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

SAFETY EVALUATION REPORT
Docket No. 71-9212
Model No. RH-TRU 72-B

SUMMARY

On May 31, 2019, as supplemented on June 12, 2019, Nuclear Waste Partnership LLC (NWP) requested approval of a one-time shipment, on behalf of the Department of Energy, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71. NWP requested that Certificate of Compliance No. 9212 for the Model No. RH-TRU 72-B package be amended to transport a breached cesium chloride (CsCl) source containing up to 2942 Curies of Cs-137.

The breached Cs-137 source encapsulated and placed in a radial gamma shield insert (the transfer cask shown in Drawing No. INIS-DWG-0091, Revision No. B), and the transfer cask will be placed into an NWP-designed shielded dunnage assembly (shown in Drawing No. NNSA-DWG-0002, Revision No. 1). The shielded dunnage assembly shall be placed into a removable lid canister (RLC) along with two, 55-gallon drums to fill the available space inside the RLC. The RLC is an authorized inner container for the RH-TRU 72-B package.

NRC staff evaluated the request by NWP and determined that, since none of the stresses in the shielded dunnage assembly exceeds their respective yield stress, the shielded dunnage will retain the transfer cask in its loaded configuration for both normal conditions of transport and hypothetical accident conditions, thus keeping the source within the transfer cask and not open any streaming paths. Given that the package is leaktight in accordance with American National Standards Institute (ANSI) N14.5, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials," and with the shielding provided by the transfer cask, shielded dunnage, and the RH-TRU 72-B package, the containment criteria and dose rates for normal conditions of transport and hypothetical accident conditions will meet the requirements in 10 CFR Part 71. Based on the statements and representations in the application, and the conditions listed in the letter, the staff concludes that the package meets the requirements of 10 CFR Part 71.

The staff used the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," as well as any appropriate interim staff guidance documents to perform the review of the NWP application. Based on the statements and representations in the application, as supplemented, and the conditions listed in the following chapters, the staff concludes that the package meets the requirements of 10 CFR Part 71.

EVALUATION

As requested by NWP's letter dated May 31, 2019, as supplemented on June 12, 2019, on behalf of the Department of Energy, pursuant to 10 CFR Part 71, to request a letter amendment to Certificate of Compliance No. 9212 for the Model No. RH-TRU 72-B package to transport a breached source containing up to 2942 Curies of Cs-137 in the form of CsCl.

1.0 General Evaluation

1.1 Packaging

The breached Cs-137 source was encapsulated and placed in a radial gamma shield (the transfer cask shown in Drawing No. INIS-DWG-0091, Revision No. B), and the transfer cask will be placed into an NWP-designed shielded dunnage assembly (shown in Drawing No. NNSA-DWG-0002, Revision No. 1). The shielded dunnage assembly shall be placed into a removable lid canister (RLC) along with two, 55-gallon drums to fill the available space inside the RLC. The RLC is an authorized inner container for the RH-TRU 72-B package.

RH-TRU 72-B is a shipping container for transporting remote-handled transuranic (RH-TRU) wastes, and byproduct, source and special nuclear materials by truck and rail transport. The packaging is composed of an inner vessel that optionally provides an inner containment boundary, an outer cask that provides an outer containment boundary and acts as an environmental barrier, and energy-absorbing impact limiters at each end of the outer container.

2.0 Structural Evaluation

The objective of the structural evaluation is to verify that the structural performance of the package for this one-time shipment is adequately demonstrated to meet the requirements of 10 CFR Part 71.

2.1 Review and Evaluation

NWP submitted a structural evaluation for the shielded dunnage assembly for the one-time authorization of a shipment of the breached cesium-137 source located in a transfer cask (payload) in the RH-TRU 72-B package.

The RH-TRU 72-B package was previously reviewed by the NRC staff (see Certificate of Compliance No. 9212, Revision No. 10, ADAMS Accession No. ML16063A113 and previous approvals) per the guidance provided in NUREG-1609 "Standard Review Plan for Transportation Packages for Radioactive Material", and the NRC staff issued a safety evaluation report (SER) on the RH-TRU 72-B package in 2011, where the NRC staff concluded that the RH-TRU 72-B package provides adequate structural, thermal, containment, shielding and criticality protections under normal conditions of transport and hypothetical accident conditions.

The applicant stated that there are no structural concerns due to the payload for this one-time shipment because: (i) the payload will be assembled in a RLC, which was previously reviewed and approved by the NRC staff, (ii) the total actual weight of the RH-TRU 72-B package (which includes the payload) is less than the maximum allowable weight specified in the RH-TRAMPAC and RH-TRU 72-B safety analysis report (SAR), and (iii) the potential buildup pressure that could occur inside the RH-TRU 72-B inner vessel will be less than the allowable design pressure limit.

Additionally, the applicant evaluated the structural performance of the payload in the shielded dunnage under the hypothetical accident conditions to demonstrate the structural integrity of the shielded dunnage assembly. The shielded dunnage assembly is designed to maintain the geometry of the transfer cask so that the CsCl source remains in a shielded position within the transfer cask.

The methodology used in the analysis was consistent with the structural evaluation presented in the RH-TRU 72-B SAR. The side and end drop impact accelerations of 81.2g and 89.7g, respectively, for a 30-ft drop were directly applied to the payload in the shielded dunnage assembly, where the g-loads were from the previous structural calculations that were reviewed and approved by the NRC staff. The applicant used the ANSYS finite element (FE) computer code to calculate stresses at the various points in the shielded dunnage and payload. The applicant presented a summary of the FE analysis in Attachment D, Addendum 1 of the June 12, 2019, supplement, where Figures 4.3 through 4.10 present peak stress levels on structural components of the shielded dunnage and payload for the end and side drops. Based on the results of the analysis, the applicant concluded that the design of the payload is adequate, and it has sufficient safety margin against the hypothetical accident conditions to ensure the shielded dunnage assembly will maintain its geometry and the source in a shielded position within the transfer cask.

The NRC staff reviewed the applicant's analyses, and finds that any effects of the payload on the 72-B package under the normal conditions of transport and hypothetical accident conditions are bounded by the currently approved the RH-TRU 72-B SAR evaluations because (i) the proposed total package weight of 43,030 lbs is bounded by the maximum allowable weight (45,000 lbs) for the RH-TRU 72-B package, (ii) the RLC, in which the payload and shielded dunnage will be stored, is previously reviewed and accepted by the NRC staff, (iii) any potential buildup of pressure in the payload and released into the RH-TRU 72-B inner vessel cavity will be maintained below the allowable design pressure of 150 psig as specified in the RH-TRAMPAC and RH-TRU 72-B SAR, and (iv) the NRC staff reviewed the results of the FE analysis for the payload and shielded dunnage in Appendix D of the application and confirms that the applicant demonstrated that positive safety margins are retained relative to the confinement of the Cesium-137 source within the transfer cask when assembled into the shielded dunnage assembly during this one-time shipment when subjected to hypothetical accident conditions. In addition, since there are positive safety margins against yield for the hypothetical accident conditions analysis, which are more challenging to the package than normal conditions of transport, shielded dunnage assembly will remain intact and maintain the source in a shielded position during the 1-foot drop for normal conditions of transport. Thus, the applicant's evaluations are acceptable.

2.2 Materials Evaluation

The Model No. RH-TRU 72-B packaging is constructed of a stainless steel outer container, which establishes the primary containment boundary, a stainless steel inner vessel, intended and expected to provide a secondary containment boundary, stainless steel and foam impact limiters and the carbon or stainless steel payload canister. Section 1.2.1 of the application discusses the Model No. RH-TRU 72-B packaging materials. The materials of construction of the shielded dunnage and the transfer cask are carbon steel, stainless steel and lead, along with the rubber gaskets in the transfer cask. The materials of construction of the shielded dunnage and the transfer cask are similar to those of the RH-TRU 72-B. NWP evaluated the chemical compatibility of the payload contents and determined that it meets the chemical compatibility specified in Section 4.4.1 of RH-TRAMPAC. NWP concluded that the materials contained within the RLC are inert and non-reactive, and are chemically compatible with the contents, payload canister, inner vessel, and the O-ring seals. The NRC staff has concluded that there will be no significant chemical, galvanic or other reaction for this one-time shipment.

2.3 Conclusion

The NRC staff reviewed documentations provided by the applicant to verify that statements presented by the applicant are accurate and within acceptable engineering practices. Based on the review of the statements and its structural and material evaluations in the application, the NRC staff concludes that the 72-B package for a one-time authorization of a shipment of the payload is adequately described and evaluated to demonstrate that has been adequately evaluated for its structural capability and meets the regulatory requirements of 10 CFR 71.71 and 10 CFR 71.73.

3.0 Thermal Evaluation

The applicant requested transport of up to 2942 Curies of Cs-137, which has a decay heat of 3.227 Watts. The package is authorized to transport up to 90 Watts per canister in accordance with Remote-Handled Transuranic Waste Authorized Methods for Payload Control (RH-TRAMPAC), Revision No. 3 (ADAMS Accession No. ML15351A508). Since the package decay heat limit is greater than the decay heat from the CsCl source, no thermal evaluation was required.

The breached Cs-137 source is inorganic solid material and generates no gas. The staff is confident that this one-time shipment will have hydrogen generated less than 5% in volume in the package even if the shipment period is greater than 60 days.

4.0 Containment Evaluation

The package is leaktight in accordance with ANSI N14.5, therefore a containment analysis was not required. In addition, since the CsCl source is inorganic solid material and generates no gas. The paint on the exterior of the transfer cask is the only potential source of flammable gases. The transfer cask will be painted in a ventilated area and the fast-drying paint will be completely dried prior to loading into the RLC. The applicant stated that any off-gassing from the paint will be nonexistent. The NRC staff is confident that this one-time shipment will have hydrogen generated less than 5% in volume in the package even if the shipment period is greater than 60 days.

5.0 Shielding Evaluation

5.1 Shielding Model

The Model No. RH-TRU 72-B consists of a stainless-steel outer cask and a separate, stainless-steel inner vessel. The radioactive material contents are loaded in a payload canister. The RH TRU 72-B design with the outer cask and inner vessel was previously reviewed by staff (Certificate of Compliance No. 9212, Rev. 9, ADAMS Accession No. ML16020A218). For this one-time shipment, the payload will consist of a single INIS Transfer Cask, which will contain a 2942 Ci ^{137}Cs source and source holder, and a NNSA Shielded Dunnage Assembly which provides additional axial shielding and structural support. Additionally, two empty dunnage drums are placed to fill the space above the shielded dunnage assembly.

The transfer cask consists of a carbon steel shell around cast-in-place lead shielding. The inner cavity consists of a 0.25-inch thick tube with an inner diameter of 2.5 inches that spans the full axial height of the transfer cask. The shielded dunnage assembly provides additional axial shielding via lead plates on the top and bottom which are kept in compression on the axial ends of the shielded dunnage assembly via stainless-steel tie rods. Five, 1-inch thick lead plates sit

over each axial end of the transfer cask with the innermost lead plates having recesses to accommodate the transfer cask plugs and safety plates. The shielded dunnage assembly provides structural support for the transfer cask and serves as a lifting device to facilitate operations.

Staff previously reviewed and approved the applicant's analysis (Certificate of Compliance No. 9212, Revision No 9) which showed that the 2 m normal conditions of transport dose rate is most limiting. The applicant only evaluated the shielding design under normal conditions of transport for this one-time shipment. Staff reviewed the applicant's finite-element analysis of the shielded dunnage assembly under hypothetical accident conditions and concluded neither it nor the transfer cask will be significantly impacted under the testing conditions required in accordance with 10 CFR 71.73 (see Chapter 2, "Structural Evaluation," above). For this reason, staff finds it acceptable that the applicant only considered normal conditions of transport in its shielding evaluation.

The applicant modeled the source region as a 1 cm tall cylinder with a diameter of 1 cm, positioned in the center of the transfer cask cavity. The actual source length is approximately 28 cm (11 inches) long. The staff finds the applicant's model is conservative as it concentrates the source. The applicant also modeled the source material at greatly reduced density, which effectively eliminates self-shielding. The staff finds that eliminating the self-shielding is also conservative. For these reasons, staff finds the applicant's modeling of the radioactive source acceptable.

The applicant modeled the carbon steel shells and plates, and the plate lead shielding of the NNSA Shielded Dunnage Assembly. The applicant also modeled the recesses in the innermost axial lead plates. Staff reviewed the applicant's MCNP sample input and found the applicant appropriately and accurately modeled these features. The applicant ignored the carbon steel gusseting, lifting features, and tie rods, which staff finds acceptable as this would have a minor impact on the calculated dose rates. For the INIS Transfer Cask, the applicant modeled the outer carbon steel shell and inner tube. The applicant modeled the space within as lead. The applicant used ASTM standards to determine material properties for carbon steel, stainless steel, and lead. NRC has determined these standards to be acceptable for use in nuclear applications. Except for the source cylinder, the applicant omitted all materials in the transfer cask cavity, and aside from the transfer cask and shielded dunnage assembly, the applicant omitted all other material within the inner vessel. Staff finds this conservative since it ignores existing material from the model that would otherwise provide shielding and; therefore, over-predicts external dose rates. The applicant used a thin cell tally to count the flux contribution per source particle. Staff reviewed the locations and geometry of the tally cells and found them to be acceptably located.

5.2 Shielding Evaluation

The applicant conducted a shielding analysis with MCNP version 6.2. MCNP is a three-dimensional, Monte-Carlo code that has long been used in shielding applications. Staff finds its use here acceptable. The applicant used updated MCPLIB photon cross-section data (LANL 2012). This data is based on ENDF/B nuclear data and MCNP-6.2 can recognize differences in library formats and treat them appropriately, thus staff finds the applicant's use of this data acceptable.

The applicant conducted an additional point kernel shielding evaluation to check the validity of the MCNP results. The applicant evaluated the dose rate with separate lead and iron buildup factors. With this method, the applicant effectively determined a high and low point kernel

estimate. The applicant's MCNP results fell within their point kernel estimates. NRC has accepted point kernel methodology, and staff reviewed the applicant's use of this method here and found it accurately applied. The applicant presented its calculated dose rates in Table 2-1 of Attachment C to the application.

Staff conducted its own confirmatory calculations with the transfer cask and shielded dunnage assembly in place. Staff used the MONACO code in the SCALE 6.2.2 suite with multigroup cross-section libraries based off the ENDF/B-VII nuclear data. Staff modeled the source as a single point centered in the transfer cask. Staff used both point detectors and mesh tallies to evaluate dose rates at various points of interest. Staff model conservatively assumed the thinnest dimension for the entirety of the recessed lead plate. Since ^{137}Cs emits relatively low-energy photons that are being transported through relatively thick lead and steel components, staff used MAVRIC to determine an importance map for variance reduction to improve tally statistics. Staff performed successive calculations with an increasing number of particles transported. Staff observed that the calculated results were not changing significantly (less than 10%) and increasing the length of calculation mostly served to reduce statistical uncertainty. Staff's results did not match those of the applicant for the relative difference between side and bottom dose rates. The staff found the side dose rates to be higher, by about a factor of 2.5, than the bottom. However, staff confirmed that the dose rates with the transfer cask and shielded dunnage assembly in placed are exceedingly low. Even after applying the staff's multiplier to the applicant's highest dose rate, many orders of magnitude of margin exist between the highest calculated dose rates and the regulatory limits in 10 CFR 71. Considering the difficulties in determining dose rates with low-energy, deep-penetration models using the Monte Carlo method, staff analysis confirms the applicant's conclusion that the dose rates will be low.

5.3 Conclusion

Staff finds the applicant's analysis accurately or conservatively accounted for the source, and packaging geometry and materials. Staff's calculations confirm expected dose rates are low. For these reasons, staff finds with reasonable assurance that the Model No. RH-72-B with a 2942 Ci ^{137}Cs source within a NNSA Shielded Dunnage Assembly and INIS Transfer Cask will meet the requirements of 10 CFR Part 71.

Reference:

1. "Further Notes on MCPLIB03/04 and New MCPLIB63/84 Compton Broadening Data for All Versions of MCNP5" LA-UR-12-00018, Los Alamos National Laboratory, January 3, 2012

6.0 Criticality Evaluation

The package for this shipment will not contain fissile material, therefore a criticality evaluation is not required.

7.0 Operating Procedures

There were no changes to the operating procedures for this shipment.

8.0 Acceptance Tests and Maintenance Program

There were no changes to the acceptance tests or maintenance program for this shipment.

CONDITIONS

Certificate of Compliance No. 9212 for the Model No. RH-TRU 72-B package has been amended by letter to authorize transport of a breached CsCl source containing up to 2942 Curies of Cs-137. All other conditions of Certificate of Compliance No. 9212, Revision 10, (ADAMS Package Accession No. ML16063A113) shall remain in effect for the shipment, except:

1. The CsCl source shall be placed in a transfer cask, as shown in Drawing No. INIS-DWG-0091, Revision No. B, and the transfer cask will be placed into an NWP-designed shielded dunnage assembly as shown in Drawing No. NNSA-DWG-0002, Revision No. 1. The shielded dunnage assembly shall be placed into a removable lid canister along with two, 55-gallon drums to fill the available space inside the removable lid canister.

2. The shielded dunnage assembly shall be operated and used in accordance with the "Instructions for the Assembly and Operating of NNSA [National Nuclear Security Administration] Shielded Dunnage assembly," located in the June 12, 2019, supplement.

3. The maximum shipping period requirement specified in Condition 10 of the certificate does not apply to this shipment.

This authorization is valid for one shipment of the subject package and expires on December 31, 2019.

CONCLUSION

Considering the statements and representations contained in the application, as supplemented, and conditions listed in the approval letter, and for the reasons listed above, the NRC staff has concluded that the RH-TRU 72-B package, as amended meets the requirements in 10 CFR Part 71.