance

Aspect Technologies Ltd. maintains a Quality Assurance (QA) program that meets the requirements of Paragraph 310 of TS-R-1 as referenced in paragraph 13(a) of the Packaging and Transport of Nuclear Substances Regulations. IAEA Safety Series 113 was followed in the establishment of the program. All elements applicable to designers of transport packages have been included in the QA program per IAEA Safety Series 113, Table I.

9.1 Findings

Based on review of the statements and representations in the application, the staff concludes the design has been adequately described and evaluated to meet the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1). A summary of the TS-R-1 requirements related to the QA program of the ASPECT 12K package, along with the staff's findings, is provided in the enclosed table.

Conclusion

Based on the statements and representations contained in the application, the staff concludes the Model No. ASPECT 12K package design, with the above stated conditions meets the 1996 Edition (Revised) of the IAEA *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. TS-R-1).

Issued with letter to R. Boyle, Department of Transportation,
on May 5, 2015.