

June 19, 2013

Mr. T. E. Sellmer
Manager – Transportation Packaging
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P.O. Box 2078
Carlsbad, NM 88221

SUBJECT: REVISION 21 OF CERTIFICATE OF COMPLIANCE (COC) NO. 9218 AND
REVISION 7 OF COC NO. 9279 FOR THE MODEL NOS. TRUPACT-II AND
HALFPACT PACKAGES, RESPECTIVELY

Dear Mr. Sellmer:

By letter dated April 30, 2012, as supplemented June 5, 2012, December 3, 2012, and March 27, 2013, Nuclear Waste Partnership, LLC, on behalf of the U.S. Department of Energy, submitted a revised application in accordance with 10 CFR Part 71 for amendments to CoCs No. 9218 and 9279 for the Model Nos. TRUPACT-II and HalfPACT packages, respectively.

The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of Title 49 of the *Code of Federal Regulations* (49 CFR) 173.471. Those on the attached list have been registered as users of the package under the general license provisions of 10 CFR 71.17 or 49 CFR 173.471.

If you have any questions regarding this certificate, please contact me or Huda Akhavannik of my staff at (301) 287-9241.

Sincerely,

/RA/ W. C. Allen for

Michele Sampson, Acting Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket Nos. 71-9218 and 71-9279
TAC Nos. L24643 and L24642

Enclosures: 1. Certificate of Compliance
No. 9218, Rev. No. 21
2. Certificate of Compliance
No. 9279, Rev. No. 7
3. Safety Evaluation Report
4. Registered Users

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J. Shuler, Department of Energy

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ADAMS P8 Package No.: ML13170A446 Letter No.: ML13170A464

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SAFETY EVALUATION REPORT
Docket Nos. 71-9218 and 71-9279
Model Nos. TRUPACT-II and HalfPACT Packages
Certificate of Compliance Nos. 9218 and 9279
Revision Nos. 21 and 7

SUMMARY

By application dated April 30, 2012, as supplemented June 5, 2012, December 3, 2012, and March 27, 2013, Nuclear Waste Partnership LLC (NWP), on behalf of the U.S. Department of Energy (the applicant) requested revisions to Certificates of Compliance (CoCs) No. 9218 and 9279 for the Model Nos. Transuranic Package Transporter-II (TRUPACT-II) and HalfPACT packages, respectively. NWP submitted a consolidated application on March 27, 2013.

The primary purpose of the application is to seek the addition of a new authorized payload container (Criticality Control Overpack [CCO]) for shipment of increased fissile content waste in the TRUPACT-II and HalfPACT packagings. The TRUPACT-II and HalfPACT safety analysis reports (SARs) have been revised to incorporate the CCO and the Criticality Control Container (CCC) into the packaging design basis and to add a drawing for the new payload container. Revisions to the Contact-Handled Transuranic Waste Authorized Methods for Payload Control (CH-TRAMPAC) and Contact-Handled Transuranic (CH-TRU) Payload Appendices are primarily those required to define the payload controls necessary for the CCO. A new Appendix 4.6 of the CH-TRU Payload Appendices provides a detailed description and summary of the design basis for use of the CCO with the TRUPACT-II and HalfPACT packagings.

The following is a summary of the major technical changes included in the packaging SARs:

- Definition of Packagings as Single Containment – The application incorporates revisions to modify the designation of the TRUPACT-II and HalfPACT Outer Containment Vessels to Outer Confinement Vessels (OCV) such that the Inner Containment Vessel provides the primary (single) layer of containment.
- Revision of Shielding Evaluation – Chapter 5.0 of the TRUPACT-II and HalfPACT SARs has been revised to replace the previous qualitative shielding evaluation, based on pre-shipment dose rate surveys of the packages, with a comprehensive quantitative shielding evaluation that establishes a methodology for implementing activity limits to satisfy normal conditions of transport (NCT) and hypothetical accident conditions (HAC) dose rate requirements.
- Specification of Comprehensive Qualification Test Requirements for Containment O-ring Seal Materials – Revisions to the TRUPACT-II and HalfPACT SARs, particularly Appendix 2.10.2, establish the worst-case compressions and temperatures applicable to containment O-ring seals in the packagings and present material formulation and batch qualification tests that demonstrate the ability of seal materials to achieve and maintain a leaktight seal when subject to those worst-case conditions.
- Addition of Packaging-Related Operational Enhancements – The application includes revisions to the TRUPACT-II and HalfPACT SARs and associated drawings that define revised requirements to facilitate packaging fleet repair and maintenance activities,

enhance operational effectiveness, and provide for implementation of lessons-learned improvements.

The CH-TRAMPAC is the governing document for shipments in the TRUPACT-II and HalfPACT shipping packages. Users of the TRUPACT-II and the HalfPACT shall comply with all payload requirements outlined in this document, using one or more of the methods described.

This application also incorporates revisions to the CH-TRAMPAC and CH-TRU Payload Appendices that are consistent with the above SAR changes. In addition, these documents include the following technical changes:

- CH-TRAMPAC, Table 3.1-2, includes revisions to update the specific activity and decay heat values summarized for the listed radionuclides according to a more current reference source.
- CH-TRU Payload, Appendix 4.6, added to describe the CCO under Appendix 4.0, "Payload Container Design Basis Evaluations."
- CH-TRU Payload, Appendix 6.6, includes revisions to update the appendix consistent with RH-TRU Payload Appendix 4.6, "Thermal Stability of Payload Materials at Transport Temperatures", (approved as part of the RH-TRU 72-B SAR) and based on additional literature review.
- CH-TRU Payload, Appendix 6.12, includes revisions to allow the use of the currently approved governing equations and methodology to determine gas generation limits for assignment of additional high-wattage waste packaging configurations to Content Codes LA 154 and SQ 154.
- CH-TRU Payload Appendix 6.14 includes revisions to require any type of analytical category payload container containing one or more puck drums to be qualified by the test category measurement methodology described in that appendix, thereby extending to other payload container types the logic that was previously required for 100-gallon drums.

Accordingly, CoC Nos. 9218 and 9279 have been amended based on the statements and representations in the application, and staff agrees that the changes do not affect the ability of the packages to meet the requirements of 10 CFR Part 71.

EVALUATION

1 GENERAL INFORMATION

1.1 Package Description

The model TRUPACT-II package and model HalfPACT package have been developed for the applicant as a safe means for the transportation of CH-TRU materials and other authorized payloads. The TRUPACT-II and HalfPACT package are designed for both truck and rail transport. As many as three loaded TRUPACT-II or HalfPACT packages can be transported on a single semi-trailer. As many as seven loaded TRUPACT-II or HalfPACT packages can be transported per railcar.

The TRUPACT-II and HalfPACT packagings are 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.

The OCA consists of a lid and body, each primarily comprised of an inner stainless steel shell structure, a relatively thick layer of rigid polyurethane foam, and an external stainless steel structure. The inner OCA shell structure comprises the OCV. The ICV assembly consists of an ICV lid and body, each primarily comprised of a stainless steel shell structure.

Changes to package description include modifying the designation of the TRUPACT-II and HalfPACT outer containment vessels to outer confinement vessels. This change was made to highlight that the ICV provides the primary (single) layer of containment. The use of O-ring seals (and corresponding pressure and leakage rate testing) is now optional for the OCV. The O-ring seals are polymer with a nominal $3/8 \pm 1/8$ -inch diameter cross-section. These seals are used for optional helium and pressure rise leakage rate testing. An additional change is that the design and fabrication of the OCA (including the OCV) now falls under ASME Boiler and Pressure Vessel Code, Section III, Subsection NF.

1.2 Contents

The payload within each TRUPACT-II and HalfPACT package will be within 55-gallon drums, 85-gallon drums, 100-gallon drums, standard waste boxes (SWBs), a ten drum overpack (TDOP) (in the case of the TRUPACT-II package only), and shielded container assemblies (SCAs) (in the case of the HalfPACT package only). Pipe overpacks and CCOs utilize 55-gallon drums as overpacks. A single TRUPACT-II package can transport fourteen 55-gallon drums (with or without pipe components or CCCs), eight 85-gallon drums, six 100-gallon drums, two SWBs, or one TDOP. In contrast, a single HalfPACT package can transport seven 55-gallon drums (with or without pipe components or CCCs), one SWB, four 85-gallon drums (with or without 55 gallon drums), three 100-gallon drums, or three SCAs. Chapter 2.0 of the CH-TRAMPAC document has been updated to include requirements and specifications for the CCOs. Staff reviewed these changes and found them to be adequately described and to meet the requirements in 10 CFR Part 71.

Based on the shielding and criticality assessments provided in SAR Chapter 5.0, *Shielding Evaluation*, and SAR Chapter 6.0, *Criticality Evaluation*, the Criticality Safety Index (CSI) for the TRUPACT-II and HalfPACT packages is zero (0.0), and the shielding Transport Index (TI) is determined at the time of shipment.

1.3 Engineering Drawings

To capture the request of CCOs as an added content, the applicant added Drawing No. 163-009, sheets 1-2, Rev. 0. Staff reviewed the drawings and confirmed that the changes requested in this amendment have been comprehensively captured in the Packaging General Arrangement Drawings for both the TRUPACT-II and HalfPACT.

2 Structural Evaluation

The objective of this review was to verify that the structural performance of the addition of a CCO as an additional authorized payload is adequately evaluated to meet the requirements of 10 CFR Part 71, including the tests and conditions specified under NCT and HAC.

2.1 Structural Design

The CCO is comprised of a 55 gallon drum overpack containing a CCC which is constructed of stainless steel flanges and stainless steel Schedule 40 pipe. The CCC is concentrically positioned inside the 55 gallon drum and is restrained internally by laminated plywood dunnage. The maximum CCO gross weight is 350 pounds.

2.2 Normal Conditions of Transport

Since the CCO is an additional authorized payload and is bounded in terms of total weight by a previously approved authorized payload with similar methods and materials of construction (6-inch Standard Pipe Overpack), no additional analysis is required for NCT.

In addition, the methods employed to evaluate the CCO performance under HAC are sufficiently severe to bound any damage that may be introduced during normal transport.

2.3 Hypothetical Accident Conditions

The CCO was tested independently of the TRUPACT-II and HalfPACT packagings which resulted in conservative test conditions for the HAC tests. These tests are conservative because they do not rely on the impact absorbing material that is present in the TRUPACT-II or HalfPACT packaging as well as the deformability of surrounding as shipped CCOs, thereby maximizing the damage experienced by the tested CCO.

The test configurations consisted of an end drop and side drop orientation which bound maximum decelerations experienced by the CCO payload in a load scenario that is a combination of side or end drop. Each drop orientation had a specialized configuration which simulated the mass of additional CCOs in a stacking arrangement which could be experienced when placed within the TRUPACT-II or HalfPACT. Both tests were performed at a bounding temperature of over 200° F, which maximized the extent of material crushing.

In both drop test scenarios, the inner confinement of the CCC was maintained as demonstrated by a visually undamaged structure (no plastic deformation), lack of dispersed fluorescein indicator, and essentially no loss of pretest closure bolt torque values. This also indicates that under a true accident scenario, with the TRUPACT-II or HalfPACT packaging in place, the damage would be less severe.

2.4 Materials Evaluation

The CCO provides packaging for the CCC and Upper and Lower Dunnage assemblies designed to be used for shipment in the TRUPACT-II and HalfPACT packages.

Appendix 4.6 of CH-TRU Payload Appendices discusses the description of the CCO with the TRUPACT-II and HalfPACT packagings. The CCO consists of a steel 55-gallon drum containing a CCC confinement vessel that is centrally positioned within the drum by laminated plywood dunnage. The CCC is constructed of ASTM A182, Grade F 304/304L, 6-inch Class 150 standard blind and slip stainless steel (SS) flanges and ASTM A312, Grade TP 304/304L Schedule 40 SS pipe. The lid of the CCC is sealed with an ASTM F104 aramid-inorganic/NBR standard ring gasket and retained with eight ASTM A193, Grade B8, Class 1, 3/4-10UNC hex head SS bolts. A lifting attachment is optionally integrated into the CCC lid to facilitate handling.

This type of steel found in the CCO has carbon as the primary alloying constituent which contributes to the properties of the metal. Cold rolled, this method of forming will harden the

steel providing high tensile strength. The steel is roll formed into a ring-shape where the ends of the ring are joined together through welding to form the drum's body.

Section 2.10.2 of the application discusses elastomer O-ring seal performance and the application of performance tests that demonstrate the material's ability to achieve and maintain a leaktight seal at temperature, duration, minimum seal compression, and maximum seal compression change. Rainier Rubber R0405-70 Formulation Qualification Test Results summarizes the results of qualification testing on butyl rubber compound R0405-70 and each batch of containment O-ring seal material is additionally required to satisfy the requirements of ASTM D2000.

The staff reviewed the materials selected and determined that they are acceptable and provide reasonable assurance for the safety of the package. Specifications and temperature dependent mechanical properties, including yield strength, tensile strength, allowable strength, modulus of elasticity, and coefficient of thermal expansion conform to ASME Code, Section II, Part D.

2.4.1 Chemical or Galvanic Reactions

Section 2.4.4 of the application discusses reactions due to chemical, galvanic or other reactions. The staff concludes that, during NCT, the CCO internals will not be subject to continuous or frequent exposure to moisture or that any water intrusion is not likely to occur in great quantities. The CCC is a one-time-use payload container with a boundary constructed of stainless steel. The number of, and galvanic potential between, the different metals used in fabrication is low. Therefore, the conditions required to create the possibility for galvanic corrosion is small.

2.4.2 Brittle Fracture

Section 2.1.2.2.1 of the application discusses material brittle fracture concerns. By avoiding the use of ferritic steels in the packaging components, brittle fracture concerns are precluded. Specifically, most primary structural components are fabricated of Type 304 SS. Since this material does not undergo a ductile-to-brittle transition in the temperature range of interest (down to -40 °F), it is safe from brittle fracture. Therefore, staff notes that because, in austenitic SS metal, the force required to move dislocations is not strongly temperature dependent and dislocation movement remains high (i.e., will deform more readily under load before breaking) even at low temperatures, the material remains relatively ductile.

2.4.3 Materials and Material Testing

Section 8 of the application discusses the acceptance tests and maintenance program. The metallic materials of construction are procured and fabricated to consensus industry standards. Section 8.2.3.3.1 presents seal area inspection and repair. Before each use and at the time of seal replacement, sealing surfaces shall be visually inspected for damage that could impair the sealing capabilities of the packaging. Annual seal area dimensional inspection shall be performed. Visual inspections at various timed intervals provide additional reasonable assurance against occurring of unnoticed corrosion.

2.5 Evaluation Findings

The staff reviewed the TRUPACT-II and HalfPACT SARs as well as the CH-TRAMPAC document and CH-TRU Payload appendices which presented a new CCO payload. Based on the statements and representations contained in the application and the conditions given in the

CoC, the staff concludes that the packages and payloads have been adequately described and evaluated to demonstrate their structural capabilities, including materials performance, to meet the 10 CFR Part 71 requirements.

3.0 THERMAL EVALUATION

3.1 General Considerations

TRUPACT-II and HalfPACT are Type B packages designed to transport contact-handled transuranic waste. This evaluation focused on the CCO and CCC; these vessels formed the basis of this amendment application. The two packages are sized such that the TRUPACT-II payload consists of fourteen CCOs and the HalfPACT payload consists of seven CCOs; a CCC is placed within each CCO. The type of content that is placed within the CCC is limited to solids and residual liquid less than 1 volume percent of the payload container. The amount of waste that can be shipped is limited by decay heat, flammable gas generation rate, or the pressure within the ICV. The content and amount of waste payload allowed within a package must be determined by detailed procedures described in the CH-TRAMPAC, Rev. 4, based on the decay heat and radiolysis activity.

3.2 Thermal Design Features

The CCC/CCO assembly is placed within a TRUPACT-II or HalfPACT 304 stainless steel ICV; containment is achieved by O-ring seals and the lid is secured with a locking ring arrangement. The ICV, which is the containment boundary of the package, is placed within a 304 stainless steel OCA vessel. The inner OCA shell structure comprises the OCV. The inclusion of an OCA/OCV O-ring is optional. The applicant noted that the absence of the optional OCA/OCV O-ring would not affect the ICV during HAC fire conditions, as the circuitous Z-flange region and the external and internal outer package components (ceramic fiber tape, etc.) protect the O-ring region, as demonstrated during HAC fire testing. LAST-A-FOAM FR-3700 polyurethane foam fills the space between the inner and outer walls of the OCA. The foam absorbs impacts and acts as a thermal barrier to fire, thereby limiting the damage that can result during HAC tests.

3.3 Decay Heat

The total decay heat limits for the TRUPACT-II and HalfPACT packages are 40 watts and 30 watts, respectively, and the maximum decay heat within a single CCO is limited to 20 watts, per Section 4.6.4 of the CH-TRU Payload Appendices.

3.4 Summary of Temperatures

Table 4.6-1 and Table 4.6-2 of the CH-TRU Payload Appendices provide a summary of TRUPACT-II component temperatures for the 10 CFR 71.71 NCT conditions of no insulation and insulation, respectively. Likewise, Table 4.6-3 and Table 4.6-4 provide a summary of HalfPACT calculated component temperatures for the 10 CFR 71.71 NCT conditions of no insulation and insulation, respectively. These tables show that the maximum component temperatures were within the operating and allowable temperature limits for NCT. Table 4.6-5 and Table 4.6-6 provide a summary, respectively, of TRUPACT-II and HalfPACT component temperatures associated with the HAC. These tables show that the maximum CCC and CCO temperatures were within the components' allowable temperature limits for HAC.

3.5 Thermal Evaluation for Normal Conditions of Transport

The applicant performed thermal analyses of TRUPACT-II and HalfPACT packages in order to analyze the thermal performance of each package design under NCT. A representation of the TRUPACT-II and HalfPACT packages with a CCO payload was modeled using the Thermal Desktop and SINDA/FLUINT computer programs. A series of analyses were performed based on different boundary conditions. Results were provided for both the presence and absence of solar insolation. The design decay heat for each package type was modeled in various configurations to observe the effect on seal temperature, etc. Thermal transport mechanisms included conduction and radiation heat transfer between the package's gaps and convection and radiation heat transfer to the surroundings.

The solar insolation applied to the package was modeled by the applicant using 10 CFR 71.71(c)(1) flux values and a "12 hour on / 12 hour off" transient model. Analyses for maximum temperature assumed a 100°F ambient temperature. For all models, the OCA outer shell temperature was below the 185°F 10 CFR 71.43(g) regulatory limit for exclusive use shipping.

Package component temperatures were within their allowable limits for the cold, -40°C NCT condition, thereby meeting 10 CFR 71.71(c)(2).

As indicated in Section 4.6.4.1 of the CH-TRU Payload Appendices, thermal stresses associated with the CCC/CCO assembly are bounded by those presented in Section 3.4.5, "Maximum Thermal Stresses," of the TRUPACT-II SAR and HalfPACT SAR.

The maximum pressure associated with the ICV containment boundary is a function of radiolysis, water vapor, and heat up from the loading's initial pressure and temperature. The pressure generated within a CCC would be relieved to the ICV by filter vents located on the CCC and CCO. An offset between the dunnage and the CCC's filter vent provides an open flow area for gases leaving the filter vents. The filter vents must meet the specifications described in Section 2.5 of the CH-TRAMPAC. The applicant determined the maximum normal operation pressure (MNOP) for the different waste types by assuming a 60 day transportation period (Table 3.4-12 of the TRUPACT-II SAR and Table 3.4-9 of the HalfPACT SAR). This is a conservative transportation period, as the normal expected shipment time is three to five days and the off-normal maximum shipment time is 31 days, as noted in CH-TRU Payload Appendices, Table 3.4-3. The MNOP for Waste Material Type I, II, and III was less than 50 psig, which is the design pressure for both the TRUPACT-II and HalfPACT ICV and OCV.

The detailed procedures described in CH-TRAMPAC are used to ensure there is less than 5%, by volume, of hydrogen within the innermost layer of confinement.

3.6 Thermal Evaluation for Hypothetical Accident Conditions

The applicant performed HAC test simulations on the CCC and CCO (CH-TRU Payload Appendices, Appendix 4.6). The CCC/CCO assembly was heated to greater than 200°F and then subjected to side and end drops. Results of the testing indicated that the CCC/CCO assembly maintained confinement and shielding integrity. In addition, as part of an earlier package test program, a number of full-scale certification test units (CTU) were subjected to pool fire tests subsequent to various drop and puncture HAC tests as specified in 10 CFR 71.73. The TRUPACT-II CTU payload consisted of fourteen concrete and sand filled 55-gallon drums placed within the ICV and OCA. The 500 lb weight of each CTU drum bounded the 350 lb weight of the currently evaluated CCO. In addition, the HalfPACT CTU payload consisted of

seven 55-gallon drums with a total weight of 7350 lbs. Thermocouples and temperature indicator strips located throughout the test units were used to record temperatures. The results of these tests were used by the applicant to confirm the integrity of the CCC/CCO assembly during HAC.

In order to determine the temperatures within a CCC/CCO assembly under the thermal HAC, the applicant first calculated the amount of heat absorbed in each packaging and payload component based on the component weights, specific heats, and temperature increases due to the HAC fire testing. The heat absorbed was applied to the packaging component temperatures to model the case of having no payload weight, which would tend to result in larger component temperatures for a given heat input. The applicant applied this analysis to predicted TRUPACT-II package and HalfPACT package temperatures with CCC/CCO assemblies. As presented in Table 4.6-5 of CH-TRU Payload Appendices, the CCC gasket and ICV O-ring seal temperatures for the TRUPACT II package were 340°F and 160°F, respectively, below their allowable limit. Likewise, Table 4.6-6 indicated the CCC gasket and ICV O-ring seal temperatures for the HalfPACT package were 335°F and 162°F, respectively, below their allowable limit.

The applicant indicated in Section 4.6.4.2 of the CH-TRU Payload Appendices that the maximum internal pressure of the TRUPACT-II and HalfPACT packages with the CCC/CCO assembly during HAC is bounded by the determination presented in Section 3.5.4 of the TRUPACT-II SAR and HalfPACT SAR.

3.7 Evaluation Findings

Based on a review of the thermal sections of this amendment application, the staff has reasonable assurance that the TRUPACT-II and HalfPACT packages with the CCC/CCO assembly meet the thermal requirements of 10 CFR Part 71.

4.0 CONTAINMENT REVIEW

The TRUPACT-II and HalfPACT are developed for the applicant as a safe means for transportation of CH-TRU materials and other authorized payloads. Both packaging designs are very similar with the HalfPACT packaging shortened by 30 inches.

4.1 Containment System

4.1.1 Containment Boundary

The containment system of the ICV of the TRUPACT-II and HalfPACT packages consist of an innermost stainless steel vessel comprised of a mating lid and body, the uppermost/innermost of the two main O-ring seals between them, and a brass ICV outer vent port plug with a mating butyl O-ring seal. The OCV of both packages consist of an inner stainless steel vessel comprised of a mating lid and body, two optional O-ring seals, and a brass OCV vent port plug with a mating optional O-ring seal. The ICV is the containment boundary of both packages and is designed to demonstrate "leaktight" as defined in ANSI N14.5, "Radioactive Materials – Leakage Tests on Packages for Shipment."

4.1.2 Welds and Closure

All containment boundary welds of the TRUPACT-II and HalfPACT packages are full penetration welds that have been radiographed to ensure structural and containment integrity. The safety related welds which attach the ICV vent port insert to the containment shell are examined using liquid penetrant testing on the final pass or both the root and final passes, as

applicable. All containment boundary welds of the TRUPACT-II package are confirmed to be leaktight as described in SAR Section 8.1.3.

4.2 General Considerations

4.2.1 Gas Generation Requirement in Payload Control (CH-TRAMPAC)

Flammable (Gas/VOC) Concentration Limits

The applicant will ensure, by tests/measurements or analysis, that the flammable gas generation by radiolysis is in compliance with the gas generation requirements over a period of time that is twice the expected shipment time for both TRUPACT-II and HalfPACT packages. The hydrogen generated must be limited to no more than 5% by volume of the innermost layer of confinement if present at standard temperature and pressure. While the main flammable gas is hydrogen, the presence of methane and flammable volatile organic compounds (VOCs) is also limited along with hydrogen to ensure the absence of flammable (gas/VOC) mixtures in TRU waste payloads, as described in CH-TRAMPAC 5.2.2.

The applicant provided logic diagrams for compliance with flammable (gas/VOC) limits by analysis, measurement, testing, and mixing of shipping categories in CH-TRAMPAC Section 5.2.

The CCO payload is not associated with any change in the maximum heat load authorized for shipment in a TRUPACT-II or HalfPACT packaging. In addition to the individual CCO payload container 20 watt limit, any assembled CCO payload is required to meet the maximum total of 40 watt or 30 watt limit per TRUPACT-II or HalfPACT package, respectively. Therefore, both MNOP and flammable gas generation remain unchanged with CCO payload shipped in a TRUPACT-II or a HalfPACT package.

Under NCT and HAC, the CCO retains its contents within the CCC confinement boundary. The applicant conducted a full scale test program and demonstrated: (1) confinement, shielding integrity and adequate array spacing for criticality control of the CCO, and (2) no measurable deformation and no degradation of the CCC as the confinement vessel. The test results were described in CH-TRU Payload Appendices 4.6.3 and in Chapter 2 of this SER.

The applicant noted in CH-TRAMPAC that for Content Codes LA 154 and SQ 154, compliance with the gas generation requirements must be in accordance with Appendix 6.12 of the CH-TRU Payload Appendices. The gas generated in the payload and released into the ICV cavity shall be controlled to maintain the pressure below the acceptable design pressure of 50 psig for TRUPACT-II and HalfPACT packages.

The staff reviewed Appendices 6.1, 6.5, and 6.6 of the CH-TRU Payload Appendices, and agreed that gas generation due to chemical, biological, and thermal mechanisms is insignificant during transport and the radiolysis is the primary mechanism for potential flammable gas generation based on: (1) chemical composition of the waste, (2) gas generation potential of the waste material type, and (3) gas release resistance of packaging configuration (payload container and confinement layers).

4.2.2 Venting and Aspiration

The applicant noted in CH-TRAMPAC that the payload containers that have been stored in an unvented condition (no filter and/or unpunctured liner) shall be aspirated for the specific length

of time to ensure equilibration of any gases that may have accumulated in the closed container. Compliance of aspiration time requirement at sites can be determined by three options: (1) date of payload container closure (2) headspace gas sampling at the time of venting, and (3) headspace gas sampling during aspiration.

For payload containers with waste types in packaging configurations that do not generate any flammable gas, aspiration is not required. Given that the Waste Material Type II.2 is packaged in the metal cans and does not generate any flammable gas, aspiration is not required for the Waste Material Type II.2.

4.3 Containment Requirements for NCT

The TRUPACT-II and HalfPACT packages are verified by structural and thermal tests that there will be no release of radioactive materials per the leaktight conditions defined in ANSI N14.5 under NCT tests described in 10 CFR 71.71. The maximum MNOP of the both ICV and OCV is 50 psig per SAR 3.4.4. The ICV boundary should be subject to an internal pressure test equal to a minimum of 75 psig (150% of the MNOP) in compliance with 10 CFR 71.85(b). The OCV pressure test is optional.

4.4 Containment Requirements for HAC

The TRUPACT-II and HalfPACT packages are verified by structural and thermal tests that there will be no release of radioactive materials per the leaktight conditions defined in ANSI N14.5 under HAC tests described in 10 CFR 71.73. There are no fission gas products in the TRUPACT-II or HalfPACT package payload.

4.5 Leakage Rate Tests

4.5.1 Fabrication Leakage Rate Tests

The ICV of the TRUPACT-II and HalfPACT packages should be pressure tested as described in SAR Section 8.1.2.2 and fabrication leakage rate tested as delineated in SAR Section 8.1.3, in accordance with the guidelines of Section 7.3 of ANSI N14.5 (1997). The fabrication leakage rate testing on TRUPACT-II and HalfPACT verifies the containment integrity of ICV to a leakage rate not to exceed 1×10^{-7} ref-cm³/sec, air. The fabrication leakage rate testing on the OCV for both TRUPACT-II and HalfPACT is optional.

4.5.2 Maintenance/Periodic Leakage Rate Tests

The ICV O-ring containment seals of the TRUPACT-II or HalfPACT should be leakage rate tested annually or at the time of damaged seal replacement or sealing surface repair, as delineated in SAR Section 8.2.2, in accordance with the guidelines of Sections 7.4 and 7.5 of ANSI N14.5 (1997). The maintenance/periodic leakage rate tests verify the sealing integrity of ICV lid uppermost O-ring seal and ICV outer vent port O-ring seal to a leakage rate not to exceed 1×10^{-7} ref-cm³/sec, air. The maintenance/periodic leakage rate testing on the OCV O-ring seals of the TRUPACT-II and HalfPACT package is optional.

4.5.3 Pre-shipment Leakage Rate Tests

The lid uppermost O-ring seal and vent port plug O-ring seal for the ICV, prior to shipment of the loaded TRUPACT-II or HalfPACT package, should be leakage rate tested as delineated in SAR 7.4, in accordance with the guidelines of Section 7.6 of ANSI N14.5 (1997). The pre-shipment leakage rate testing verifies the ICV main O-ring seal and vent port plug O-ring seal to a

leakage rate of no detected leakage when tested to a sensitivity of at least 1×10^{-3} ref-cm³/sec, air. The pre-shipment leakage rate testing for the lid uppermost O-ring seal and the vent port plug O-ring seal of the OCV is optional for the TRUPACT-II and HalfPACT packages.

4.6 CH-TRU Payload Appendices

4.6.1 Payload Compatibility with Butyl Rubber O-ring Seals

The applicant notes in Section 6.3 of CH-TRU Payload Appendices that payload materials and chemicals in both TRUPACT-II and HalfPACT packages do not present an incompatibility issue with respect to the butyl rubber O-rings. The applicant evaluated the compatibility of the chemicals of concentrated oxidizing acids, aromatic hydrocarbons, and halogenated organic solvents that are incompatible with the butyl rubber O-rings, and concluded that: (1) the free liquid acids are not allowed because the waste is required to be in solid form or solidified, (2) the aromatic hydrocarbons are limited in concentrations less than or equal to 500 ppm in the headspace of the payload containers, and (3) the halogenated organic solvents, if existed, are present in extremely small amount in the waste (waste type I, II, and III) and will only cause a negligible amount of swelling on the O-rings if the solvents interact with the O-rings.

The staff reviewed Section 6.3 of CH-TRU Payload Appendices and re-confirmed that both TRUPACT-II and HalfPACT packages do not present an incompatibility concern with respect to the butyl rubber O-rings.

4.6.2 Thermal Stability of Payload Materials on Hydrogen Generation

The applicant addressed the thermal stability of payload materials in terms of the threshold decomposition temperatures in Appendix 6.6 of CH-TRU Payload Appendices and stated that (1) the effect of irradiation on the materials at the lowest threshold decomposition temperature is negligible, (2) the gas generation through thermal decomposition of the waste materials does not occur at temperatures lower than 302°F (150°C), and (3) the gas generation in polymetric materials is negligible even at much higher temperatures (up to 100°F above the thermal decomposition temperature).

The staff referenced to Chapter 7 of the SFPE Handbook of Fire Protection Engineering, and confirms that the threshold decomposition temperatures (in air) of the waste materials are higher than 150°C (for Pylox gloves).

4.6.3 Shipment of High-Wattage CH-TRU Waste (CH-TRU Payload Appendix 6.12)

The applicant defined, in Appendix 6.12 of CH-TRU Payload Appendices, the conditions and control under which the high-wattage CH-TRU waste can be shipped in TRUPACT-II and HalfPACT for compliance with gas generation requirements and all CH-TRAMPAC requirements. The objectives in Appendix 6.12 are to establish the additional safety margin of hydrogen generation, define the applicable maximum shipping period (5 or 10 days) and ensure the MNOP below the packaging design pressure of 50 psig.

In Appendix 6.12 of CH-TRU Payload Appendices, the applicant estimated the allowable shipping periods of Content Codes LA 154 (mixed combustible/noncombustible waste from plutonium processing activities at Los Alamos National Laboratory [LANL]) and SQ 154 (mixed combustible/noncombustible waste from plutonium processing activities at the DOE sites) by considering the loading time, transport time, and unloading time from LANL to Waste Isolation Pilot Plant (WIPP), and derived the maximum shipping periods of 5 days for LA 154 and 10 days for SQ 154 as summarized in Table 1 below.

Table 1. Analytical Shipping Periods of Content Codes LA 154 and SQ 154 from LANL to WIPP

Activity	LA 154	LA 154	SQ 154	SQ 154
	Normal Expected Time (days)	Max. Time Used in Analysis (days)	Normal Expected Time (days)	Max. Time Used in Analysis (days)
Loading Time	< 1	1	< 1	1
Transport Time	0.37	2	< 2.5	5
Unloading Time	< 1	1	< 1	1
Safety Margin	---	1	---	3
Shipment Time	2.37	5	4.5	10

The applicant then performed the mathematical analyses used to arrive at the flammable gas generation limits for Content Codes LA 154 and SQ 154 when shipped by the TRUPACT-II package under the maximum allowable shipping periods (5 days for LA 154 and 10 days for SQ 154) and displayed the flammable gas generation rate and decay heat limits in Tables 6.12-3 (LA 154) and 6.12-4 (SQ 154) of CH-TRU Payload Appendices (Appendix 6.12). The analysis was performed for the TRUPACT-II package which bounds the HalfPACT analysis.

The staff reviewed and accepted the bounding calculations of flammable gas generation rate limit and decay heat limit per drum for the Content Codes LA 154B for the maximum shipping period of 5 days and SQ 154F for the maximum shipping period of 10 days. The results are shown in Table 2, below.

Table 2. Flammable Gas Generation Rate and Decay Heat Limit for Content Codes LA 154B and SQ 154F

Content Code	Flammable Gas Generation Rate Limit per SWB (watt)	Decay Heat Limit Per SWB (watt)
LA 154B	2.7172E-7	2.4053
SQ 154F	2.6261E-7	2.3247

The applicant calculated MNOPs of TRUPACT-II for the Content Code LA 154 payloads and the Content Code SQ 154 payloads for the maximum shipping period of 5 days and 10 days, respectively, and presented the results of the pressure analyses in Table 6.12-5 (LA 154) and Table 6.12-6 (SQ 154) of CH-TRU Payload Appendices (Appendix 6.12).

The staff reviewed and accepted the bounding calculations of: (1) pressure increase under the maximum shipping period and (2) time to attain the pressure limit of 50 psig for the Content Codes LA 154B (maximum shipping period of 5 days) and SQ 154B (maximum shipping period of 10 days).

The results, shown in Table 3, indicate that the pressure increase of 8.17 psig for LA 154B at the maximum 5-day shipping period and the pressure increase of 7.81 psig for SQ 154B at the maximum 10-day shipping period are below the limit of 50 psig. The calculated time periods to

attain the pressure limit of 50 psig are 68.14 days (LA 154B) and 126 days (SQ 154B) which are greater than the maximum shipping periods of 5 days and 10 days for LA 154B and SQ 154B, respectively.

Table 3. Pressure Increase under Maximum Shipping Period and Time to Attain Pressure Limit of 50 psig for Content Codes LA 154B and SQ 154B

Content Code	Pressure Increase under Maximum Shipping Period	Time to Attain Pressure Limit of 50 psig
LA 154B	8.17 psig at 5 days	68.14 days
SQ 154B	7.81 psig at 10 days	126 days

4.6.4 Analytical Category Payload Containers Containing Puck Drums (CH-TRU Payload Appendix 6.14)

The applicant specifies in Appendix 6.14 of CH-TRU Payload Appendices that the analytical payload container containing puck drums must: (1) limit the decay heat less than or equal to the analytical decay heat limit specified per payload container, (2) limit the total concentration of VOCs (within the payload container headspace) less than or equal to 500 ppm, and (3) be classified as Waste Type I (10), II (20), or III (30).

The applicant proposed in Appendix 6.14 of CH-TRU Payload Appendices to establish controls to require that all payload containers containing puck drums which meet analytical category decay heat limits and have total headspace flammable VOC concentrations less than or equal to 500 ppm, must additionally undergo a test category by measurement evaluation to ensure hydrogen concentrations in compliance with flammable gas generation limits prior to shipment. The test category by measurement methodology consists of: (1) measurement of payload container headspace hydrogen concentration and (2) application of test category by measurement methodology. Any payload container containing puck drums meeting analytical category decay heat limits that does not meet test category flammable gas generation rate FGGR limits is not authorized for shipment.

The staff reviewed the test procedures described in Section 6.14.2 and the flowchart in Figure 6.14-1 of CH-TRU Payload Appendices, and agrees that the test category measurement methodology provides assurance of the elevated hydrogen in a payload container containing puck drums for compliance with flammable gas generation limits.

4.7 Evaluation Findings

Based on the review of the statements and representations in this amendment application, the staff concludes that the containment design has been adequately described and evaluated and that the package design meets the containment requirement of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The objective of the shielding review is to evaluate the proposed changes to the shielding design as part of this application to ensure they meet regulatory requirements of 10 CFR Part 71 for external radiation during NCT and HAC. This application was also reviewed to determine

whether the package fulfills the acceptance criteria listed in Section 5 (Shielding Review) of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

The purpose of this application is to add a new authorized payload container (CCO) for shipment of increased fissile content waste in the TRUPACT-II and HalfPACT transportation packages. Included as part of this application is the revision of the Shielding Evaluation. In the past, a qualitative shielding analysis was performed, utilizing pre-shipment measurements (dose rate surveys). This shielding evaluation provided the methodology for implementing activity limits, but did not provide actual quantitative results in the analysis. As part of this newly submitted application, a quantitative shielding analysis was performed which was used to demonstrate compliance with dose rate limits established in Part 71.

5.1 Description of Shielding Design

The TRUPACT-II and HalfPACT packages are comprised of an OCA and an ICV. Although the SAR states that the TRUPACT-II and HalfPACT packages are not designed, within themselves, to provide neutron or gamma shielding, the structural characteristics of the ICV and overpack can be credited with maintaining distance during NCT. Authorized steel-walled payload containers as specified in the SAR (e.g., standard pipe overpacks, CCO containers, or SC Assemblies) can be shipped in the TRUPACT-II and HalfPACT packages. Section 4 of the CH-TRU Payload Appendices provides a description of the payload containers.

5.2 Source Specification

The applicant used a 1 particle per second of ^{60}Co as the concentrated gamma source and 1 particle per second of ^{252}Cf as the concentrated neutron source for analyzing the different payloads in the TRUPACT-II and HalfPACT packages.

5.3 Shielding Model

The applicant provided the NCT and HAC surface, 1 meter, and 2 meter dose rates for both a concentrated gamma and neutron source for each of the payload containers authorized for the TRUPACT-II and HalfPACT. For NCT scenarios, credit was taken for the payload material and for maintaining the distance between the source and the surface of the payload container as the source was positioned in the center of the container. However, in response to staff request for additional information, subsequent analyses were performed to address possible shifting of the concentrated source within the payload cavity under NCT. For HAC, the source was moved to the container wall closest to the detector. In all cases no credit was taken for the dunnage packaging material. The resulting dose rates on the package surface and 2 meters from the package surface are shown to be less than the 10 CFR Part 71 limits of 200 mrem/hr and 10 mrem/hr, respectively. For HAC, the dose rates are shown to be less than 1000 mrem/hr at 1 meter.

5.4 Shielding Evaluation

5.4.1 Methods

The applicant used the three-dimensional Monte Carlo N-Particle (MCNP5 v1.60) code and cross section set to perform the shielding analysis. MCNP is a three-dimensional Monte Carlo transport code developed and maintained by Los Alamos National Laboratory. This code is

used routinely for dose rate calculations, and staff has determined that the code is acceptable for use in this shielding analysis.

Using the code, four cases were generated to compare the TRUPACT-II and HalfPACT packages with generic and CCO payloads. From this, the activity allowable to meet each of the regulatory dose rate limits is determined based on the source strength, dose rate, and the statistical error. In each of the three cases, the limiting allowable activity was lowest for the NCT at 2 meter requirement. Therefore, the applicant states that maintaining the limiting allowable activity limit to meet the NCT at 2 meter limit ensures that the HAC limit of 1000 mrem/hr is maintained as well. The resulting dose rates are shown in Tables 5.4-4 through 5.4-10 of the SAR.

The shielding analysis was then expanded to analyze the effect of dose rate self-attenuation from payload materials within TRU waste on external radiation. The applicant used a homogenous Zirc (Zr) source to be distributed within the available cavity area of the different payloads. The allowable activities were calculated based on the dose rates at 2 meters from the surface of the package. Distributed source ranges were determined using a 1 g/cc gamma source and a density correction factor. The results are shown in Sections 5.5.2 through 5.5.5 of the SAR.

The staff evaluated the shielding models and found them to be acceptable. Based on the statements and calculations presented by the applicant, the staff finds the model to be acceptable for the packaging system described in Section 5 of the SAR.

5.4.2 Input and Output Data

The applicant provided input and output files for the MCNP calculations used to determine the dose rates for the ^{60}Co and ^{252}Cf point sources as well as for the calculations used to develop the method for determining the limiting allowable activities discussed above.

5.4.3 Flux-to-Dose-Rate Conversion

The applicant used the ANSI/ANS 6.1.1-1977 standard to ensure proper conversion of gamma and neutron flux to dose rates. Staff finds use of these conversion factors acceptable for use in this analysis.

5.4.4 External Radiation Levels

The applicant used the methods described in Section 5 of the SAR to determine the maximum allowable activity to meet the dose rate requirements in 10 Part Part 71. Staff had some concern regarding the assumptions used in the shielding analysis. To alleviate these concerns, the applicant provided additional analyses and instituted a 10% administrative margin determining allowable activity based on the limiting 2 meter dose rate.

5.5 Evaluation Findings

The staff reviewed the methodology used by the applicant as part of this evaluation. Staff determined that use of the ^{60}Co and ^{252}Cf concentrated sources is acceptable in determining the most limiting allowable activity limits for the different payloads in the TRUPACT-II and HalfPACT packages. As part of this evaluation, the applicant has agreed to institute a 10% administrative margin to address the potential for a highly concentrated source being introduced into a

payload/package near or at the container wall during NCT activities. Staff agrees with this approach.

Staff also reviewed the methodology used by the applicant in analyzing the effects of dose rate self-attenuation within TRU waste on external radiation. Staff communicated concerns to the applicant regarding other materials that could potentially have lower mass attenuations at higher gamma energies. However, based on conservatisms used in the determination of acceptable waste and the use of pre-shipment measurements, staff has reasonable assurance that the dose rates can be maintained below regulatory requirements for exclusive-use shipments.

Based on review of the statements and representations in the application and independent confirmatory calculations, the staff finds reasonable assurance that the shielding design has been adequately described and evaluated and that the package meets the external radiation requirements of 10 CFR Part 71.

6.0 Criticality Evaluation

This revision seeks the authorization of a new payload container, the CCO, for shipment of increased mass of fissile waste in the TRUPACT-II and HalfPACT packaging.

6.1 Areas of Review

The applicable regulations considered in the review of the criticality safety portion of this application include the fissile material requirements in 10 CFR Part 71, specifically the general requirements for fissile material packages in §71.55, and the standards for arrays of fissile material packages in §71.59. The staff also used the review guidance contained in NUREG-1609.

The changes to the SAR apply to the CCO and containment only. Criticality was analyzed via a new scenario, "Case I." Staff reviewed the changes and information in the current SAR revision and verified that the information is consistent as well as all descriptions, drawings, figures, and tables are sufficiently detailed to support an in-depth staff evaluation. The staff evaluated the effect on criticality safety that the proposed changes to the TRUPACT-II and HalfPACT packages will have.

6.1.1 Packaging and Design Features

The TRUPACT-II packaging is comprised of an OCA which can optionally provide a secondary confinement barrier, and an ICV which serves as the primary containment boundary. Two aluminum honeycomb spacer assemblies are used within each of the torispherical heads of the ICV. The payload is located within 55-, 85-, or 100-gallon drums, SWBs, TDOPs, POCs, or CCOs.

Neither the TRUPACT-II nor the HalfPACT require any design feature that specifically provides neutron moderation and absorption for criticality control. Fissile mass limits are used to ensure the package remains subcritical. These limits are based on optimally moderated and reflected fissile material.

The CCO consists of a steel, 55-gallon drum approximately 60.96 cm (24 inches) in diameter and 88.9 cm (35 inches) tall. The drum contains upper and lower plywood dunnage assemblies and a single stainless-steel CCC. Up to 14 of these drums may be accommodated by the

TRUPACT-II package and 7 by the HalfPACT package. Mass limits are consistent with previously implemented and reviewed analytic approaches.

The CCC is approximately 74.93 cm (29.5 inches) tall, and it is constructed of 304/304L stainless steel 15.24 cm (6-inch) Class 150 standard blind and slip flanges, and Schedule 40 pipe. The CCC lid is retained with eight (8), 1.905 cm (¾ inch) stainless steel bolts and sealed with a gasket. The lid and base thickness is nominally 2.54 cm (1 inch), and that of the pipe shell is nominally 0.7112 cm (0.28 inches). The maximum gross weight is 158.757 kg (350 lbs).

6.1.2 Summary Table of Criticality Evaluations

Table 4. Summary Table of Criticality Evaluations

Normal Conditions of Transport (NCT)	
Case I	k_s
Single Unit Maximum	.8033
Infinite Array Maximum	0.9002
Hypothetical Accident Conditions (HAC)	
Case I	k_s
Single Unit Maximum	0.8209
Infinite Array Maximum	0.9357
USL = 0.9377	

6.1.3 Criticality Safety Index (CSI)

The applicant demonstrated that an infinite array of TRUPACT-II/HalfPACT packages with the most reactive contents in both NCT and HAC remains adequately subcritical. Therefore, the CSI is 0.0 in accordance with 71.59(b).

6.2 Fissile Material Contents

CCOs are designed to transport high fissile material concentrations of TRU waste. A maximum payload is 380 fissile gram equivalent of ²³⁹Pu per CCO provided the contents are not machine compacted and contain less than or equal to 1% by weight of all other special reflector materials unless: (1) the thickness and/or packing fraction of the special reflector material is less than the reference polyethylene/water reflector, or (2) the special reflector material (excluding beryllium) is mechanically or chemically bound to the fissile material. This information is summarized in Table 5, below.

Table 5. Special Reflector Material Parameters that Achieve the Reactivity of the Reference 25%/75% Polyethylene/Water Mixture Reflector

Special Reflector Material	Equivalent Thickness at 100% Theoretical Density (inch)	Equivalent Thickness at 70% Theoretical Density (inch)	Equivalent Packing Fraction at 24 inch Thickness (%)
Be	N/A	N/A	7
BeO	N/A	N/A	7
C	0.18	0.25	9
D ₂ O	.24	.27	14
MgO	.26	.33	15
U(Natural)	.08	.1	1
U(0.6% ²³⁵ U)	.14	.18	1
U(0.5% ²³⁵ U)	.18	.28	2
U(0.4% ²³⁵ U)	.33	.51	3
U(0.3% ²³⁵ U)	.56	.73	5

6.3 General Considerations

The TRUPACT-II and HalfPACT are essentially identical packages with the HalfPACT consisting of a single layer, whereas the TRUPACT-II has two layers of payload containers within the assembly. The radial spacing of the two packages is identical, and considering the annular polyurethane insulation spacing is the same, the vertical spacing between stacked ICVs is not changed. Thus, the TRUPACT-II will contain more fissile material and have higher reactivity.

6.3.1 Model Configuration

The TRUPACT-II package is modeled using conservative assumptions. The package is modeled with reduced outer dimensions consistent with a damaged package. The package heads are modeled as flat planes which reduces the vertical separation of adjacent payloads.

Under NCT, the drum spacing is preserved.

Under HAC, the TRUPACT-II is modeled with reduced dimensions consistent with a damaged package. The steel CCO drum is ignored in all models, and the stainless steel CCC is modeled explicitly. The applicant claims this is conservative as steel would absorb neutrons and lower reactivity. Although the steel drums are not explicitly modeled, the spacing of the CCCs due to the CCO drum and dunnage accounts for reduced dimensions consistent with the data from the drop tests. The HAC array is modeled with an infinite number of packages in the x and y directions, and two packages in the z direction. This array is conservative as TRUPACT-II packages are designed to preclude stacking.

6.3.2 Material Properties

Fissile material is modeled as 380 g pure ²³⁹Pu homogeneously mixed with moderator. The moderator is modeled as 74% water, 25% polyethylene, and 1% beryllium by volume. The 25% polyethylene bounds the observed volume fraction in the waste stream, typically less than 14%. The fissile material and moderator mixture is modeled as a single cylinder with the height varied to optimize moderation, with the H/X ratio varying from 100 to 900. In addition, the position of

the fissile mixture of the top layer is at the bottom of the drum, and the bottom layer is at the top of the drum.

6.3.3 Computer Codes and Cross-Section Libraries

The applicant used KENO-V.a module in the SCALE 4.4 code suite driven by the CSAS25 utility for criticality analysis. KENO-V.a is a three-dimensional Monte Carlo transport code. The cross-section library used was the 238-group library based on ENDF/B-V nuclear data. Both this software and cross-section library have been previously evaluated and found to be appropriate for use in this application.

6.3.4 Demonstration of Maximum Reactivity

The applicant's analysis included several scenarios which varied the geometry and moderator and reflector materials. Within each scenario, the applicant varied the H/X ratio of the fissile material to find the optimum cylinder height that resulted in maximum reactivity for that particular scenario.

Maximum reactivity is shown to be when all of the materials are modeled as void under HAC, except for the fissile mixture. Under NCT, the fissile mixture contains moderator materials, dunnage, foam and flooding serves to shield the fissile cylinders and reduce interaction between cylinders.

6.3.5 Confirmatory Analysis

Staff, using the same assumptions as the applicant, analyzed the TRUPACT-II model using SCALE 6.1 with a continuous energy ENDF/B-7 cross section library. In order to fully reflect the model, a layer of water was explicitly modeled rather than used as a boundary condition. The staff used the dimensions provided in the SAR.

The staff's analysis confirmed that under HAC, the reactivity of an infinite array of packages is most reactive when the packaging materials are modeled as void. Staff also analyzed the effect of beryllium in the fissile mixture.

Given the approximations and changes to the model, the staff's results are in reasonable agreement with those of the applicant.

6.4 Single Package Evaluation

6.4.1 Configuration

The single package under NCT is modeled with maximum external reflection, with the polyurethane foam modeled in the space between the ICV/OCV and OCA shells, and the water/polyethylene/beryllium mix is modeled inside each CCC. The area in the ICV but outside the drums is modeled with full-density water.

The applicant made the following changes to the NCT model to analyze a single package under HAC: (1) the drum diameter is reduced from 60.96 to 39.37 cm (24 to 15.5 inches); (2) the drum height is reduced from 88.9 to 79.0575 cm (35 to 31.125 inches); and (3) foam between the ICV/OCV and OCA is replaced with water.

6.4.2 Results

The most reactive single package under NCT has a k_s of 0.8033 and occurs with a fully-flooded drum and an H/X ratio of 400.

The most reactive single package under HAC has a k_s of 0.8209 and occurs with a voided drum and an H/X of 500. With the CCCs closer together, reactivity decreases with increased drum flooding.

In both cases, the reactivity remains below the USL.

6.5 Evaluation of Package Arrays under NCT

6.5.1 Configuration

The applicant models the single package with reflective boundary conditions to analyze an array of packages that is stacked two high and infinite in the x- and y-axes and fully water-reflected both above and below. The analysis is based off of the more reactive series from the analysis of a single package under NCT. This includes scenarios that alter the presence of dunnage and foam, and change the H/X ratio.

6.5.2 Results

The most reactive array occurs where all materials except the fissile mixture are modeled as void, and yields a k_s of 0.9002 with an H/X ratio of 650. This is below the stated USL.

6.6 Evaluation of Package Arrays Under HAC

6.6.1 Configuration

The applicant repeats the boundary conditions used to analyze an array of packages under NCT. The changes reflect reduced dimensions due to damage and are conservative. The applicant analyzes cases which alter the presence of dunnage and reflector density and composition.

6.6.2 Results

The addition of hydrogenous material between the CCCs is shown to reduce reactivity. The most reactive configuration occurs with the case where all materials are modeled as void except the fissile mixture. For this scenario, H/X=650 and the k_s is 0.9357. This is below the stated USL.

6.7 Benchmark Evaluations

The applicant used USLSTATS to determine the USL for the criticality analysis. Both the methodology and software are appropriate for determining criticality safety limits.

6.7.1 Experiments and Applicability

The fissile benchmark experiments selected are thermal solutions of plutonium and for beryllium in a thermal system. Only one experimental benchmark met the requirements for beryllium. No

benchmarks are available that contain both plutonium and beryllium in a thermal system. Some experiments contain Plexiglas, which is used to validate the presence of polyethylene. The benchmark uncertainty in the 196 experiments listed is combined with the KENO uncertainty to create the total uncertainty.

6.7.2 Bias Determination

The calculated upper subcritical limit for the fissile material evaluations includes both the bias and uncertainty in the bias, with the most limiting of these presented in Table 6-1.

6.8 Evaluation Findings

The staff has reviewed the description of the packaging design and concludes that it provides an adequate basis for the criticality evaluation.

The staff reviewed the design and materials and concludes that it is prepared for shipment such that there will be no significant reduction in the effectiveness of the packing under the tests specified in 10 CFR 71.71.

The staff has reviewed the applicant's criticality evaluation of a single package and concludes that it will remain subcritical under the most reactive credible conditions.

The staff has reviewed the criticality evaluation of an infinite array of the most reactive configuration under both NCT and HAC and concludes that it is subcritical under these conditions.

The staff has reviewed the benchmark evaluation of the calculations and concludes that they are sufficient to determine an appropriate bias and uncertainty for the criticality evaluation.

7.0 PACKAGE OPERATIONS

The package operating procedures in both the TRUPACT-II and HalfPACT were updated to reflect the OCV O-ring seal being made optional. The optional leakage rate testing of the OCV main O-ring is based on the following criteria:

- (a) If the OCV upper main O-ring seal is replaced or the corresponding sealing surface(s) was repaired, then perform the maintenance/periodic leakage rate test per Section 8.1.3.6, "Optional Helium Leakage Rate Testing the OCV Main O-ring Seal Integrity" and;
- (b) If there are no changes to the OCV upper main O-ring seal and no repairs made to the corresponding sealing surfaces, then perform pre-shipment leakage rate testing per Section 7.4, "Pre-shipment Leakage Rate Test," or per Section 8.1.3.6, "Optional Helium Leakage Rate Testing the OCV Main O-ring Seal Integrity."

Based on the statements and representations in the application, the staff concludes that the package operations meet the requirements of 10 CFR Part 71 and that they are adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

The CoCs for both TRUPACT-II and HalfPACT are conditioned to specify that the package must be prepared for shipment and operated in accordance with Chapter 7 of the application.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The staff reviewed the TRUPACT-II and HalfPACT packages to ensure that the packages will be tested and maintained in accordance with 10 CFR Part 71, and to ensure that the welding examinations, the fabrication leakage rate tests and the maintenance/periodic leakage rate tests are done in accordance with ANSI N14.5 and the regulatory requirements. The acceptance tests and maintenance program were updated to reflect the OCV O-ring seal being made optional and the updated ASME Boiler and Pressure Vessel Code.

The OCV and ICV of the TRUPACT-II and HalfPACT have an MNOP of 50 psig and so will be pressure tested to 75 psig, although for the OCV, this testing is optional. After pressure testing, all accessible welds and adjacent base metals (minimum 1/2-inch on each side of the weld) directly related to the pressure testing will be visually inspected for plastic deformation or cracking, and liquid penetrant inspected per ASME Boiler and Pressure Vessel Code, Section V, Article 6, and ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NF, Article NF-5000 (for the OCV), and Subsection NB, Article NB-5000 (for the ICV).

The fabrication leakage rate tests of the ICV containment structure integrity, ICV main O-ring seal, and ICV outer vent port plug O-ring seal are performed according to the guidelines of ANSI N14.5, Section A.5.4, *Evacuated Envelope – Gas Detector*, as described in SAR 8.1.3. For the fabrication leakage rate test, the package shall have a leakage rate of not greater than 1.0×10^{-7} ref-cm³/sec, demonstrated to a sensitivity of 5.0×10^{-8} ref-cm³/sec. The fabrication leakage rate testing for the OCV is optional and instructions parallel to the ICV testing are provided under a new section added in this amendment, “Optional Helium Leakage Rate Testing the OCV Main O-ring Seal Integrity,” and “Optional Helium Leakage Rate Testing the OCV Vent Port Plug O-ring Seal Integrity.”

The minimum O-ring seal compression was revised from 12.5 percent to 10.73 percent per calculations provided in Section 2.10.2 of the SAR.

Based on the statements and representations in the application, the staff concludes that the acceptance tests and maintenance program for the TRUPACT-II and HalfPACT meet the requirements of 10 CFR Part 71 and that they are adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

The CoCs for the TRUPACT-II and HalfPACT are conditioned to specify that the package must be prepared for shipment and operated in accordance with Chapter 8 of the application.

9.0 QUALITY ASSURANCE

The quality assurance section in both the TRUPACT-II and HalfPACT was revised to incorporate the latest revision of Regulatory Guide 7.10 and clarified that Type B packaging may only be used under the conditions specified in the certificate of compliance.

CONDITIONS

The following updates apply to CoC No. 9218, Rev. 21 and CoC No. 9279, Rev. 7:

Condition No. 3.b., “Title and Identification of Report or Application,” and the “References” section have been updated to reflect the new consolidated SAR.

Condition No. 5.(a)(2), "Description," has been updated to reflect a single containment system and the new definition of the OCA and OCV. Prior to this, OCA was defined as "outer containment assembly" and OCV was defined as "outer containment vessel."

Condition No. 5.(a)(3), "Drawings," has been updated to reflect the latest revisions to the already listed drawings and to include Drawing No. 163-009, Rev. 0, for assembly of the CCO.

Condition No. 5.(b)(1), "Contents," and Condition No. 5.(b)(2), "Maximum quantity of material per package," has been updated to include the CCO as a payload container. Condition No. 5.(b)(1) has also been updated to explicitly state Pu-239 special reflector material limitations.

Condition No. 13 has been updated to allow for use of the previous revision of the CoC for up to one year. In CoC No. 9279, Rev. 7, Condition No. 14 has been switched with Condition No. 13.

Revision numbers for the CH-TRAMPAC and CH-TRU Payload Appendices documents have been revised to reflect the latest revision throughout the CoC.

CONCLUSION

Based on the statements and representations in the application, and the conditions listed above, the staff concludes that the Model Nos. TRUPACT-II and HalfPACT packages designs have been adequately described and evaluated and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9218, Revision No. 21, and Certificate of Compliance No. 9279, Revision No. 7 on June 19, 2013.