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. 7

Summary

By application dated January 30, 2018, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18044A145), as supplemented on July 24, 2018, (ADAMS Accession No. ML18213A230), September 27, 2018 (ADAMS Accession No. ML18285A039) and on November 14, 2018 (ADAMS Accession No. ML18327A075), Orano Federal Services LLC (OFS) [then AREVA Federal Services], requested that the U.S. Nuclear Regulatory Commission (NRC) approve a revision to the Certificate of Compliance No. 9341 for the Model No. BRR package. The applicant requested the addition of Co-60 isotope production targets to the authorized contents in the certificate of compliance (CoC) for this package.

In addition to editorial changes to ensure consistency with the new information, OFS revised one drawing, submitted one new drawing, and requested the following changes to sections of the safety analysis report (SAR) associated with the revised certificate of compliance:

1. Updates to structural, thermal, and shielding analyses

2. Changes to chapters 1 and 7 to accommodate the isotope payloads

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 applicant also requested correction of a typo introduced by NRC in a previous revision to the CoC. An incorrect outer diameter of one of the approved TRIGA fuels contained a typographical error that has been corrected during this review.

The NRC staff (the staff) reviewed the application, as supplemented, including relevant information in the attachment to the application, using the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material." Based on the statements and representations in the application, as supplemented, and the "conditions" section of this safety evaluation report (SER), 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, twelve 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 (ASTM) 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 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.

The applicant added a personnel barrier to the design of the packaging to accommodate the new payloads requested in this revision to the CoC. The following sections include the evaluation of the changes to the packaging to accommodate the proposed contents in this revision request.

1.1.2 Package Body

There are no changes in the design of the package body except the addition of a personnel barrier which will be used between the upper and lower impact limiters (see Drawing 1910-01-01-SAR, Assembly A4). The personnel barrier is only required with the isotope payload.

1.1.3 Personnel Barrier

A personnel barrier consisting of four equal assemblies of expanded stainless steel sheet and 0.135-inch (10 gauge) stainless steel perimeter strips will be used between the upper and lower impact limiters (Drawing 1910-01-01-SAR, Assembly A4). The personnel barrier will limit access to the package body such that a person cannot touch the package surface where the surface temperature may exceed the allowable limit for exclusive use shipments. The addition of a personnel barrier is not accounted for in the shielding analysis, thus, the personnel barrier has no radiological purpose. The barrier encloses the exposed portions of the package body, and is inset from the outer edge of the impact limiters. The barrier rests on the upper, flat surface of the lower impact limiter, and is not attached to the package or impact limiters. It is maintained in lateral position using the guidance of the impact limiter attachment blades.

1.1.4 Baskets

The BRR packaging system can utilize five different kinds of payload baskets for research reactor fuel. This revision incorporates isotope production targets as a sixth payload using a new basket. The basket for isotope production targets (Drawing 1910-01-04-SAR) is made from welded construction primarily using Type 304 stainless steel in plate, bar, pipe, and tubular forms, has a diameter of 15.63 inches, and a length of 53.45 inches. Each basket has a cavity that fits the size and shape of the fuel to minimize “free play” between the fuel and the basket and facilitate the insertion and removal of the elements. The baskets are open on the top, and the payload is located at the top end, nearest the shield plug. The design of the baskets allows water to drain freely during the movement of the package outside of the spent fuel pool.

1.2 Drawings

OFS revised one drawing and submitted a new drawing showing the new target basket and holder assembly associated with the proposed changes.

The revised drawings showing the transport packaging include:
1910–01–01–SAR, Sheets 1-5, Rev. 7 BRR Package Fuel Assembly

New drawing:
1910–01–04–SAR, Sheets 1-2, Rev. 1 BRR Package Isotope Target Basket

For the contents related to this revision of the CoC for the BRR package, the applicant proposed adding a new Drawing No. 1910-01-04, showing the configuration associated with the new payloads and changes to Drawing No. 1910-01-01, “BRR Package Fuel Assembly,” Revision 6 to include the personnel barrier associated with the isotope targets. The staff reviewed the dimensions, package markings, materials of construction, and the codes and standards the applicant used to design the package.

1.3 Contents

The applicant is requesting to add isotope production targets and target holders as authorized contents of the BRR. There are two different payload types for the isotope production targets:

a. Payload Type 1 consists primarily of higher-activity targets

Type 1 consists primarily of higher-activity targets of a newer design, which may also include lower-activity targets. The pellets are arranged in several stacks in an annular configuration within the target body. Payload Type 1 consists of up to 10 targets, which must be loaded in the inner row of basket holes, and be arranged using a loading plan into five zones of two holes each. The maximum activity in any zone is 22,000 Ci. A loading collar must be installed to block access to the outer row of holes before loading payload Type 1 targets. Table 1 includes the characteristics of payload type 1 of the isotope production targets.

Table 1. Characteristics of Isotope Production Targets, Payload Type 1

Parameter	Value
Target Diameter	1/2 inches
Target Length	16 inches
Cladding Material	6061-T6 aluminum alloy
Target Contents	6,000 pellets (approximately)
Pellet Size	1mm diameter × 1mm thick
Maximum Activity	up to 14,100 Ci, Co-60
Payload Quantity	10 targets
Total Activity	up to 82,000 Ci

b. Payload Type 2 consists of lower-activity targets

Type 2 consists of lower-activity targets of an older design. There are two kinds:

A. Aluminum core rod with pellets placed in dimples on the outer surface and retained by a close-fitting outer sleeve, which is welded to the core rod on each end.
B. Solid rod of cobalt inside a stainless steel tube with welded ends

Table 2 includes the characteristics of payload type 2 isotope production targets.

Table 2. Characteristics of Isotope Production Targets, Payload Type 2

Parameter	Value
Target Diameter	5/8 inches (pellet design) 5/16 inches (solid rod design)
Target Length	Up to 16.5 inches
Cladding Material	Aluminum alloy 6061-T6 (pellet design) Stainless steel (solid rod design)
Target Contents	Approximately 5,500 pellets or one solid or segmented rod of cobalt metal
Pellet Size	1 mm diameter x 1 mm thick
Maximum Activity	Up to 4,000 Ci, Co-60
Payload Quantity	20 targets
Total Activity	Up to 80,000 Ci

The BRR package may contain up to 10 targets of payload type 1 or 20 targets of payload type 2.

1.4 Evaluation Findings

The staff has reviewed the description of the new contents and associated packaging changes and concludes that they meet the requirements of 10 CFR Part 71.

2.0 STRUCTURAL AND MATERIALS 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). Since this amendment request is limited to addition of new approved contents and an associated new basket design and a personnel barrier to limit surface accessibility, the structural review will focus only on those changes in detail.

2.1 Structural Design

2.1.1 Description of Structural Design

The principal components of the BRR are:

- lead-shielded package body,
- separate, removable upper shield plug,
- bolted closure lid,
- upper and lower impact limiters containing polyurethane foam, and
- various payload baskets specifically designed for each type of fuel being transported.

Except for the closure bolts, the lead shielding, the impact limiter attachment pins, and the aluminum thermal shunt for the isotope production target basket, the package is primarily of welded construction, using Type 304 austenitic stainless steel.

2.1.2 Design Criteria

As stated by the applicant in the safety analysis report (SAR):

> *The isotope production target basket, target holders, outer shell, thermal shield, and impact limiter attachments are classified as [American Society of Mechnical Engineers] ASME Code, Section III, Subsection NF [ASME Boiler and Pressure Vessel Code (the ASME Code)]. However, the outer shell is conservatively analyzed to the requirements of Subsection NB.*
>
> *The isotope production target basket and target holders are defined by NUREG/CR-3854 [Fabrication Criteria for Shipping Containers]", Table 1.1, as 'Other Safety', and consequently, are evaluated as NF, Class 1 components. For HAC, equivalent to Service Level D, ASME B&PV Code, Section III, Division 1, Appendix F is appropriate. To assure no reconfiguration under NCT and HAC occurs, an elastic analysis will be used.*

2.1.3 General Considerations for Package Structural Analysis

The applicant performed structural analyses of the package using both hand calculation and finite element modeling. The former approach by equations and formulas is generally used for the isotope production target basket. For the stress performance evaluation, stress margins of safety, each defined as the ratio of the allowable and the calculated stress minus unity, are reported. A margin of safety greater than zero is considered acceptable.

The NRC reviewed the package structural design including the design criteria and structural evaluation approaches and finds them acceptable.

2.2 Weights and Centers of Gravity

The maximum gross weight of the package is 32,000 lb. Table No. 2-1.2 of the SAR summarizes information on weights of package components and corresponding centers of gravity for the MURR, MITR-II, ATR, and TRIGA fuel types and isotope production targets, with applicable baskets.

2.3 Normal Conditions of Transport (10 CFR 71.71)

2.3.1 Heat

Table 3.6-1 of the SAR lists the maximum temperatures calculated for various locations of the package components. They are based on the maximum decay heat, an ambient temperature of 100° F, and solar insolation under the Normal Conditions of Transport. The corresponding maximum package cavity pressure is calculated to be 14.7 psig. SAR Section 2.6.1.1 notes that, for structural evaluation purposes, the bounding temperature of 450° F is considered for the Isotope Production Target fuel basket, 500° F for the isotope production target holder, and 250° F for other cask body components, including the end structures, shells, and closure lids and bolts. A design pressure of 25 psig, which is significantly higher than the conservatively defined maximum operating pressure (MNOP) of 15 psig, was also used to evaluate the package structural performance.

Section No. 2.6.1.2 of the SAR evaluates differential thermal expansion of package components for possible interference among package components.

The NRC reviewed structural performance of the package under the heat condition and concludes that the differential thermal expansion and stress effects have properly been evaluated. Thus, the requirements of 10 CFR 71.71(c)(1) are satisfied.

2.3.2 Cold

No change.

2.3.3 Reduced External Pressure

Reduced external pressure was reevaluated since the MNOP for the isotope production targets is now bounding. The reevaluated pressure of 26.2 psig produced a large positive margin of safety in the containment boundary.

2.3.4 Increased External Pressure

No change.

2.3.5 Vibration

No change.

2.3.6 Water Spray

New basket and payload are not affected by water spray.

2.3.7 Corner Drop

Not applicable.

2.3.8 Compression

No change.

2.3.9 Penetration

No change.

2.4 Hypothetical Accident Conditions (10 CFR 71.73)

2.4.1 30-FT Free Drop

Fuel Baskets – End Drop (Side Drop neglected as end drop was the bounding condition): Section No. 2.7.1.5.2 of the SAR provides an evaluation of the fuel basket for the Isotope Production Targets. For the 120 g end drops, the basket was analyzed for modes of failure applicable to its design, such as bending, weld shear, and buckling for the bounding weights. Table 2.7-10 of the SAR lists calculated stress margins of safety, which are all positive. These results demonstrate that the BRR package fuel baskets are adequate to support the fuel in bounding HAC free drops. The detailed stress evaluations can be found in Section 2.12.8.8 of the SAR.

On the basis of the above, the NRC concludes that the applicant has properly evaluated the test as required by 10 CFR 71.73(c)(1).

2.4.2 Crush

Not applicable.

2.4.3 Puncture

No change.

2.4.4 Thermal

See Section No. 3.0 of this SER on thermal performance of the package.

2.4.5 Immersion - Fissile Material

No change.

2.4.6 Immersion - All Packages

No change.

2.4.7 Deep Water Immersion Test

No change.

2.5 Isotope Target Materials Analysis

BRR package amendment request, SAR, Revision 14, adds the transport of Co-60 isotope production targets to the authorized payloads and as such a new basket has been designed to accommodate the targets, and target holders have been designed to house each target. In addition, a personnel barrier has been designed for use with the isotope payloads, to maintain the accessible surface temperature within regulatory limits. The BRR package is designed to be loaded either in a pool of water (wet) or in a hot cell or transfer cask (dry). The staff will evaluate materials used in fabrication, added as part of this amendment request, for the following BRR package components:

- Personnel barrier (thermal)
- Target basket
- Isotope target holder

2.5.1 Target Basket

The basket for isotope production targets is shown on Drawing No. 1910-01-04-SAR and discussed throughout sections 1.2 and 2.1 of the SAR. The baskets are made from welded construction primarily using ASTM Type 304, stainless steel plate, bar, pipe, and tubular forms. The baskets are designed to freely drain water to enable submerged loading of the package. The isotope production basket also contains an aluminum round bar located on the central axis of the basket for heat transfer purposes only, running nearly the entire length of the basket, the aluminum bar serves to distribute some of the decay heat to the lower region of the BRR package.

2.5.2 Isotope Target Holder

The isotope target holder is shown on Drawing No. 1910-01-04-SAR and discussed throughout sections 1.2 and 2.1 of the SAR. All isotope production targets are housed in individual target holders prior to loading into the basket. The target holders are fabricated primarily from ASTM Type 304, stainless steel bar, sheet, and tubular forms. A bottom plug includes drain holes that cannot pass a 1mm x 1mm cylindrical Co-60 pellet, should any escape from a target. Targets are helium backfilled to a pressure of approximately 1 atmosphere and helium leak tested. The highest temperature the targets can reach in the BRR packaging is 838 °F and is achieved during the vacuum drying process.

2.5.3 Isotope Production Targets

Section 1.2.2.6 of the SAR describes two types of isotope production targets. Payload Type 1 consists primarily of higher-activity targets of a newer design, however Type 1 may also include lower-activity targets. The new design is fabricated from ASTM Type 6061, Temper T6 aluminum alloy. Payload Type 1 consists of up to 10 targets and must be loaded in the inner row of basket holes, and be arranged, using a loading plan, into five zones of two holes each.

Payload Type 2 consists of lower-activity targets of an older design. They are nominally up to ⅝ inches in diameter and up to 16.5 inches long. The pellet-type target is fabricated from ASTM Type 6061, Temper T6 aluminum core rod with a large quantity of dimples made around the outer surface. Pellets are placed in the dimples and retained by a close-fitting outer sleeve, which is welded to the core rod on each end.

A second type of older-design target is a solid rod of cobalt, approximately 1/4 inches in diameter, inside an approximately 5/16 inch diameter, stainless steel tube with welded ends. Payload Type 2 consists of up to 20 targets with no location restrictions. Isotope production target payloads must be used with the personnel barrier described above.

2.5.4 Material Properties and Specifications

Table 2.2-1 through Table 2.2-6 of the SAR present the mechanical properties for the structural materials used in the BRR package. The mechanical properties of the materials used for fabrication of the new package structural components are identical to those previously reviewed and approved. In addition, the exposure temperatures of the materials for the new package configuration to transport the isotope production targets, described in Section 3.6 of the SAR are bounded by the temperatures previously evaluated for the other contents. Therefore, the staff finds the material properties to be acceptable.

2.5.5 Drawings

The staff reviewed the engineering assembly drawings and finds the drawings contain a bill of materials, including appropriate consensus code information, that is, American Welding Society (AWS), ASME, and ASTM specification number(s) for the material(s) used in fabrication.

2.5.6 Brittle Fracture

The staff notes that all structural components of the target basket and holders are fabricated from austenitic stainless steel, this material is not subject to brittle fracture in the temperature range evaluated for the BRR package.

2.5.7 Codes, Standards, Fabrication, and Inspection

The applicant stated that for new structures such as the isotope production target baskets, target holders, and thermal shield, the criteria is taken from Section III, Subsection NF of the ASME Code. The isotope production target basket, and target holders are classified as ASME Code, Section III, Subsection NF. The isotope production target basket and target holders are defined by NUREG/CR-3854, Table 1.1, as ‘Other Safety’, and consequently, are evaluated as NF, Class 1 components.

The applicant also stated that all welding procedures and welding personnel must be qualified in accordance with Section IX of the ASME Code. All welds are subject to visual examination per AWS D1.6. All welds on the BRR package, except welds on the personnel barrier, are liquid penetrant inspected on the final pass in accordance with the ASME Code, Subsection Nx, Article Nx-5000, and Section V, Article 6. The appropriate subsection for the containment welds NB, and for the fuel baskets, NG are used.

The staff verified that that the weld design and inspections are in accordance with the recommendations in NUREG/CR-3019, “Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials," which includes the use of ASME Code Section III, Subsection NB for containment boundary welds, and Subsections NF, and NG for other code welds (basket), as appropriate. Non-code welds are examined in accordance with ASME Code Section V, with acceptance criteria per Subjection NF. The staff concludes that the welded joints of the BRR meet the requirements of the ASME, and AWS Codes, as applicable.

2.5.8 Chemical, Galvanic, or Other Reactions

The staff notes that conditions required to create the possibility for galvanic corrosion is small since stainless steel is used in fabrication which is corrosion resistant, the internal environment is vacuum dried, helium is used as the inert environment, and insufficient moisture exists to create a galvanic cell. In addition, visual inspections of the payload cavity will be performed at various timed intervals which provide reasonable assurance against any considerable corrosion occurring unnoticed. Therefore, there will be no corrosion of the BRR materials of construction or the generation of combustible gases during transport.

2.5.9 Effects of Radiation on Materials

The applicant states that radiation associated with the decay of Co-60 will have no effect on the austenitic stainless steel comprising the structural components of the BRR package. Since the payload of the BRR package is heavily shielded, the radiation exposure of the materials is negligible. The butyl rubber containment seal (Rainier Rubber R-0405-70) conforming to ASTM D2000, which is also located outside of the gamma shield, receives a negligible exposure. For these reasons, there will be no deleterious radiation effects on the packaging and the requirements of 10 CFR 71.43(d) are met.

The staff considered any potential damaging effects of radiation on the packaging materials, including degradation of the seals and sealing materials and degradation of the properties of the structural materials. The materials used in construction of the BRR personnel barrier, target basket, and target holder are similar to previously approved BRR materials and are not subject to radiation embrittlement during transportation from the isotope production targets as bounded by BRR spent fuel payloads.

2.6 Conclusion

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

3.0 THERMAL EVALUATION

The objective of the thermal evaluation of the BRR package design is to verify that the design satisfies the thermal requirements of 10 CFR Part 71 and that the thermal performance of the package has been adequately evaluated for the conditions specified for NCT and HAC. Since this amendment request is limited to addition of new approved contents and an associated new basket design and a personnel barrier to limit surface accessibility, the thermal review will focus only on those changes.

3.1 Description of the Thermal Design

3.1.1 Package Design Features

The principal components of the BRR are:

- lead-shielded package body
- separate, removable upper shield plug
- bolted closure lid
- upper and lower impact limiters containing polyurethane foam
- various payload baskets specifically designed for each type of fuel being transported.

Except for the closure bolts, the lead shielding, the impact limiter attachment pins, and the aluminum thermal shunt for the isotope production target basket, the package is primarily of welded construction, using Type 304 austenitic stainless steel.

Section 3.6.1.1 of the SAR describes the principle thermal design features of the package. The BRR design basis decay heat loadings for the isotope production targets are 1264 W per basket for Type 1 payload and 1233 W for Type 2 payload.

Payload type 1 includes targets consisting of no more than 14,100 Ci each. Payload type 2 includes targets consisting of less than 4,000 Ci each. Further specifications for each payload target type can be found in Sections 3.6.1.1.1 of the SAR.

3.2 General Considerations for Thermal Evaluations

The BRR package thermal performance is analyzed using Thermal Desktop and SINDA/FLUINT computer programs as identified in Rev. 0 of this SAR. As indicated by the NRC in that technical review, Thermal Desktop and SINDA/FLUINT is a general purpose code that solves steady state and transient thermal problems and the NRC has found these codes acceptable for applications evaluating transportation of spent fuel and other radioactive nuclear materials.

The applicant's thermal model is unchanged from previous revisions of the SAR and as before provides a full height, half symmetry representation of the packaging and Isotope Productions Target payload components. As stated by the applicant, the modeling approach permits simulation of the varying insolation loads along the length of the package, captures the various degrees of symmetry within the fuel baskets, and allows the non-symmetry conditions of the HAC free drop damage to be simulated. A separate thermal model is used to evaluate the thermal performance during NCT for both payload types for the isotope production targets. The details of the NCT thermal modeling are provided in Appendix 3.6.5.1 of the SAR, "Analytical Thermal Model for Isotope Production Target Payloads".

The analytical model for HAC is also unchanged from previous revisions of the SAR and as before is a modified version of the half symmetry NCT model described in Appendix No. 3.6.5.1. The principal model modifications made to the NCT thermal model to convert it to the HAC model consisted of:

- simulating damage to reflect the altered design behavior following the drop testing,
- removing personnel barrier,
- changing the package orientation from upright to horizontal to reflect its probable orientation following the HAC drop event,

- capturing the thermal decomposition of the polyurethane foam under HAC, and
- changing the package surface emissivities to reflect the assumed presence of soot and/or surface oxidization.

The NRC confirmed that the methods used for the thermal analyses were sufficiently described and provided an adequate representation of the thermal performance of the package for NCT and HAC.

3.3 Evaluation of Accessible Surface Temperatures

The applicant performed an evaluation of the package, with the personnel barrier installed, for an ambient air temperature of 100°F without insolation loads, and demonstrated that the temperatures of all exterior surfaces of the packaging are below the maximum temperature of 185 °F permitted by 10 CFR 71.43(g) for accessible surface temperature in an exclusive use shipment.

3.4 Thermal Evaluation under Normal Conditions of Transport

3.4.1 Temperatures and Pressure

Table No. 3.6-3 of the SAR presents the predicted BRR package temperatures under NCT for an isotope productions target Type 1 Payload basket dissipating 1264 W of decay heat.

As with previous basket designs, the minimum temperature achieved within the fuel basket would be achieved with a zero decay heat load and an ambient air temperature of -40 °F per 10 CFR 71.71(c)(2) and as such, this thermal condition requires no thermal calculation.

Assuming the backfill gas has an initial temperature of 70 °F at the time of filling and that a fill pressure of 1 atmosphere is used, the applicant predicted a maximum operating pressure within the package cavity for the transport of the isotope production target Type 1 payload of 14.7 psig. Based on this calculated pressure during NCT, the applicant established a maximum normal operating pressure (MNOP) of 15 psig for the BRR package.

The NRC reviewed selected calculations and results for NCT and found them acceptable since they are below acceptable limits.

3.5 Thermal Evaluation during Drying Operations

The applicant performed transient calculations of vacuum drying operations using the modified NCT thermal model described in Appendix No. 3.6.5.1. The modifications made for this evaluation were the same as those made for the previously approved fuel contents and consisted of assuming air as the backfill gas. As with the previous analyses, the applicant also did not remove impact limiters or the package lid from the analytical models using the same conclusions which were accepted by the NRC. Based on the transient calculation results, the applicant determined that the isotope production targets do not reach their material limits, even at steady state. As such, no time limit exists for vacuum drying operations for the isotope production targets. Based on the similarity of the described model to what was previously accepted by the NRC, and the thermal evaluation results, the NRC finds the BRR thermal evaluation during vacuum drying operations acceptable.

3.6 Thermal Evaluation under Hypothetical Accident Conditions

The initial conditions for the HAC are assumed to be 100°F ambient with no insolation. The applicant performed the HAC fire analysis with a fire temperature of 1475°F and a conservative package surface-emissivity of 1.0 to meet the requirements of 10 CFR 71.73(c)(4), This provides an adequate representation of the fully engulfing fire environment consisting of a 1475°F ambient with an effective flame emissivity of 0.9.

The applicant's HAC evaluation uses an ambient temperature of 1475°F for all convection based heat transfer calculations and all radiation based heat transfer calculations. The convection heat transfer coefficients between the package and the ambient during the 30-minute fire event are based on an average gas velocity of 10 m/sec. Following the 30-minute fire event the convection coefficients are based on still air. The ambient condition of 100°F with insolation is assumed following the 30-minute fire event. The applicant identified that they continued the post-fire analysis to capture the peak temperatures. A solar absorptivity of 0.9 is assumed for the exterior surfaces to account for potential soot accumulation on the package surfaces. The details presented above are consistent with methods and calculations provided in previous SAR revisions.

Table 3.6-4 of the SAR presents the predicted peak temperature for the BRR package with the isotope production target payload(s) under HAC conditions. Given that the isotope production target Type 1 Payload dissipates an identical total decay heat to the MURR fuel payload, the presented temperatures are reasonably consistent with the values reported for the MURR fuel and as illustrated in Table 3.6-1, significant thermal margins exist for all components.

The NRC reviewed selected calculations and the SAR results for HAC and found them acceptable. The HAC model of the isotope production target payload and assumed damage configurations adequately represents the basket configurations and heat loads that are requested.

3.7 Personnel Barrier

The personnel barrier is depicted on Drawing 1910-01-01-SAR and discussed throughout Sections 1.2 and 2.1 of the SAR. The personnel barrier is primarily fabricated from Type 304 stainless steel product forms and consists of four equal assemblies of expanded, stainless steel sheet to ASTM specifications and is installed between the upper and lower impact limiters enclosing the BRR package body. In addition, the personnel barrier also includes several acetal plastic pads, attached using, stainless steel, flat head screws, and 1/2-inch thick neoprene foam pads, attached using Loctite adhesive, to avoid damaging the impact limiter coating during routine use. The applicant stated that the Acetal and neoprene pads serve no safety function, and have a negligible impact on the thermal performance of the BRR package due to their small size and location on the outside of the impact limiters. In addition, the personnel barrier serves no radiological purpose.

3.8 Conclusion

Table No. 3.6-1 of the SAR provides a summary of the package component temperatures under normal and accident conditions. As stated by the applicant in the SAR, the temperatures for normal conditions are based on an analytical model of the BRR package for steady-state operation with an ambient temperature of 100°F and the 10 CFR 71.71(c)(1) prescribed insolation averaged over 24 hours. Further, the temperatures for accident conditions are based on a transient simulation using an analytical model of a damaged BRR package.

Table No. 3.6-2 of the SAR presents a summary of the maximum pressures predicted under NCT and HAC conditions. The BRR package has a design maximum pressure of 25 psig.

The NRC reviewed the design description of the isotope production targets and basket thermal design and finds them acceptable. The NRC also reviewed the temperature and pressure design limits and calculated temperatures and pressures for the package and found them to be acceptable and consistent with the previously approved design basis package contents.

The NRC reviewed the thermal design of the new package contents description and evaluation and concludes that they are sufficient to satisfy the thermal requirements of 10 CFR Part 71. In addition, the NRC reviewed the methods used in the thermal evaluation and found them to be similar in scope both in breadth and depth to those presented for previously approved contents. Since the maximum basket decay heat for the Cobalt-60 source targets is essentially the same as the maximum bounding design basis decay heat for the MURR fuel, there is reasonable assurance that the package thermal performance will remain unchanged.

The NRC reviewed the accessible surface temperatures of the package as it will be prepared for shipment and found reasonable assurance that they satisfy 10 CFR 71.43(g) for packages transported by exclusive-use vehicle.

The NRC reviewed the package design, construction, and preparations for shipment and found reasonable assurance that the package material and component temperatures will not extend beyond the specified allowable limits during NCT, consistent with the tests specified in 10 CFR 71.71.

The NRC reviewed the package design, construction, and preparations for shipment and found reasonable assurance that the package material and component temperatures will not exceed the specified allowable short-time limits during HCT, consistent with the tests specified in 10 CFR Part 71.

The NRC has reviewed the BRR transport package designed for shipment of the isotope production targets proposed in SAR Revision 14 associated with the Certificate of Compliance No. 9341. Based on the statements and representations contained in the application and the conditions given in the certificate of compliance, the NRC concludes that the package has adequately been described and evaluated to demonstrate its structural capabilities to meet the requirements of 10 CFR Part 71.

4.0 CONTAINMENT EVALUATION

The objective of this review is to verify that the package design satisfies the containment requirements of 10 CFR Part 71 under NCT and HAC. The BRR package is designated as a Type B(U)F-96 Category I leaktight container and is used for shipment of spent fuel elements that have been irradiated in various test and research reactors, including MURR, MITR-II, ATR, and TRIGA reactors.

Since no changes were made to the packaging and the proposed new contents do not produce any safety significant unanalyzed conditions, the previous conclusions and findings for containment function made by the NRC are still valid.

5.0 SHIELDING EVALUATION

The purpose of this evaluation is to verify that the BRR package's shielding design provides adequate protection against direct radiation from the proposed new contents by ensuring that the package design meets the external dose rate limit requirements of 10 CFR Part 71 under NCT and HAC. This proposed revision adds Co-60 isotope production targets to the authorized payloads along with a unique target basket. The target basket is separate from the five fuel basket designs. The package is designed for exclusive use.

5.1 Shielding Design Description

The principal shielding feature of the BRR package is a stainless steel transport package, consisting of a lead-filled upper shield plug, lead-filled side wall, and lead-filled bottom shield plug encased in stainless steel shells. The lid consists of a top plug with approximately 9.5 inches of lead between a 1-inch stainless steel bottom plate and 0.5 inch stainless steel top plate. The lid is constructed of 2-inch thick stainless steel. The lead in the side wall of the package is 8 inches thick. The inner stainless steel shell is 1-inch thick, and the outer stainless steel shell is 2 inches thick. The package bottom consists of 7.7 inches of lead through the centerline, with a 1-inch stainless steel bottom cover plate, and approximately 1.2-inch stainless steel inner forging. The personnel barrier used to limit access to the package body has no radiological purpose, and is therefore not accounted for in the shielding analysis.

The proposed Co-60 isotope production targets will be transported in target holders, positioned in a unique target basket. The target basket is used to support up to 20 targets inside the individual target holders inside the BRR package cavity. The isotope production target basket, which is constructed of stainless steel, consists of a central, 6.5 inch outer diameter, 0.25-inch thick seamless tube and four centering plates. The two uppermost plates contain 20 holes each, distributed equally between two concentric hole patterns. Target holders are housed through holes in the top two support plates, with a third plate providing axial support. The holes are arranged into evenly spaced inner and outer rows (10 holes per row). All plates are 0.5 inches thick except for the topmost support plate, which is 1.25 inches thick. All components are stainless steel except for a 6-inch diameter aluminum bar within the central tube. For the highest activity payload, only the inner row of holes is used. In this configuration, the outer row is blocked by a loading collar which is bolted in place on the top of the upper plate. When not in use, the loading collar may be attached to the bottom plate for storage. The target holder is individually housed in a nominal 0.875 inch diameter tube. The hollow center of the central tube contains a loose fitting, solid aluminum bar running nearly the entire length of the basket. The aluminum bar serves to distribute some of the decay heat to the lower region of the BRR package. The top end is enclosed with a removable cap that is retained by two locking pins. The cap is spring-loaded to ensure the locking pins stay in the locked position during transport. The cap cannot be removed once the package lid is in place. The isotope production target basket is shown in Figure 1.2-9 of the application. The staff verified the drawing to assure that the components for BRR Package Isotope Target Basket SAR Drawing No. 1910-01-04-SAR are well described.

5.2 Summary Table of Maximum Radiation Levels

Due to the heavy weight of the package, only one package will be transported. Therefore, the dose rate limits for exclusive use package established in 10 CFR 71.47(b)(1) are used. A summary of the maximum dose rates for Co-60 isotope production target payloads are shown in Table 5.6-1 of the application for NCT and HAC. Under NCT, the maximum package surface dose rate is 172.9 mrem/hr, the maximum vehicle surface dose rate is 57.3 mrem/hr, the maximum dose rate 2 meters from the vehicle surface is 3.1 mrem/hr, and the dose rate at the occupied location is 0.5 mrem/hr. Under HAC, the maximum dose rate at 1 meter from the vehicle surface is 25.4 mrem/hr. As stated in 10 CFR 71.47(b)(1), a package that exceeds 200 mrem/hr at any point on the external surface of the package, must be transported by exclusive use only, for which the radiation limit is 1000 mrem/hr. Based on the maximum dose rates and that this package with the isotope targets will be transported under exclusive use, the staff found that there is margin to the regulatory dose rate limits established in 10 CFR 71.47(b).

5.3 Radiation Source Specification

All source term data are calculated using the ORIGEN module of the SCALE 6.2.1 code package (only Co-60 sources are modeled). Co-60 is a gamma and beta emitter, though from a package shielding standpoint, only gamma emissions contribute to dose rates. No neutron sources are authorized for transport in the BRR. Co-60 isotope production targets are assumed to have no axial variation in gamma source strength. Systematic movement of targets during irradiation cycles within the ATR ensures minimal axial variation in source strength. Tables 5.6-4 through 5.6-7 of the application include the key dimensions relevant to the modeled package, target basket, and target holder (including targets), which were used to create the input to the TRITON code. TRITON code is a control module in SCALE computer software that enables 2-D and 3-D depletion calculations and to generate cross sections data. Once the cross section data is obtained from TRITON code, it is used in SCALE depletion code to perform gamma source terms calculations. Table 5.6-2 of the application summarizes the gamma source terms for the Co-60 isotope production targets.

5.3.1 Gamma Source

The applicant stated that the isotope production targets consist of either aluminum rods embedded with cobalt or cobalt rods encased in steel for use in creating Co-60 by irradiation in the ATR. The targets rods are enclosed in a diameter of 0.635 inches and a length of 16.517 inches. Aluminum rods are called “new-design” (Type 1 payloads) and steel rods are called “old design” (Type 2 payloads).

Type 1 payloads include up to 10 new-design or old-design targets. The maximum individual target activity is 14.1 kCi, while the maximum total payload activity is 82 kCi. Targets must be loaded into the inner row of target basket holes and arranged, using a loading plan, into five zones of two (adjacent) holes each. The maximum activity within each zone is 22 kCi. The worst-case shielding configuration is shown in Figure 5.6-6 of the application.

Type 2 payloads consist of up to 20 targets (old-design only). The maximum individual target activity is 4 kCi, resulting in a maximum possible activity of 80 kCi. There are no additional restrictions on how these targets may be loaded. The worst-case shielding configuration, shown in Figure 5.6-7 of the application, is a fully loaded target basket of maximum activity targets.

Since the beta particles will be shielded by the steel and lead shields, no beta radiation is expected to contribute directly to the external dose rate of the package with the exception of beta particles existing due to surface contamination. The surface contaminations will be removed by decontamination procedures to acceptable limits as required by the operating procedures.

The Co-60 isotope production target is modeled in ORIGEN as a 1 kCi source due to the ease of multiplicative scaling. The 1 kCi source is scaled as necessary to model different sources with varying strengths since the selected characteristics change proportionally with source strength. Source intensity and gamma energy release rate for the 1 kCi Co-60 source are shown in Table 5.6-2 of the application as well as scaled total values for the Type 1 and Type 2 payloads.

The staff performed confirmatory analysis for the proposed new contents source term by using an ORIGEN input file similar to the applicant to perform confirmatory analysis. The key parameters in Table 5.6-2 were used to develop the ORIGEN input. The staff confirmed the applicant's results in the radiation source term analysis and conclusion that the radiation source term are appropriate for the shielding analysis for the BRR package with the new contents.

5.4 Shielding Model

5.4.1 Shielding Model Specification

Section 5.3.1 of the application provides the model specifications for the shielding evaluation. All relevant design features of the BRR Package were modeled in three-dimensions in MCNP. Some assembly hardware (for example, the loading collar) and minor component geometry features (such as chamfers or small holes) are considered to have an insignificant effect on radiation attenuation and are not modeled. The key dimensions relevant to the modeled package, target basket, and target holder (including targets) are summarized in Table 5.3-1, Table 5.6-4, and Table 5.6-5 of the application, respectively. The modeled package, target basket, and target holder are shown in Figure 5.6-1, Figure 5.6-2, and Figure 5.6-3 of the application, respectively. New-design targets are shown in Figure 5.6-4 while old-design targets are shown in Figure 5.6-5 of the application. The target holder cavity housing the target has a nominal length of 16.75 inches, and minimum length of 16.67 inches. The bounding isotope production target length is 16.52 inches and fabricated out of stainless steel. The minimum clearance with tolerance stack-up between the target and target holder at a reference temperature of 70 ºF is 0.15 inches (i.e., 16.67 - 16.52 = 0.15 inches). The packaging drawings as well as lead slump are discussed in Section 5.3.1 of the application. Lead slump occurs when end drop impact forces act on the lead gamma shield which could cause a reconfiguration of the lead in the direction of impact. It has been shown in the evaluation of the package body stress that the steel shells which enclose the lead will not significantly deform, but the lead could experience flow strains causing a gap to appear at the upper surface of the lead. An evaluation of lead slump in the end drop orientation was performed, and resulted in a bounding value of 1.185 inches. This value was used in the shielding evaluation documented in Chapter 5.0, Shielding Evaluation.

The applicant developed a joint NCT/HAC dose rate model using MCNP. The staff found this approach acceptable based on the evaluation of the target holder within Chapter 2 of the application that shows that the sources will remain within the target basket in the position. The presence of the impact limiters are credited in the NCT model in the space they occupy to determine the location of the surface of the package. The target holders and targets are shifted upwards in this shielding model to maximize top dose rates, which are significantly more limiting than bottom dose rates. This configuration is based on the fact that on the top there is a streaming path for gamma radiation between the top lid and the package. The applicant also states that it included chamfered corners to the impact limiter model. The applicant stated that this was made to ensure dose rates are calculated as close as possible to the source. The staff found this conservative and acceptable. For HAC dose rates, no credit is taken for geometry of the impact limiters during an accident. No reconfiguration of the package internal cavity is expected to occur during an accident condition, except for limited axial movement of the target holders (less than 1 inch) and targets (less than 1 inch within target holder, less than 2 inches total). The applicant modeled target holders and targets shifted upwards to maximize dose rates, which are significantly more limiting on the top than bottom dose rates. New-design and old-design targets can be transported in the BRR package at the same time, but the two cases modeled produce the highest possible dose rates because they have all target holders and targets shifted upwards the maximum amount possible to maximize package top dose rates. The staff verified that the proper geometry dimensions in the engineering drawings were translated to the analysis model.

5.4.2 Material Properties

In Section 5.6.3.2 of the application, the material properties of the BRR System are described. The target basket and target holders are manufactured out of stainless steel, with the exception of the aluminum rod inside the target basket central tube. The package is constructed of stainless steel and lead. The isotope production targets are manufactured out of aluminum with embedded cobalt pellets.

The stainless steel, dry air, and lead compositions and densities used within the shielding analysis are consistent as those used in the irradiated fuel payload shielding analysis, detailed in Section 5.3.2 of the SAR and previously found acceptable by the staff in Revision 5. The staff found acceptable the aluminum composition and density used in the analyses based on the facts that these materials keeps the dose rates under the regulatory limits established in 10 CFR 71.47.

Cobalt and helium are modeled as pure with densities of 8.9 g/cm^3 and 0.000166 g/cm^3, respectively. Pure means that there is no other composition mixing with the isotope, which makes the modeling conservatives. The old-design target rods are modeled as a homogenous aluminum-cobalt mixture to account for the presence of the embedded cobalt pellets without explicit modeling. The new-design target rods include an internal helium-filled cavity, modeled at atmospheric pressure. It is a common practice to use homogenous contents for shielding calculations. It has been demonstrated in the past that homogenous gives similar results as implicit models.

The staff reviewed the methods used in the shielding evaluation, including material compositions, computer input files, methodology used for shielding calculations and found that they are described in detail to permit an independent review, with confirmatory calculations, of the package shielding design.

5.5 Shielding Evaluation

5.5.1 Methods

The methods used in the shielding analyses for this application are described in Section 5.6.4 of the application. The dose rates were computed using the MCNP6.1 code for the Co-60 isotope production targets. The staff compared the input file against the gamma source, model geometry, and material descriptions to verify proper setup. The BRR package is modeled with full three-dimensional details. Two runs are performed for the joint NCT/HAC model dose rates for both payload configurations. The content region is modeled as a homogenized mass. Homogenization is performed to simplify the source description and the results are similar to the explicit model. For HAC, the impact limiters are modeled as void which means no credit is taken for the shielding provided by the impact limiters in the dose rate calculations. For NCT, credit is taken for the geometry of the impact limiters meaning that the surface dose rates are calculated at the location of the impact limiter surface.

5.5.2 Input and Output Data

A sample input file (gamma source, Co-60 source intensity) was included in Section 5.6.6.2 of the application. The staff compared the input file against the gamma sources in Table 5.6-2 of the application and gamma axial distribution in Table 5.6-3 of the application. A sample MCNP input file (Type 2 payload shielding) is included in Section 5.6.6.2 of the application.

The staff verified that the information provided by the applicant has the proper model setup, model geometry, and material descriptions.

5.5.3 Flux-to-Dose Rate Conversion

ANSI/ANS-6.1.1-1977 flux-to-dose rate conversion factors are provided in Section 5.4.3 of the application, Table 5.4-1. This approach is consistent with the guidance provided in NUREG-1609, “Standard Review Plan for Transportation Packages for Radioactive Material.”

5.5.4 External Radiation Levels

The external radiation levels are described in Section 5.6.4.4 of the application. For NCT, package surface dose rates are captured using five mesh tallies at the following locations: the package side surface, the top surface of the top impact limiter, the bottom surface of the bottom impact limiter, the impact limiter side surfaces, and the impact limiter ‘underside’ surfaces. The impact limiter ‘underside’ surfaces are considered to be part of the package side surface. Additionally, two segmented surface tallies are used on the conical surfaces of the top and bottom impact limiters. These conical surfaces are considered to be parts of the top and bottom surfaces of the package (rather than the side). Vehicle surface dose rates are captured using one mesh tally at the projected transport vehicle side surface (4 feet from package centerline). The vehicle top surface is the same as the package top surface, while the vehicle bottom surface is conservatively captured at the package bottom surface. Two meter dose rates are captured using one mesh tally 2 meters from the transport vehicle projected side surface. For HAC, 1 meter dose rates are captured using three mesh tallies at the following locations: 1 meter from the package side, 1 meter from the package top surface, and 1 meter from the package bottom surface.

The applicant did not model reconfiguration of old design targets (Payload Type 2; see Table 2) due to rupture. The applicant found that the worst case rupture of old targets is 1%. This is discussed in Section 5.6.4.1 of the SAR. The staff reviewed this information and found the applicant's assessment acceptable because reconfiguration of pellets could only occur following rupture of an older design aluminum target design. Though rupture has only occurred once, it is estimated that up to 15% of the older-design aluminum targets are susceptible to rupture. For this discussion, a bounding failure rate of 25% is assumed. The staff found that neglecting target reconfiguration is non-conservative however has reasonable assurance that any uncertainty due to source reconfiguration would not cause dose rates to exceed these limits since there is more that 30% margin to the regulatory dose rate limit for exclusive use transport.

The maximum dose rates for each tally location are shown in Table 5.6-8 for the Type 1 payload and Table 5.6-9 of the application for the Type 2 payload. This method for analyzing dose rates is not uncommon for radioactive materials in transportation packages. The staff finds the method valid because it accounts correctly for the various factors that influence the calculated dose rates. Thus, in its review, the staff considered the description of how the mesh tallies were developed to ensure that the applicant calculated and used the correct tallies for the Type 1 and Type 2 payloads configurations. Based on that review, the staff determined that the applicant calculated and used appropriate mesh tallies because they ensure that the maximum dose rates are properly captured. Mesh tallies compute fluxes in thin, non-physical volumes (using track-length estimates) before converting to dose rates using the flux-to-dose rate conversion factors discussed in Section 5.6.4.3 of the application, Flux-to-Dose Rate Conversion. Cylindrical tallies are split into six circumferential segments to properly capture circumferential variations in dose rates.

The staff reviewed the applicant's models used in the shielding analyses. The staff examined the code input file in the calculation packages and confirmed that the applicant used the proper material properties and bounding conditions. The staff also reviewed the engineering drawings to verify that proper geometry dimensions were translated to the analysis model. The staff reviewed the material properties presented in the application to verify that these were correctly referenced and used.

The staff reviewed the applicant's source term and shielding analysis. The staff also performed confirmatory analyses of the source term using the SCALE 6.1 computer code with the ORIGEN/ARP isotopic depletion and decay sequence. Using parameter assumptions similar to the applicant's, the staff obtained source terms that were similar to those determined by the applicant and finds the applicant's result acceptable. Based on its review of the application and its confirmatory analyses, the staff finds that the applicant has correctly calculated the sources and the dose rates. The methods are appropriate for these types of calculations and results are acceptable.

5.6 Evaluation Findings and Conclusion

The staff concludes that the design of the shielding system for the BRR complies with 10 CFR Part 71. The staff has reasonable assurance that the shielding evaluation of the shielding system provided by the applicant allows for the safe transport of the new contents in the BRR packaging system. This finding is based on a review of the specifications in the application, the applicable regulations, appropriate regulatory guides, staff confirmatory (including calculations and modeling) analyses, and accepted engineering practices. The staff reviewed the external radiation levels under NCT and HAC and found reasonable assurance that these satisfy 10 CFR 71.43(f) and 71.51(a)(1).

The staff evaluated the adequacy of the description, methods, and analyses of the package design bases related to the shielding evaluation of the BRR package and found them acceptable. The staff reviewed the maximum dose rates for NCT and HAC and determined that the reported values were below the regulatory limit in 10 CFR 71.47 and 71.51. Based on its review of the statements and representations provided in the application, the staff has reasonable assurance that the shielding evaluation is consistent with the appropriate codes and standards for shielding analyses and NRC guidance. Therefore, the staff finds that the package design and contents satisfy the shielding and dose limits in 10 CFR Part 71.

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.

The applicant revised the operations procedures to include loading and handling of the isotope production targets, including the appropriate use of the personnel barrier.

Based on review of the statements and representations in the application and conditions imposed in the CoC for the BRR package, the staff concludes that the revised operating controls and procedures for the BRR package to accommodate the new payloads meet the requirements of 10 CFR Part 71, and that these controls and procedures are adequate to ensure the safe use of the package.

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. 5.(a)(2), "Description," was updated to include reference to fuel baskets for the isotope production targets. This section was also updated to include a description of the personnel barrier.

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

Revised drawing:	
1910–01–01–SAR, Sheets 1-5, Rev. 7	Assembly
New drawing:	
1910–01–04–SAR, Sheets 1-2, Rev. 1	Isotope Target Basket

Condition No. 5.(b)(1)(iv), "Type and form of material," was revised to correct a typographical error in Table 1.4 for TRIGA Fuel ID 201. The corrected fuel OD of 1.41 inches is now listed.

Condition No. 5.(b)(1)(vii), “Type and form of material,” was added for the new isotope production target payloads. Tables 1 and 2 listing characteristics of the two payload types were added to the certificate as Tables 1.8 and 1.9, respectively.

Condition No. 5.(b)(2)(viii), “Maximum quantity of material per package,” was added to state the maximum quantity of targets when shipping payload type 1.

Condition No. 5.(b)(2)(ix), “Maximum quantity of material per package,” was added to state the maximum quantity of targets when shipping payload type 2.

Condition No. 6.(a)(v) was added to include details of shipment preparations and operations.

Condition 9 was revised to authorize use of revision No. 6 of the certificate until January 31, 2020, for the purpose of shipping material under the letter authorization requested on April 19, 2018, as supplemented on September 26, 2018.

Previous Condition 9 was renumbered to Condition 10.

Revised the “References” section of the CoC to read as follows:

> AREVA Federal Services LLC application dated January 30, 2018. (Model No. BRR Safety Analysis Report, Revision 11)
>
> Orano Federal Services LLC supplements dated: July 24, September 27, and November 14, 2018.

The staff also made editorial changes to the CoC to improve its readability.

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.

Issued with CoC No. 9341 for the Model No. BRR, Revision No. 7.