January 24, 2012

Mr. Ahmad M. Al-Daouk, Director
Office of Transportation and Packaging
U.S. Department of Energy
National Nuclear Security Administration
Washington, DC 20585

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9329, REVISION 4, FOR THE MODEL NO. S300 PACKAGE

Dear Mr. Al-Daouk:

As requested by your application dated October 20, 2011, enclosed is Certificate of Compliance No. 9329, Revision No. 4, for the Model No. S300 package. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's Safety Evaluation Report is also enclosed.

The National Nuclear Security Administration has been registered as a user of the package under the provisions of 49 CFR 173.471. The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR 173.471.

If you have any questions regarding this certificate, please contact Pierre Saverot of my staff at (301) 492-3408.

Sincerely,

/RA/

Michael D. Waters, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9329
TAC Nos. L24585, L24586

Enclosures:
1. Certificate of Compliance No. 9329, Rev. No. 4
2. Safety Evaluation Report

cc w/encls: R. Boyle, Department of Transportation

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OFC:	SFST	E	SFST		SFST		SFST		SFST		SFST	E
NAME:	P. Saverot		S. DePaula		J. Smith		D. Pstrak		M. Rahimi		M. DeBose	
DATE:	12/21/2011		12/29/2011		01/04/2012		12/29/2011		01/19/2012		01/19/2012	
OFC:	SFST											
NAME:	M. Waters											
DATE:	1/24/12											

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SAFETY EVALUATION REPORT

Docket No. 71-9329
Model No. S300 Package
Certificate of Compliance No. 9329
Revision No. 4

SUMMARY

By application dated October 20, 2011, the U.S. Department of Energy National (DOE) Nuclear Security Administration (NNSA or the applicant), requested renewal and revision of Certificate of Compliance (CoC) No. 9329, for the Model No. S300 package. The applicant requested a change of certificate holder from DOE to NNSA, the addition of target materials listed in the special form capsule certificates to the contents of the package, the addition of Los Alamos National Laboratory drawing numbers of the special form capsules, and the revision of the Criticality Safety Index (CSI) to 0.3 and a mass limit of 350 g for Plutonium-Beryllium (PuBe) sources.

NRC staff reviewed the application using the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material." Based on the statements and representations in the application, as supplemented, the staff finds that these changes do not affect the ability of the package to meet the requirements of 10 Code of Federal Regulations (CFR) Part 71.

1.0 GENERAL INFORMATION

The certificate holder responsibility for the Model No. S300 package was transitioned from the DOE Packaging Certification Program to the NNSA Office of Packaging and Transportation. Such change more accurately reflects the actual primary user of this CoC. NNSA has acknowledged responsibility for the use of the package and maintaining maintenance records as required by 10 CFR 71.91.

At the time CoC Revision No. 3 was issued, target materials other than Beryllium (Be) had not yet been incorporated into the special form certificates (USA/0696/S-96 for the Model II and USA/0695/S-96 for the Model III). The latest revision (Revision No. 6 in both cases) of the IAEA Certificate of Competent Authority Special Form Radioactive Materials Certificate Nos. USA/0695/S-96 and USA/0696/S-96, issued by the U.S. Department of Transportation (DOT) now incorporates the target materials Be, Li, F, C and B. Such target materials are now added to the authorized contents of the CoC.

Revision No. 6 of the special form capsule certificates shows that the Model II and Model III capsules may be fabricated using either the Los Alamos National Laboratory (LANL) or AEA Technology QSA, Inc., drawing numbers. Drawing numbers were added to the CoC per the evaluation performed by staff in Section No. 2 below.

2.0 MATERIALS EVALUATION

In reviewing the LANL Drawing No. 90Y-219998, Rev. H and AEA Technology QS, Inc., Drawing No. R20047, Rev. B, for the Model II capsule, staff found a few differences such as threads/depth not linked to items; lack of material specifications (stainless steel) for items 2, 3, 4, or 5; lack of tolerance specifications; and requirement for lubricant only indicated for item 4 instead of item 2, with items 3, 4, and 5 as required. However, the review of the detailed fabrication drawings for the Model II showed that such differences were corrected and of no consequence. Also, staff found that, while the lubricant requirement for item 4 was shown in the descriptive drawings for informational purposes, the fabrication drawings do not address lubricants as it is considered procedural and is part of the assembly/use instructions.

For the Model II Special Form Capsule, the staff found that the LANL Drawing No. 90Y-219998, Rev. H, has one material change from the previously referenced AEA Technology QSA, Inc., drawing R20047, Rev. B. The snap ring is fabricated from zinc-plated steel in the LANL drawing and was fabricated from stainless steel in the previously referenced AEA Technology QSA, Inc., drawing. The purpose of the snap ring is to hold the impact plug loosely in place. It is not credited in the shielding evaluation and has been approved for use in the U.S. DOT special form certification. The staff reviewed this proposed change and determined that the level of safety is maintained by this change.

In reviewing the LANL Drawing No. 90Y-220045, Rev. A and AEA Technology QSA, Inc. Drawing No. R20048, Rev. B, for the Model III capsule, staff found that the LANL drawing had the following discrepancies: threads/depth not linked to items, thread depth (apparently for items 1 and 2) of 0.680” instead of 0.75” as shown in AEA/QSA drawing; lack of specification of tolerances; and lubricant requirement specified for item 3 only (instead of 2, with 1, 3 as required). As for the Model II drawings, the review of the detailed fabrication drawings showed that such differences were of no consequence. For the Model III Special Form Capsule, the staff found that the LANL Drawing No. 90Y-220045 is equivalent to the AEA Technology QSA, Inc., Drawing No. R20048, Rev. B.

Staff reviewed the drawings of the special form capsules and found that the Model II and Model III capsules may be fabricated using either LANL or AEA Technology/QSA drawings. Staff also evaluated the ability of the SFC to maintain its integrity based on the rigorous qualifications of special form radioactive material under 10 CFR 71.75. Based on the results of these tests, the specimen did not break or shatter. The previously approved SAR considered structural loads on the SFC, as well as potential Pu alloying and combustion during HAC, and demonstrated that the SFC would remain watertight after an accident. Based on these analyses, staff finds that the plutonium sources are bounded for the purposes of the shielding and criticality assessments.

3.0 THERMAL EVALUATION

Not applicable

4.0 CONTAINMENT EVALUATION

Not applicable

5.0 SHIELDING EVALUATION

Not applicable

6.0 CRITICALITY EVALUATION

The applicant has requested revisions to the CoC in Section 5 to change 5.b.(1) to cover all plutonium-based sources, and to include a CSI of 0.3 and a mass limit of 350 grams for exclusive use shipment of $PuBe_{13}$ sources in the Model II Special Form Capsule (SFC) as Content No. 1 in 5.b.(2).

Staff had previously reviewed these limits and identified that the application did not provide a minimum limit for beryllium in the PuBe sources, and consequently had limited the maximum exclusive use loading for Model II contents to a CSI of 4.0 and a mass of 300 grams. The amendment request also desired to raise the mass limit of Content No. 2 of the CoC from 300 to 350 grams of plutonium; however, since there is no accompanying analysis to support this increase, this CoC limit will not be changed.

The applicant referred to the paper, "Plutonium-Beryllium Neutron Sources, Their Fabrication and Neutron Yield," by R.E. Tate and A.S. Coffinberry (A/CONF.15/P/700, June 1958), and included it as part of the SAR in Section 6.9.1. This paper evaluated the various advantages and disadvantages of numerous neutron sources and determined that $PuBe_{13}$ was the most advantageous due to the stability of the neutron yield with respect to time, the small growth in neutron flux, and the fact that it has a predictable neutron yield for a specific weight of source material. Tate and Coffinberry also described the method of fabricating pure $PuBe_{13}$ sources and the loading of the source capsule. Since the $PuBe_{13}$ sources are manufactured to the exact requirements of 13 beryllium atoms to one plutonium atom in the alloy, the applicant indicated that a "minimum limit for beryllium" is not applicable since the amount of beryllium is directly dependent on the amount of plutonium present in the source. Staff reviewed the referenced paper and found that the fabrication methodology of obtaining pure $PuBe_{13}$ sources is an appropriate assumption for Content No. 1 of the Model II SFC. Also, staff noted that the current CoC content requirement for plutonium-beryllium neutron sources not to exceed 1.519E+5 neutrons/second per gram of plutonium correlates to a Pu:Be atom ratio of 1:13, and is equivalent to 0.49 grams of beryllium for every one gram of plutonium. This requirement is adequate to ensure the composition of any loaded PuBe neutron sources is bounded by $PuBe_{13}$.

Although the majority of neutron sources (i.e., several thousand) consists of plutonium mixed with beryllium as $PuBe_{13}$, there are additional target isotopes that have a non-negligible source strength (e.g., boron-11 and fluorine-19) that may have been used as a neutron source; however, these number less than 10 worldwide and are adequately bounded by the more reactive $PuBe_{13}$ source analyses performed by the applicant. Therefore, staff agrees that modifying CoC 5.b.(1) to allow all plutonium-based sources is acceptable.

The applicant did not provide any additional criticality analyses as part of their amendment request, instead relying on the previous analyses submitted as part of S300 Safety Analysis Report, Revision 5, June 2010. For Hypothetical Accident Conditions (HAC), the applicant modeled close packed hexagonal arrays of the Model II SFCs that contained up to 350 grams of ^{239}Pu as part of the $PuBe_{13}$ alloy. The applicant assumed that the SFC would be completely ejected from the package, and therefore all of the sources were modeled without the external S300 packaging and include only the $PuBe_{13}$ source material and the stainless steel capsule

along with various amounts of water both within the SFC and interstitially between SFCs. The array model consisted of at least 334 packages to support the calculated Criticality Safety Index (CSI) of 0.3 for all cases. SFC's were modeled and arranged in layers of two or three high and SFCs added or removed to maintain the overall cylindrical shape of the array, resulting in arrays that met or exceeded the minimum 334 packages necessary for the requested CSI, depending on the array configuration. Full water reflection surrounds the entire array. The results of the applicant's criticality analyses can be found in Tables 6-11, -12, and -13 of the SAR. The most reactive model remains the 3-layer array of Model II SFCs with full density water inside the SFC and void modeled in the space between SFCs, with a calculated $k_{eff} + 2\sigma$ of 0.9045, which remains adequately below the upper subcritical limit (USL) at a k_{eff} of 0.9257.

The applicant used the MCNP5 v1.40 computer code for their criticality analysis, primarily utilizing continuous energy ENDF/B-VI cross sections. The ^{239}Pu uses preliminary ENDF/B-VII cross-sectional data. The benchmarking analysis has not changed from the previous amendment and the selected USL of 0.9257 is still appropriate for this amendment.

Staff performed confirmatory calculations using the CSAS6 sequence of the SCALE code system, with KENO-VI and ENDF/B-VII 238-group cross sections. The staff's models were created using assumptions similar to the applicant's for various array configurations of Model II SFCs under HAC. For the most reactive case identified by the applicant (Case D32), staff created a model of 351 SFCs in a close packed hexagonal array with full density water next to the $PuBe_{13}$ source, void above the source, and void between the SFCs, which resulted in a calculated $k_{eff} + 2\sigma$ of 0.9071, closely matching that calculated by the applicant, and well below the USL. Staff also modeled other variations of array layering and moderation both above the source and between the SFCs and in all instances the staff's k_{eff} confirmatory calculations agreed well with those performed by the applicant. Staff also modeled varying ratios of beryllium to plutonium to evaluate the sensitivity of k_{eff} to alternate levels of beryllium and found that while the Δkeff of the modeled array could increase by approximately 2%, it was still well below a value of 0.95. In addition, staff performed hand calculations using information from Radiation Shielding by Shultis & Faw and the Radioactive Decay Tables by Kocher (DOE/TIC-11026) confirming that the neutron/second per gram of Pu limit of 1.519E+5 was an appropriate limit.

Based on the review of the statements provided in the amendment request, the staff concludes that the nuclear criticality safety design has been adequately described and evaluated, and that the S300 package continues to meet the criticality safety requirements of 10 CFR Part 71 for the increased $PuBe_{13}$ mass limit of 350 grams with a CSI of 0.3, as well as bounding plutonium-based sources.

CONDITIONS:

As a result of the revision request, the following changes have been made to the Certificate:

Item No. 3(a) was revised to include NNSA as certificate holder.

Condition No. 5.b(1) was revised to designate plutonium-beryllium (α, n) neutron sources as Content No. 1, and to specify the limit of 1.519E+5 neutrons/second per gram of plutonium.

Condition No. 5.b(1)(a) was revised to specify that the Model II source capsule can be fabricated using either the LANL or AEA/QSA, Inc., assembly drawing.

Condition No. 5(b)(1)(b) was revised to specify that the Model III source capsule can be fabricated using either the LANL or AEA/QSA, Inc., assembly drawing.

Condition No. 5(b)(2) was revised to replace “300 grams fissile plutonium” for the Exclusive Use shipment, Model II Content No. 1, with “350 grams fissile plutonium.”

Condition No. 5.c was revised to incorporate the change in Criticality Safety Index (CSI) from 4.0 to 0.3, to reflect the results of the revised criticality analysis for Content No. 1.

Condition No. 10 was modified to authorize use of the previous revision of the certificate for approximately one year.

Condition No. 11 was added, as a consequence of the modification of the previous Condition No. 10, to revise the expiration date of the certificate.

CONCLUSION

Based on the statements and representations in the application, and the conditions listed in the Certificate, the staff concludes that the design has been adequately described and evaluated and meets the requirements of 10 CFR Part 71. These changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9329, Revision No. 4,
on January 24, 2012.