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DOE Packaging Certification Program

Safety Evaluation Report for Content Amendment to Increase the Enrichment of HEU Metal or Alloy Turnings, Fines, or Powders in the Model ES-3100 Package

Docket No. 17-05-9315

Prepared by: _____ Date: 6/20/17

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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 submitted by the National Nuclear Security Administration (NNSA) Office of Material Management and Minimization (NA-23) to amend DOE Certificate of Compliance (CoC) Number 9315 to authorize increasing the maximum enrichment of "[Highly Enriched Uranium] HEU Metal or Alloy Turnings, Fines or Powders" in the Model ES-3100 Package from 80% to 100%, for ground transport.

Summary

By letter [1] dated September 8, 2016, as supplemented [2], NNSA NA-23 requested that the DOE PCP authorize a content amendment to DOE CoC Number 9315, Revision 10, to increase the allowable enrichment from 80% to 100% for the material category "HEU metal or alloy turnings, fines, or powders", for ground transport.

The applicant (NA-23) submitted Revision 2 of the ES-3100 Safety Analysis Report for Packaging (SARP) [3] in support of this request. The increased enrichment does not affect the packaging design or operational features.

On the basis of the statements and representations in the SARP, Revision 2, and PCP staff's confirmatory evaluation as summarized in this SER, staff finds this content amendment in the Model ES-3100 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 SARP Revision 2 as the "SARP" as, unless otherwise specified.

Evaluation

SARP Revision 1 was revised to implement the following changes:

1. Revise maintenance interval on EPDM O-rings from one to two years;
2. Remove fluorocarbon elastomer (Viton) O-rings from the CoC;
3. Revise the density range authorized for oxide from 2.0 - 6.54 g/cc to 0.5 - 6.54 g/cc;
4. Remove the carbon limit of 921 g for all oxide types;
5. Increase the allowable enrichment for the material category "HEU metal or alloy turnings fines or powder" to 100% for ground transport;
6. Add an oxide loading of 12.323 kg U-235 with a CSI of 0.4;
7. Remove the requirement to include the mass of non-uranium metallic constituent and claddings in the calculation of U-235 mass when shipping alloys and research reactor fuel; and
8. Update the shielding evaluation presented in Chapter 5 of the SARP using the MCNP Monte Carlo radiation transport code. This code is up-to-date and more supported. This update does not change any technical parameters associated with the HEU shielding calculations.

PCP assigned Docket 16-45-9315 to review these changes, which were implemented in Revision 2 of the SARP. However, the applicant subsequently requested PCP to only focus item number 5, due to an immediate need for an international shipment of HEU metal turnings with an enrichment above 80%.

Therefore the scope of this SER is the applicant's request to increase the allowable enrichment for the material category "HEU metal or alloy turnings fines or powders" to 100% for ground transport.

1.0 General Information

1.1 Packaging Description

There are no changes to the existing Model ES-3100 packaging design or operational features authorized in the CoC.

1.2 Contents

Table 1.3 in SARP, which shows the authorized contents and fissile material loading limits for ground transport was updated for the increase of allowable enrichments and mass loading limits.

1.3 Criticality Safety Index

The criticality safety index (CSI) of the package ranges from 0 (zero) to 3.2, depending upon the radioactive contents (mass loading) of the package as shown in Table 1.3 of the SARP.

1.4 Radiation Level and Transport Index

PCP staff confirmed that the radiation transport indices (TIs) is less than 10, the TI limit in 10 CFR 71.47(a) for non-exclusive use shipment. The actual TI of the package will be determined by measurement prior to shipment.

1.5 Conclusion

Based on a review of the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff concludes that the package described in Chapter 1 of the SARP, has been adequately described in sufficient detail to provide an adequate basis for its evaluation under 10 CFR Part 71.

2.0 Structural Evaluation

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect structural evaluation.

2.1 Evaluation Findings

Based on review of the statements and representations in the SARP, and the PCP staff's confirmatory evaluation, staff finds the structural design and performance presented in Chapter 2 acceptable and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

3.0 Thermal Evaluation

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect thermal evaluation.

3.1 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the thermal design and performance presented in Chapter 3 acceptable and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

4.0 Containment

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect containment evaluation.

4.1 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the containment design and performance presented in Chapter 4 acceptable and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

5.0 Shielding Evaluation

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect shielding evaluation.

5.1 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the shielding design and performed presented in Chapter 5 acceptable and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

6.0 Criticality Evaluation

PCP staff reviewed the criticality safety design and performance of the package described in Chapter 6 and Appendices 6.9.9 and 6.9.11 of the SARP. Staff also performed independent Monte Carlo confirmatory analyses for criticality safety under the most reactive conditions.

6.1 Criticality Evaluation

The Model ES-3100 package design includes a stainless steel containment vessel (CV) inside a 30 gallon outer drum (See Figures 1.1 and 1.2 of the SARP). The contents are placed in convenience cans or bottles or otherwise protected to prevent contamination of the interior surface of the CV. The package includes two features intended for criticality control: neutron absorber that surrounds the CV and can spacers placed between convenience cans; both the neutron absorber and the can spacers are filled with alumina borated cement. The SARP drawings provide the dimensions of the relevant packaging components. Chapter 2 of the SARP provides material specifications for the packaging components.

Descriptions of the package design features include identification of packaging materials, densities and compositions of packaging materials, and the fissile/fissionable material forms, masses, and isotopic compositions of the payloads. PCP staff confirmed that criticality-related information in the SARP is complete and representative of the actual materials specified for the package.

Section 6.9.11.4 of Appendix 6.9.11 of the SARP established the upper subcritical limit (USL) as 0.935 using SCALE 6.1.1. This USL was used for the criticality calculations of the HEU metal or alloy turnings, fines or powders.

For a reflected and flooded CV (moisture fraction inside the containment vessel, MOCFR = 1.0), the highest amount of U-235 that is shown to be below the USL is approximately 11.1 kg for

100% enriched, 17.6 kg for 95% enriched, and 21.7 kg for 90% enriched, as shown in SARP Table 6.9.11.1. Table 6-1 below shows the $k_{eff} + 2\sigma$ listed in Table 6.9.11.2 (MOCFR = 1) of the SARP compared with PCP staff's confirmatory analyses for the reflected and flooded CV at enrichments 100%, 95% and 90%.

Table 6-1 - SARP and Staff Criticality Analysis Results for HEU metal or alloy turnings, fines or powder reflected and flooded CV

U-235 Enrichment	U-235 Mass (g)	Maximum $k_{eff} + 2\sigma$ [a]	
		SARP (SCALE 6.1.1)	Staff (MCNP5)
100%	11,097	0.9319	0.9337
95%	17,581	0.9344	0.9354
90%	21,667	0.9340	0.9298

[a] The USL for SCALE 6.1.1 is 0.935 (see Appendix 6.9.11, Section 6.9.11.4 of the SARP)

6.2 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds that the criticality safety design and performance presented in Chapter 6 acceptable, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

7.0 Package Operations

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect package operations.

7.1 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the package operations presented in Chapter 7 acceptable, and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

8.0 Acceptance Tests and Maintenance Program

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect the acceptance tests and maintenance program.

8.1 Evaluation Findings

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the acceptance tests and maintenance program presented in Chapter 8 acceptable, and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

9.0 Quality Assurance

PCP staff reviewed the SARP for the increase of allowable enrichment for the "HEU metal or alloy turnings, fines or powder" to 100% for ground transport. The increase of allowable enrichment does not affect the quality assurance program.

9.1 Evaluation Findings

On the basis of the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the quality assurance program presented in Chapter 9 acceptable, and will provide reasonable assurance that the regulatory requirements in 10 CFR 71 have been met.

Conditions of Approval

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

- Contents 5.(b), first paragraph was revised from "..., and HEU metal or alloy turnings, fines or powders with an enrichment of ≤ 80 %." to "..., and HEU metal or alloy turnings, fines or powders with an enrichment of ≤ 100%."
- Content 5.(b), Table 1.3 was revised to add enrichments for "HEU metal or alloy turnings, fines, or powders" from ≤ 80% to ≤ 100%, and the respective criticality safety index for each mass loading.
- Condition 5.(d)(12) was revised to append "..., Revision 1 (Revision 2 is not authorized in this certificate)." to the last sentence, since no other changes to SARP Revision 2 have been authorized by PCP.
- Condition 5.(d)(13) was revised to authorize the use of Revision 10 of the certificate until December 31, 2017.
- Conditions 5.(d)(17)-(18) were added to clarify the basis for the DOE CoC and user restrictions.
- Supplement 5.(e) was added to the certificate.
- Supplement 5.(e)(1) was added for this application, "*Safety Analysis Report for Packaging, Y-12 National Security Complex, Model ES-3100 Package with Bulk HEU Contents*, SP-PKG-801940-A001 Revision 2, dated September 8, 2016."

Conclusion

Based on the statements and representations in the SARP and PCP staff's confirmatory evaluation, staff finds the request to increase the allowable enrichment of "HEU metal or alloy turnings, fines or powder" from 80% to 100% for ground transport acceptable, 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] *Request for Amendment to ES-3100 Certification of Compliance (CoC) USA/9315/B(U)F-96 (DOE), Revision 10, Docket No. 16-45-9315*, from W. E. Kilmartin to James M. Shuler, September 8, 2016.

[2] *Topic: Docket 17-05-9315*, Email from William Kilmartin to James Shuler, DOE PCP, April 05, 2017.

[3] *Safety Analysis Report for Packaging, Y-12 National Security Complex, Model ES-3100 Package with Bulk HEU Contents,* SP-PKG-801940-A001 Revision 2, Consolidated Nuclear Security, LLC, September 8, 2016.