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

SAFETY EVALUATION REPORT

Docket No. 71-9341
Model No. BRR
Certificate of Compliance No. 9341
Revision No. 8

Summary

By application dated June 13, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19176A171), as supplemented on July 23, 2019 (ADAMS Accession No. ML19220A336) and July 30, 2019 (ADAMS Accession No. ML19219A162), Orano Federal Services, LLC (OFS or the applicant), requested that the U.S. Nuclear Regulatory Commission (NRC) revise Certificate of Compliance (CoC) No. 9341 for the Model No. BEA Research Reactor (BRR) package. The applicant requested the amendment due to a small change in the thickness of the inner shell resulting from a machining error and to consolidate its associated safety analysis report (SAR). The application includes one revised drawing, and structural and shielding analyses associated with the drawing change.

The Model No. BRR is a Type B(U)F-96 package to ship irradiated fuel from research reactor facilities. The package's design allows transporting one package per conveyance, with its longitudinal axis vertical, by truck or by rail in exclusive use.

The NRC staff (the staff) reviewed the application, as supplemented, including relevant information in the attachment to the application, using the guidance in NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel." Based on the statements and representations in the application, as supplemented, and the "conditions" section of this safety evaluation report, the staff concludes that the package meets the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, "Packaging and Transportation of Radioactive Material."

EVALUATION

1.0 GENERAL INFORMATION

1.1 Packaging Description

The BRR package consists of a payload basket, a lead–shielded package body, a separate, removable upper shield plug, a closure lid, 12 closure bolts, upper and lower impact limiters containing polyurethane foam, and a personnel barrier used only with the isotope payload.

The BRR package body is a right circular cylinder 77.1 inches long and 38 inches in diameter. It comprises inner and outer shells connected by a thick lower end casting. The shells and lower end casting are made of American Society for Testing and Materials Type 304 stainless steel

with an encased lead shield. The cast-in-place lead shielding fills the annulus between the shells. Together with the removable 11.2-inch-thick shield plug under the closure lid, the package body assembly constitutes the payload cavity, which has a diameter of 16 inches and a length of 54 inches.

The principal components of the BRR are:

1) a lead-shielded package body,
2) a separate, removable upper shield plug,
3) a bolted closure lid,
4) upper and lower impact limiters containing polyurethane foam,
5) various payload baskets specifically designed for each type of fuel being transported, and
6) a personnel barrier for isotope production targets to limit access to the package body.

Except for the closure bolts, the lead shielding, and the impact limiter attachment pins, the package is primarily a welded structure using Type 304 austenitic stainless steel. Drawing No. 1910-01-01, Rev. 8 of the application provides the details of the structural design of the package body assembly. In addition, a set of eight receptacles are attached to the outer shell at each end of the body to serve as impact limiter attachments.

1.2 Drawings

OFS revised one drawing associated with the proposed changes.

1910-01-01-SAR, Sheets 1-5, Rev. 8	BRR Package Fuel Assembly

1.3 Evaluation Findings

The staff has reviewed the proposed changes and concludes that they meet the requirements of 10 CFR Part 71.

2.0 STRUCTURAL EVALUATION

The objective of the structural evaluation of the BRR package design is to verify that the design satisfies the requirements of 10 CFR Part 71 and that the structural performance of the package has been adequately evaluated for the conditions specified for normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

2.1 Background

The applicant proposed changing the thickness of the inner shell from a dimension of 1.0 inch minimum, as currently authorized, to a dimension of 1.00 ± 0.06 inches. The reason for the proposed change is due to an error in machining the inner diameter of one of the two packages currently being fabricated. The inner diameter has been partially machined such that part of the inner shell has a thickness less than 1.0 inch. This proposed change (1.00 ± 0.06 inches) allows a minimum thickness of 0.94 inch so that the package with the machining error can meet the dimension specified in the drawing. The applicant performed structural evaluation of the consequences of this change on the free drop analysis.

2.2 Evaluations

2.2.1 Center of Gravity

SAR Table 2.1-2, Rev. 16 shows the new center of gravity (CG) of the package. The new CG is located 38.7 inches from the bottom outside surface of the cask body. It is identical to the CG location previously reviewed and accepted. Since the CG location is not changed, the NRC staff found that the inner shell thickness change of ± 0.06 inch acceptable.

2.2.2 Total Weight

SAR Table 2.1-2, Rev. 16 shows the total weight of the package. The authorized maximum allowable total weight of the package is 32,000 pounds, which was previously reviewed and accepted. The NRC staff found that the weight increase due to the thickness change of ± 0.06 inch is very small and a new actual total weight of the package is still bounded by 32,000 pounds. Therefore, the total weight of the package is acceptable.

2.2.3 Buckling Assessment

The applicant previously performed a buckling analysis using the methodology of American Society of Mechanical Engineers Boiler and Pressure Vessel Code Case N-284-2. The applicant noted that there is no need for additional buckling analysis due to the thickness change because the strength of the inner shell for the buckling assessment was conservatively ignored in the previous buckling analysis. The NRC staff evaluated the applicant's assessment and concludes with reasonable assurance that the buckling performance of the inner shell continues to be acceptable.

2.2.4 Cask Body Stresses

The applicant calculated cask body stresses with a thickness of 0.94 inch for a free drop under NCT and HAC. The applicant used a linear elastic approach to calculate cask body stresses where the stresses were proportionally calculated based on the previously calculated cask body stresses with the inner shell thickness of 1.0 inch.

The calculations in SAR Section 2.6.7.3, Rev. 16 show that the minimum stress margins of safety of the inner shell for the top-down drop under NCT and HAC are +0.33 and +0.69, respectively. The calculations also show that the minimum margins of safety of the package for the side drop under NCT and HAC are +0.06 and +0.23, respectively, indicating that the effect of the inner shell thickness change of 0.06 inch is minor and the package with the inner shell thickness of 0.94 inch is safe. The NRC staff reviewed the calculations and found them acceptable.

2.3 Findings

Based on the statements and representations contained in the application, as supplemented, and the conditions given in the certificate of compliance, the NRC staff concludes that the package has adequately been described and evaluated to demonstrate that the package has adequate structural integrity to meet the requirements of 10 CFR Part 71.

3.0 THERMAL EVALUATION

There were no changes that affected the package's thermal evaluation.

4.0 CONTAINMENT EVALUATION

There were no changes that affected the package's containment evaluation.

5.0 SHIELDING EVALUATION

The purpose of this evaluation is to verify that the proposed changes to the shielding design of the BRR package would continue to provide adequate protection against direct radiation from its contents and that the package design meets the external radiation requirements of 10 CFR Part 71 under NCT and HAC given the proposed changes.

5.1 Background

The applicant states that the currently authorized design of the BRR package shows a dimension of the inner shell of 1.0 inch as shown in Drawing 1910-01-01-SAR, Revision 8, Sheet 4, Zone B-6. The tolerance is ± 0.06 inches. According to the applicant, this proposed change to the inner shell thickness is necessary due to an error in machining the inner diameter of one of the two BRR packages currently being fabricated. The inner diameter has been partially machined such that part of the inner shell has a thickness less of than 1.0 inches. The as built inner shell has a minimum thickness of 0.94 inches (1.00 ± 0.06 inches).

5.2 Evaluation

The staff reviewed the shielding effect of the reduced steel thickness for both gammas and neutrons in the analyses submitted by the applicant in document CALC-3022582-000 (ADAMS Accession No. ML19220A336). The applicant performed shielding calculations using a simplified MCNP shielding model. The most significant gamma and neutron sources (in terms of resulting total dose) were selected by the applicant from Revision 16 of the SAR. The applicant built a spherical model of the BRR side wall with a point source at the center. Surface dose rates at the most limiting location per the SAR, were calculated for the currently-licensed BRR side wall material thickness and compared to surface dose rates using the reduced inner shell wall thickness.

The shielding analysis performed by the applicant shows the effect of reducing the inner shell of 0.94 inches results in a 1% increase in the maximum side dose rates reported for the fuel payloads in SAR Table 5.1-1, Summary of Maximum Total Dose Rates (Exclusive Use) for Irradiated Fuel Payloads, and a 6% increase in the maximum side dose rates reported for isotope production target payloads in SAR Table 5.6-1, Summary of Maximum Total Dose Rates (Exclusive Use) for Isotope Production Target Payloads. Shielding calculations presented by the applicant in document CALC-3022582-000 showed that the dose rates from all currently-licensed BRR payloads will remain less than applicable limits. The applicant applied the maximum gamma and neutron fractional increases (6% and 0.7%, respectively) to the most limiting fuel payload and location dose rates (TRIGA fuel, side surface) which resulted in a maximum dose rate of 68.7 mrem/hr on the side surface for the case with a reduced inner steel thickness of 0.94 inches, which is significantly less than the limit of 200 mrem/hr. Similarly, applying the applicant applied the maximum gamma fractional increase to the most limiting Co-60 payload and location dose rate (side surface) which resulted in a maximum dose rate of 183.3 mrem/hr for the case with a reduced inner steel thickness of 0.94 inches, which is less than the limit of 200 mrem/hr.

The staff reviewed the applicants' simplified model and considered whether the applicant could have neglected important details such as streaming paths. Additionally, the staff considered if

the simplified spherical geometry would accurately represent the source term and the geometry of the package in terms of shielding because a detector will receive more radiation from a line source than it does from a point source with the same total strength. The impact in the difference in the modeling is dependent on the geometry of the sources and the distance between the source and the point of interest. As such, the staff determined that the applicant model of the source in the shielding design analyses may not be conservative. However, based on the large margin of the calculated dose rates at the most limiting fuel payload location to the dose rate limits, the staff has reasonable assurance that the regulatory limits will not be exceeded. Thus, the staff found the reduction of inner shell thickness acceptable.

5.3 Findings

Based on the review of the statements and representations in the application request, the staff finds that the BRR transportation package has been adequately described and evaluated and that the package design with the reduction in the inner shell wall thickness still meets the shielding design requirements of 10 CFR 71.47 and 10 CFR 71.51.

6.0 CRITICALITY EVALUATION

There were no changes that affected the package's criticality evaluations.

7.0 PACKAGE OPERATIONS

The purpose of this evaluation is to verify that the proposed changes to the operating controls and procedures of the BRR transport package meet the requirements of 10 CFR Part 71. This amendment also incorporates revised operating procedures approved in a letter authorization dated August 5, 2019 (ADAMS Accession No. ML19217A124) stemming from a request for this authorization.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM REVIEW

Chapter 8 of the application identifies the acceptance tests and maintenance programs to be conducted on the Model BRR package and verifies its compliance with the requirements of 10 CFR Part 71.

9.0 CONDITIONS

The CoC includes the following condition(s) of approval:

Condition No. 3.(b), "Title And Identification Of Report Or Application," was updated to include reference to the most recent application, which included Revision 16 of the SAR.

Condition No. 5.(a)(3), "Drawings," was updated to reflect one revised drawing.

1910–01–01–SAR, Sheets 1-5, Rev. 8 Assembly

Revised the "References" section of the CoC to read as follows:

> AREVA Federal Services LLC application dated June 13, 2019. (Model No. BRR Safety Analysis Report, Revision 15).
>
> Orano Federal Services LLC supplements dated: July 23 and July 30, 2019 (Safety Analysis Report, Revision 16).

10.0 CONCLUSIONS

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the design has been adequately described and evaluated, and the Model No. BRR package meets the requirements of 10 CFR Part 71. In the consolidated SAR, OFS incorporated all supplements previously approved by NRC.

Issued with CoC No. 9341 for the Model No. BRR, Revision No. 8.