

**Safety Evaluation Report for an Addendum to the
10-160B Consolidated Safety Analysis Report for
Shipment of Corrugated Metal Box Contents**

Docket No. 13-23-9204

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SUMMARY

This Safety Evaluation Report (SER) documents the independent technical review by the Department of Energy (DOE) Packaging Certification Program (PCP) staff for compliance with 10 CFR Part 71 of the application submitted by the Los Alamos Field Office (LAFO) to amend DOE Certificate of Compliance (CoC) Number 9204, Rev 5. *EnergySolutions* prepared the application for LAFO.

The Los Alamos National Laboratory requested authorization for shipment of filter-vented, Type A, corrugated metal boxes (CMBs) containing legacy transuranic (TRU) waste as a new content in the 10-160B package. Each CMB will be overpacked in a 10-160B and shipped to the Advanced Mixed Waste Treatment Facility in Idaho for waste treatment.

The 10-160B will transport one CMB per shipment. A cribbing system was designed to minimize the movement of the CMB within the 10-160B and to ensure CMB filter-vents are not obstructed during loading or transport.

The safety performance of the CMB, overpacked in the Model 10-160B Type B Radwaste Shipping Cask, with the contents, shipping configuration, and conditions described in this SER, meet the applicable requirements of 10 CFR Part 71 and DOE CoC Number 9204, Revision 5.

1. GENERAL INFORMATION AND DRAWINGS

DOE PCP staff performed a review of the general information and drawings provided in the application request ^[1] (i.e., addendum) to DOE Certificate Number 9204^[2] for compliance with 10 CFR Part 71.^[3] The review focused on the CMB, cribbing design, and contents in the 10-160B.

The Applicant proposes that the CMB, cribbing design, and legacy TRU waste items be treated as authorized contents in the 10-160B.

The CMB meets the requirements for a Department of Transportation (DOT) 7A, Type A package per 49 CFR 178.350. The overall dimensions (in inches) of the CMB are approximately 38 (height) x 54 (width) x 68 (length). The CMB shipping configuration includes three NUCFIL filter vents installed on the CMB body to aid hydrogen diffusion to the 10-160B containment system. There are no special operational features of the CMB.

The cribbing design is essential to maintain the position of the CMB within the 10-160B for structural protection and to ensure adequate venting of the CMB into the package containment system.

CMBs may contain three material waste forms:

- Material Form No. 1: Solids - any particle size
- Material Form No. 2: Solids - large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids - objects with no significant dispersible or transferable contamination

Waste items include: heterogeneous debris, including steel plates and other cut and size-reduced glovebox items (e.g., plastics, Personal Protective Equipment, paper, rags, rubber, aerosol cans, wood-based High Efficiency Particulate Air filters, and glass) contaminated with nuclear materials. Table 1-3 of the addendum lists the CMB content data, such as, weight, A₂ values, and fissile gram equivalents per CMB package identification number.

The addendum adequately describes the CMB shipping configuration in the 10-160B.

Based on the PCP staff review of the statements and representations in the application, PCP concludes the addition of the CMB, cribbing design, and contents have no impact on the safety performance of the 10-160B. The requirements of 10 CFR Part 71 for normal conditions of transport (NCT) and hypothetical accident conditions (HAC) are satisfied, with the following conditions for the contents on a per CMB basis:

- < 3000A₂ of mixed TRU nuclides
- ≤ 20 aerosol cans allowable
- ≤ 4.0 fluid ounces (97.7 grams, 3.45 ounces avoirdupois weight) total residual flammable liquids in any aerosol cans present in a CMB
- <500ppm volatile organic compound (VOC) content

2. STRUCTURAL

PCP staff performed a review of the structural evaluation in the application for compliance with 10 CFR Part 71. The review focused on the CMB, cribbing design, and contents in the 10-160B.

The Applicant evaluated the structural impact of the CMB configuration on the 10-160B shipping cask during NCT and HAC. PCP staff accepted the validity of the existing Consolidated Safety Analysis Report (CSAR) ^[4] analysis based on previous review by the Nuclear Regulatory Commission.

The CMBs are a welded construction, fabricated from 14 gauge mild steel. Overall dimensions (in inches) are approximately 38 (height) x 54 (width) x 68 (length). The CMB is closed by welding the lid to the container body. All seams in the CMB are continuous welds. The heaviest CMB is 3,730 lb.

The cribbing design prevents movement of the CMB within the 10-160B cask during NCT and HAC. The estimated weight of the cribbing design is 4,800 lb. The cribbing is a two-piece design, consisting of Lower and Upper Guide Assemblies. The Lower Guide Assembly sits below the CMB and the Upper Guide Assembly is installed after the CMB is loaded in the 10-160B. The Upper Guide Assembly has an adjustable height plate to eliminate axial gaps between the cribbing and the 10-160B cavity. Both the Upper and Lower Guide Assemblies have eight cantilevered guide arms that center the CMB and bear upon the 10-160B containment shell walls through ultra-high molecular weight polyethylene contact guides.

The CMB contents are well within the previously evaluated content loads for the 10-160B structure. To show the load paths would not adversely affect the CSAR analysis, the Applicant performed simple analyses on the loads transferred to the 10-160B containment shell in an end drop and side drop configuration. PCP staff reviewed and confirmed the performance of the package for the 10 CFR 71.71 and 71.73 impact scenarios evaluated by the Applicant.

The most vulnerable orientation of the cribbing design evaluated by the Applicant was side-drop orientation or drop orientations with significant loads in the lateral direction. The Applicant analyzed the bearing stress on the cask cavity from the guide arms in a side-drop configuration by conservatively applying the 120-g side loading to the payload mass. CALC-5063-ST-0001 also analyzed the guide-arm weld stress in a side-drop configuration with four of the smaller guide arms loaded in shear from a side-drop. This calculation did not analyze bending of the guide arms; however, since only the lower 12 inches of the guide arms are in contact with the CMB; because of the taper on the inner surface, the Applicant's analysis is sufficient.

PCP staff noted that the static payload configuration depends on the rigidity of the CMB, given the significant unsupported length between the guide arms of the Upper and Lower Guide Assemblies. Even in the event of the CMB crushing under NCT conditions leading to an axial gap under HAC end drop scenarios, any secondary impact is insignificant given the energy absorption from deformation of the thin walled CMB. Guide pins and setscrew do not present a hazard since any protrusion of these components from the cribbing will project into the cavity below the inner lid of the 10-160B.

Based on the PCP staff review of the statements and representations in the application, PCP concludes that the addition of the CMB, cribbing design, and contents has no impact on the safety performance of 10-160B shipping cask. The requirements of 10 CFR Part 71 for NCT and HAC are satisfied, with the following condition:

- The CMB is cribbed within the 10-160B as described and evaluated in the addendum.

3. THERMAL

PCP staff performed a review of the thermal evaluation in the application for compliance with 10 CFR Part 71. The review focused on the analysis of pressurization during NCT and HAC and a flammability analysis to define the maximum quantity of light lubricant from aerosol cans, modeled as WD-40 oil.

The CSAR limit of 200 watts bound the 1-watt heat load of the CMB.

The pressurization analyses for both NCT and HAC assumed:

- a) The CMB is sealed
- b) There is sufficient quantity of water present to form water vapor at its saturation pressure
- c) The propellant from 20 aerosol cans is released into the gas space inside the CMB (as a bounding case).

The analyses also include radiolytic gases generated during the shipping window, extended for a thirteen month period (September 1, 2013 to September 30, 2014). The Applicant used Radcalc software to determine the amount of gases generated by the contents and the Ideal Gas Law to calculate pressurization due to heating. The Applicant performed a flammability analysis to rule out additional pressurization due to a postulated flammable gas deflagration. The flammability analysis determines the maximum quantity of flammable WD-40 that can be released from punctured aerosol cans and stay below the lower flammability limit (LFL). The flammability analysis conservatively assumed that all WD-40 released from the cans evaporates.

The Applicant initially performed a deflagration analysis to determine the additional pressurization due to a postulated deflagration. Subsequently, they decided to substitute a flammability analysis and calculate a maximum permissible amount of WD-40 released within the CMB without exceeding the LFL. After some discussion with PCP staff, the Applicant credited the venting of hydrogen generated by radiolysis in the flammability analysis. In other words, the analysis assumed that there was no accumulation of flammable hydrogen gas in the CMB.

The Applicant calculated a maximum NCT pressure of 22.6 psig, which is below the 31.2 psig pressure limit listed in the CSAR. For HAC, the maximum pressure was determined to be 75.7 psig, which is below the 94.3 psig CSAR limit. PCP staff found the pressure calculations to be conservative, in that they do not credit ventilation. Based on the Applicant's analysis, a maximum of 97.7 g (4.028 fluid oz.) of residual flammable liquids (modeled as WD-40) can be present in the CMB contents without exceeding the LFL.

Based on the PCP staff review of the statements and representations in the application, PCP concludes that the addition of the CMB, cribbing design, and contents has no impact on the safety performance of 10-160B. The requirements of 10 CFR Part 71 for NCT and HAC are satisfied, with the following condition:

- The maximum amount of total residual flammable liquids in aerosol cans present in a CMB without exceeding the LFL is 97.7 g (4.028 fluid oz.)

4. CONTAINMENT

PCP staff performed a review containment evaluation in the application for compliance with 10 CFR Part 71. The review focused on the contents in the 10-160B.

The CMB is vented with three filter-vents and does not include a containment system.

The A_2 value of the CMB content ranges from 0.0040 to 203.5, per Table 1.3 of the addendum. The CSAR uses $3,000A_2$ for the leakage rate evaluation in CSAR Sections 4.2 and 4.3. The Applicant also derived a conservative "Theoretical Bounding CMB" by assuming the presence of the maximum amount of any radionuclide in a single box given the entire inventory of 52 CMBs. The corresponding A_2 of the Theoretical Bounding CMB was determined to be 634.1. Therefore, the Applicant's containment evaluation demonstrates that the 23 CMBs planned for shipment, as well as the remaining 29 CMBs, are in compliance with the current containment evaluation basis of the CSAR and CoC Section 5(b)(2)(i).

Based on the PCP staff review of the statements and representations in the application, PCP concludes that the addition of the CMB, cribbing design, and contents have no impact on the safety performance of 10-160B. The requirements of 10 CFR Part 71 for NCT and HAC are satisfied, with the following condition:

- The A_2 in the CMB shall be less than 3,000.

5. SHIELDING

PCP staff performed a review of the shielding evaluation in the application for compliance with 10 CFR Part 71. The review focused on the CMB package, cribbing design, and radionuclide contents in the 10-160B.

Based on the PCP staff review of the statements and representations in the application, PCP concludes that the evaluation of the TRU waste in the CMB has been described adequately and conservatively and has no impact on the safety performance of 10-160B. The dose rate requirements of 10 CFR 71 for NCT and HAC for shipment by exclusive use conveyance are satisfied, with the following condition:

- The quantities and material forms of the TRU waste in the CMB shall be limited to those described and evaluated in the addendum.

6. CRITICALITY

PCP staff performed a review of the criticality evaluation in the application for compliance with 10 CFR Part 71. The review focused on the CMB package, cribbing design, and radionuclide contents in the 10-160B.

The Applicant proposes to ship the 10-160B with the CMB contents by exclusive use conveyance. The fissile mass limit for the 10-160B package is 325 Fissile Gram Equivalents (FGE) with a Criticality Safety Index (CSI) of 0 (zero). The maximum FGE measured within a single CMB, of the 23 CMBs proposed for shipment, is 35.68 FGE. Therefore, the CSAR analysis and current CoC bound the maximum FGE in a CMB.

Based on the PCP staff review of the statements and representations in the application, PCP concludes the CMB complies with the current criticality basis of Section 6.0 the CSAR, and the CSI remains zero for shipment by an exclusive use conveyance in accordance with CoC Section 5(c). The requirements of 10 CFR Part 71 for NCT and HAC are satisfied, with the following condition:

- The fissile mass in the CMB shall not exceed 325 FGE.

7. PACKAGE OPERATIONS

PCP staff performed a review of the package operations evaluation in the application for compliance with 10 CFR Part 71. The review focused on the CMB, cribbing, and contents in the 10-160B.

Based on the PCP staff review of the statements and representations in the application, PCP concludes that 10-160B operating procedures meet the requirements of 10 CFR 71, Subpart G, with the following conditions:

- The package must be prepared for shipment and operated in accordance with the Operating Procedures of Chapter 7 of the CSAR.
- The CMB must be prepared and loaded as specified in the addendum.

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

There are no additional acceptance tests and maintenance activities required for the 10-160B for this addendum to the CSAR.

9. QUALITY ASSURANCE

There are no additional Quality Assurance requirements for the 10-160B for this addendum to the CSAR.

REFERENCES

- [1] *Corrugated Metal Box Inner Container Addendum for Model 10-160B Type B Radwaste Shipping Cask*, dated September 2013, transmitted with Letter from C.H. Keilers to Dr. James M. Shuler, *Transmittal of Q1 Responses and Final SARP Addendum for Type B Packaging Model 10-160B for Corrugated Metal Box Content* dated September 27, 2013.
- [2] DOE Certificate of Compliance, Certificate Number 9204, Revision 5.
- [3] Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), Packaging and Transportation of Radioactive Materials
- [4] Consolidated Safety Analysis Report for Model 10-160B Type B RADWASTE Shipping Cask, Energy Solutions Revision 4, July 2012