Safety Evaluation Report for
10-160B Consolidated Safety Analysis Report
Source Insert Addendum Revision for Wooden Cribbing

Docket No. 14-11-9204

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This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) technical review of the application submitted by Energy*Solutions* for the Idaho National Laboratory in support of the Global Threat Reduction Initiative (NA-211) missions.

SUMMARY

By application [1, 2] dated May 22, Energy*Solutions* requested an amendment to U.S. Department of Energy (DOE) Certificate of Compliance (CoC) Number 9204, Revision 7 [3], to add wooden cribbing as an alternative to the steel cribbing configuration for the Source Insert content configuration in the Model 10-160B package.

PCP staff reviewed the application using the guidance in the DOE "Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings."[4] Based on the statements and representation in the application and the conditions listed below, PCP staff concludes that the package continues to meet the requirements of 10 CFR Part 71.[5]

EVALUATION

1. GENERAL INFORMATION AND DRAWINGS

PCP staff performed a review of the general information and drawings provided in the application.

There are no changes to the 10-160B packaging, contents, or the Source Insert, as described in the Consolidated Safety Analysis Report (CSAR), Revision 4 [6], as a result of using wooden cribbing as an alternative to steel cribbing to support and protect the Source Insert and packaging.

PCP staff reviewed application drawing numbers DWG-4132-ST-0005-01 through -07, Revision 1, *Transport of Source Insert in 10-160B Cask, Assembly & Details*, (Sheets 1-7) and determined that the submitted drawings are adequate.

PCP concludes that the information presented in the application provides an adequate basis for the evaluation of the package against the 10 CFR Part 71 requirements.

2. STRUCTURAL

PCP staff performed a review of the structural evaluation in the application for consistency with the CSAR evaluation and compliance with 10 CFR Part 71.

The application submittal included a structural calculation (evaluation), CALC-4132-ST-0002, Revision 1 [7], and cribbing design/fabrication drawings, *Transport of Source Insert In 10-160B Cask-Assembly & Details*, DWG-4132-ST-0005-01 through -07, Revision 1. PCP staff reviewed the calculation to confirm the structural integrity of the Source Insert and wooden cribbing

during normal conditions of transport (NCT) and hypothetical accident conditions (HAC), and verified that the drawings captured the structural features credited in the calculation.

The applicant divided Chapter 2 of the application into two sections, Section 2A and 2B. The structural evaluations of the Source Insert with steel and wooden cribbing are in Section 2A and 2B respectively. Section 2A retained the initial structural evaluation from the CSAR for the Source Insert, except for a correction (reduction) to the allowable shear stress of the Source Insert Lid bolts under NCT and HAC loadings. PCP staff concurs that there is ample margin for lower allowable shear stress in the bolts.

The structural evaluation in Section 2B of the application for the wooden cribbing design is supported by calculation CALC-4132-ST-0002, Revision 1. This calculation evaluated the effectiveness of the wooden cribbing to protect the Source Insert and package during NCT and HAC, per 10 CFR 71.71 and 71.73 respectively, and included a lifting analysis of the cribbing wood screws to ensure that the cribbing holds together during a lift with a design factor-of-safety of 2.

The Source Insert is enclosed with a two-piece wood cribbing structure sized to fit within the package. The cribbing is constructed of common white pine (or similar) lumber, in combinations of both plywood and planks. The cribbing is used as a compression-only component, with the credited wood strength ranging from minimum to maximum expected values for each load/wood orientation condition being evaluated.

The maximum content weight (Source Insert + wooden cribbing + Co-60 payload) evaluated in the application is less than 10,000 lb., which is less than the package maximum content weight of 14,250 lbs.

Table 1. Content Weight

Source Inert Configuration	Weight (lb)
Source Insert (with contents)	8,000
Wooden Cribbing	1,550
Total	9,550

The combined effect of the wooden cribbing size and stiffness was reviewed by PCP staff for compliance with the existing CSAR evaluation. The integrity of the contents was reviewed to establish essentially no damage under NCT and that the credited damage state for HAC was within defensible capacities of the Source Insert and wooden cribbing. PCP staff checked CALC-4132-ST-0002, Revision 1, to ensure acceptable package performance for the potential range of material properties associated with the materials of construction. This review included coordination with other Chapters of the application to ensure consistency between the calculated and credited post-NCT/HAC damage states. PCP verified the applicant's calculations for wood-crush magnitudes. The applicant's calculations relied on empirical equations based on tests

conducted on similar softwoods, but not specifically pine, whereas PCP staff's confirmatory analysis was based on a more rigorous method, employing actual crush strength data, which included southern, western, and eastern pines, with strengths listed parallel, perpendicular, and traverse to the wood grain.

The effects of the NCT free drop tests on the end, side, and corner of the package to crush the wooden cribbing were evaluated by the applicant by calculation. Based on the NCT calculation results, the wooden cribbing design provides sufficient resistance to the crush forces and is essentially undamaged from the free drop tests. PCP staff confirmed the applicant's calculations.

The effects of the HAC free drop tests on the end and side of the package to crush the wooden cribbing, and the cribbing to puncture the skin of the Source Insert were evaluated by the applicant by calculation. Based on the HAC calculation results, the wooden cribbing design provides sufficient resistance to crush forces (i.e., crushes to a depth of 2 inches), the skin thickness of Source Insert exceeds the minimum thickness required to resist shear forces (penetration) from the cribbing, and the stresses in the Source Insert meet all the applicable stress allowable values listed in the CSAR. PCP staff confirmed the applicant's calculations.

Based on the statements and representations in the application, PCP staff concludes that the structural design of the wooden cribbing for the Source Insert has been adequately described and evaluated and does not affect the structural integrity of the package design to meet the structural performance requirements of 10 CFR Part 71.

3. THERMAL

PCP staff performed a review of the thermal evaluation in the application for consistency with the CSAR evaluation and compliance with 10 CFR Part 71.

The Source Insert content decay heat is 154 watts and is bounded by the CSAR limit of 200 watts. Thermal conductivity of steel (cribbing) is greater than that of the wood; consequently, steel cribbing distributes heat over the package bulk air volume at a rate higher than wood cribbing; therefore the air temperature in the cask cavity is bounded by the evaluation for steel cribbing.

The applicant calculated, per CALC-4132-NS-0002, Revision 1 [8], combustible gas generation (hydrogen) and pressure buildup in the package containment system due to radiolysis of cellulose (wooded cribbing) and neoprene (Source Insert gasket), and compared the calculation results with the CSAR evaluation. With respect to gas generation, the time to reach 5% hydrogen in the package is 84 years; therefore, a "safe" shipping window is not required. With respect to pressure buildup, the maximum normal operating pressure in the package for NCT at 5 volume% hydrogen is approximately 5 psig at a peak bulk air temperature of 111 degrees C (232 degrees F), as compared to 31.2 psig in the CSAR, and the maximum pressure buildup for HAC at 5 volume% hydrogen is approximately 7 psig at a peak temperature of 147 degrees C (297 degrees F), as compared to 94.3 psig in the CSAR.

Based on the statements and representations in the application, PCP staff concludes that the thermal design of the wooden cribbing for the Source Insert has been adequately described and evaluated, and does not affect the thermal performance of the package design to meet the requirements of 10 CFR Part 71.

4. CONTAINMENT

The applicant proposed no changes to the package containment system.

The structural and thermal sections of the application evaluated the effectiveness of the wooden cribbing design to protect the Source Insert and package during NCT and HAC. There was no damage to the package containment system.

The applicant included gas generation and pressure buildup in this Section 4 of the application, rather than Chapter 3 (Thermal). This SER addressed these topics in Chapter 3.

Based on the statements and representations in the application, PCP staff concludes that the use of wooden cribbing for the Source Insert does not affect the ability of the package design to meet the containment requirements of 10 CFR Part 71.

5. SHIELDING

PCP staff performed a review of the thermal evaluation in the application for consistency with the CSAR evaluation and compliance with 10 CFR Part 71.

The applicant divided Chapter 5 of the application into two sections, Section 5 and 5B. Section 5 is the initial shielding evaluation of the Source Insert with steel cribbing and Section 5B is the new shielding evaluation of the Source Insert with wooden cribbing. The only change to Section 5 was a correction to the total package weight (reduced) in Section 5.1.1.1 of the application. PCP staff agrees with this correction to Section 5.

The shielding evaluation for HAC considered the wooden cribbing crush depth of 2 inches (based on the load areas of the top cribbing plug and Shield Insert Lid) as documented in Section 2 of the application.

The Applicant performed a shielding analysis of the package, with Source Insert and wooden cribbing for NCT and HAC by computer model (MCNP5).

Tables 5B-3 and 5B-4-1 in the application summarize the maximum dose rates for NCT and HAC. The NCT dose rates for the package are within the allowable limits of 10 CFR 71.47(b). The HAC dose rates for the package are within the allowable limits of 10 CFR 71.51.

Section 5B.5 evaluates the energy deposition rates from the contents to the wood cribbing and neoprene gasket uses this data to calculate (CALC-4132-NS-0002, Rev 1) combustible gas generation and pressure build up in the package, that is, the time to reach 5 volume% hydrogen in the package.

PCP concludes that the use of wooden cribbing as an alternative to steel cribbing does not affect the ability of the package to meet the external radiation requirements of 10 CFR Part 71 for exclusive use shipment.

6. CRITICALITY

The applicant proposed no changes to the package that require a criticality evaluation.

7. PACKAGE OPERATIONS

PCP staff performed a review of the package operations evaluation in the application for compliance with 10 CFR Part 71.

The procedure for loading the Source Insert with wooden cribbing in the package is listed in Section 7.3 of the application and supplements the operating procedure in Chapter 7 of the CSAR.

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

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

PCP staff performed a review of the acceptance tests and maintenance evaluation in the application for compliance with 10 CFR Part 71.

Acceptance of the wooden cribbing prior to first use in the packaging is evaluated in Section 8.2 of the application, by a combination of document review for materials of construction, and confirmatory measurements for structural components in accordance with the drawings DWG-4132-ST-0005-01 through -07.

Based on the statements and representations in the application, PCP staff concludes that the acceptance tests (i.e., inspection) of the wooden cribbing meet the requirements of 10 CFR Part 71 to assure packaging performance during its service life.

9. QUALITY ASSURANCE

PCP staff reviewed the quality assurance (QA) evaluation in the application for compliance with 10 CFR Part 71, Subpart H.

The wooden cribbing is essential to the shielding function of the package when the Source Insert is loaded with Co-60, for shipment in the package. The Source Inert is supported and constrained by the wood cribbing during NCT and HAC respectively. The applicant assigned the wooden cribbing as a "Q" item (important to safety) and Category B, "for which a failure or

malfunction could indirectly result in a condition that would adversely affect public health and safety."[9] PCP staff agrees with this assignment of the wooden cribbing as Safety Category B.

The application specifies the level of QA effort for the wooden cribbing as a Q item, Category B, in accordance with Subpart H. PCP staff agrees with level of QA effort specified for the wooden cribbing.

PCP concludes that the use of wooden cribbing as an alternative to steel cribbing does not affect the ability of the package to meet the requirements of 10 CFR Part 71, and the requirements of 10 CFR Part 71, Subpart H, are satisfied, provided that the wooden cribbing is designed, fabricated, procured, used, maintained, and loaded in the package as described and evaluated in the application.

CONCLUSION

Based on the statements and representations in the application and the conditions listed above, the PCP staff concludes that the Model No. 10-160B package design has been adequately described and evaluated and that the use wooden cribbing as an alternative to steel cribbing for the Source Insert do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

REFERENCES

[1] *Transmittal of Q1 Responses and Final SARP Addendum for 10-160B, Certificate No. USA/9204/B(U)F-96 (DOE)*, Letter from Energy*Solutions*, Colalancia to Shuler, May 22, 2014.

[2] *Source Insert Addendum for Model 10-160B Type B RADWASTE Shipping Cask*, Revision 2, May 22, 2014, Energy*Solutions, Columbia, SC.*

[3] DOE Certificate of Compliance, Certificate Number 9204, Revision 7.

[4] Lawrence Livermore National Laboratory, *Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings,* UCID-21218, Revision 3, February 2008, Livermore, California.

[5] Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), Packaging and Transportation of Radioactive Materials.

[6] *Consolidated Safety Analysis Report For Model 10-160B Type B Radwaste Shipping Cask*, Revision 4, July 2012. As amended by revised Chapter 7 submitted to NRC on July 26, 2012, and by drawing DWG-CSK-12CV01-EG-0002-01, Rev 3 "Cask Secondary Lid Thermal Shield Details submitted to NRC on August 26, 2012.

[7] *Transport of the Co-60 Source Insert in the 10-160B Type B RADWASTE Shipping Cask —Structural Evaluation of the Co-60 Source Insert Wood Cribbing for the NCT and HAC Tests,* CALC-4132-ST-0002, Revision 1, May 22, 2014

[8] *Transport of the Co-60 Source Insert in the 10-160B Type B RADWASTE Shipping Cask — Hydrogen Gas and Pressure Buildup Analysis,* CALC-4132-NS-0002, Revision 1, May 22, 2014

[9] U.S. Nuclear Regulatory Commission, *Regulatory Guide 7.10 Establishing Quality Assurance Programs for Packaging Used In Transport of Radioactive Material*, Revision 2, March 2005.