Environmental Management

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DOE Packaging Certification Program

# Safety Evaluation Report for Content Amendment for U-233 and Co-60 Configurations in the Model 8-120B Package

**Docket No. 16-38-9168**

Prepared by: [signature] Date: 8/9/17

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This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) independent technical review of the application prepared and submitted by Atkins Global/Energy*Solutions* for the Idaho Cleanup Project (ICP) requesting an amendment to DOE Certificate of Compliance Number (CoC) 9168 to authorize U-233 and Co-60 shipping configurations in the Model 8-120B package.

## Summary

By letter [1] dated December 31, 2016, as supplemented [2, 3] May 12, 2017 and July 18, 2017, Atkins Global prepared and submitted an Addendum to the Safety *Analysis Report for Model 8-120B Type B Shipping Package Consolidated Revision 11* [4] (CSAR), for ICP, requesting an amendment to DOE CoC 9168 to authorize U-233 and Co-60 shipping configurations in the Model 8-120B package.

Atkins, with concurrence from the certificate holder, Energy*Solutions*, prepared and submitted *Idaho Cleanup Project Shipping Addendum for Model 8-120B Type B Shipping Package* [4] in support of their request to DOE PCP for ICP.

This Addendum evaluates six new content configurations for ground transport. The new configurations do not affect the currently authorized packaging components, but require additional new shoring components internal to the package containment system for placement of secondary containers within the containment. The secondary containers also provide criticality control for the U-233 configurations and additional shielding for the Co-60 configuration.

The U-233 configurations exceed §71.15, *Exemption from classification as fissile material*; consequently, the Addendum evaluates the fissile contents for compliance with the applicable sections of §71.55, *General requirements for fissile material packages*, and §71.59, *Standards for arrays of fissile material packages* to authorize the package for shipment of fissile radioactive materials (RAM).

On the basis of the statements and representations in the Addendum to the CSAR and PCP staff's confirmatory evaluation as summarized in this SER, staff finds the addition of U-233 and Co-60 content configurations in the Model 8-120B package acceptable, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

This SER will hereafter refer to Atkins as the "applicant" and *Idaho Cleanup Project Shipping Addendum for Model 8-120B Type B Shipping Package* as the "Addendum", unless otherwise specified. The Addendum also includes Supplements A and B submitted on July 18, 2017.

# Evaluation

## 1.0 General Information

The principal safety functions of the package are to provide gamma shielding and containment.

The limits authorized in the current CoC for the Model 8-120B package are summarized below:

- Gross weight of the package is approximately 74,000 pounds,
- Content weight is 14,150 pounds,
- Decay heat is 200 watts, and
- Content defined in Section 5(b) of the CoC.

The CoC requires in Section 5(b)(1), that RAM contents must be packaged in secondary containers and in Section 5(c)(2), except for close fitting contents, shoring must be placed between the secondary containers and the walls of the package cavity to prevent movement of the containers during transport. Secondary containers and shoring are not important-to-safety package components with respect to gamma shielding and containment for the current Type B(U)-96 package design authorized in the CoC.

The usable containment cavity of the packaging is approximately 62 inches in diameter and 74 inches in length. The package was designed to transport up to eight 55-gallon drums (stacked in two layers, with four drums in each layer), but the cavity volume can accommodate, with shoring, up to four 110-gallon drums, or three 85-gal drums and four 55-gallon dunnage drums, stacked in two layers, with the 85-gallon drums in the lower layer for ballast.

An amendment to the CoC is necessary because the proposed contents exceed the CoC limits for fissile materials or require additional shielding; consequently, the Addendum evaluates six new content configurations to ensure the package provides gamma shielding, containment, and criticality control, and to qualify the package design for Type B(U)F-96 (i.e., as a Type B fissile package).

## 1.1 Packaging Description

There are no changes to the existing Model 8-120B packaging design or operational features authorized in the CoC and evaluated in the CSAR.

The RAM, secondary containers, and shoring configurations are defined in the Addendum as Payload Types 1 through 6. The secondary containers and shoring for the RAM contents may also function as important-to-safety package components with respect to gamma shielding and criticality control, and to qualify the Mode 8-120B package design for Type B(U)F-96.

The secondary containers used for Payload Types 1 and 2 are DOT 6M Type B fissile packages certified by Nuclear Regulatory Commission (NRC) CoC Number 5908. NRC notified the registered users on January 7, 1993, that CoC 5908 was expired. These packages were fabricated in 1979, based on their marking, so one could surmise that they were previously authorized for use by NRC.

The metal convenience handing drum pallet, (Reference *Pallet Assembly*, Drawing No. C-032-001456-001) for all Payload Types in this Addendum was previously evaluated in the CSAR for Configuration-3 of the package with a load limit for the pallet of 4,800 pounds.

### 1.1.1 Secondary Containers and Shoring for Payload Types 1-4, and 6

Payload Types 1-4, and 6 are fissile payloads. The secondary containers and shoring are required safety class items for criticality control for Payload Types 1 and 2 under hypothetical accident conditions (HAC) by limiting the radial spacing between the contents in damaged containers. The secondary container and shoring configurations for these Payload Types are described in Section 1.2.1 and Appendix 1.3.1 of the Addendum, and are summarized below. The mass limits on Payload Types 3, 4, and 6 are sufficient in lieu of safety class packaging components or shoring for criticality safety. The loading configurations of the secondary containers and shoring into the 8-120B containment cavity are illustrated in Figure 7-1, *Payload Types Examples*, of the Addendum.

Payload Type 1 Packaging Configuration

Secondary Containers - Up to eight DOT-6M Type B, insulated 55-gallon drums, with a lead-shielded 2R Container (approximately 5 inches in diameter by 25-¾ inches in overall length) in each 6M drum (Reference Drawing No. 784499). Each drum functions as an overpack for a fiberboard assembly sandwiched between 1-inch thick disks of plywood at the top and bottom of the assembly. The RAM is loaded in the 2R Container, and the 2R is loaded into the fiberboard assembly. The fiberboard assembly is overpacked in the 55-gallon open-head drum.

The 8-120B packaging is sufficient for the thermal protection and shielding for this Payload Type; however, the secondary containers are important-to-safety for criticality control by limiting the radial distance between the fissile contents under HAC.

Shoring – Up to four Payload Type 1 drums or shoring drums are loaded on a convenience handling pallet. A *Payload Separator*, Drawing ATKINS-NS-DWG-FIL-ME-0301, is placed on each pallet to separate the drums into four quadrants and to provide space and stability between the two layers of palletized drums. After the drums are loaded into the 8-120B cavity, a *Cask Top Spacer* (Reference Drawing ATKINS-NS-DWG-FIL-ME-0302) may by installed if shoring is required between the top layer of drums and the containment closure.

The *Payload Separator* is an important-to-safety feature for criticality control by limiting the radial distance between the fissile contents under HAC.

Payload Type 2 Configuration

Secondary Containers - Up to four DOT-6M Type B, insulated 110-gallon drums, with a lead-shielded 2R Container (approximately 4 inches in diameter by 50 inches in overall length), in each 6M drum (Reference Drawing No. 784499). Each drum functions as an overpack for a fiberboard assembly sandwiched between 1-inch thick disks of plywood at the top and bottom of the assembly. The RAM is loaded in the 2R Container, and the 2R is loaded into the fiberboard assembly. The fiberboard assembly is overpacked in the 110-gallon open-head drum.

The 8-120B package is sufficient for the thermal protection and shielding for this Payload Type; however, the secondary containers are important-to-safety for criticality control by limiting the radial distance between the fissile contents under HAC.

Shoring - Four Payload Type 2 containers are loaded onto a convenience handling pallet. A *Pallet Spacer (for 110 Gal Drums)*, Drawing ATKINS-NS-DWG-FIL-ME-0502, is placed on the pallet to separate the containers into four quadrants. After the containers are loaded into the 8-120B cavity, a *110 Gal Drum Assy Spacer* (Reference Drawing ATKINS-NS-DWG-FIL-ME-0503) is installed for shoring between the top of the drums and the containment closure.

The *Pallet Spacer (for 110 Gal Drums)* is an important-to-safety feature for criticality control by limiting the radial distance between the fissile contents on each pallet, under HAC.

<u>Payload Type 3 Packaging Configuration</u>

Secondary Containers - Up to eight DOT-17C, 55-gallon drums. The RAM is loaded in the open-head 55-gallon drums.

Shoring – Same as Payload Type 1. In this configuration, the *Payload Separator* is not an important-to-safety feature, but is used to separate the drums into four quadrants and to provide space and stability between the two layers of drums

<u>Payload Type 4 Packaging Configuration</u>

Secondary Containers - Up to seven drums: three drums with RAM contents and the remaining drums for shoring. The RAM is loaded in up to three DOT-17C, 55-gallon open-head drums. Each drum is then macro-encapsulated in a bag, *Liftpac 27 X 40* [Reference Drawing LP2740-HMPPSZTL (SP) IP], and then overpacked in an 85-gallon drum body.

Shoring – Three Payload Type 4 containers are loaded directly into the 8-120B cavity. Four 55-gallon shoring drums are placed on a convenience handling pallet, and then loaded in the cavity to stack on the Payload Type 4 containers. The pallet also functions as a cover for the 85-gallon drum bodies.

<u>Payload Type 6 Packaging Configuration</u>

Secondary Containers - Up to seven drums: three drums with Payload Type 6 RAM contents and four Payload Type 3 drums (with Payload Type 3 RAM) or shoring drums. The RAM for Payload Type 6 is loaded in up to three DOT-17C, 55-gallon open-head drums. These drums are then overpacked in 83 or 85-gallon drums.

Shoring – Up to three Payload Type 6 drums are loaded directly into the 8-120B cavity. Four 55-gallon Payload Type 3 drums or shoring drums are placed on a convenience handling pallet, and then loaded in the cavity to stack on the Payload Type 6 containers. A *Payload Separator*, Drawing ATKINS-NS-DWG-FIL-ME-0301, is placed on the pallet to separate the drums into four quadrants and to provide space and stability between the two layers of drums.

1.1.2 Secondary Container and Shoring Payload Type 5

Payload Type 5 is a non-fissile payload, but requires additional shielding within the secondary containers for normal conditions of transport (NCT) and HAC. The shoring also provides a safety function for shielding by prevent movement of the secondary containers during transport and retention of the lid of the supplemental shield body during HAC. The secondary containers and shoring configuration for this Payload Type is described in Section 1.2.1 and Appendix 1.3.1 of the Addendum, and summarized below. The loading configuration of the secondary containers and shoring into the 8-120B containment cavity are illustrated in Figure 7-1, *Payload Types Examples*, of the Addendum.

<u>Payload Type 5 Packaging Configuration</u>

Secondary Containers - Up to eight 55-gallon DOT-7A Type A drums. Each 55-gallon open-head drum, with polypropylene & polyester lift-bag, and a wooden spacer, functions as an overpack for an insulated, lead-shielded, 30-gallon open-head drum. This packaging is an important-to-safety item for this configuration and is defined on *Type A Packaging Configuration for 3" Lead Shielded 30 Gallon Containers*, Drawing 799075. The fiberboard insulation in the 30-gallon drum protects a lead-shield insert that is 3-inches thick with a content cavity size approximately 3-inches in diameter by 21-inches long. The 30-gallon drum lid is "loose" fit on the drum body, but is held in place by the wooden spacer and lid of the 55-gallon overpack drum.

The 8-120B package shielding is <u>not</u> sufficient for this Payload Type; consequently, the secondary containers are important-to-safety items for shielding by providing 3 inches of supplemental shielding and by limiting the displacement of the contents under NCT and HAC.

Shoring - Up to four Payload Type 6 drums or shoring drums are loaded on a convenience handling pallet. A *55/30 Gal Drum Assy Separator*, Drawing ATKINS-NS-DWG-FIL-ME-0303, is placed on each pallet to separate drums into four quadrants and to provide space and stability between the two layers of palletized drums. The pallet with the heaviest set of Payload drums must be loaded in the bottom of the 8-120B cavity. After the drums are loaded in the cavity, a *Cask Top Spacer* (Reference Drawing ATKINS-NS-DWG-FIL-ME-0302) must by installed between the top layer of drums and the containment closure.

The *55/30 Gal Drum Assy Separator* and *Cask Top Spacer* are important-to-safety items for shielding and are credited with limiting radial and axial movement of the secondary containers and retention of the supplemental shield lid during the HAC side drop.

## 1.2 Contents

The RAM contents for Payload Types 1 through 6 shall comply with the CoC and CSAR, except as noted below.

### 1.2.1 RAM for Payload Types 1-4, and 6

Payload Types 1 and 2 are normal form RAM consisting of unirradiated Light Water Breeder Reactor (LWBR) or equivalent U-233 fuel rods, pellets, and powder, grinding sludge, metallography mounts and miscellaneous debris contaminated with pellet powder, consisting of a mixture of unirradiated uranium dioxide, thorium dioxide, and zirconium dioxide as ceramic materials. Fissile contents shall be limited to the fissile gram equivalent of 2,200 grams of Pu-239, as determined in the Addendum.

The applicant created a composite "bounding" drum in Table 1.2 of the Addendum, based on the maximum curie value observed for each nuclide in these Payload Types, to demonstrate that the contents, approximately 37 $A_2$ and 116 milliwatts per drum, were compliant with the CoC limits of less than 3,000 $A_2$s and 200 watts per package.

Payload Type 3 is normal form RAM consisting of metallurgical mounts of LWBR or equivalent wastes, or various inner waste containers contaminated with LWBR fines, pellets, tools, rags, gloves, nuts, and solidified solutions.

Payload Type 4 is normal form RAM consisting of LWBR or equivalent wastes as solidified grinding sludge and contaminated debris in a macro-encapsulation bag.

Payload Type 6 is the form of Payload Type 3 contents or equivalent, overpacked into 83- or 85-gallon drums. This configuration also authorizes four Payload Type 3 drums, with contents, in the top layer of the 8-120B cavity in lieu of shoring drums.

Fissile contents for Payload Types 3, 4, and 6 shall be limited to the fissile gram equivalent of 325 grams of Pu-239, per package, as determined in the Addendum.

### 1.2.2 RAM for Payload Type 5

Payload Type 5 is normal form RAM and consists of Co-60 contaminated or irradiated equipment items and debris. The estimated $A_2$s and decay heat for Payload Type 5 is approximately 563 $A_2$s and 96 watts respectively per package, which complies with the CoC limits. Maximum contents for Payload Type 5 shall be limited to 28.675 TBq (775 Ci) of Co-60 per drum and 229.4 TBq (6,200 Ci) per package, based on the shielding evaluation in Chapter 5 of the Addendum.

## 1.3 Criticality Safety Index

The criticality safety index (CSI) of the package is 0 (zero) and is evaluated in Section 6.1.3 of the Addendum.

## 1.4 Radiation Level and Transport Index

The external radiation level and transport index (TI) will be established by measurement at the time of shipment. The external radiation level must meet §71.47 standards for exclusive use shipment.

## 1.5 Conclusion

Based on a review of the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff concludes that the package described in Chapter 1 of the CSAR, as supplemented by the Addendum, has been described in sufficient detail to provide an adequate basis for its evaluation under 10 CFR Part 71, for Payload Types 1 through 6.

## 2.0 Structural Evaluation

PCP staff reviewed Chapter 2 of the Addendum for the effects of the new shipping configurations on the structural performance of the package. Staff confirmed the weight and center of gravity of the new Payload Types were adequately defined and within the authorized limits of the package, materials of construction were compatible with the package, and reviewed the adequacy of the performance of the supplemental packaging for Payload Types 1, 2, and 5 during NCT and HAC.

## 2.1 Structural Evaluation Results

The maximum content weight authorized in the CoC is 14,150 pounds. The maximum estimated content weights for Payload Types 1 through 6, including the secondary containers and shoring, are listed in Table 2.1 of the Addendum. The heaviest content loading is Payload Type 5, of approximately 9,000 pounds (rounded), which is well below the authorized content weight limit for the package.

The applicant confirmed by calculation that the package center-of-gravity is essentially the same, or lower, for the new payload types, subject to the following loading restrictions:

- For Payload Types 1, 3, and 5 - the four heaviest drums must be loaded on the pallet in the bottom position of the 8-120B cavity.
- For Payload Type 6 (three drums) and Payload Type 3 (four drums) – the total weight of the Payload Type 6 drums and pallet must be greater than the total weight of the Payload Type 3 drums and *Payload Separator*, and the Payload Type 6 drums must be placed in the bottom of 8-120B cavity.
- For Payload Type 2 – for balance, the two heaviest drums must be flanked on the pallet by the two lightest drums.

The materials and properties for the secondary containers and shoring, including Class or Grade, yield stress, ultimate stress, and density are summarized in Table 2-2 of the Addendum. The shoring components are to be fabricated from 304L stainless steel for durability and compatibility with the package.

The secondary containers and shoring for Payload Types 3, 4, and 6 are not important-to-safety items with respect to containment, shielding, and criticality, but are required by the CoC to prevent both radial and axial movements during transport.

The secondary containers and shoring for Payload Types 1 and 2 are important-to-safety items with respect to criticality control.

The secondary containers and shoring for Payload Type 5 are important-to-safety items with respect to shielding, and are required by the CoC to prevent both radial and axial movements during transport.

The applicant performed NCT end, side, and corner free drop test simulations from 1-foot for Payload Type 1, 2, and 5 configurations using LS-DYNA code to ensure secondary containers and shoring provide adequate structural integrity for the contents.

The applicant performed HAC end, side, and corner free drop simulations from 30-feet for Payload Type 1, 2, and 5 configurations using LS-DYNA code to provide the input for the shielding and criticality analysis by estimating the radial and axial spacing after the drop simulations. For the Payload Type 1 and 2 drum configurations, the applicant assumed a maximum weight of 560 pounds per drum. For the Payload Type 5 configuration, the applicant assumed maximum weight of 873.2 pounds per drum. These drum configurations were modeled with shoring as described in the Addendum. Table 2.1 of the Addendum summarizes the content spacing changes for each configuration and free drop simulation.

In all HAC side and corner drops, the drum lids are predicted to at least partially separate from the drum shell because the drum closure rings are predicted to fail in these orientations; however, the shoring confines the space within the package cavity and retains the secondary container so that the failure of the drum closure ring will not significantly alter the final position of the contents in the 8-120B cavity.

In addition, the HAC drop simulation results for Payload Type 5 estimate that deformations in the secondary container shielding would not decrease its effectiveness.

## 2.3 Evaluation Findings

Based on review of the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the structural design and performance of the package described in Chapter 2 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 3.0 Thermal Evaluation

PCP staff reviewed the thermal design and performance of the package based on the composite "bounding" drum in Table 1.2 of the Addendum for Payload Types 1-4, and 6, and RAM contents for Payload Type 5. The staff's review focused on the content decay heat loads, maximum normal operating pressure (MNOP), and flammable gas generation.

## 3.1 Thermal Evaluation Results

There were no changes to the thermal design of the package for the new Payload Types.

Decay heat load

The total maximum decay heat load is approximately 96 watts per package, based on 12 watts per drum of Payload Type 5 contents (Co-60), as described in Section 3.1.2 of the Addendum. This decay heat load is bounded by the maximum thermal loading limit of 200 watts for the package.

Maximum Pressure in the Containment System

The applicant calculated the MNOP and maximum pressure in the containment under HAC for comparison with the CSAR. The applicant used a secondary container and shoring configuration (e.g., Payload Type 5) that minimized the void volume in the containment in order to generate the greatest pressure. For Payload Types 1 through 6, the calculated MNOP and maximum pressure under HAC are 3.53 psig and 5.45 psig respectively, as compared with the CSAR MNOP and maximum pressure of 35 psig and 155 psig respectively.

Flammable Gas Generation

The applicant evaluated all Payload Types, in Section 3.3.2 of the Addendum, to ensure that flammable gases are less than 5% by volume of the total gas inventory within any confined volume. Based on the applicant's calculations, as summarized in Table 3.5 of the Addendum, the maximum hydrogen generated in one year in the 8-120B containment cavity for Payload Types 1 through 6 is approximately 0.2%. Additionally, the applicant credited a previous facility safety evaluation of the various layers of confinement in the secondary containers that demonstrated that hydrogen does not exceed 5% volume within the inner confinement layers after 31 years of storage.

Thermal Evaluation under NCT and HAC

The applicant evaluated the package with Payload Types 1 through 6 by comparison with the CSAR and previous a thermal evaluation of the DOT-6M containers for maximum temperatures, pressures, and thermal stress. PCP staff concurs the comparison is valid, mainly because the internal package temperatures from the 200 watt content evaluated in the CSAR is twice the maximum wattage produced by Payload Type 5 (approximately 96 watts).

## 3.2 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the thermal design and performance presented in Chapter 3 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and that it will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 4.0 Containment

Payload Type 1 through 6 use the same containment system authorized in the CoC and described in the CSAR. The 8-120B containment system provides a leaktight containment boundary for the contents of the package. The new shipping configurations do not affect the containment system of the package.

## 4.1 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the containment design and performance described in Chapter 4 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and that it will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 5.0 Shielding Evaluation

PCP staff reviewed the shielding analysis of the package as described in Chapter 5 of the CSAR and the Addendum, and the new MCNP 6.1 shielding calculations for Payload Type 5. Staff verified the supplemental shielding and spacing configuration of the Payload Type 5 secondary containers and shoring to ensure the package dose rates met the regulatory limits under NCT and HAC, for exclusive use shipment on a single conveyance.

## 5.1 Description of the Shielding Design

There were no changes to the shielding design of the package for Payload Types 1-4, and 6. The applicant asserted that the neutron emission rate for Payload Types 1 and 2, for 2,200 FGE of Pu-239 per package is significantly less than 1.1E+05 neutrons/second, resulting in a dose rate of less than 0.1 millirem/hour, which is the neutron dose rate limit for the package according to Section 5.2.2 of the CSAR. PCP staff ran two cases in ORIGEN-S with 2,200 grams: one with Pu-239 and the other with U-233. The resulting neutron source was 8.7 E+4 neutrons/second and 1.1 E+4 neutrons/second respectively. Staff concurs with the applicant that the package and CSAR shielding evaluation is sufficient for Payload Types 1-4, and 6.

Supplemental shielding is required for Payload Type 5 in the secondary containers in accordance with *Type A Packaging Configuration for 3" Lead Shielded 30 Gallon Containers,* Drawing 799075. The shield is cylindrical with approximate overall dimensions of 9-¾ inches in diameter and 26 inched in length, and a usable cavity approximately 3-inches in diameter and 21-inches in length. The lead thicknesses in the shield lid and bottom are approximately 2-½ inches and approximately 3-inches in the shield wall. Based on the HAC structural evaluation, the secondary container closure lid rings on the 55-gallon overpacks are predicted to fail during a side or corner drop from 30-feet; consequently, the *55/30 Gal Drum Assy Separator* and *Cask Top Spacer* are important-to-safety items for shielding because the applicant credits these items for limiting radial and axial movement of the secondary containers and retention of the shield lid.

The drawings in the CSAR and Addendum provide the dimensions of the relevant packaging components. Chapter 2 of the CSAR, as supplemented by the Addendum Section 5.3.2, provides material specifications for the packaging components.

## 5.2 Source Specification

Table 5-1 of the Addendum shows gamma energies and intensities for Co-60. Gammas emitted below 500 keV were excluded as insignificant in intensity and radiological significance. For Payload Type 5 with a maximum of 6,200 Ci, the resulting gamma emission rate was 1.65 E+18 gammas/hour. There are no neutron sources present in the Payload Type 5, and although Co-60 is a beta emitter, Section 5.4.4.2 of the CSAR omits isotopes for the source term with peak beta energies less than 0.3 MeV because beta source strengths less than 2 E+12 betas per second do not contribute significantly to exterior dose rates of the package.

PCP staff reviewed the gamma source terms in the Addendum, and requested a change to the applicant's shielding calculations and Addendum to use the fluence-to-dose-rate conversion factors from ANS-6.1.1-1977, *Neutron and Gamma-Ray Fluence-to-Dose Factors*, instead of ANS-6.1.1-1991. The applicant implemented staff's comment in the final submittal to revise the source specifications. This change reduced the maximum Co-60 content from 9,600 curies to 6,200 curies, and no additional analysis by the applicant was required because the 1977 conversion factors are more conservative.

## 5.3 Shielding Models

PCP staff reviewed and commented on the models for the Payload Type 5 configurations shown in Figures 5-1 to 5-4 of the Addendum. Dose rates were calculated at the positions shown in these figures and defined in Tables 5-3 and 5-4 of the Addendum, using point detector tallies.

For the NCT model, eight 55-gallon drums were arranged in two tiers of four drums per tier in a square array in the 8-120B package. Each 55-gallon drum contained one 30–gallon drum with shield insert. Only the shield insert material (lead) is credited with attenuating radiation to supplement the 8-120B package shielding. All other materials are treated as shoring for the NCT shielding evaluation. A Co-60 point source represented the RAM contents. A point source was placed on the axial centerline of each shield insert at either the top, middle, or bottom depending on the dose rate location of interest.

For the HAC model, the applicant assumed the same condition of the 8-120B package as the CSAR evaluation, that is, the lead shielding in the package wall cavity slumped axially by approximately 0.15-inch and caused a gap near the Cask Body Bolt Ring (Reference Drawing C-110-E-0007), and the radial thickness of the lead was uniformly reduced by 0.5-inch to represent damage sustained in the puncture drop test. The Payload Type 5 configuration was modeled with the shield insert lids separating from the shield body by approximately 1.10-inches from the side drop test orientation. In addition, the fiberboard insulation was crushed such that four of eight lead shield inserts were displaced within a radial distance of 1-inch from the package wall cavity, as shown in Figure 5-4 of the Addendum. Only the shield insert material (lead) is credited with attenuating radiation to supplement the 8-120B package shielding. All other materials were treated as shoring for the HAC shielding evaluation. A point source was placed on the axial centerline of each shield insert at either the top, middle, or bottom depending on the dose rate location of interest. Radial detectors were placed along radii passing through the drum centerlines at the axial mid-planes of two drums in each of the upper and lower tiers.

## 5.4 Shielding Analysis Results

Tables 5-9 and 5-11 of the Addendum shows the calculated maximum dose rates for a single package under NCT and HAC. The applicant calculated these dose rates for the Payload Type 5 configuration using the dose conversion factors from *Conversion Coefficients for use in Radiological Protection against External Radiation*, ICRP Publication 74 and 9,600 Curies of Co-60 per package. The maximum dose rate for NCT is 197.7 millirem/hour and is located at the bottom surface of the package; for HAC, the maximum dose rate is 503.1 millirem/hour at 1-meter from the side surface of the package.

Based on PCP staff comments, the applicant recalculated package dose rates for 6,200 Curies of Co-60 using dose conversion factors from *Neutron and Gamma-Ray Fluence-to-Dose Factors*, ANSI/ANS-6.1.1-1977, plus 2σ Monte Carlo uncertainty, which resulted in maximum NCT dose rate of 198.5 millirem/hour at the package bottom surface and HAC dose rate of 487.5 millirem/hour at 1-meter from the side of the package.

PCP staff's calculations confirm the Payload Type 5 configuration meets §§71.47 and 71.51 for loadings up to a maximum 775 Curies per container and 6,200 Ci per package.

## 5.5 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the shielding design and performance described in Chapter 5 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and that it will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 6.0 Criticality Evaluation

PCP staff reviewed and evaluated the criticality safety design and performance of the package in the Chapter 6 of the Addendum and the supporting criticality safety calculation.

The CSAR demonstrates that the Model 8-120B package design only meets the requirements for Type B, but not the additional requirements for fissile material packages. Therefore, the Addendum is necessary to demonstrate the package also meets the §71.55 *General requirements for fissile material packages* and §71.59 *Standards for arrays of fissile material packages* for Payload Types 1-4 and 6. Payload Type 5 is non-fissile and therefore omitted from criticality evaluation in Chapter 6 of the Addendum. Staff verified the RAM material limits, secondary containers, and shoring for Payload Types 1-4 and 6 ensure the package remains subcritical under NCT and HAC, for exclusive use shipment on a single conveyance. Staff reviewed the applicant's MCNP 6.1 criticality calculations to ensure the methodology and models were correctly applied. During the review process, staff requested the applicant to improve their description in Chapter 6 in lieu of additional calculations. Staff's comments were implemented by the applicant in the final submittal of the Addendum. Chapter 6 of the Addendum and its supporting analyses adequately demonstrate the package configuration satisfies the criticality requirements of §§ 71.55 and 71.59. Staff did not perform an independent confirmatory analysis because the margin demonstrated in the Addendum is conservative and well below any criticality concerns.

## 6.1 Description of the Criticality Design

**Packaging and Design Features**

The 8-120B packaging consists of a steel and lead cylindrical shipping cask with a pair of cylindrical foam-filled impact limiters installed on each end. The package configuration is shown in CSAR Figure 1.2-1. The internal cavity dimensions are 61-13/16 inches in diameter and 74-⅞ inches high. The cylindrical cask body is composed of a 1-1/2 inch thick external steel shell and a ¾-inch thick internal steel shell. The annular space between the shells is filled with 3.35 inch thick lead. The base of the cask consists of two 3-¼ inch thick flat circular steel plates. The cask lid consists of two 3-¼ inch thick flat circular steel plates. The lid is fastened to the cask body with twenty 2-8 UN bolts. There is a secondary lid in the middle of the primary lid. This secondary lid is attached to the primary lid with twelve 2-8 UN bolts. A thermal shield protects the secondary lid and sides of the cask. The thermal-shield consists of two polished stainless-steel plates that are separated by a thin air gap with stand-offs which provide an additional air gap above the secondary lid or cask wall. The thermal shields were ignored in the criticality calculations. The package was designed to transport up to eight 55-gallon drums (stacked in two layers, with four drums in each layer), but the cavity volume can accommodate, with shoring, up to four 110-gallon drums, or three 85-gal drums and four 55-gallon dunnage drums, stacked in two layers, with the 85-gallon drums in the lower layer for ballast.

The secondary containers and shoring for Payload Types 1-4 and 6 are described in Sections 1.2.1 and 6.1.1 of the Addendum.

The secondary containers for Payload Types 1 and 2 are significant to the criticality safety design.

The secondary container packaging for Payload Type 1 consists of DOT-6M Type B, insulated 55-gallon, open-head drum, with a lead-shielded 2R Container (approximately 5 inches in diameter by 25-¾ inches in overall length, and 24-inches in useable length) in each 6M drum (Reference Drawing No. 784499). The 2R shielding may be configured with a lead cylinder inside and/or outside the 2R container, and lead disk at the bottom and/or top of the inside of the 2R. Total lead thickness is not to exceed two inches. Each drum functions as an overpack for a fiberboard assembly sandwiched between 1-inch thick disks of plywood at the top and bottom of the assembly.

The secondary container packaging for Payload Type 2 consists of DOT-6M Type B, insulated, open-head 110-gallon drum, with a lead-shielded 2R Container (approximately 4 inches in diameter by 50 inches in overall length, and 48-inches in useable length), in each 6M drum (Reference Drawing No. 784499). The lead shield is a cylinder 0.75-inches thick and internal to the 2R, and ½-inch thick lead disks at the top and bottom inside the 2R. Each drum functions as an overpack for a fiberboard assembly sandwiched between 1-inch thick disks of plywood at the top and bottom of the assembly.

Secondary containers used for shoring for Payload Types 1 and 2 contain fiberboard insulation.

The secondary container packaging for Payload Types 3, 4, and 6 are DOT-17C, 55-gallon drums or 17C 55-gallon drums overpacked in 85-gallon drums. Payload Types 3, 4, and 6 drums are not insulated or shielded and do not contain 2R containers. These secondary containers are not significant to the criticality safety design, because the fissile mass is limited for these Payload Types.

**Summary Table of Criticality Evaluations**

| Case | Maximum keff + 2σ |
|---|---|
| **Payload Types 1 and 2** | 0.88690 |
| **Payload Types 3-4, & 6** | 0.93191 |
| **Payload Types 1 and 2** | did not evaluate |
| **Payload Types 3-4, & 6** | did not evaluate |
| **Payload Types 1 and 2** | 0.89314 |
| **Payload Types 3-4, & 6** | 0.93486 |
| $k_{safe}$ | 0.93542 |

**Criticality Safety Index (CSI)**

The applicant demonstrated, in Table 6-1 of the Addendum, that an infinite array of Model 8-120B packages with the most reactive contents in both NCT and HAC remains adequately subcritical. Therefore the CSI is 0.0 in accordance with 10 CFR 71.59(b).

## 6.2 Fissile Material Contents

For Payload Type 1, up to 275 grams Pu-239 FGE per 2R container in each drum and up to 2,200 grams Pu-239 FGE per package; for Payload Type 2, up to 550 grams Pu-239 FGE per 2R container in each drum and up to 2,200 grams Pu-239 FGE per package; and for Payload Types 3, 4, and 6, up to 325 grams Pu-239 FGE per package. Contents must be in solid form and no more than 25 percent by volume of hydrogenous material. Liquids and gases are prohibited. Conversion of fissile isotopes to Pu-239 FGE is performed per the multipliers presented in the

*Remote Handling Transuranic Waste Authorization Methods for Payload Control*, Rev. 1 (RH-TRAMPAC).

## 6.3 General Considerations

**Model Configuration**

The applicant's 8-120B package model for criticality is the same model used for the shielding analysis described in Section 5 of CSAR and Addendum. The applicant developed two additional model configurations for the criticality analysis to represent the 6M/2R configuration for Payload Types 1 and 2 and Payload Types 3, 4, and 6.

The 6M/2R model for Payload Types 1 and 2 assumes the 8-120B is loaded with four secondary containers, but each container consists only of a fiberboard insulation assembly, 2R container with a lead disk in bottom of the 2R, and 2-inch thick lead shield cylinder external to the 2R. Each container is represented as three tightly-nested radially symmetric cylinders, as shown in Figure 6.1 of the Addendum. The model dimensions of these components are listed in Table 6.2 of the Addendum and were altered from the drawing dimensions for simplification and conservatism. For example, the diameter of the fiberboard assembly was reduced to allow the containers to be placed in a triangular pitched configuration for increased interaction between the fissile contents. The shoring and drum (steel) were omitted to decrease neutron absorption and increase interaction between containers, and the 2R internal lead shield cylinder was omitted to increase the fissile region diameter to a more favorable geometry and increase reactivity.

The model for Payload Types 3, 4, and 6 assumes that there were no secondary containers or shoring in the package cavity and that the RAM contents were in spherical form and suspended in water.

All calculations in Chapter 6 of the Addendum consider a fissile region moderated by a mixture of 25 volume percent polyethylene and water, that is, the fissile solution for Payload Types 1 and 2 and the fissile sphere for Payload Types 3, 4, and 6 are a modeled as a mixture of Pu-239, polyethylene (25% by volume), and water.

For the single package evaluation of Payload Types 1 and 2 under NCT, the applicant assumed the secondary containers are closely packed in a triangular-pitched array adjacent to the interior wall of the packaging; the 2R is filled with fissile solution and water in various arrangements in the 2R; the containment is filled with air; and the impact limiters are installed on the package. For HAC, the secondary container arrangement is the same as NCT, but the fiberboard assemblies are compressed radially from the HAC side drop. The applicant used the results from the side drop analysis to decrease the radial spacing between 2R containers as shown in Figure 6.5 of the Addendum. For HAC, the containment is filled with water, the impact limiters are removed, and the package is enveloped with 30-centimeters of water for full reflection.

For the single package evaluation of Payload Types 3, 4, and 6 under NCT and HAC, the model is the same internally, but externally for HAC the impact limiters are removed, and the package is enveloped with 30-centimeters of water for full reflection.

**Material Properties**

The fissile material for Payload Types 1 and 2 is modeled as a fissile solution containing 550 grams of Pu-239, polyethylene (25% by volume), and water in the 2R container. This solution does not fill the entire volume of the 2R so the remaining volume (i.e., the non-fissile region) is modeled with full density water to provide maximum neutron reflection for the fissile region.

The fissile material for Payload Types 3, 4, and 6 is modeled as a fissile sphere containing 325 grams of Pu-239, polyethylene (25% by volume), and water.

The fissile material properties are listed in Tables 6.3 (solution) and 6.4 (sphere) and non-fissile material properties are listed in Tables 6.5 (steel, lead, and water) and 6.6 (fiberboard) of the Addendum.

**Computer Codes and Cross Section Libraries**

The applicant used MCNP6.1 code with the ENDF/B-VII.1 cross section library to determine the effective multiplication factor ($k_{eff}$) for the specified configuration geometry and materials. MCNP® and Monte Carlo N-Particle® are registered trademarks owned by Los Alamos National Security, LLC. MCNP® radiation transport code has been widely used for many decades for nuclear criticality safety and licensing applications and is considered an industry standard code. This software and cross-section library have been previously evaluated and found to be appropriate for use in this application.

**Demonstration of Maximum Reactivity**

In single package evaluations for Payload Types 1 and 2, the applicant demonstrated that maximum reactivity is achieved when the height of the fissile solution (fissile region) in the 2R container is 40 centimeters, and the fissile solution layer is at the bottom of the 2R and below a layer of water (non-fissile region); the fissile solution is 25% by volume polyethylene and remainder of the fissile solution is 90 grams of Pu-239 per liter; the 2R containers are in a triangular pitched array approximately 16.32 inches center-to-center between any three 2R containers and adjacent to the wall of the containment cavity; and 10% water density in the containment cavity.

Maximum reactivity for Payload Types 3, 4, and 6 is achieved when the fissile sphere is 12.5 centimeters in radius and located adjacent to wall and floor of the containment cavity; the fissile solution is 25% by volume polyethylene and remainder of the fissile solution is 40 grams of Pu-239 per liter; the containment cavity flooded with the water, and the package enveloped in 30-centimeters of water at full density.

The evaluation of package arrays is the same as the single package evaluation, except the density of water between packages is at 50% density.

Tables and Figures 6.7 through 6.12 of the Addendum show the results of the calculations and sufficiently demonstrate the configuration of maximum reactivity.

Staff reviewed the applicant's maximum reactivity calculations to ensure they were correctly applied.

## 6.4 Single Package Evaluation(s)

The single package analysis under NCT scenarios for Payload Types 1 and 2 include a dry package containment cavity and varying: (a) lead thickness on the shield external to the 2R, (b) density of the fiberboard assembly, and (c) volume height of the fissile solution in the 2R. The most reactive configuration assumes a lead thickness of 2-inches, fiberboard density of 0.70 grams/cubic centimeter, and fissile solution volume height of 40 centimeters (15.75 inches). Optimal moderation occurs at 90 grams of Pu-239 per liter with an H/X ratio of 309.2. The resulting $k_{eff} + 2\sigma$ is 0.86907, which is less than $k_{safe}$ (0.93542).

The single package analysis under HAC scenarios for Payload Types 1 and 2 include decreasing the radial spacing between 2R containers, a flooded package containment cavity, replacing the packaging impact limiter with 30-centimeters of water, enveloping the package in 30-centimeters of water, and varying: (a) water density in the flooded containment and (b) volume height of the fissile solution in the 2R. The most reactive configuration assumes a lead thickness of 2-inches, fiberboard density of 0.70 grams/cubic centimeter, fissile solution volume height of 40 centimeters (15.75 inches), and water density in the containment of 10 percent. Optimal moderation occurs at 90 grams of Pu-239 per liter with an H/X ratio of 309.2. The resulting $k_{eff} + 2\sigma$ is 0.88690, which is less than $k_{safe}$ (0.93542).

The single package analysis under NCT and HAC scenarios for Payload Types 3, 4, and 6 include a flooded package containment cavity and varying: (a) water density in the flooded containment, (b) fissile sphere location, and (c) radius of the fissile sphere. The most reactive configuration assumes a water density 100 percent, the sphere is at the bottom and against the wall of the containment cavity, and fissile sphere radius of 12.5 centimeters. Optimal moderation occurs at 40 grams of Pu-239 per liter with an H/X ratio of 698.3. The resulting $k_{eff} + 2\sigma$ is 0.92982, which is less than $k_{safe}$ (0.93542).

## 6.5 Evaluation of Package Arrays under Normal Conditions of Transport

The applicant reasoned that since the single undamaged package evaluation for Payload Types 1 and 2 under NCT is less reactive than the single damaged package evaluation under HAC, and the single package evaluation is equal for Payload Types 3, 4, and 6 under NCT and HAC (i.e, assumes no packaging), an infinite NCT array would also result in an infinite value for N. Therefore, the value for N is equal for the NCT and HAC arrays and it is not necessary to model NCT arrays.

## 6.6 Evaluation of Package Arrays under Hypothetical Accident Conditions

The package analysis scenarios for an infinite square-pitched array for Payload Types 1 and 2 include enveloping the package in 30-centimeters of water and varying: (a) water density in the space between packages and in the containment, (b) volume height of the fissile solution in the 2R, and (c) position of secondary containers so that containers in adjacent packages are nearest radially for maximum reflection. The most reactive configuration occurs when water density is 50 percent between packages and 10 percent in the package containment, fissile solution volume height of 40 centimeters at 90 grams of Pu-239 per liter with an H/X ratio of 309.2. The resulting $k_{eff} + 2\sigma$ is 0.89314, which is less than $k_{safe}$ (0.93542). The applicant also ran a case with eight 55-gallon drums (275 gram of Pu-239/drum) per package to evaluate the effect of reactivity based on axial separation, rather than radial separation. The resulting $k_{eff} + 2\sigma$ is 0.82584, which is less than $k_{safe}$ (0.93542).

The package analysis scenarios for an infinite square-pitched array for Payload Types 3, 4, and 6 include enveloping the package in 30-centimeters of water and varying the: (a) water density in the space between packages and in the containment and (b) radius of the fissile sphere. The most reactive configuration occurs when the water density between packages is 50 percent and 100 percent in the containment, and the sphere radius is 12.5 centimeters and located the bottom and against the wall of the containment cavity. The resulting $k_{eff} + 2\sigma$ is 0.93746, which exceeds the $k_{safe}$ (0.93542). The only case where $k_{eff} + 2\sigma$ is less than $k_{safe}$ is when the water density between packages is 100 percent. The applicant moved the sphere 1-centimeter from the wall of the containment cavity and reran the analysis with the most reactive configuration. The resulting $k_{eff} + 2\sigma$ is 0.93486, which is less than the $k_{safe}$ (0.93542). PCP staff agrees this configuration is reasonable to account for the drum and shoring omitted for conservatism.

## 6.7 Benchmark Evaluations

The applicant applied the benchmarks from the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP Handbook). Table 6.13 of the Addendum compares the Area(s) of Applicability (AOA) between the benchmarks and the applicant's criticality evaluation. Section 6.7.2 of the Addendum summarizes the bias determination to determine the Upper Subcritical Limit (USL) as 0.93542 ($k_{safe}$).

## 6.9 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the criticality safety design and performance described in Chapter 6 of the Addendum, acceptable for Payload Types 1-4 and 6, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 7.0 Operating Procedures

PCP staff reviewed the operating procedures described in Chapter 7 of the CSAR and Addendum. Procedures for package loading, package unloading, preparation of empty packages for transport, and other operations were implemented in the Chapter 7 of the Addendum for Payload Types 1 through 6 to supplement the CSAR.

## 7.1 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the package operating procedures described in Chapter 7 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 8.0 Acceptance Tests and Maintenance Program

PCP staff reviewed the acceptance tests and maintenance program described in Chapter 8 of the CSAR and Addendum. There are no changes to the acceptance testing and maintenance of the 8-120B packaging. The acceptance tests for secondary container and shoring components required for Payload Types 1 through 6 are outlined in Chapter 8 of the Addendum and incorporated in the respective fabrication drawings. Chapter 8 of the Addendum supplements the CSAR for the Payload Types 1 through 6 configurations.

## 8.1 Acceptance Tests

The shoring for Payload Types 1 through 6 is constructed from 304L stainless steel square tubing and plate, and joined by welding. All welds for the shoring components are inspected per ASME Code, Section III, Division I, Subsection NF; NF-5350 and NF-5360 per the engineering drawings. Prior to use, the final shoring assemblies are load-tested to 125 percent of the authorized gross weight in accordance with ASME B30.20.

The lead shield inserts for Payload Type 5 are tested prior to each use per Section 8.1.5 of the Addendum by performing gamma surveys on the surface each 55-gallon drum overpack, prior to loading in the 8-120B packaging. The acceptance criterion is a maximum dose rate of 30 rem/hour on the surface of the overpack. This criterion is based on a modification to the MCNP shielding models used for the NCT shielding analysis and a safety factor of 2.4. The applicant added tallies on the overpack drum surfaces and re-ran the model with a 775 Curie Co-60 point source: the minimum dose rate on the surface of the overpack was 73 rem/hour. The applicant assumed a safety factor of 2.4, that is, (73 rem/hour)/(30 rem/hour) = 2.4 to account for discontinuities in the shield insert. PCP staff concurs that this acceptance test is acceptable to demonstrate the integrity of the lead shield insert.

## 8.2 Maintenance Program

The shoring for Payload Types 1 through 6 will be visually examined for broken welds or component damage that impairs the reliability of its function. The acceptance and load tests are repeated for shoring after weld repairs or component replacement, per Section 8.1 of the Addendum.

The secondary containers for Payload Types 1 through 6 are being shipped for disposal and are not intended for reuse; consequently, there is no maintenance requirements for these containers.

## 8.3 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the acceptance tests and maintenance program described in Chapter 8 of the CSAR, as supplemented by the Addendum, acceptable for Payload Types 1 through 6, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## 9.0 QUALITY ASSURANCE

PCP staff reviewed Chapter 9 of the Addendum for the Applicant's Quality Category assignment of the packaging components that are important-to-safety for Payload Types 1 through 6. The Addendum was prepared and submitted by Atkins Nuclear Solutions, US, Inc., and was concurred with by the DOE certificate holder, Energy*Solutions* Services, Inc. The work was performed for Fluor Idaho, LLC, Idaho Cleanup Project (ICP). Consequently, Atkins performed this work under the Quality Assurance Programs (QAP) of Energy*Solutions* and Fluor Idaho, which has been approved by the DOE Headquarter Certifying Official: QAP Approvals 0001 and 0029 respectively. The Atkins' Organizational Roles and Responsibilities involved with the Addendum are defined in Figure 9-1 of the Addendum.

## 9.1 QA Evaluation

Table 9.2-2b of the Addendum, as supplemented, lists the function, failure effect, and quality level of the shoring and secondary containers for Payload Load Types 1 through 6. The applicant addressed the safety function of all items placed within 8-120B containment and concentrically about the RAM contents and assigned quality level classifications for these items. PCP staff concurs with these assignments.

Note: The applicant's quality level classifications used for the Payload Type 1 through 6 packaging are Quality Levels (QL) 1, 2, and 3, which correspond to Categories A, B, and C in Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in Transport of Radioactive Material* and NUREG/CR-6407, *Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety*.

There were no changes to existing the 8-120B packaging design. PCP staff confirmed by document review of the Addendum, as supplemented, that the shoring and secondary components meet the applicable the Subpart H requirements, based on their quality level classifications, and that the activities important to quality were performed under Subpart H Quality Assurance Programs approved by the DOE Headquarters Certifying Official.

## 9.2 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the quality assurance programs described in the Addendum, as supplemented, acceptable for Payload Types 1 through 6, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

## Conditions of Approval

The following changes to the CoC are required to implement the conditions in this SER.

- Packaging Description 5.(a)(2) revise to add the description for the packaging for Payload Types 1 through 6.
- Drawings 5.(a)(3), revise to add the applicable drawings.
- Contents 5.(b)(1)(iii) through (vii), revised to add type and form of contents for Payload Types 1 through 6.
- Contents 5.(b)(2)(ix) through (xi), revised to add the maximum for Payload Types 1 through 6.
- Criticality Safety Index 5.(c) added, CSI = 0.
- Condition 5.(c) revised to 5.(d).
- Condition 5.(d)(1)(i) and (ii) revised to reference the Addendum.
- Condition 5.(d)(6) added to prohibit air transport of fissile material.
- Condition 5.(d)(7) added for Payload Types 1-4 and 6 to prohibit machine-compacted contents and restricted to no more than 1% by weight of special reflectors and no more than 25% by volume of hydrogenous material.
- Supplements 5.(e) was added and 5.(e)(1) through (3) added for the Addendum and additional supplements.
- Package Identification Number in the header changed from B(U)-96 to B(U)F-96.

## Conclusion

Based on the statements and representations in the CSAR, as supplemented by the Addendum, and supplements A and B to the Addendum, and PCP staff's confirmatory evaluation, staff concludes that the package design described in the has been adequately described and evaluated for the Model 8-120B and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met, subject to the Conditions in the CoC and listed above.

## References

[1] *Amendment Request for the 8-120B, Certificate No. USA/9168/B(U)-96 (DOE), Docket No. 16-38-9168,* Atkins Nuclear Solutions US Inc., December 31, 2016.

[2] *Idaho Cleanup Project Shipping Addendum for Model 8-120B, Type B Shipping Package, Docket No. 16-38-9168,* May 2017 (Rev.1)

[3] *Transmittal of Supplements A and B to Docket No. 16-38-9168, "Idaho Cleanup Project Shipping Addendum for the Model 8-120B Type B Shipping Package, Updated May 2017 (Rev.1)",* July 18, 2017

[4] *Safety Analysis Report for Model 8-120B Shipping Package, Consolidated Revision 11,* May 2016