UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION REPORT

Model No. HalfPACT, Docket No. 71-9279
Certificate of Compliance No. 9279
Revision 10
Model No. TRUPACT-II, Docket No. 71-9218
Certificate of Compliance No. 9218
Revision 26

Enclosure 3

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SUMMARY

By letter dated February 23, 2021 (NWP, 2021a), and supplemented on June 24, 2021 (NWP, 2021b), October 6, 2021 (NWP, 2021c), November 18, 2021 (NWP, 2021d); January 28, 2022 (NWP, 2022a), February 24, 2022 (NWP, 2022b), and March 14, 2022 (NWP, 2022g); Nuclear Waste Partnership LLC (NWP thereafter), on behalf of the U.S. Department of Energy (DOE), submitted applications to revise Certificate of Compliance (CoC) No. 9218 for the Model No. TRUPACT-II package (TRUPACT-II) and CoC No. 9279 for the Model No. package HalfPACT (HalfPACT). The applicant requested administrative changes and to add shielded containers configurations as authorized content to the HalfPACT package. The purpose of this revision is to support future transport and disposal of waste to the Waste Isolation Pilot Plant (WIPP). The CoCs will reference consolidated application dated February 24, 2022.

U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application, including its supplement, using the guidance in NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material" (NRC, 2020). Based on the statements and representations in the application, as supplemented, and the conditions listed below, the staff concludes that the packages meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, "Packaging and Transportation of Radioactive Material."

1. GENERAL INFORMATION EVALUATION

The objective of this general information evaluation is to verify that the applicant has provided an adequate description of the package to familiarize reviewers with the pertinent features of package. The drawings provided by the applicant, as these pertain to the proposed changes to the packages' Model Nos. TRUPACT-II and HalfPACT are sufficiently detailed and consistent with the package description to provide reasonable assurance that the transportation package can meet the regulations.

1.1 Purpose of the application

The applicant requested the following changes as part of this revision to the design of the Model Nos. TRUPACT-II and HalfPACT packages:

a) *Model No. TRUPACT-II*

Administrative changes:

(1) replacement of Figure 1.1-1 of the TRUPACT-II application with a color rendered version and

(2) clarification of weights related to the approved contents of the 55-gallon drum, 100-gallon drum, Standard Waste Box (SWB) and ten drum overpack (TDOP).

b) Model No. HalfPACT

Add shielded containers configurations, that provide gamma (γ) shielding, as authorized content. The shielded payload container designs (i.e., SC-30G2, SC-30G3, SC-55G1, and SC-55G2), along with the currently authorized SC-30G1 shielded container. The applicant also added the corresponding payload container fissile gram equivalent (FGE) limits to the allowed FGE per package for shielded containers in the HalfPACT package. The proposed contents are described, discussed, and evaluated in more detail in Sections 1.2.2, 5, and 6 of this safety evaluation report (SER)..

The applicant stated that the new shielded container designs will allow the WIPP emplacement of a portion of the DOE remote-handled transuranic (RH-TRU) waste inventory in stackable configurations instead of in RH-TRU removable lid canisters in excavated boreholes underground.

1.2 Package Design Information

1.2.1 Packaging

The applicant did not propose any changes to the packaging design of the Model Nos. TRUPACT-II and HalfPACT packages.

The TRUPACT-II and HalfPACT packaging is comprised of an outer confinement assembly (OCA) that provides a secondary confinement boundary when its optional O-ring seals are utilized, and an inner containment vessel (ICV) that provides the primary containment boundary and houses the shielded containers. Two aluminum honeycomb spacer assemblies are used within the ICV, one inside each ICV torispherical head. The honeycomb spacer assemblies provide adequate protection from the payload. A silicone wear pad is utilized at the interface between the bottom exterior of the ICV and the bottom interior of the OCA. An optional polyester foam annulus ring may be used in the annulus between the ICV and outer containment vessel (OCV), just below the OCV lower seal flange, to prevent debris from becoming entrapped between the vessels. Inside the ICV, the payload will be within 55-gallon drums, 85-gallon drums, 100-gallon drums, standard waste boxes, or a ten drum overpack.

1.2.2 Contents

The Model Nos. TRUPACT-II and HalfPACT are Type B packages used to transport radioactive material to the WIPP facility. The packages are designed to transport contact-handled transuranic (CH-TRU) waste materials and other authorized payloads such as tritium-contaminated materials that do not exceed $10^5 A_2$ quantities. The applicant's proposed changes to the packages are briefly described in Section 1.1 of this SER. The "CH-TRU Payload Appendices," Revision 5, (NWP, 2022d) and "CH-TRAMPAC," Revision 6, (NWP, 2022c) include the description of the allowable contents in Model Nos. TRUPACT-II and HalfPACT packages.

The SC-30G2, SC-30G3, SC-55G1, and SC-55G2 containers provide gamma shielding. The applicant also renamed the "shielded container" previously authorized in HalfPACT's CoC, Revision 9, to "SC-30G1," and revised the quantity limit for the container. In Table 2.1-1 in the Contact-Handled Transuranic Waste Authorized Methods for Payload Control (CH-TRAMPAC), Revision 6, the applicant noted that the four new containers can be transported only in the HalfPACT package. Sections 5 and 6 of this SER include more detailed description of the shielded containers.

The maximum weight of the HalfPACT package is 18,100 lb. Tables 1 and 2 below include the maximum weight of the proposed payload and the maximum number of containers per package, respectively. Section 6 of the application includes a description of the FGE for the shielded container.

Table 1.1. Maximum number of payload containers per package and authorized packaging configurations

Type of Payload Container	Maximum Weight (lbs.)
SC-30G1	2,260
SC-30G2	3,160
SC-30G3	6.300
SC-55G1	3,410
SC-55G2	6,500

Table 1.2. Maximum number of shielded containers per shipment

Type of Payload Container	Maximum No. of Shielded Containers per Package
SC-30G1	3
SC-30G2	2
SC-30G3	1
SC-55G1	2
SC-55G2	1

The SER includes the evaluation of the proposed contents. The CONDITIONS section of this SER includes a summary of the changes to the certificates of the Model Nos. TRUPACT-II and HalfPACT.

1.3 Drawings

The applicant revised the following drawings:

1) Model Nos. TRUPACT-II and HalfPACT

   a) Drawing No. 163-001, "Standard Pipe Overpack SAR Drawing," sheets 1-3, Rev. 9;

   b) Drawing No. 163-009, "Criticality Control Overpack SAR Drawing," sheets 1 and 2, Rev. 2.

2) Model No. HalfPACT (in addition to the drawings in item No. 1)

a) Drawing No. 163-008, “SC-30G1 Shielded Container SAR Drawing,” sheets 1-6, Rev. 4;

b) Drawing No. 163-010, “SC-30G2 Shielded Container SAR Drawing,” sheets 1-7, Rev. 1;

c) Drawing No. 163-011, “SC-30G3 Shielded Container SAR Drawing,” sheets 1-8, Rev. 1;

d) Drawing No. 163-012, “SC-55G1 Shielded Container SAR Drawing,” sheets 1-5, Rev. 0; and

e) Drawing No. 163-013, “SC-55G2 Shielded Container SAR Drawing,” sheets 1-4, Rev. 1.

The staff updated the revision No. of Drawing No. 2077-500SNP, “TRUPACT-II Packaging SAR Drawing,” sheets 1-11, Rev. AA, in the certificate for the TRUPACT-II package.

The staff evaluated the changes to the drawings in Section 7 of this SER.

1.4 Evaluation Findings

The staff reviewed documentation provided by the applicant including package and packaging descriptions as well as design drawings to verify that statements presented by the applicant are acceptable for the review and approval of the revision of the CoCs for the Model Nos. TRUPACT-II and HalfPACT packages, as required by 10 CFR 71.33. Based on the review of the statements and representations provided by the applicant, the staff concludes that the package, packaging, and contents have been adequately described to meet the requirements of 10 CFR Part 71.

2. STRUCTURAL EVALUATION

The staff reviewed the proposed changes to the TRUPACT-II and HalfPACT shipping packages to verify that the applicant has performed acceptable structural evaluations demonstrating that the packages, as proposed, meet the requirements of 10 CFR Part 71 under both normal conditions of transport (NCT) and hypothetical accident conditions (HAC). For the TRUPACT-II package, the applicant proposed a series of administrative changes. For the HalfPACT package, the applicant proposed adding four new versions of shielded container designs as part of its authorized payload. The staff’s focus of this SER on the review of these new shielded container designs.

2.1 Structural Design

2.1.1 Description of Structures

Section 1 of this SER includes a description of the applicant’s proposed changes to the TRUPACT-II and HalfPACT packages. The applicant proposed administrative changes to the Model No. TRUPACT-II and adding new shielded containers as payload of the Model No. HalfPACT.

The applicant noted that the proposed administrative changes to the Model No. TRUPACT-II do not have an impact on the safety design basis. The staff reviewed the administrative changes described in the application and concludes that there are no safety implications related to the design basis. The staff finds that there are no structural design changes made in this application and the changes are administrative. Hence, further structural evaluation of the TRUPACT-II design is not necessary because the current structural evaluation is bounding.

In terms of the Model No. HalfPACT, the outer confinement assembly (OCA) and inner containment vessel (ICV) designs of the Model No. HalfPACT remain the same in this application.

In Appendix 1.3.1, "Packaging General Arrangements Drawings," of the application, the applicant provided licensing drawings with tolerances, dimensions, and welding symbology, as well as definitions, material designation, and associated standards for the new shielded containers. The applicant also described and detailed component descriptions and arrangement of components relative to each other. The applicant described the weight of the package with and without its contents in Table 2.2-1, "HalfPACT Weight and Center of Gravity," of the application. The weight of the shielded canisters is bounded by the weight used in the previous analysis.

The overall physical dimensions of the package are shown in the listed drawings in Appendix 1.3.1 of the application. The design basis maximum normal operating pressure (MNOP) of the package is 50 psig. A loaded HalfPACT package could be lifted using the pair of forklift pockets that are located at the base of the OCA body. The pockets are sized to accommodate forks up to 10 inches (in.) wide and up to 4 in. thick. An overhead crane could also be used to lift the loaded package, utilizing lifting straps, through the forklift pocket. The staff finds that the applicant provided sufficient information to characterize the HalfPACT design and finds the information to be acceptable.

The staff reviewed the structural design description of the HalfPACT package and concludes that the contents of the application satisfy the requirements of 10 CFR 71.31(a)(1)(c) and (a)(2), 71.33(a) and (b), and 10 CFR 71.35(a).

2.1.2 Design Criteria

A transportation package must be designed to meet the regulatory requirements of 10 CFR 71 design criteria of a transportation package and should be designated as those that affect the containment boundary which contribute to the overall structural performance of the package.

The applicant evaluated the HalfPACT package with a combination of analytical tools and physical drop testing. The acceptance criteria for analytical assessments are in accordance with Regulatory Guide 7.6, "Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels," and the American Society of Mechanical Engineers (ASME), Boiler Pressure Vessel Code, Section III, Division 1. The acceptance criteria for empirical assessments are demonstrations that the containment boundary remains leak tight throughout NCT and HAC certification testing. The acceptance criteria for both analytical assessments and empirical assessments were reviewed and accepted in the previous certification by the staff.

Based on the review of the design criteria presented in Section 2.1.2 of the application, the staff finds that the structural design criteria for the HalfPACT package provide adequate structural integrity to meet the NCT and HAC requirements of 10 CFR 71.

2.1.3 Identification of Codes and Standards for Package Design

The applicant did not request changes to the codes and standards used in the design of the currently authorized SC-30G1. The same codes and standards are used in the four new shielded payload containers' (i.e., SC-30G2, SC-30G3, SC-55G1 and SC-55G2) designs. The staff reviewed Section 2.1, "Structural Design," of the HalfPACT application to verify that there were no changes to the codes and standards of the package. The staff concluded that these codes and standards continue to be appropriate for the intended purpose and are properly applied.

2.2 Weights and Centers of Gravity

The nominal weights and location of the center of gravity (CG) of the package components are provided in Tables 2.2-1, "HalfPACT Weight and Center of Gravity," of the application. These weights and CG are used for the structural evaluations to meet the NCT and HAC requirements of 10 CFR 71.

2.3 Materials

Section 7 of this SER includes the materials evaluation related to the proposed changes to the HalfPACT package.

2.4 General Requirements

2.4.1 Minimum Package Size

According to Section 2.4.1 of the HalfPACT application, the minimum package dimension is greater than 4 in. Therefore, the staff finds that the HalfPACT package satisfies the requirements of 10 CFR 71.43(a) for minimum size.

2.4.2 Tamper-Indicating Feature

The closure of the package is facilitated by the tamper-indicating seals. They are installed at one OCA lock bolt location and at the OCV vent port access plug, as delineated on the drawings in the HalfPact SAR Appendix 1.3.1, "Packaging General Arrangement Drawings." For the proposed package, the tamper-indicating feature is not changed from the previously approved certification. The staff reviewed the tamper-indicating feature description and finds that the HalfPACT package satisfies the requirements of 10 CFR 71.43(b) for a tamper-indicating feature.

2.4.3 Positive Closure

The positive closure of the package in the application has not been changed from the previously approved HalfPACT design certification. The staff reviewed the information provided about positive closure in Section 2.4.3 of the HalfPACT application and Appendices 4.7 through 4.10 of the CH-TRU Payload Appendices of the application and finds that the package satisfies the requirements of 10 CFR 71.43(c) for positive closure.

2.4.4 Package Valve

The applicant did not propose any changes to the previously approved valve designs of the package; as described in Section 2.4.5 of the HalfPACT and the TRUPACT-II applications, neither the OCV nor the ICV have valves. The staff reviewed the package closure description of the HalfPACT package and finds that it satisfies requirements of 10 CFR 71.43(e).

2.5 Lifting and Tie-Down Standards

2.5.1 Lifting Devices

The applicant described lifting and handling of the package in Section 2.5.1 of the HalfPACT and CH-TRU pay load Appendix 4.7 through 4.10. The method of lifting for the HalfPACT and lifting devices for the OCA and ICV lid have not been changed in this application. The design remains the same and is able to lift the weight of the proposed payloads while maintaining the minimum factor of safety of 3.0 per the requirements of 10 CFR 71.45(a).

The staff reviewed the lifting for the package and concludes that it satisfies the requirements of 10 CFR 71.45(a) for lifting.

2.5.2 Tie-Down Devices

The applicant did not change the tie-down design for the package. The safety margin of the package tie-down remains the same per 10 CFR 71.45(b).

The staff reviewed the tie-down requirements for the package and concludes that they satisfy the requirements of 10 CFR 71.45(b) for tie-down.

2.6 Normal Conditions of Transport

The applicant used the acceptance criteria for NCT to demonstrate that the lid cover closure remains secured and that the ICV is not breached during NCT. The applicant demonstrated that, under HAC, the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 maintain both confinement and shielding integrity without loss of particulate or degradation of the shielding material. Therefore, the demonstrations for HAC conditions bound the results for NCT. The staff reviewed the application for the testing performed and concluded that the results for NCT continue to be valid and the structural performance of the package under NCT satisfies the requirements of 10 CFR 71.71.

2.7 Hypothetical Accident Conditions

2.7.1 Free Drop

Subpart F of 10 CFR 71 requires performing a 30-feet (30-ft) free drop test in accordance with the requirements of 10 CFR Part 71.73(c)(1). The applicant performed physical model testing for two shielded containers, SC-30G3 and SC-55G1). The applicant selected containers SC-30G3 and SC-55G1 as bounding over the containers SC-30G2 and SC-55G2 based on the following considerations:

a) similarity in size and weight as well as the quantity of containers that may be shipped within a HalfPACT package, and

b) the results of the physical testing for both DOT-7A Type A 4-foot drop tests and Type B HAC 30-foot drop tests for the container SC-30G1, which were performed in 2007, and reviewed and accepted by the staff in the previous certification.

In Section 4.8.3 of CH-TRU report, the applicant provided a description of the HAC tests, a structural evaluation of the tests, and figures of the test configurations for SC-30G3 and found the following:

a) *No apparent deformation or damage to the SC-30G3.*

Visual inspection. Post-test visual inspection of the interior and exterior surfaces of the SC-30G3 indicated no apparent global or localized deformation or damage to the SC-30G3. The solid, concrete-filled rolling hoops in the 30-gallon test payload drum left no visible deformation on the SC-30G3's inner shell, even though the payload drum was loaded to exceed the 6,300-lb. SC-30G3 gross weight.

b) *No impact to the integrity of the containment boundary.*

(1) **Visual inspection**. Post-test visual inspection of the HalfPACT ICV shell at its interface with payload dunnage components revealed no localized deformations that could compromise containment integrity of the HalfPACT package.

(2) **Ultraviolet scanning.** Subsequent to the performance of end and side drop testing, the flour/fluorescein mixture placed within the SC-30G3 was verified via ultraviolet scanning to be 100% retained throughout the testing, thereby confirming containment integrity of the SC-30G3.

c) *No significant impact to the integrity of the lead shield*

(1) **Shielding integrity tests**. Pre- and post-test shielding integrity tests coupled with destructive disassembly of SC-30G3 sidewalls showed no evidence of lead slump or significant changes to the shielding capabilities of the HalfPACT design.

(2) **Visual inspection**. Post-test visual inspection of the SC-30G3 wall cut-outs revealed some modest global and localized shell deformation, but the magnitudes were very limited, of no structural significance, and not coupled with measurable lead thinning, or reduction in shielding.

The staff reviewed the applicant's performance, results, and conclusions of the physical tests. The staff finds that the SC-30G3 under HAC maintained shielding integrity with little measurable damage to the HalfPACT package and concludes that the results of the tests are acceptable.

Additionally, in Section 4.9.3 of CH-TRU report, the applicant provided a description of the HAC tests, a structural evaluation of the tests, and figures of the test configurations for SC-55G1 and concluded the following:

a) *No apparent or significant damage or deformation to the SC-55G1.*

Visual inspection. Post-test visual inspection of the interior and exterior surfaces of the SC-55G1 indicated no apparent global damage and minimal localized deformation to the SC-55G1. The solid, concrete-filled rolling hoops in the 55-gallon test payload drum left no visible deformation of the SC-55G1 shells, even though the payload drums were loaded to exceed the 3,410-lb. SC-55G1 gross weight.

b) *No impact to the integrity of the containment boundary.*

(1) **Visual inspection**. Post-test visual inspection of the HalfPACT ICV shell at its interface with payload dunnage components revealed no localized deformations that could in any way compromise containment integrity.

(2) **Ultraviolet scanning**. Subsequent to the performance of end and side drop testing, the flour/fluorescein mixture placed within the SC-55G1 was verified via ultraviolet scanning to be 100% retained throughout the testing, thereby confirming confinement integrity of the SC-55G1.

The staff reviewed the applicant's performance of the physical tests and conclusion related to the SC-55G1. The staff concludes that the SC-55G1 will preserve its contents within the shielded boundary. Section 5 of this SER includes the shielding evaluation for the proposed content for the HalfPACT package. The staff finds the results of the tests to demonstrate the structural integrity of the package under HAC are acceptable.

Based on the applicant test methods and testing of the shielded containers, the staff finds that the HalfPACT package meets the requirements for free drop testing and concludes that the requirements of 10 CFR 71.73(c)(1) are met.

2.7.2 Crush

The crush test per 10 CFR 71.73(c)(2) is required only when the mass of the specimen is not greater than 1,100 lbs. (500 kg). This test is not applicable to the proposed change to the HalfPACT package, since the package weighs more than 1,100 lbs.

2.7.3 Puncture

The puncture drop test for the package has not been changed from the previously certified package design. Therefore, the staff concludes that they satisfy the standards of 10 CFR 71.73(c)(3).

2.7.4 Thermal

The thermal test for the package remains the same as previously certified package designs. Therefore, the staff concludes that it satisfies the regulatory requirements of 10 CFR 71.73(c)(4).

2.7.5 Immersion - Fissile Material

For fissile material, per 10 CFR 71.73(c)(5), the package shall be subject to the requirements on 10 CFR 71.55. If water in-leakage has not been assumed for criticality analysis, the package must be evaluated for immersion under a head of water of at least 3 ft. in the attitude for which maximum leakage is expected.

2.7.6 Immersion - All Packages

In accordance with 10 CFR 71.73(c)(6), an undamaged package is subjected to a water pressure equivalent to immersion under a head of water of at least 50 ft., or an equivalent external pressure load of 36.4 pounds force per square inch (psi) absolute (psia) (21.7 psi gauge +14.7 psi). The package design was previously evaluated for immersion in the certified design. Therefore, the staff concludes the previous evaluation for immersion is also applicable to this request and the package continues to satisfy the requirement in 10 CFR 71.73(c)(6).

2.7.7 Deep Water Immersion Test

Per 10 CFR 71.61, a Type B package containing more than 10^5 A_2 must be designed so that its undamaged containment system can withstand an external water pressure of 290 psi for a period of not less than 1 hour without collapse, buckling, or in-leakage of water. However, the package does not transport payloads with an activity of greater than 10^5 A_2, therefore, the requirement of10 CFR 71.61 does not apply.

2.8 Special Form

This section is not applicable since this application does not seek approval for transport of special form radioactive materials.

2.9 Fuel Rods

This section is not applicable since fuel rods are not included as an approved payload configuration.

2.10 Evaluation Findings

The staff reviewed the changes proposed by the applicant to the TRUPACT-II and HalfPACT packages. Based on a review of the statements and representations in the application and the responses to the staff's requests for additional information (RAI), the staff concludes that the structural design has been adequately described and evaluated and that the HalfPACT package has adequate structural integrity to meet the structural requirements of 10 CFR Part 71.

3. THERMAL EVALUATION

The objective of the thermal evaluation is to ensure that the applicant has adequately evaluated the thermal performance of the transportation package design under review for the thermal tests specified under NCT and HAC, and that the package design meets the thermal performance requirements of 10 CFR Part 71. The staff reviewed the proposed changes to the TRUPACT-II and HalfPACT packages to verify that the applicant has performed acceptable thermal

evaluations demonstrating that the packages, as proposed, meet the requirements of 10 CFR Part 71 under both NCT and HAC.

3.1 HalfPACT Package

The primary purpose of the application for the Model HalfPACT is to propose the addition of four new shielded container designs as authorized payload containers for the HalfPACT packaging (i.e., the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers, as described in Section 1.1 of this SER).

In the HalfPACT package application (NWP, 2022e), the applicant described package pressure increases for the proposed content configurations as specified in the following tables:

1) Table 3.4-8 with three SC-30G1 shielded containers,

2) Table 3.4-10 with two SC-30G2 shielded containers,

3) Table 3.4-11 with one SC-30G3 shielded container,

4) Table 3.4-12 with two SC-55G1 shielded containers, and

5) Table 3.4-13 with one SC-55G2 shielded container.

The applicant considered a 60-day duration (the maximum allowed shipping period that is in condition 10 of the CoC) in the evaluation of each configuration. The staff reviewed the decay heat per drum and the total decay heat per configuration or package provided by the applicant in Tables 3.4-8, and 3.4-10 through 3.4-13 of the HalfPACT application to confirm that the total decay heat per package configuration was below the 30 watts (W) limit described in Section 3.0 of the HalfPACT application and in condition 5(b)(2) of the CoC.

The staff also reviewed the pressure increase results at 60-day duration provided by the applicant in Tables 3.4-8, and 3.4-10 through 3.4-13. The staff determined that the pressure increase results at a 60-day duration meet the design pressure of 50 psi gauge (psig) described in Section 3.4.4.1 of the HalfPACT application.

3.1.1 Contact-Handled Transuranic (CH-TRU) Payload Appendices

The staff also reviewed the CH-TRU Payload Appendices, Revision 5 (NWP, 2022d), specifically, Sections 2.2.4, 4.5.4, 4.7.4, 4.8.4, 4.9.4, and 4.10.4. The applicant added to Section 2.2.4 of the CH-TRU Payload Appendices to address the four new shielded container designs within the load type resistance worksheets. The applicant specifically addressed, by name, the SG-30G1 shielded container in Section 4.5.4 of the CH-TRU Payload Appendices; there were no changes in calculated temperatures. The applicant added Sections 4.7.4, 4.8.4, 4.9.4, and 4.10.4 of the CH-TRU Payload Appendices to address the four new shielded container designs, SC-30G2, SC-30G3, SC-55G1, and SC-55G2, respectively.

In Section 4.7.4 of the CH-TRU Payload Appendices, the applicant described that the NCT thermal analysis was developed using the ANSYS® finite element analysis (FEA) code. The applicant's thermal model is a 3-D half-symmetric model of the HalfPACT with the SC-30G2 shielded container payload configuration. As described by the applicant, a temperature of -40 °C (-40 °F) will not negatively impact any of the materials of construction of the SC-30G2

shielded container payload. In Section 4.7.4.1 of the CH-TRU Payload Appendices and Section 3.2.3 of the calculation package No. SCA-CAL-0002 (NWP, 2021a; and ADAMS Accession No. ML21054A059), the applicant described NCT boundary conditions that were consistent with 10 CFR 71.71(b) and 10 CFR 71.71(c)(1). The applicant demonstrated that all packaging component and content temperatures remain below the allowable temperature limits. The applicant noted that the HAC fire analysis was not required as it was bounded by the previously approved HAC thermal analysis. The staff reviewed the justification that the previously approved HAC thermal analysis was bounding as described in Section 3.1.1 of the SCA-CAL-0002 calculation package. The staff found the justification to be accurate and, therefore, acceptable.

The applicant provided similar descriptions for the NCT thermal analysis, software, minimum temperature, boundary conditions, component temperatures, and HAC fire analysis in the following sections of the CH-TRU Payload Appendices:

a) Section 4.8.4 for the HalfPACT with the SC-30G3 shielded container,

b) Section 4.9.4 for the HalfPACT with the SC-55G1 shielded container, and

c) Section 4.10.4 for the HalfPACT with the SC-55G2 shielded container.

3.1.2 Thermal Analysis for the Four Shielded Container Designs

The applicant further described the thermal analysis for the four shielded container designs in the SCA-CAL-0002 calculation package. The applicant further described the NCT thermal analysis for each of the four shielded container designs, which used the ANSYS® FEA code. Figures 4-1 through 4-4 of the calculation package showed computer aided design (CAD) models of the HalfPACT package with the four different shielded container designs loaded. The applicant modeled heat transfer between the shielded container components by conduction and radiation and heat transfer between the package surface and the ambient by radiation and natural convection. The applicant summarized in Section 3.1.1 of the SCA-CAL-0002 calculation package that the materials of construction for the four new shielded container designs were the same as those used for the original SC-30G1 shielded container. Therefore, the staff finds the material properties to be acceptable, since these have been previously approved in Revision No. 5 of the CoC for the Model No. HalfPACT and documented in the corresponding SER (NRC, 2009).

The applicant summarized the temperature results in Tables 2-1 through 2-4 of the calculation package for the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers, respectively. The staff confirmed that all the NCT temperature results listed were below their maximum allowable temperature limits, which the staff finds to be acceptable. The applicant maintained that the shielded container designs were bounded by previously analyzed NCT cases (both cold and without solar insolation), and HAC fire analyses. The staff finds the applicant's discussion in Section 3.1.1 of the SCA-CAL-0002 calculation package to be accurate and, therefore, acceptable. The applicant also applied NCT boundary conditions of 38 °C (100 °F) ambient as required in 10 CFR 71.71(b) and insolation required by 10 CFR 71.71(c)(1) to their analysis models as described in the calculation package.

3.1.3 HalfPACT Accessible Surface Temperature

The applicant described the HalfPACT package OCA outer shell as the accessible surface during transport. The OCA outer shell maximum allowable temperature limit is 85 °C (185 °F) based on the maximum accessible surface temperature for exclusive use shipments in 10 CFR 71.43(g). The applicant calculated the HalfPACT package OCA outer shell temperature as 38.7 °C (101.6 °F) in still air and in the shade (shown in Table 3.5-1 of the HalfPACT application). Therefore, from a thermal perspective, the HalfPACT package, based on the aforementioned analysis results, can be transported as non-exclusive use, which has a maximum allowable temperature limit, in 10 CFR 71.43(g), of 50 °C (122 °F). However, see Section 5.1.1 of this SER for the shielding perspective on transport by exclusive use on the HalfPACT package.

3.1.4 HalfPACT Thermal Evaluation Summary

Based on the staff's review of the sections described above of the HalfPACT application, CH-TRU Payload Appendices, and the SCA-CAL-0002 calculation package, the staff concludes that the HalfPACT package with the four new shielded container configurations is consistent with the guidance in Section 3.4, "Review Procedures," of NUREG-2216 and continues to demonstrate that it meets the thermal requirements of 10 CFR Part 71.

3.2 TRUPACT-II Package

As stated in Section 3.1 of this SER, this application proposes the addition of four new shielded container designs as authorized payload containers for the HalfPACT packaging: the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers. The applicant described these new containers in Sections 5.5.6, 5.5.7, 5.5.8, and 5.5.9 of the TRUPACT-II package application, Revision 25, (NWP, 2022f) and stated that these proposed new shielded containers are only authorized for transport in the HalfPACT package. Therefore, the staff confirmed that there were no proposed changes necessitating a thermal evaluation for the TRUPACT-II package.

3.3 Evaluation Findings

Based on a review of the statements and representations in the application, the NRC staff concludes that the HalfPACT thermal design has been adequately described and evaluated, and that the thermal performance of the package meets the thermal requirements of 10 CFR Part 71.

4. CONTAINMENT EVALUATION

The objective of the NRC's containment evaluation is to verify that the applicant has adequately evaluated the performance of transportation packages for radioactive material and that the packages (packaging together with any contents) meet the containment requirements in 10 CFR Part 71.

4.1 HalfPACT Package

The primary purpose of the application is to propose the addition of four new shielded container designs (i.e., SC-30G2, SC-30G3, SC-55G1, and SC-55G2) as authorized contents for the HalfPACT packaging. The staff reviewed Chapters 4, 7, and 8 of the HalfPACT package

application and confirmed that there were no proposed changes necessitating a containment evaluation for the HalfPACT package.

The staff also reviewed the report No. HPT-REP-0001, "Regulatory Hypothetical Accident Condition Type B Testing for the HalfPACT Shielded Container Payloads," Revision 0 (NWP, 2021a; and ADAMS Accession No. ML21054A060), that describes Type B HAC 30-ft. drop testing for the four proposed shielded containers. The applicant selected the SC-55G1 and SC-30G3 designs as the bounding payload for this request. A key test observation presented by the applicant was that there were no localized deformations at the interface of the HalfPACT ICV shell (the containment boundary) with the payload dunnage components that could in any way compromise containment integrity.[1] In addition, the HalfPACT OCA, which serves as secondary confinement, had energy absorbing polyurethane foam (normally in place when presented for transport) conservatively omitted from the tests. The staff finds this conservatism to be acceptable.

The staff also reviewed the HalfPACT Drawing No. 163-001, Revision 9, (NWP, 2022e), which described removal of leak testing of each pipe component. The staff finds this to be acceptable as the pipe is not the containment boundary for the HalfPACT package.

Therefore, based on the staff's review of the HalfPACT application, as described above, the staff concludes that the HalfPACT package continues to satisfy and comply with the containment requirements in 10 CFR Part 71.

4.2 TRUPACT-II Package

As stated in Section 4.1 of this SER, this application proposes the addition of four new shielded container designs as authorized payload containers for the HalfPACT packaging: the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers. The applicant described these new containers in Sections 5.5.6, 5.5.7, 5.5.8, and 5.5.9 of the TRUPACT-II package application, Revision 25 and stated that these proposed new shielded containers are only authorized for transport in the HalfPACT package. Therefore, the staff confirmed that there were no proposed changes necessitating a containment evaluation for the TRUPACT-II package.

4.3 Evaluation Findings

Based on review of the statements and representations in the application, the NRC staff concludes that the HalfPACT package has been adequately described and evaluated to demonstrate that it satisfies the containment requirements of 10 CFR Part 71.

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[1] Section 2.7.1 of this SER also includes a discussion regarding the integrity of the containment boundary as it relates to the physical tests and structural evaluation.

5. SHIELDING EVALUATION

The objectives of the shielding review are the following:

1) confirm that the packages meet the external radiation requirements in 10 CFR Part 71.

2) evaluate the proposed shielding design changes as part of this application to ensure they meet the 10 CFR Part 71 regulatory requirements for external radiation under NCT and HAC.

The staff considered whether the changes had any impacts on the shielding capabilities of the packages. Section 1 of this SER includes a summary of the changes requested by the applicant. The staff performed a review of the package shielding designs following the guidance in NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material," (NRC, 2020). The following subsections of this SER chapter document the staff's evaluation of the shielding design of this application.

5.1 Description of Shielding Design

In Table 2.1-1 in the CH-TRAMPAC, Revision 6, the applicant noted that the four new containers, SC-30G2, SC-30G3, SC-55G1, and SC-55G2, can be transported only in the HalfPACT package. Therefore, the staff focused its review on the proposed changes to the HalfPACT package design.

5.1.1 HalfPACT Overpack

The HalfPACT overpack includes the following components:

a) an outer confinement assembly (OCA)

   (1) provides both free drop and thermal protection.

   (2) serves as a secondary confinement boundary when optional O-ring seals were utilized.

b) an inner containment vessel (ICV), which is composed of two torispherical heads,

   serves as the containment boundary.

c) an aluminum honeycomb spacer assembly, inside each ICV torispherical head,

   serves to attenuate impact loads.

The applicant provided Drawing Number 707-SAR, "HalfPACT Packaging SAR Drawing," for the HalfPACT design in Appendix 1.3.1, "Packaging General Arrangement Drawings" of the HalfPACT application. Except for distance attenuation, the packaging structures and components provided neither significant gamma nor significant neutron shielding. Chapter 5.0 of the TRUPACT-II application includes the shielding evaluation for the new proposed contents (i.e., SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers) for the HalfPACT

package. The evaluations consider both NCT and HAC regulatory dose rate limits under exclusive use requirements.

5.1.2 Shielded Containers

The various waste containers provided the primary shielding function. The applicant provided drawings showing the waste container details in Revision 8 of the HalfPACT application (NWP, 2022e).

Table 5.1. Height, diameter, and minimum lead thickness of shielded containers SC-30G2, SC30-G3, SC-55G1, and SC-55G2.

Shielded Container ID	Approximate height	Approximate diameter	Minimum Thickness of Lead Shield
SC-30G2	36.625	24.5	1.4
SC-30G3	42.25	28	2.75
SC-55G1	40.5	29.375	No lead shield
SC-55G2	45.15	31	1.98

5.1.2.1 SC-30G1 Shielded Container

The applicant renamed the “shielded container” to “SC-30G1.” The “shielded container” was used as an overpack for 30-gallon drums and was approved as authorized in Revision 9 of the HalfPACT’s CoC. The applicant designed the HalfPACT to transport three SC-30G1 containers at one time. The staff reviewed the drawings provided in this application and verified that there was no change in the shielding design of the previously approved container and the overpack. On this basis, the staff did not perform further review of the shielding design of the SC-30G1 container.

5.1.2.2 SC-30G2 Shielded Container

The SC-30G2, which was used as an overpack for 30-gallon drums, consisted of a twin-shell, carbon steel cylindrical structure with both a base and a lid. The applicant designed the HalfPACT to transport two SC-30G2 containers at one time. The SC-30G2 shielded container had an overall diameter of approximately 24.5-in. and an overall height of approximately 36.625 in. The SC-30G2 nominally had 1.5 in. (1.40-in. minimum) of lead shielding between 0.30-in. thick inner and outer shells. The shells attached to an upper flange and a 3-in. thick steel base. The base integrated a 21.5-in. diameter, 0.50-in. thick lower lead plate, and a 20-in. diameter, 0.70-in. thick upper lead plate. The 3.89-in. thick steel lid integrated a 19.5-in. diameter, 0.75-in. thick lead plate. The lid also utilized a 4-in. diameter, 0.25-in. thick lead disk that was aligned under the vent port feature. The applicant depicted the SC-30G2 container design as well as associated dunnage assembly in Drawing No. 163-010 (NWP, 2022e).

5.1.2.3 SC-30G3 Shielded Container

The SC-30G3, which was used as an overpack for 30-gallon drums, consisted of a twin shell, carbon steel cylindrical structure with both a base and a lid. The applicant designed the HalfPACT to transport one SC-30G3 container at one time. The SC-30G3 shielded container had an overall diameter of approximately 28-in. and an overall height of 42.25-in. The SC-30G3 had 2.75-in., minimum, of lead shielding between 0.50-in. thick inner and outer shells. The shells connected to an upper flange and a 5.75-in. thick steel base. The base integrated a

23-in. diameter, 0.75-in. thick lower lead plate, and a 20-in. diameter, 1.75-in. thick upper lead plate. The 6.79-in. thick steel lid integrated a 19-in. diameter, 2.25-in. thick lead plate. The lid also utilized a 23.5-in. outside diameter, 17.75-in. inside diameter, 0.75-in. thick lead ring. The applicant depicted the SC-30G3 container design as well as associated dunnage assembly in Drawing Number 163-011 (NWP, 2022e).

5.1.2.4 SC-55G1 Shielded Container

The SC-55G1, which was used as an overpack for 55-gallon drums, consisted of a carbon steel cylindrical structure with both a base and a lid. The applicant designed the HalfPACT to transport two SC-55G1 containers at one time. The SC-55G1 shielded container had an overall diameter of approximately 29.375-in. and an overall height of approximately 40.5-in. The 2.20-in. thick sidewall is connected to a 2.35-in. thick steel base. The 2.40-in. thick steel lid integrated a 4-in. diameter, 0.40-in. thick lead disk that was aligned under the vent port feature. The applicant depicted the SC-55G1 container design as well as associated dunnage assembly in Drawing Number 163-012 (NWP, 2022e).

5.1.2.5 SC-55G2 Shielded Container

The SC-55G2, which was used as an overpack for 55-gallon drums, consisted of a twin-shell, carbon steel cylindrical structure with both a base and a lid. The applicant designed the HalfPACT to transport one SC-55G2 container at one time. The SC-55G2 shielded container had an overall diameter of approximately 31-in., and an overall height of approximately 45.75-in. The SC-55G2 nominally had 2 in. (1.98-in. minimum) of lead shielding between 0.50-in. thick inner and outer shells. The shells connected to an upper flange and a 4.25-in. thick steel base. The base integrated a 27-in. diameter, 0.75-in. thick lower lead plate, and a 24.5-in. diameter, 1.00-in. thick upper lead plate. The 5.76-in. thick steel lid integrated a 23.75-in. diameter, 1.50-in. thick lead plate. The lid also utilized a 26.625-in. outside diameter, 21.625-in. inside diameter, 0.50-in. thick lead ring. The applicant depicted the SC-55G2 container design as well as associated dunnage assembly in Drawing Number 163-013 (NWP, 2022e).

5.1.3 Summary Tables of Maximum External Radiation Levels

The applicant summarized the maximum dose rates for the HalfPACT package, under NCT and HAC, when loaded with each of the new four new containers in Tables 5.1-8 to Table 5.1-11 of the TRUPACT-II application (NWP, 2022f). The applicant reported that the maximum NCT dose rates are 100.84 mrem per hour (mrem/hr) on the HalfPACT surface and 9.99 mrem/hr two meters from the HalfPACT package. The applicant also reported that the maximum HAC dose rate was 298.72 mrem/hr.

5.1.4 Conclusion

The staff reviewed the drawings and text describing the package shielding features. Staff determined that there is sufficient information describing the shielding features, materials, and dimensions with tolerances. The staff reviewed the dose rates in TRUPACT-II SAR Tables 5.1-8 to Table 5.1-11 (NWP, 2022f) and determined that they meet the regulatory dose rate requirement for NCT in 10 CFR 71.47(b) and HAC in 10 CFR 71.51(a)(2). Therefore, staff found that the applicant sufficiently described the package's shielding capabilities.

5.2 Radioactive Materials and Source Terms

5.2.1 Contents and Radiation Sources

The applicant designed the HalfPACT to transport material contaminated with transuranic elements (i.e., elements in the periodic table having atomic numbers higher than uranium) such as neptunium (Np), plutonium (Pu), and americium (Am). The material ranged in size from fine powders to concrete and it could either be directly loaded into the shielded containers or loaded into metal cans which were placed inside the shielded containers. The radiation emitted by transuranic elements included alpha particles, gamma radiation, and neutrons. The applicant used one particle per second of cobalt-60 (^{60}Co) as a concentrated gamma source and one particle per second of californium-252 (^{252}Cf) as the concentrated neutron source for analyzing the different payloads. In Section 5.2.2 of the TRUPACT-II application (NWP, 2022f), the applicant explained that they also reduced the ^{252}Cf specific activity to be consistent with the ^{252}Cf specific activity in Table 3.1-2 of the CH-TRAMPAC (NWP, 2022c). The applicant used this value as the maximum activity in Tables 5.4-6 to 5.4-15 of the TRUPACT-II application. The applicant asserted that updating the ^{252}Cf specific activity value had no impact on the safety basis because it resulted in no changes to the energy-based activity limits.

5.2.2 Activity Limits

5.2.2.1 Activity Limit Determination

Because a multitude of radionuclides can comprise TRU waste, the applicant used a “response function method” to demonstrate compliance with 10 CFR 71.47 and 71.51. In developing the response functions, the applicant back calculated the allowable content quantity based on the dose rates prescribed in 10 CFR 71.47 and 71.51 for a waste content with a specific radioactivity and specific geometric source distribution. Therefore, using the packaging models described in Section 5.3, “Shielding Model,” of the application for the TRUPACT-II package (NWP, 2022f), the applicant performed calculations to determine the maximum activity that can be contained in the shielded containers transported in the HalfPACT. Since the results in Section 5.4, “Shielding Evaluation,” of the TRUPACT-II application showed that the two-meter NCT dose rate limits were the most restrictive, the applicant determined the maximum activity that would satisfy these limits.

To determine the activity limit for each of the packaging and payload configurations considered in Section 5.4, “Shielding Evaluation,” of the TRUPACT-II application, the applicant evaluated the following two source configurations:

(1) **<u>Concentrated Source</u>** – activity in a 1-in. diameter by 1-in. high stub-cylinder centered in the packaging payload cavity under NCT evaluations or located adjacent to the packaging payload cavity inner surface nearest the detector under HAC evaluations.

(2) **<u>Distributed Source</u>** – activity homogenously distributed in a right-circular cylinder either centered within the packaging payload cavity or centered within the payload container confinement boundary.

The applicant selected Zirconium (z=40) as the source region material for both concentrated and distributed sources after performing multiple Monte Carlo N-Particle (MCNP) calculations with various materials. Based on the results of these calculations, the applicant determined that Zirconium was conservative for gamma calculations and inconsequential to neutron calculations.

The applicant calculated dose rates for the range of discrete gamma [0.15 to 10 mega electron volt (MeV)] and neutron (0.1 to 15 MeV) energies listed in Table 5.5-1 of the TRUPACT-II application with a source strength of one particle per second (par/s) (NWP, 2022f). The applicant determined the maximum allowed gamma and neutron activity in par/s for each discrete energy by multiplying the modeled source strength by the ratio of the dose rate limit (10 mrem/hr) to the calculated dose rate. The applicant also conservatively increased the calculated dose rate by the statistical error associated with the calculated dose rate as explained in Section 5.4.5 of this SER.

Although the concentrated source dose rates were determined for a one gram per cubic centimeter (1 g/cm^3) source density (i.e., unit density), the applicant applied them to all concentrated gamma and neutron sources. The applicant determined the distributed source dose rates for a range of source densities from 0.5 to 8 g/cm^3 for each discrete gamma and neutron energy listed in Table 5.5-1 of the TRUPACT-II application (NWP, 2022f). For each density value, the applicant used the available payload cavity size and the maximum allowed content weight to determine the distributed source size. To conservatively model the source (i.e., minimize the effects of self-attenuation and distance), the applicant maintained the source region diameter at 0.125 in. less than the payload cavity inside diameter and varied the source height based on an assumed content density ranging between 0.5 and 8 g/cm^3.

For distributed gamma sources, the applicant utilized a density correction factor (DCF) to make the distributed gamma unit-density source dose rates applicable to any source density. As a result, the allowable activity for the distributed gamma source differed from the concentrated gamma source due to both distance and material attenuation effects. For distributed neutron sources, the applicant did not use a DCF with the unit-density source since Zirconium does not significantly attenuate neutrons. Therefore, the distributed neutron source allowable activity differed from the concentrated neutron source allowable activity solely due to distance attenuation effects.

To determine the gamma DCFs, the applicant calculated the maximum allowable activity for gamma energies in the range of 0.5 to 2.0 MeV over the 0.5 to 8 g/cm^3 density range. Then, the applicant took the ratio of the maximum activity for the non-unit-density source to the maximum activity for the unit-density source to calculate the gamma DCF. To facilitate DCF calculations for any content density, the applicant developed third order polynomial curve-fits for the shielded containers using the smallest DCF calculated for each energy listed in Table 5.5-1 of the TRUPACT-II application at each source density (NWP, 2022f). The applicant provided the third order polynomial curve fit for each shielded container in Sections 5.5.6 to 5.5.9 of the TRUPACT-II application. Based on this scheme, the applicant developed the maximum source term limits for distributed and concentrated sources in the HalfPACT package loaded with each of the four shielded containers in Tables 5.5-16 to 5.5-22 of the TRUPACT-II application. These tables also included information on the dose rate for each gamma or neutron energy band.

5.2.2.2 Qualifying the Contents for Transport

The applicant requires package users to qualify the contents presented for transport by referencing "CH-TRAMPAC" in Section 7.1.4 of the HalfPACT application (NWP, 2022e). The "CH-TRAMPAC" (NWP, 2022c) directs package users to estimate the radionuclide quantity in each payload container by any of the following approaches:

(1) a direct measurement,

(2) a review of records for the individual payload container,

(3) a summation of assay (i.e., a radiation measurement technique that determines the quantity of nuclear material in TRU wastes) results from individual packages in a payload container, or

(4) a direct measurement on a representative sample of a waste stream (e.g., solidified inorganics).

The package user used the radiation measured to calculate the radionuclide quantities and the total quantity of ^{239}Pu fissile gram equivalent. In addition, "CH-TRAMPAC" specified that each payload would only be acceptable for shipment if the determined activity plus the error (i.e., one standard deviation) met the limits specified in Section 5.5.10 of the TRUPACT-II application (NWP, 2022f).

5.2.3 Staff Evaluation

The staff reviewed "A Handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessments" (DOE, 1981). The staff determined that ^{60}Co photons reasonably approximate the more energetic photons emitted by transuranic elements. In addition, the staff evaluated the neutron source strength of ^{252}Cf to other actinides. The staff found that ^{252}Cf had a higher source strength in the energy ranges which provides the greatest contribution to dose. The staff also determined that reducing the ^{252}Cf specific activity from 540 Curies per gram (Ci/g) to 536 Ci/g caused a very slight increase in the ^{252}Cf source strength. The staff multiplied the new source strength by the response functions reported in Section 5.4.4 of the TRUPACT-II application. The staff found that reducing the ^{252}Cf specific activity is acceptable since it did not increase the predicted dose rates. Therefore, for the reasons stated above, staff found that the applicant's description of the radioactive material and the source strength acceptable.

The staff previously reviewed and approved the applicant's "response function" approach for calculating dose rates as documented in a June 19, 2013, SER (NRC, 2013). The staff reviewed the current application and found the applicant's "response function" approach also appropriate for this application. In addition, the staff found the applicant's use of Zirconium as the material for both the concentrated and distributed sources consistent with the study "Best Practices for Shielding Analyses of Activated Metals and Spent Resins from Reactor Operation," September 4, 2020 (https://doi.org/10.2172/1669765).

The staff also reviewed the applicant's approach for calculating DCFs in the current application, and found it to be identical to the approach approved in the June 19, 2013, SER. The applicant stated that DCF value uncertainties are addressed by including the error associated with MCNP calculated dose rates (NWP, 2021c).

The staff concludes that the applicant's DCF approach acceptable for this application. The applicant's "response function" approach calculated activity limits, which satisfied the dose rate requirements. In Section 5.5.10, "Determination of Acceptable Activity," of the TRUPACT-II application, the applicant provided steps for ensuring the allowable waste quantity loaded into the package did not exceed the calculated activity limits. Staff found these instructions to be clear and specific. For these reasons, the staff has reasonable assurance that the

composition and quantity of radioactivity loaded into the package will not exceed the regulatory dose limits in 10 CFR 71.47 and 71.51.

5.3 Shielding Model and Model Specifications

5.3.1 HalfPACT Overpack

The staff had previously reviewed the HalfPACT overpack and found the model acceptable (NRC, 2013). Staff determined that the proposed changes did not impact the HalfPACT overpack. As a result, staff found the modeling assumptions associated with the HalfPACT overpack remain acceptable.

5.3.2 Shielded Containers

For the NCT shielding model, the applicant varied the number of shielded containers in the model according to Table 1. The applicant modeled undamaged containers and showed in Appendix 2.10.3, Section 2.10, of the HalfPACT application that damage to the containers under NCT was negligible (NWP, 2022e). Within each shielded container, the applicant modeled a 1-in. diameter by 1-in. long Zirconium stub-cylinder source in the center of the shielded container cavity. The applicant took no credit for the attenuation provided by the material from the payload drum loaded into the shielded container (see Table 1 of this SER). In addition, the applicant took no credit for self-shielding by the waste contents within the payload drum loaded inside the containers (i.e., the applicant modeled the space inside the containers as void). The applicant took credit for the presence of the dunnage materials surrounding the containers by centering the containers within the HalfPACT overpack in the shielding model. However, the applicant took no credit for radiation attenuation by the dunnage materials.

For the HAC shielding model, the applicant utilized the NCT shielding model with the following changes. For the SC-30G1 shielded container, the applicant reduced the lead thickness from 0.94 to 0.85 in. to account for localized damage and deformation to the outer shell and lead shielding. The applicant also reduced the thickness of the carbon steel lid and base from 3.0 to 2.5 in. For all other shielded containers, the applicant reduced the radial inner shell, lead and outer shell thicknesses by ten percent to account for localized damage and deformation. The applicant also reduced the thicknesses of all carbon steel lid and base components by ten percent (10%). For all shielded containers, the applicant located the source adjacent to the container inner shell surface nearest the detector and translated the containers radially to the inner wall of the HalfPACT ICV.

5.3.3 Material Properties

The applicant modeled carbon steel, Type 304 stainless steel, lead, and rigid urethane foam, with densities of 7.8526 g/cm^3, 8.0128 g/cm^3, 11.3500 g/cm^3, and 0.1322 g/cm^3, respectively in the shielding models. Table 5.3-1 of the TRUPACT-II application summarized the composition of each of these attenuating materials (NWP, 2022f). The applicant also modeled Zirconium at 1 g/cm^3 in the source region for the concentrated 1-in. stub-cylinder. The applicant chose Zirconium after performing multiple calculations with various materials. The applicant noted that these calculations showed that Zirconium was a conservative choice for gamma calculations and inconsequential for neutron calculations.

5.3.4 Lead Gap Evaluation

During post-test destructive disassembly of some shielded containers, the applicant found axial gaps in the lead in the sidewall that were believed to have formed during the lead pouring process. Although the largest measured axial gap was 0.318 in., the applicant evaluated axial gaps as great as 0.5 in. in the sidewall lead column. The applicant evaluated the impact on dose rates from a 0.5-in. gap at the bottom of the sidewall lead column as well as a 0.5-in. gap at the top of the sidewall lead column. Since the applicant associated the axial gaps with the fabrication process, the applicant re-evaluated the previously calculated NCT dose rates, as well as the HAC dose rates, for the SC-30G2, SC-30G3, and the SC-55G2. The applicant determined that a 0.5 inches gap caused the two-meter HalfPACT package dose rates to exceed the regulatory limits with the greatest dose rate increase for the SC-30G2 design. Therefore, the applicant chose to reduce the content source term loaded into the SC-30G2, SC-30G3, and SC-55G2 shielded containers to address the possibility of lead gaps. The applicant did not revise the dose rates reported in Tables 5.4-11 to 5.4-15 of the TRUPACT-II application (NWP, 2022f).

5.3.5 Evaluation of Normal Conditions of Transport and Hypothetical Accident Conditions

Since the shielded containers experienced neither significant damage nor significant deformation from NCT tests, the staff determined that the shielded container models used by the applicant to calculate the NCT dose rates reasonably depict the NCT package configurations. The staff found modeling the source as Zirconium acceptable for the following reasons:

a) it shields gammas less effectively compared to other materials associated with the HalfPACT package (e.g., steel) and

b) it does not attenuate neutrons significantly.

The staff determined that modeling the shielded container payload cavity as void to calculate both photon and neutron dose rates is conservative because this eliminates material attenuation and produces higher dose rates.

In evaluating the assumption of centering the radiation source within the shielded container, the staff reviewed the following information:

a) a response to a request for additional information dated March 27, 2013, referenced by the applicant (NWP, 2013).

In the 2013 response, the applicant chose to reduce the content source term loaded into shielded containers by 10% to address potential source term reconfiguration during NCT. The applicant implemented this penalty by modifying step No. 10 in Section 5.5.10 of the TRUPACT-II application (NWP, 2022f) and Section 3.3.2.1 of CH-TRAMPAC (NWP, 2022c) because the HalfPACT application (NWP, 2022e) incorporates these instructions by reference.

b) A SER dated June 19, 2013 (NRC, 2013)

As documented in a June 19, 2013, SER, the staff found the approach proposed by the applicant acceptable.

For the current application, the staff confirmed that the 10% penalty is still in effect. Therefore, the staff found centering the radiation source within the shielded container acceptable for NCT evaluations.

The HAC drop tests demonstrated that the shielded containers did not move significantly from their pre-drop test location; therefore, staff found that translating both the source and the shielded containers closer to the detector is a conservative assumption. Because the HAC tests demonstrated that the shielded containers neither experienced significant damage nor significant deformation, staff determined that the HAC dose rate shielding model dimensions are conservative. In Section 5.4.5 of the TRUPACT-II application, the applicant evaluated the impact of axial gaps in the lead shielding. In addition, staff reviewed the material properties and compositions provided in Table 5.3-1 of the TRUPACT-II application and found them to be reasonable based on a review of open literature.

For these reasons, the staff finds that the applicant's shielding models reasonably depict the package under both NCT and HAC.

5.3.6 Conclusion

In Table 5.4-16 in TRUPACT-II application (NWP, 2022f), the applicant identified that the greatest two-meter dose rate increase was 0.8% for the SC-30G2 shielded container. However, the applicant decreased the content source term loaded into the SC-30G2, SC-30G3 and the SC-55G2 shielded containers by one percent. The staff finds this approach acceptable since the source term reduction exceeds the potential dose rate increase due to lead shielding gaps. In addition, the applicant revised the gamma scan testing procedure as discussed in Section 8 of this SER. Therefore, the staff finds acceptable for the applicant not to revise the dose rates reported in Tables 5.4-11 thru 5.4-15 of the TRUPACT-II application.

5.4 Shielding Evaluation

5.4.1 Methods of Evaluation

The applicant performed shielding calculations using the general-purpose, continuous-energy, generalized-geometry, time-dependent MCNP code. The applicant used MCNP5, version 1.60 to analyze the SC-30G1 shielded container, and MCNP6, version 6.2.0, to analyze the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers. To calculate dose rates, the applicant tallied either neutron or gamma fluxes over surfaces of interest using three-dimensional models that depicted all the relevant design parameters of both the HalfPACT package and the associated shielded containers. The applicant calculated dose rates with segmented surface detectors that were either axially aligned with the source centerline when a single source or tier of sources exist, or axially aligned with a plane that is midway between upper and lower tiers of sources. The applicant aligned the surface detectors in this way to minimize the aggregate distance from the source(s) to the detector and to generate the maximum dose rate.

The applicant ran the models in photon-only mode when evaluating gamma emitting radionuclides. The applicant ran the models in neutron only mode when evaluating neutron emitting radionuclides even though the code is able to analyze the dose from photons generated when neutrons (n) are captured by the packaging materials [i.e., (n,γ) reactions]. The applicant chose to do this because their MCNP evaluations showed that gamma dose rates generated by neutrons interacting with the shielding materials, as well as the gamma particles emitted by ^{252}Cf, increased the dose rate by less than 1% compared to the neutron dose rate alone.

The applicant performed supplemental calculations to justify excluding the photon dose rate due to (n,γ) reactions. In the supplemental calculations, the applicant modified the SC-30G2 and SC-55G1 shielding models described previously by adding polyethylene with a density of 0.94 g/cm^3 to the payload cavity. Pointing to the supplemental calculation results, the applicant stated that the photon dose rate generated by (n,γ) reactions is less than the decrease of the neutron dose rate from radiation attenuation by the proposed waste content material (i.e., self-shielding). Therefore, the applicant asserted that accounting for the photon dose rate from (n,γ) reactions leads to lower dose rates due to self-shielding from the proposed waste content.

5.4.2 Flux-to-Dose-Rate Conversion

The applicant used the American National Standards Institute (ANSI)/ANS-6.1.1-1977 flux-to-dose rate conversion factors in their analyses. The applicant multiplied the reference conversion factors by a factor of 1,000 within the code to generate dose rates in units of mrem/hr rather than rem/hr. The applicant provided the conversion factors in Tables 5.4-3 and 5.4-4 of the TRUPACT-II application (NWP, 2022f).

5.4.3 External Radiation Levels

The applicant summarized the dose rates calculated for NCT and HAC in Tables 5.4-11 to 5.4-15 of the TRUPACT-II application (NWP, 2022f). The staff found that these values meet the regulatory dose rate requirements for NCT in 10 CFR 71.47(b) and HAC in 10 CFR 71.51(a)(2).

5.4.4 Conclusion

Given the capabilities and the extensive application of the MCNP code within the nuclear industry, the staff found MCNP an acceptable code for this application. After reviewing the application, the staff determined that the shielding models used to calculate NCT and HAC dose rates reasonably depicted the package configurations under NCT and HAC situations. The staff found the applicant's approach of not calculating the photon dose rate from (n,γ) reactions acceptable because the applicant demonstrated that the ignoring self-shielding from the container contents is conservative because it compensates for excluding the photon dose rate from (n,γ) reactions. The staff confirmed that the tallies were located at the appropriate distances relative to the package to demonstrate regulatory compliance and that the applicant used NRC accepted flux-to-dose rate conversion factors.

Because the dose rate values presented in Tables 5.4-11 to 5.4-15 of the TRUPACT-II application (NWP, 2022f) were extremely close to the regulatory limit, the staff confirmed that the statistical error associated with the MCNP results had been included in the results. In Tables 5.4-11 to 5.4-15 of the TRUPACT-II application, the applicant provided the dose rates

that incorporated the statistical error associated with the MCNP results according to the following equation:

$D_a = D_c \times (1 + E)$

where,

> D_a is the adjusted dose rate,
> D_c is the dose rate calculated by the MCNP code, and
> E corresponds to the tally error.

The staff determined that including the MCNP calculation error in the dose rates presented in the application is conservative.

Section 5.5.10 of the TRUPACT-II application requires that the sum of gamma sources plus the sum of neutron sources be less than or equal to 0.9. As discussed in Section 5.3.4 of the SER, the staff had previously accepted this approach for accounting for source strength and geometric uncertainties. Therefore, the staff finds it acceptable for this application.

In addition, the applicant stated that the code was run until the tally error, a statistical check used to evaluate the validity of an MCNP calculation result, was less than one percent. The staff noted that the applicant's error value goal is less than one tenth the value required by MCNP to pass this statistical check. The staff determined that running the code until an error of less than one tenth the value required to pass the MCNP statistical check provides greater confidence in the accuracy of the result.

The staff determined that the applicant incorporated several conservatisms into their shielding evaluation. Therefore, staff has reasonable assurance that package dose rates will not exceed the 10 CFR 71.47 regulatory limits, and the staff found that the applicant's shielding methods acceptable.

5.5 Evaluation Findings

The staff reviewed the application regarding the package shielding design. Based on its review of the statements and representations provided in the application, as well as staff's calculations as documented in Section 5.2.3 of this SER, the staff has reasonable assurance that the HalfPACT and TRUPACT-II packages with the proposed contents and design changes, will continue to satisfy the shielding requirements and radiation level limits in 10 CFR 71.47 and 71.51.

6. CRITICALITY SAFETY EVALUATION

The purpose of the criticality review is to confirm that the packages together with their contents meet the requirements in 10 CFR Part 71 for criticality safety. The applicant requested to revise the certificates and designs of the packages to incorporate various changes, as described in Section 1.0 of this SER and the sections below. The staff used the guidance in the standard review plan (NRC, 2020), to conduct this review.

As specified in Table 2.1-1 of the application, the four new shielded containers contain RH-TRU material for transportation in the HalfPACT packages. These containers are not authorized

contents in the TRUPACT-II packages. No special design features are required to maintain criticality of the HalfPACT packages due to the separation provided by the packages, and no neutron poisons are used. The methodology used in the applicant's analysis build on the previous NRC approved analyses and demonstrate that the materials requested to be transported in the TRUPACT-II and HalfPACT packages continue to meet the requirements of 10 CFR Part 71.

6.1 Fissile Material Contents

The quantities of the fissile isotopes present in the waste material were converted to FGE using the conversion factors that are outlined in the DOE report, "Contact-Handled Transuranic Waste Authorized Methods for Payload Control (CH-TRAMPAC)," Revision 6 (NWP, 2022c). For all of the models analyzed by the applicant, the package is assumed to contain ^{239}Pu at the FGE limit. Fissile composition of a typical payload is illustrated in the applicant's calculation SCA-CAL-0001 and is as follows:

Nuclide	Weight Percent
^{238}Pu	Trace
^{239}Pu	93.0
^{240}Pu	5.8
^{241}Pu	0.4
^{243}Pu	Trace
^{241}Am	Trace
All other fissile isotopes	0.7

No credit is taken for the parasitic neutron absorption in either the waste materials or dunnage. The contents of each package are modeled as an optimally moderated sphere of ^{239}Pu, which was determined by varying the H/Pu atom ratio. The overall size of each sphere is calculated based on the H/Pu ratio and the Pu mass.

6.2 Shielded Containers

6.2.1 Description of the Shielding Design of the Shielded Containers

Section 1 of this SER includes additional information about the design of the shielded containers.

6.2.1.1 SC-30G2

The SC-30G2 shielded container is a twin-shell vented carbon steel and lead cylindrical structure designed to ship TRU waste with high gamma energies within the HalfPACT package. The HalfPACT can contain up to two SC-30G2. Each SC-30G2 is designed to carry one 30-gallon drum, with the option to use a mesh "bag" to allow remote installation of the drum into the shielded container.

6.2.1.2 SC-30G3

The SC-30G3 shielded container is similar to the SC-30G2, since it also is a twin-shell vented carbon steel and lead cylindrical structure designed to ship TRU waste with high gamma energies within the HalfPACT. The SC-30G3 has additional shielding on the top, bottom, and periphery of the shielded container. The HalfPACT can contain one SC-30G3. Each SC-30G3

is designed to carry one 30-gallon drum, with the option to use a mesh “bag” to allow remote installation of the drum into the shielded container.

6.2.1.3 SC-55G1

The SC-55G1 shielded container is a vented carbon steel and lead cylindrical structure designed to ship TRU waste with high gamma energies within the HalfPACT. The HalfPACT can contain two SC-55G1 containers. Each SC-55G1 is designed to carry one 55-gallon drum, with the option to use a mesh “bag” to allow remote installation of the drum into the SC.

6.2.1.4 SC-55G2

The SC-55G2 shielded container is a vented carbon steel and lead cylindrical structure designed to ship transuranic waste with high gamma energies within the HalfPACT. The HalfPACT can contain one SC-55G2 container. Each SC-55G2 is designed to carry one 55-gallon drum, with the option to use a mesh “bag” to allow remote installation of the drum into the shielded container.

6.2.2 Shielded Containers Evaluation

Two different payloads are considered in the applicant’s analysis.

a) *Manually compacted waste* (i.e., not machine compacted), that has less *than 1.0 weight % (wt%) beryllium*, and is limited to *a maximum 325 FGE of ^{239}Pu*, which is identified as Case G throughout the applicant’s analysis.

b) *Machine compacted waste* that has *less than 1.0 wt% beryllium*, and is limited to *a maximum of 245 FGE*, which is identified as Case H throughout the applicant’s analysis.

For Case G, the waste stream is manually compacted, with an internal and external moderator composed of 25% polyethylene, 74% water, and 1% beryllium (by volume). For Case H, where the waste stream is mechanically compacted, the external moderator is composed of 100% polyethylene, and the internal moderator is composed of 99% polyethylene and 1% beryllium (by volume). The resulting dimensional composition of the modeled fissile sphere as a function of the hydrogen/plutonium (H/Pu) ratio is summarized in Table 2-2 for Case G, and Table 2-3 for Case H in the applicant’s calculation package SCA-CAL-0001 (NWP, 2021a).

The applicant states that polyethylene is the bounding hydrogenous moderating material present in both cases based on the SAIC-1322-001 study, “Reactivity Effects of Moderator and Reflector Materials on a Finite Plutonium System.” The applicant used a 25% packing fraction for polyethylene, which staff finds conservative based on the physical testing performed for TRU waste. Other materials that could provide better reflection than polyethylene are considered “special reflectors” and are limited to less than 1 wt.% for the HalfPACT package.

The applicant used KENO-V.a as part of the SCALE-PC v4.4a package of codes with the ENDF/B-VII continuous energy cross-section library to perform their analysis. In all models, the fissile material is assumed to form a single optimally moderated sphere. The staff found that conservative damage assumptions were used for both the NCT and HAC criticality safety analysis such as the following:

a) no credit for the head of the HalfPACT in order to reduce separation in the array configuration,

b) all foam and aluminum were replaced with reflectors,

c) in the array models, the internal and external reflector densities were varied to maximize neutron interaction between packages,

d) 1 wt.% of beryllium to account for any special reflector materials, and

e) maximize reactivity of the loaded HalfPACT by evaluating the shielded container materials in various configurations with fissile spheres.

Based on the analysis of the SC-30G2 and SC-30G3 shielded containers, the applicant concluded that the maximum reactivity of the single package and the arrays of packages were very similar, indicating that the neutron communication between packages is limited due to the isolation of each SC-30G2. The most reactive cases are listed in Table 4.7-2 in CH-TRU Payload Appendices, and both the NCT and HAC configurations result in k_{eff} values that are below the upper safety limit (USL) of 0.9375 (NWP, 2022d).

Based on the analysis of the SC-55G1 and SC-55G2 shielded containers, the applicant's analyses concluded that the maximum reactivity of the single package and the arrays of packages were very similar, indicating that the neutron communication between packages is limited due to the isolation of each SC-55G1. The most reactive cases are listed in Table 4.9-2 in CH-TRU Payload Appendices, and both the NCT and HAC configurations result in k_{eff} values that are below the USL of 0.9375.

6.3 Revised FGE limits for Cases A and C

The applicant revised the payload container FGE limits for Cases A and C. In previous approvals, the original 200 FGE limit that was placed on individual drums is not related to the Case A and Case C analysis assumptions. The applicant modified Table 6.1-1 of TRUPACT-II application to increase the FGE allowed in Case A from 200 to 325, and the FGE allowed in Case C up to 250 (NWP, 2022f). Since all drum payload configurations evaluated under Cases A and C assumed that all of the fissile material within a package consolidates into a single fissile region within the package such that no credit is taken for individual material absorption, is optimally moderated, used a very conservative spherical moderator with full density reflection, and using the supporting analyses provided in Section 6.4 of TRUPACT-II application and justified using the DOE report CH-TRAMPAC, "Contact-Handled Transuranic Waste Authorized Methods for Payload Control" (NWP, 2022c) staff finds this acceptable.

6.4 Evaluation Findings

The staff performed calculations using SCALE 6.2.3 and the continuous energy cross sections from ENDF/B-VII to confirm the conclusion of the applicant's calculations. In all cases the most reactive scenario for manually compacted waste bounded the reactivity of machine compacted waste for materials that had less than 1 wt% special reflectors. Based on a review of the information and representations provided in the application and the staff confirmatory analysis, the staff has reasonable assurance that the TRUPACT-II and HalfPACT packages with the proposed four new shielded containers identified above with the proposed contents, and the modified FGE limits for Cases A and C will continue to meet the criticality safety requirements in

10 CFR Part 71. Staff also finds that the Criticality Safety Index (CSI) of zero is appropriate for the SC-30G2, SC-30G3, SC-55G1, and SC-55G2 shielded containers in the HalfPACT package.

7. MATERIALS EVALUATION

The staff reviewed the application for the TRUPACT-II and HalfPACT shipping packages to verify that applicant has performed an acceptable evaluation with respect to materials to demonstrate that these packages meet the requirements of 10 CFR Part 71 under NCT and HAC.

The following discussions focus principally on the primary important-to-safety containment and structural components. Even though there were no changes for the material's evaluation, the staff performed a comprehensive review of the applicant's evaluation. The following sections include a brief discussion on some of the key areas of the application.

7.1 Evaluation of Materials of Package's Designs and Proposed Content

Section 1 of this SER includes a summary of the changes proposed by the applicant to the TRUPACT-II and HalfPACT packages. Along with the currently authorized SC-30G1 shielded container, the new shielded container designs for RH-TRU waste inventory will be in stackable configurations instead of in RH-TRU removable lid canisters, which are placed in excavated boreholes underground.

Section 1.2.1 of this SER includes a brief description of the TRUPACT-II and HalfPACT packagings. The applicant did not add any new materials or propose any changes to the materials used in the TRUPACT-II and HalfPACT packaging designs. The staff verified that the proposed revisions to the package do not expose the proposed packaging materials to thermal, structural, or corrosive service environments more severe than those that have been previously evaluated for the existing packaging. The staff found these materials acceptable in prior revisions to the CoCs.

The staff also confirmed that the all four shielded container models are nearly identical to the prior model SC-30G1. The staff concludes that the materials evaluation for these packages satisfy the requirements for 10 CFR Part 71 and are acceptable.

The following discussion focuses principally on the primary important-to-safety containment and structural components. Even though there were no changes for the material's evaluation a comprehensive review was conducted and following is a brief discussion on some of the key areas of the SAR.

7.1.1 Drawings

The staff reviewed the licensing drawings included in the TRUPACT-II and HalfPACT applications and verified that the drawings contain the following information:

a) bill of materials,

b) appropriate consensus code information such as the American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM), American Welding Society (AWS), and

c) specification number(s) for the material(s) used in fabrication.

The licensing drawings well-characterize the weld requirements including standard welding symbols and notations are in accordance with AWS Standard A2.4, “Standard Symbols for Welding, Brazing, and Nondestructive Examination.” Therefore, based on the above discussion, the staff finds the description of materials, and fabrication in the drawing to be acceptable.

7.1.2 Codes and Standards

Section 2.1.1.1 of the application describes the design criteria and code and standards for the package. Specific subsections ASME B&PV Section III are used for the design of the package and remain unchanged from the previous amendment.

7.1.3 Material Properties

Major structural components are fabricated with austenitic stainless-steel Type 304 and mechanical properties are taken from ASME Section II, Parts A and D, and remain unchanged from the previous amendment.

Mechanical properties for polyurethane foam and metallic materials (including brass, aluminum honeycomb, 300 series stainless steel screws, etc.) remain unchanged from the previous amendment.

7.1.3.1 Brittle Fracture

In Section 2.2.2.2.1 of the applications, the applicant specifically notes that brittle fracture concerns are precluded by avoiding ferritic steel in this packaging. In addition, the bolts used to secure the ICV, and OCV locking rings in the locked position are stainless steel. Other fasteners used in the packaging assembly provide redundancy and are mainly constructed from stainless steel further reducing brittle fracture concerns.

7.1.3.2 Fatigue Assessment

Section 2.1.2.2.2 of the application addresses fatigue assessment and remains unchanged from the previous amendment.

7.1.3.3 Chemical and Galvanic Reactions

Section 2.4.4 addresses chemical and galvanic reactions to satisfy the requirements of 10 CFR 71.43(d). Materials used in packaging are not expected to have significant chemical, galvanic, or other reactions in air, inert gas, or water environments. These materials have been previously approved without incident in radioactive material packages for transport of similar payload materials and no changes have been made in this revision that may impact the safe use of the packages.

7.1.4 Conclusion

Considering the new models are nearly identical in material construction, application, and none of the changes proposed in latest revisions impact the previous material's evaluation that have been performed, the staff continues to find the applicant's evaluations of to be acceptable.

7.2 Evaluations Findings

Based on a review of the statements and representations in the application, the staff concludes that the materials used by the applicant adequately described and evaluated the transportation package design. The staff finds that the package complies with the requirements in 10 CFR Part 71.

8. OPERATING PROCEDURES

The objective of the review of the operating procedures is to verify that the applicant has included clear and specific instructions for loading and unloading the packages.

The staff reviewed the operating procedures specified in Chapter 7 of the HalfPACT application (NWP, 2022e). The staff found that the applicant included specific instructions for loading and unloading the four new payload shielded containers (i.e., SC-30G2, SC-30G3, SC-55G1, and SC-55G2) for shipment of transuranic (TRU) wastes as qualified by the method specified in the CH-TRAMPAC, Revision 6 (NWP, 2022c). On this basis, the staff finds that the operating procedures, specified in Chapter 7 of the application for the HalfPACT package, are acceptable and meet the regulatory requirements of the 10 CFR 71.31(c), 71.35(c), 71.43(g), 71.47(b)(c)(d), 71.87, and 71.89.

9. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The staff reviewed the changes to the acceptance tests and maintenance program discussed in the applications. The applicant added that the operating procedures continue to meet the requirements of 10 CFR Part 71 and that these procedures are adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

9.1 Shielding Integrity Tests

9.1.1 Acceptance Criteria

The applicant revised the applications and added Section 8.1.5 to describe how the adequacy of the lead shielding of the proposed content is confirmed. The applicant stated that confirmation

of the presence of the minimum sidewall lead thickness for each shielded container, as described in the applicable application drawing (i.e., Drawing Nos. 163-008, 163-010, 163-011, 163-013, and drawings for the SC-30G1, SC-30G2, SC-30G3, and SC-55G2 containers), is the shielding integrity testing acceptance criteria. For those portions of the shielding aligned with the shielded container cavity, the applicant determined a rejection count rate (i.e., an acceptance criterion) using a flat-block calibration standard (NWP, 2022e). Section 5.1 of this SER includes the minimum thickness of the proposed payload for the HalfPACT package.

The applicant fabricated the calibration standard from two flat steel plates representing the inner and outer shells at their minimum thicknesses and a flat lead plate having the minimum thickness identified in the drawing associated with the shielded container being tested. The applicant sized the calibration standard to preclude indirect gamma radiation from affecting the measured rejection rate. In determining the rejection count rate, the applicant placed the radiation source at a distance from the flat-block calibration standard that mimicked the test configuration (NRC, 2021).

For those portions of the shielding above and below the shielded container cavity, the applicant performed the following additional steps:

1) Identified a source position above the bottom of the payload cavity that allowed the presence of axial gaps in the sidewall lead to be identified.

2) Created an MCNP model of the prototypic gamma scan test configuration for each shielded container design. Each MCNP model included a 0.5-in. axial gap at both ends of the sidewall lead column.

3) Ran each MCNP model using a unit source strength of ^{60}Co and ^{192}Ir, which are the two radionuclides commonly used for gamma scan testing.

4) Generated a straight-through-the-wall value as well as a “slant-shot” value for locations below and above the payload cavity.

By taking the ratio of the slant-shot unit dose rate with the straight-through unit dose rate, the applicant calculated reject count rate adjustment factors and applied these reject count rate adjustment factors to the dose rate values measured above and below the shielded container cavity during the shielded container gamma scans.

9.1.2 Staff Evaluation

The staff reviewed the description for confirming the lead shield adequacy. The staff found the applicant’s acceptance criterion acceptable because it conforms to the drawing requirements. The staff found the applicant’s approach for determining the rejection count rate for those portions of the shielding aligned with the shielded container cavity acceptable for the following reasons:

a) the applicant fabricated the calibration standard using the minimum material thicknesses allowed by the drawings.

b) the distance used to obtain the rejection count rate matched the distance associated with the shielding integrity test.

The staff found the applicant's approach for determining the rejection count rate for those portions of the lead shielding above and below the shielded container cavity acceptable for the following reasons:

a) The distance modeled to obtain the rejection count rate adjustment factors matched the distance associated with the shielding integrity test.

b) Applying adjustment factors to determine the rejection count rate is appropriate, since the lead shielding geometry above and below the shielded containers is not the same as the straight-through lead shielding geometry. As discussed earlier in Section 5.4.4 of this SER, staff found the use of MCNP acceptable.

c) The staff determined that the use of ^{60}Co and ^{192}Ir is acceptable because the following reasons:

    (1) ^{60}Co reasonably approximated the more energetic photons emitted by TRU elements, and

    (2) ^{192}Ir reasonably approximated the less energetic photons emitted by TRU elements.

The staff determined that similar requirements were not required for the lead shielding in the bases and lids for the shielded containers for the following reasons:

a) The lead shielding in the bases and lids are lead plates which are press fit into the lids and bases to eliminate gaps, and if gaps are present after installing the lead plates, lead wool is used to fill the gaps.

b) Prior to closure of the lid and base cavities, a visual examination is performed in accordance with Section 8.1.1 of the HalfPACT application to confirm the lead plates meet the drawing specifications and, after the lead plates are installed, to confirm no gaps are present.

For these reasons, staff finds the modifications to the shielding integrity tests acceptable.

9.2 Evaluation Findings

The staff review the changes to the acceptance tests and maintenance program including the description of the requirements for the lead shield for the shielded canisters. The staff finds acceptable the changes to the acceptance tests, the maintenance program assures adequate packaging performance during its service life, and that the packages are in compliance with the requirements of 10 CFR Part 71.

10. QUALITY ASSURANCE

The staff reviewed the description of the quality assurance program provided in the applications and found only administrative changes, which included reference updates to the most recent revisions to 10 CFR Part 71, DOE Order 460.1(D) (DOE, 2016), and Regulatory Guide 7.10. This section continues DOE's commitment to enacting a quality assurance program that meets

the requirements and guidelines set forth in these documents. Except as exempted by law, DOE Order 460.1D specifically requires the following:

> "Each (DOE) Departmental element that participates in the use, design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of Type B or fissile materials packaging must have and maintain a quality assurance (QA) program in accordance with 10 CFR Part 71, Subpart H that is approved by the NRC or approved by the DOE CO (Certifying Official) for DOE elements or by the NNSA CO for NNSA elements, prior to the performance of those operations."

The staff finds the DOE's commitment and obligation to meet the requirements of 10 CFR 71, Subpart H in executing the above-mentioned activities relating to the HalfPACT package to be acceptable.

11. CONDITIONS

The staff made some editorial changes as well as changes to the conditions of approval to the CoCs for the Model Nos. TRUPACT-II and HalfPACT packages. The following items summarize the changes to both certificates:

11.1 Model Nos. TRUPACT-II and HalfPACT CoCs

11.1.1 General changes

The following general changes apply to the Model Nos. TRUPACT-II and HalfPACT CoCs:

a) Increased the CoCs Revision No. (Condition 1.a.) by one.

b) Changed references to CH-TRU Payload Appendices from Revision 4 (Rev. 4) to Rev. 5.

c) Changed references to CH-TRAMPAC from Rev. 5 to Rev. 6.

d) Condition No. 3.b., "Title and Identification of Report or Application," includes the date of the application.

e) Editorial changes throughout the CoCs.

11.1.2 Condition No. 5.(a)(3), "Drawings"

The Model Nos. TRUPACT-II and HalfPACT CoCs include the latest revisions for the following drawings:

a) Drawing No. 163-001, "Standard Pipe Overpack SAR Drawing," sheets 1-3, Rev. 9;

b) Drawing No. 163-009, "Criticality Control Overpack SAR Drawing," sheets 1 and 2, Rev. 2.

11.1.3 Conditions No. 14

Condition No. 14 was removed from both CoC since the due dates in the conditions have passed.

11.1.4 Condition No. 15

Condition No. 15 was renumbered as 14 due to the deletion of Condition No. 14.

11.1.5 References

The “REFERENCES” section of the Model Nos. TRUPACT-II and HalfPACT CoCs were revised to include the most recent consolidated application dated February 24, 2022.

11.2 Model No. TRUPACT-II CoC (Additional Changes)

11.2.1 Condition No. 5.(a)(3), “Drawings”

In addition to the changes depicted in Section 11.1 2 of this SER, Condition No. 5.(a)(3), “Drawings,” the staff updated the revision No. of Drawing No. 2077-500SNP, “TRUPACT-II Packaging SAR Drawing,” sheets 1-11, Rev. AA.

11.2.2 Condition No. 5.(b)(2)

a) Added Table 2 (see the table below) with the same No. of payload containers as in Rev. 25 of the CoC. This change was editorial.

Table 2. Maximum number of payload containers per package and authorized packaging configurations

Type of Payload Container	Maximum Number of Payload Containers per Package
standard pipe overpack	14
S100 pipe overpack	14
S200 pipe overpack	14
S300 pipe overpack	14
100-gallon drum	6
55-gallon drum	14
85-gallon drum	8
SWB	2
TDOP	1
CCO	14

b) Renumbered Table 2 to Table 3 because of the addition of Table 2 to the CoC.

c) Rearranged the rows and columns for the FGE values to be consistent with Table 3 of the CoC for the HalfPACT package. The values for the “Maximum FGE of ^{239}Pu” and “Additional limits…” for CCOs and pipe overpacks remain the same as in Rev. 25 of the CoC for the Model No. TRUPACT-II.

11.3 Model No. HalfPACT CoC (Additional Changes)

11.3.1 Condition No. 5.(a)(3), “Drawings”

In addition to the changes depicted in Section 11.1 2 of this SER, Condition No. 5.(a)(3), “Drawings,” the Model No. HalfPACT CoC includes a revision to Drawing No. 163-008 and drawings for new payload consisting of the shielded containers.

a) Drawing No. 163-008, “SC-30G1 Shielded Container SAR Drawing,” sheets 1-6, Rev. 4;

b) Drawing No. 163-010, “SC-30G2 Shielded Container SAR Drawing,” sheets 1-7, Rev. 1;

c) Drawing No. 163-011, “SC-30G3 Shielded Container SAR Drawing,” sheets 1-8, Rev. 1;

d) Drawing No. 163-012, “SC-55G1 Shielded Container SAR Drawing,” sheets 1-5, Rev. 0; and

e) Drawing No. 163-013, “SC-55G2 Shielded Container SAR Drawing,” sheets 1-4, Rev. 1.

11.3.2 Condition No. 5.(b)(1)

Added the shielded containers and reorganized the list as follows:

(i) 55-gallon drum,
(ii) standard waste box (SWB),
(iii) 85-gallon drum,
(iv) standard pipe overpack,
(v) S100 pipe overpack,
(vi) S200 pipe overpack,
(vii) S300 pipe overpack,
(viii) 100-gallon drum,
(ix) criticality control overpack (CCO),
(x) SC-30G1 shielded container,
(xi) SC-30G2 shielded container
(xii) SC-30G3 shielded container
(xiii) SC-55G1 shielded container
(xiv) SC-55G2 shielded container

11.3.3 Condition No. 5.(b)(2)

a) Revised Table1 to include the shielded containers identification and corresponding “Maximum Gross Rate” for the new payload and some editorial changes.

Table 1. Maximum gross weight for a payload container

Type of Payload Container	Maximum Gross Weight
6-inch standard pipe overpack	328 pounds
12-inch standard pipe overpack	547 pounds
S100 pipe overpack	550 pounds
S200 pipe overpack	547 pounds
S300 pipe overpack	547 pounds
100-gallon drum	1,000 pounds
55-gallon drum	1,000 pounds
85-gallon drum	1,000 pounds
SWB	4,000 pounds
CCO	350 pounds
Shielded container SC-30G1	2,260 pounds
Shielded container SC-30G2	3,160 pounds
Shielded container SC-30G3	6,300 pounds
Shielded container SC-55G1	3,410 pounds
Shielded container SC-55G2	6,500 pounds

b) Added Table 2 (see the table below) which includes the same No. of payload containers as in Rev. 9 of the CoC and the addition of the maximum shielded containers per type and per package.

Table2. Maximum number of payload containers per package and authorized packaging

Type of Payload Container	Maximum Number of Payload Containers per Package
standard pipe overpack	7
S100 pipe overpack	7
S200 pipe overpack	7
S300 pipe overpack	7
100-gallon drum	3
55-gallon drum	7
85-gallon drum	4
SWB	1
CCO	7
Shielded container SC-30G1	3
Shielded container SC-30G2	2
Shielded container SC-30G3	1
Shielded container SC-55G1	2
Shielded container SC-55G2	1

c) Renumbered Table 2 to Table 3 because of the addition of Table 2 to the CoC.

d) For Table 3, rearranged the rows and columns for the FGE values to accommodate the values for the “Maximum FGE of ^{239}Pu” and “Additional limits…” for the new shielded containers.

Table 3. Maximum Fissile Gram Equivalent (FGE) in CCOs and pipe overpacks and associated additional controls/limits.

	Parameters			
	Non-machine compacted material		Machine compacted material	
Payload Containers	**Maximum FGE of ^{239}Pu**	**Additional limits/controls**	**Maximum FGE of ^{239}Pu**	**Additional limits/controls**
CCO	380	≤ 1% by weight Be/BeO*	380	≤ 1% by weight Be/BeO and ≤ 2,000 grams plastic
Pipe Overpack	200	for Be/BeO > 1 wt%, Be/BeO must be chemically or mechanically bound to the fissile material	200	≤ 1% by weight Be/BeO
Shielded containers	325	≤ 1% by weight Be/BeO	245	≤ 1% by weight Be/BeO

* Be means beryllium and BeO means beryllium oxide.

11.3.4 References

The “REFERENCES” Section, besides adding the reference to the consolidated application dated February 24, includes a reference to a response to a follow up question.

CONCLUSIONS

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the designs have been adequately described and evaluated, and the Model Nos. TRUPACT-II and HalfPACT packages meet the requirements of 10 CFR Part 71.

Issued with Certificates of Compliance No. TRUPACT-II and HalfPACT packages, Revisions 26 and 10, respectively, on April 28, 2022.

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