Request for Additional Information
Nuclear Waste Partnership
Docket Nos. 71-9218 and 71-9279
Certificate of Compliance Nos. 9218 and 9279
Model Nos. TRUPACT-II and HalfPACT

By letter dated February 23, 2021 (Agencywide Documents Access and Management System Accession No. ML21054A051), the Nuclear Waste Partnership, LLC (the applicant) requested that the U.S. Nuclear Regulatory Commission (NRC) staff perform a review of the proposed changes to Model Nos. HalfPACT and TRUPACT-II transport packages.

This request for additional information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission (NRC) staff in connection with its review of the application. The requested information is listed by chapter number and title in the application. The NRC staff used NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material: Final Report," in its review of the application.

Each question describes information needed by the staff for it to complete its review of the application and to determine whether the applicant has demonstrated compliance with regulatory requirements.

STRUCTURAL EVALUATION (St)

RAI-St-1 Pertaining to SC-30G2, SC-30G3, SC-55G1, and SC-55G2, the application states that the SC-30G1 was previously approved based on 4-foot (4-ft) drop tests for normal conditions of transport (NCT) and 30-foot (30-ft) drop tests for hypothetical accident condition (HAC). Provide the following information:

a. Clarify whether the 4-ft drop test was conducted on the SC-55G1 version under NCT. If tests were performed, provide the test results. If the 4-ft drop test was not performed, demonstrate that the SC-55G1 shielded canister meets the 4-ft drop NCT requirement (e.g., show that the 4-ft drop test performed on other shielded canister bounds the SC-55G1 shielded canister or perform the test and provide the results).

The report HPT-REP-0001, "Regulatory Hypothetical accident Condition Type B testing for the HalfPACT Shielded Container Payload," Revision 0, page 2, states that 4-ft drop tests were performed for all four new versions of the shielded canisters. On page 2, the report states that the 4-ft drop test and the 30-ft drop test were conducted for the SC-30G3 and the SC-55G1 versions of the canisters for HAC, but other sections of the report (e.g., page 30) do not state that a 4-ft drop test was conducted. Similarly, the report CH-TRU on page 4.9-5 does not state that a 4-ft drop test was conducted for SC55G1.

b. Clarify whether the SC-30G2 was only tested for the 4-ft drop test. Justify why the 4-ft drop tests are an adequate means to demonstrate acceptability of the HAC 30-ft drop tests for the package with the new contents.

It appears that in the discussion in the report HPT-REP-0001, Section 7.1.4, “SC-30G2 and SC-55G2 Evaluation,” states that the 4-ft drop test was credited to demonstrate acceptable performance of the 30-ft drop test for HAC. However, on Section 5.1.1, “SC-30G2 Payload Assembly vs. SC-55G1 Payload Assembly,” it appears to state that no testing was performed on the SC-30G2 shielded canister.

c. Clarify what is intended by the term “informally” in the report HPT-REP-0001 excerpt. If the term “informally” means that the accelerometer was not calibrated or otherwise qualified for testing, then justify why the comparison of the test results is valid.

In the report, HPT-REP-0001Section 7.1.1, “SC-30G3 Impact Acceleration Comparison,” the applicant stated that “the SC-30G3 will be used for direct comparison of 30-ft protected versus 4-ft unprotected bottom and side drops. ***Informally*** [bolded for emphasis], an information only uniaxial accelerometer was installed on SC-30G3 18TU-04 (the test unit used for Type B HAC drop testing).”

Revision 8 of the application for the HalfPACT package references report CH-TRU, “Payload Appendices”, Revision 5, and the CH-TRU report references Report HPT-REP-0001. In these reports, the applicant discusses the methodology to qualify the shielded canisters included as part of the amendment request. The applicant refers in various instances to a 4-ft drop test performed for NCT (e.g., Type A tests) that is used to support the qualification of canisters. The applicant also discusses the 30-ft drop tests for HAC (e.g., Type B package tests).

The staff needs this information to determine compliance with the requirements in Title 10 of the *Code of Federal Regulations* Section 71.71(c) [10 CFR 71.71(c)] and 10 CFR 71.73(c).

SHIELDING EVALUATION (Sh)

RAI-Sh-1 Clarify, with justifications, how the uncertainties in the source intensity, source term geometric distribution, and the density correction factors (DFCs) were considered in the calculations of the dose rates and revise the allowable contents as necessary to meet the dose rate limits.

Sections 5.5.6, 5.5.7, 5.5.8, and 5.5.9 of Revision 25 of the TRUPACT-II application provide information on the allowable source intensity, source term geometric distribution, and the DFCs. However, it is not clear whether the uncertainties in these parameters have been considered in determining the maximum allowable activity for each of the containers with the targeted dose rate limit.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.47.

RAI-Sh-2 Provide the maximum size of the solid-large objects, for each of the categories of the contents as specified in “Contact-Handled Transuranic Waste Authorized

Methods for Payload Control" (CH-TRAMPAC) (ADAMS Accession No. ML21054A054) Revision 6, (ADAMS Accession No. ML21054A054) and clarify which shielding analyses supports the large objects.

CH-TRAMPAC, Revision 6, Table 2.9-49, Table 2.9-53, Table 2.9-57, and Table 2.9-61 identifies three forms of authorized contents for the SC-30G2, SC-55G1, and SC-55G1 containers. The three forms include the following:

1. solids, any particle size (e.g., fine powder or inorganic particulates),

2. large particle size (e.g., sand, concrete, or debris), and

3. large objects (e.g., metal cans containing waste).

However, it is not clear how to distinguish what constitutes a large object and particle of any size. Also, it is not clear how these definitions of the sizes of the particles or objects are related to the shielding models of distributed or concentrated sources in the package.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.33(b)(3), 10 CFR 71.47, and 10 CFR 71.51.

RAI-Sh-3 Explain why the density correction factors (DCFs) for SC-30G3 and SC-55G1 are identical.

The application shows that the equations for the self-shielding factor DCFs of the SC-30G3 and SC-55G1 are identical. Specifically, the application presents these polynomial equations as:

$$DCF_{SC\text{-}30G3} = 0.0051*\rho^3 - 0.0987*\rho^2 + 0.8030*\rho + 0.2342,$$
$$DCF_{SC\text{-}55G1} = 0.0051*\rho^3 - 0.0987*\rho^2 + 0.8030*\rho + 0.2342$$

However, it is not clear why they behave the same since these two containers have different shielding designs and source term limits as shown in Tables 5.5-18 to 5.5-21.

The staff needs this information to determine compliance with the requirements of 10 CFR 71.47 and 10 CFR 71.51.

RAI-Sh-4 Add the steps listed in Section 5.5.10 to the Chapter 7 of the safety analysis report (SAR) as part of the instructions for determining the allowable contents.

Section 5.5.10, "Determination of Acceptable Activity," of the TRUPACT-II SAR provides a list of the steps for determining the allowable quantity of the wastes based on their radioactive characteristics. These steps/instructions form the basis for determining the maximum allowable contents and should be part of the loading instructions.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.33(b)(1), 10 CFR 71.43(f), 10 CFR 71.47, 10 CFR 71.51, and 10 CFR 71.87(a).

RAI-Sh-5 Demonstrate there are no significant secondary gammas or neutrons from the package or provide control measures to ensure that there will be no significant (n, gamma) or (gamma, n) reactions in the TRU wastes.

Page 5.3-27 of the TRUPACT-II application states the following:

> "Combined photon/neutron mode evaluations were not employed for the neutron analyses as multiple test runs demonstrated that the gamma dose rate due to the interaction of neutrons in the shielding materials contributes a statistically insignificant (<1%) change in the dose rate as compared to the neutron dose rate."

However, it is not clear what the multiple runs were referred to. If the term "run" is related to the MCNP model calculation, the secondary gammas or neutrons in the TRU contents would not be captured in the analyses because the definition of the material in the sample MCNP input, as provided in the application, for the content does not include the TRU isotopes as defined in the Department of Energy's Environmental Impact Statements (DOE 2016). The (n, gamma) and (gamma, n) reactions in the TRU wastes are well understood physical phenomena (McNair, 2019). The MCNP models can only capture the secondary gamma and neutrons when the material compositions for the TRU contents are explicitly defined in the material cards.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.47 and 10 CFR 71.51.

References:

1. Department of Energy, "Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375)," Department of Energy, January 2016.

2. Carson R McNair, "Characterization techniques for TRU waste from the Analytical Laboratory Hot Cells at Idaho National Laboratory," Idaho National Laboratory, March 2019.

RAI-Sh-6 Clarify whether the uncertainties associated with the source term calculation and the statistical uncertainty associated with the dose rate calculation have been included in the final dose rates. If they are not, include the uncertainties associated with these calculations and demonstrate that the package meets the regulatory requirements.

The applicant used computer code SOURCES-4A to calculate the specific activity of each of the nuclides provided in the document CH-TRAMPAC . However, it is not clear what are the uncertainties, if any, associated with the source term calculations of the transuranic wastes using the SOURCES-4A computer code. The uncertainties of the source term calculations should include, as a minimum, how the transuranic wastes were produced, i.e., irradiation parameters, such as fluxes and spectra, cooling time, and the

uncertainties of these parameters.

The applicant developed a scheme to calculate the allowable activity for the SC-30G1 and the four new containers. The scheme determines the maximum allowable contents by dividing the targeted dose rate by the calculated dose rate per curie of each nuclide in the wastes. Table 5.1-8 to Table 5.1-11 of Revision 25 of the TRUPACT-II application provide the targeted maximum dose rates for the Half-PACT packaging system containing the payloads for the four new containers (SC-30G2, SC-30G3, SC-55G1, and SC-55G2) and Table 5.1-7 provides the revised neutron dose rate for neutron sources for the SC-30G1 container. The dose rates in these tables show that the maximum dose rate is less than one percent (e.g., 9.99 mrem/hr vs. 10 mrem/hr for the SC-30G2 container) within the regulatory limits of 10 CFR 71.47, which is 10 mrem/hr. In addition, the data provided in Table 5.4-12, Table 5.4 13, Table 5.4-14, and Table 5.4 15 show that the statistical errors of the Monte Carlo method used in the shielding analyses are in 0.1% to 0.3% for packages under NCT. Based on the MCNP manual, the error associated tally of MCNP calculation is a percentage of the mean value, thus, 0.3% * 9.99 = 0.02997. Considering the statistical error, the actual dose rate could be as high as 9.99+0.02997=10.01997 mrem/hr, which exceeds the regulatory dose rate limit of 10 mrem/hr.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.47.

RAI-Sh-7 Justify the assumption for maximizing the distance to the detector for the shielding model for the package under NCT.

On page 5.3-1, the first paragraph the TRUPACT-II SAR states the following:

> "NCT assumptions maximize the distance from the source(s) to the nearest detector whereas HAC assumptions minimize the distance from the source(s) to the nearest detector."

The staff understands the assumption for modeling of the package under HAC. However, it does not understand why the applicant tried to maximize the distance between the source and the detector in the NCT model. This assumption may not be conservative even if the source is homogeneously distributed in the waste.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.47.

RAI-Sh-8 Either demonstrate that lead slump does not occur or provide an analysis of the effect of lead slump on the dose rate at one meter for the damaged package.

In the document titled "CH-TRU Payload Appendices," Revision 5, the applicant stated in the application that no lead slump occurred by examining the lead layer of the testing unit. However, staff does not find the justification for not evaluating lead slump in the application. The staff notes that lead slump under impact is an unavoidable natural phenomenon and will occur in accordance with the basic physics (G. C. Mok, 1989, Tan, et al, 2017) unless the package is designed such

that the shielded containers inside the overpack do not experience any significant impact (g-load) under the drop tests required in 10 CFR 71.73(c)(1), which states the following:

> "Free Drop. A free drop of the specimen through a distance of 9 m (30 ft) onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected."

The staff notes that Figure 4.10-18 – SC-55G2 18TU-10 Cut AM-AN Near Mid-Span shows visible deformation of the lead layer in the middle section of the test unit. The staff also notes that the picture in Figure 7-20 of the document, with document identification number "HPT-REP-0001," seems to show a void gap at the top end of the lead shield after drop test. These gaps are probable evidence that there will be a loss of lead shield resulting from lead slump. In fact, the gap created by lead slump can be calculated by the differential contraction of the lead layer and the steel shells. If there is not sufficient data to prove lead slump will never occur for this package under HAC, a shielding analysis should be provided assuming there is lead slump under HAC, as predicted using the method in the "Cask Designers Guide" (ORNL, 1970) document. The analysis should also account for any void between the top of the lead shielding and the outer cask top flange resulting from package fabrication. Using analyses for a few radionuclide contents (e.g., Co-60), the applicant may demonstrate that the dose rates for the puncture HAC configuration bound those for the lead slump configuration. In addition, the publication from Sandia National Laboratory, "Dose Estimates in a Loss of Lead Shielding Truck Accident," clearly indicate that lead slump is a credible condition for transportation package under HAC.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.51.

References:

1. Lawrence Livermore National Laboratory. G. C. Mok, et al., "The Analysis of Lead Slump Effects in Shipping Casks for Radioactive Materials," March 1989.

2. Tan, Z., Bernal, S.A., and Provis, J.L., "Reproducible mini-slump test procedure for measuring the yield stress of cementitious pastes," Mater Struct Vol. 50, PP 235, 2017.

3. Oak Ridge National Laboratory. "Cask Designers Guide, A Guide for the Design, Fabrication, and Operation of Shipping Casks for Nuclear Applications," February 1970.

4. Matthew L. Dennis, Ruth F. Weiner, Douglas M. Osborn, and Terence J. Heames, "Dose estimates in a loss of lead shielding truck accident," Sandia National Laboratory, August 2009.

RAI-Sh-9 Show that the MCNP gamma shielding analysis model for the HalfPACT containing the SC-30G3 container properly converged.

The applicant provided the input file for the MCNP model for the HalfPACT containing the SC-30G3 container. The input model indicates that the applicant set a cut-off computing time of 1200 minutes. However, it is not clear how this cut-off time was determined and whether it can assure a proper convergence of the calculations. One method of showing convergence is providing an output file for the package under NCT. Also, clarify whether the calculations were made on a multiprocessor computer cluster or single processor. For the CTME card, the MCNP 6.2 user's manual (LA-UR-17-29981, Los Alamos National Laboratory, 2017) explicitly points out that it is highly recommended that the NPS card (Section 3.3.7.1.1) should be used to limit the run time for multiprocessor cluster computers.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.47 and 10 CFR 71.51(a)(2).

RAI-Sh-10 Confirm that pre-shipment radiation survey is not relied upon for demonstrating that the package design will meet the regulatory requirement of 10 CFR 71.51(a)(1) and revise the SAR as necessary.

On page 5.3-1, the first paragraph the TRUPACT-II SAR states:

> "Any significant deviation from the NCT configuration assumption is precluded through the use of pre-shipment radiological surveys of the package to validate that the source(s) are reasonably distributed within the package."

This statement seems to indicate that assurance of compliance with the regulatory requirement of 10 CFR 71.51(a)(1), "…, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging;.." relies on pre-shipment dose rate measurement. It is not clear how this pre-shipment measurement can assure that the package meets the regulatory requirements of no significant increase in external surface radiation levels even before a shipment has been made. A pre-shipment dose rate measurement can only assure that the package is fabricated and loaded as designed. It cannot tell any information on the potential source terms reconfiguration or relocation under NCT. Only design analysis can provide such an assurance.

In addition, as explained in Regulatory Issue Summary 2013-04, "Content Specification and Shielding Evaluations for Type B Transportation Packages," pre-shipment dose rate measurement is a requirement of 10 CFR 71.87, "Routine determinations." Per 10 CFR 71.35(a), an application for a CoC must include a demonstration that the package satisfies the standards in Subpart E which includes requirements in 10 CFR 71.51.

The staff needs this information to determine compliance with the requirements in 10 CFR 71.35 and 10 CFR 71.51.