NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE		PAGES
9316	11	71-9316	USA/9316/B(U)-96	1	OF	7

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."
b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

Alpha-Omega Services, Inc.
9156 Rose Street
P.O. Box 789
Bellflower, CA 90706

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

AOS application, Revision J-1, dated April 20, 2021, as supplemented.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model Nos.: AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S

(2) Description

A cylindrical stainless steel packaging, designed to transport Type B quantities of encapsulated solid materials or solid metals meeting Normal or Special Form criteria. The packaging is available in three model sizes – AOS-025, AOS-050, and AOS-100. Tungsten alloy is used as shielding material in model numbers with the suffix A, while carbon steel is the shielding material for model numbers with the suffix B. The Model No. AOS-100A-S has a double-ended opening configuration to be either loaded or unloaded from either end of the package. All models use a double O-ring arrangement seal in the lid joint.

The packaging includes an outer shell, a cavity, a shielding cylinder and shielding plugs, a bottom plate, a lid and lid plug. The outer shell and the cavity cylinder interlock to encase the shielding cylinder, made of either tungsten or carbon steel. A weldment attaches the upper portion of the cavity to its lower portion encasing the shielding. At the cavity's closed end, the shielding plug is encased between the cavity bottom wall and the packaging bottom plate. The shielding plug encased in the lid plug is of the same size and material (tungsten or carbon steel) as the one encased at the bottom of the packaging. The lid consists of a flat disk, with recessed areas concentric with the bolt holes on the top surface, to protect the bolts from impact loads.

5.(a)(2) Description (Continued)

The packaging may use either elastomeric or metallic lid seals: the Model Nos. AOS-025A and AOS-050A elastomeric seal has two O-rings and one flat metal retainer ring, while the Model No. AOS-100 has two O-rings and two SS300 series flat retainer rings. The metallic seal for all models is a double "C" cross section seal.

The packaging may require the use of a liner, axial shielding plates, and/or cavity spacer plates, depending on the model, for shipment of some contents, as stated in Tables 3, 4, and 5 of this certificate. Additional packaging components include lid bolts and port plugs with their threaded pipe plugs, O-ring seals, port plug covers, and a pair of trunnions with their attachment bolts.

The impact limiters consist of a thin-walled stainless steel cylindrical shell, filled with polyurethane foam, with a dish head at one end and a flat disk at the other end. At the dish-head end, another recess is provided to reduce the area available for impact during a head-on drop event. Twelve (12) squared ribs are attached to the inner wall of the cylindrical recess section of the flat disk end. Eight (8) of these ribs extend beyond the flat disk plate and are used as turnbuckle attachment points. The turnbuckles join the impact limiters and partially enclose the packaging. For the Model No. AOS-025 package, the turnbuckles are replaced with "J" hooks. The package is transported in the upright position, using a shipping cage and a pallet. The Model Nos. AOS-50 and AOS-100 may include a lifting bar with the shipping cage; the lifting points are disabled during transport when the shipping cage lifting bar is included.

The maximum weights of the package shall not exceed the values listed in Table 1 below:

Table 1: Package Dimensions and Weights

Model	Width in a transport configuration (in.)	Height[(a)] in a transport configuration (in.)	Packaging OD (in.)	Packaging Height (in.)	Cavity OD (in.)	Cavity Height (in.)	Maximum Package Weight (lbs.)
AOS-025A	18.00	21.38	7.00	9.00	1.62	5.00	220
AOS-050A	35.75	38.63[a]	14.00	18.00	3.25	10.00	1,500
AOS-100A	61.02	75.40[a]	28.00	36.00	6.50	20.00	12,500
AOS-100B	61.02	75.40[a]	28.00	36.00	6.50	20.00	11,000
AOS-100A-S	61.02	75.40[a]	28.00	36.00	6.50	20.00	12,500

(a): the height specified in a transport configuration includes the optional lifting bar on the shipping cage.

5(a)(3) Drawings

The packaging is constructed and assembled in accordance with the following drawings:

Table 2: Packaging Drawings

Model	Assembly	Rev	Impact Limiter	Rev	Packaging	Rev	Liner/Axial Shielding Plates	Rev	Cavity Spacer Plates	Rev
AOS-025A	166D8142	K	105E9722	J	166D8143	J	183C8485	H	-	-
AOS-050A	105E9718	K	166D8138	I	166D8137	J	183C8519	A	-	-
AOS-100A	105E9711	L	105E9713	J	105E9712 G001	M	183C8491	I	183C8518	B
AOS-100B	105E9711	L	105E9713	J	105E9712 G002	M	-	-	-	-
AOS-100A-S	105E9711	L	105E9713	J	105E9719	M	183C8491	I	183C8518	B

5.(b) Contents

(1) Type and form of material

Activation product radioactive materials as Normal or Special Form. Special Form materials shall have a current certificate. Dispersible Normal Form materials shall be enclosed in an inner container. The inner container is considered to be a "shoring device."

Any radioactive material with a melting point less than 900°F shall be in Special Form.

(2) Maximum quantity of material per package

(i) Maximum decay heat: 10 watts for Model No. AOS-025A; 100 watts for Model No. AOS-050A; 400 watts for Model Nos. AOS-100A, AOS-100A-S, and AOS-100B.

(ii) Maximum weight of contents: 10 lbs for Model No. AOS-025A; 60 lbs. for Model No. AOS-050A; 500 lbs. for Model Nos. AOS-100A, AOS-100A-S, and AOS-100B. Maximum weight includes any shoring devices and any additional shielding plates.

(iii) Neutron emitting nuclides, fissile materials, and irradiated fissile materials containing fission products are prohibited. Free-standing liquid is not authorized.

(iv) Maximum activities are listed in Tables 3 and 4, with the following exceptions:

(1) When transported by exclusive use, the increased maximum activities listed in Table 5 are applicable for the Model Nos. AOS-100A and AOS-100A-S.

(2) When transporting mixtures of isotopes including low energy gamma and/or beta emitters (i.e., any isotope with all gamma and/or beta emissions, including those from their progeny, ≤ 0.3 MeV), compliance with package dose rate and decay heat limits is determined per the procedure provided in Appendix 7.5.1.

Table 3- Activity Limits All Isotopes except Ir-192 and Ir-194 (TBq)

Isotope	Decay Heat Watt/Ci	AOS-025	AOS-050	AOS-100A AOS-100A-S	AOS-100B
Co-60	$1.55\ 10^{-2}$	$4.92\ 10^{-3}$	$2.76\ 10^{-2}$	10.1	0.366
Co-60-B	$1.55\ 10^{-2}$	-	-	30.5	-
Co-60-C	$1.55\ 10^{-2}$	-	-	356	-
Cs-137	$4.99\ 10^{-3}$	0.370	0.636	1300	19.6
Hf-181	$4.33\ 10^{-3}$	-	2.83	3410	146
Zr/Nb-95(1)	$1.62\ 10^{-2}$	-	$9.84\ 10^{-2}$	130	2.43
Yb-169	$2.55\ 10^{-3}$	145	287	-	-
Shipping Configuration		Use of Liner Required. Drawing 183C8485	No additional shielding required	Co-60-B quantities require axial shielding plates per drawing 183C8491 Co-60-C quantities require both axial shielding plates and cavity spacer plates per drawing Nos. 183C8491 and 183C8518.	No additional shielding required

(1): Only Nb-95 resulting from the decay of Zr-95 is allowed.

Table 4 – Activity Limits for Ir-192 and Ir-194 (TBq)

Model	Decay Heat Watt(1)	Ir-192 limit (TBq)	Ir-194 impurity limit (TBq)	Shipping Configuration
AOS-025A	0.44	2.62	0.0185	Use of Liner Required. Drawing 183C8485
	0.40	2.33	0.0740	
	0.37	2.10	0.1110	
AOS-050A	6.24	37.33	0.37	Use of Axial Shielding Plates Required. Drawing 183C8519
	5.87	34.78	0.74	
	5.13	29.67	1.48	
	4.39	24.60	2.22	
	3.66	19.49	2.96	
	2.92	14.39	3.70	
AOS-100A AOS-100A-S	400	2,286.37	148.00	No Additional Shielding Required
	400	2,094.42	370.00	
AOS-100B	13.87	80.51	3.70	No Additional Shielding Required.
	12.39	67.37	8.51	

(1) Ir-192 and Ir-194 generate 6.13 10^{-3} Watt/Ci and 5.30 10^{-3} Watt/Ci, respectively.

Table 5 - AOS-100A/A-S Activity Limits When Shipped As Exclusive Use (TBq)

Isotope	Decay Heat Watt/Ci	AOS-100A/A-S
Co-60	1.55 10^{-2}	17.0
Co-60-B	1.55 10^{-2}	58.5
Co-60-C(1)	1.55 10^{-2}	954
Cs-137	4.99 10^{-3}	2090
Hf-181	4.33 10^{-3}	3410
Ir-192	6.13 10^{-3}	2410
Ir-194	5.30 10^{-3}	1480
Zr/Nb-95(2)	1.62 10^{-2}	215
Shipping Configuration	Co-60B quantities require axial shielding plates per drawing 183C8491. Co-60-C quantities require both axial shielding plates and cavity spacer plates per drawing Nos. 183C8491 and 183C8518	

(1) For Co-60-C quantities, the maximum allowable specific activity is 350 Ci/g
(2) Only Nb-95 resulting from the decay of Zr-95 is allowed

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

   (a) The package must be prepared for shipment and operated in accordance with the Operating Procedures of Chapter No. 7 of the application, and

   (b) Each packaging must meet the Acceptance Tests and Maintenance Program of Chapter No. 8 of the application.

7. For transport by air, quantities are limited to the lesser of Tables 3, 4, or 5 of this certificate or 3,000 A_2.

8. For contents meeting Normal Form requirements, the package must be leak-tested to 10^{-7} std cm^3/sec prior to the first use of the package, and prior to each subsequent use.

9. When contents are loaded under water, or if water is introduced in the cavity of the package, the package must be vacuum dried prior to shipment, and the cavity of the package filled with helium, dry air or other inert gas for such shipments.

10. The sealing surfaces of the package must be inspected. The metallic seal shall be replaced prior to each shipment. The elastomeric seal can be used only for shipment of Special Form material.

11. The inner container, by design or with additional shoring, shall be immobilized to prevent both radial and axial movements during normal conditions of transport. Shoring devices must be comprised of materials compatible with the radioactive contents and the cask cavity material. All structural shoring materials within the cavity must have a melting point greater than (i) 600°F for Co-60 in metallic form and Cs-137 in the form of cesium chloride and (ii) 900°F for all other contents.

12. Torque values for the lid bolts and the connectors of the impact limiters must be as follows:

Model	Lid Bolt (ft-lb), lubricated	Impact limiter connector (ft-lb), lubricated
AOS-025A	35	10
AOS-050A	62.5	3
AOS-100A	500	70
AOS-100B	500	70
AOS-100A-S	500	70

13. The weight of the foam in each impact limiter must be measured and its average density calculated based on the known volume of foam fill.

14. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

15. Revision No. 10 may be used until July 31, 2022.

16. Expiration date: July 31, 2026.

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9316	11	71-9316	USA/9316/B(U)-96	7	OF	7

REFERENCES

Radioactive Material Transport Packaging System Safety Analysis Report for Model AOS-025, AOS-050, and AOS-100 Transport Packages, Rev. J-1, dated April 20, 2021.

Supplement, Rev. J-2, dated June 22, 2021.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

John B. McKirgan

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Date: 2021.07.13 09:42:38 -04'00'

John B. McKirgan, Chief
Storage and Transportation Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: July 13, 2021

SAFETY EVALUATION REPORT

Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S Packages
Certificate of Compliance No. 9316
Revision No. 11

SUMMARY

By application dated April 28, 2021 (ADAMS Accession No. ML21118A962), Alpha-Omega Services, Inc. (AOS) submitted an amendment request for the certificate of compliance (CoC) for the Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S packages.

The applicant submitted Revision J-1 of the application and provided a supplement, Rev. J-2, by letter dated June 22, 2021 (ADAMS Accession No. ML21173A323). The following changes to the package were proposed:

(ii) Justification of the radiation resistance of the elastomeric cask lid seals.

(ii) Revision of the pressure evaluation under normal conditions of transport to include the slight pressure due to backfilling with Helium after leak testing.

(iii) Revision of Chapter 7, “Package Operations” and of Chapter 8, “Acceptance Tests and Maintenance Program” to clarify instructions for wet loading, reflect current equipment, modify the leak testing procedure, clarify the test procedure sensitivity, the fabrication leak testing requirements as well as updated leak testing procedures.

(iv) Revision of the title to paragraph 7.1.3.3 Test B to read, “Helium Mass Spectrometer Leak Test: For Normal Form Contents …”; and addition of a reference to test method A.5.3 or A.5.4 from ANSI N14.5-2018 to the description of the leak test of the containment system.

Based on the statements and representation in the application, and the conditions listed below, the staff concludes that the proposed changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

CONTAINMENT EVALUATION

The family of AOS transportation packages consists of the AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S. The “A” designation refers to a tungsten shield, and the “B” designation refers to a carbon steel shield. The “S” designation on the AOS-100A-S means that the cask is double ended and there is a lid on each end of the cask. All of the packages have the same geometric shape, with the AOS-025A and AOS-050A having all dimensions scaled down to 25% and 50% (respectively) of the dimensions of the AOS-100 package.

The objective of the NRC's containment evaluation is to verify that the applicant has adequately evaluated the performance of transportation packages for radioactive material so that the packages (packaging together with contents) meet the regulations in 10 CFR Part 71.

1. Proposed Changes

This amendment request included: an expanded justification of the radiation resistance of elastomeric seals, revised pressure evaluation under normal conditions of transport (NCT) and hypothetical accident conditions (HAC), and clarifications in Chapter 7, "Package Operations," and Chapter 8, "Acceptance Tests and Maintenance Program," of the AOS safety analysis report (SAR) associated with leakage rate testing and vacuum drying.

1.1 Radiation Resistance of Elastomeric Seals

The applicant provided an expanded justification of the radiation resistance of elastomeric seals in Section 2.2.3 of the SAR. The applicant addressed that the expected maximum dose to the lid seal region is 1×10^4 rad in one year, which is less than 1×10^6 rad that the applicant described as having minor radiation effects on elastomeric seals. The staff reviewed the radiation effects described in the applicant's reference 2.35(1) and finds the expanded justification to be acceptable.

1.2 Revised Pressure Evaluation Under NCT and HAC

The applicant revised the maximum normal operating pressure (MNOP) for each of the four models of AOS packages under NCT in Section 3.3.2 and Table 4-6 of the SAR. The staff reviewed the MNOP calculations and finds that the helium backfill pressure used in the calculations was consistent with the upper bound value in Section 7.1.3.1 of the SAR, as well as a lower indoor ambient temperature, which were both acceptable.

The staff confirmed that the resulting recalculated MNOP pressure values for each of the models of AOS packages remained below the respective design pressure limits, and therefore are acceptable. In Table 4-7 of the SAR, the applicant similarly revised the cavity pressure values for each of the four AOS packages under HAC, using the same upper bound helium backfill pressure, and lower indoor ambient temperature. The staff confirmed that the resulting cavity pressures for each of the models of AOS packages under HAC remained below the respective design pressure limit, and therefore are acceptable.

1.3 Clarifications Associated with Leakage Rate Testing and Vacuum Drying

The applicant provided leakage rate testing and vacuum drying clarifications in Chapters 7 and 8 of the SAR. The staff reviewed the leakage rate testing clarifications to secure the package lid in the preparation for package transport procedures in Section 7.1.3.1 of the SAR.

The staff finds it to be acceptable for special form material contents to not perform a maintenance leakage rate test after replacing the elastomeric seal, provided that a periodic leakage rate test has been performed within the 12 months prior to transport, because the containment function is primarily provided by the special form source material. The applicant also noted this in Section 8.2.2 of the SAR.

The staff reviewed the leakage rate testing clarifications to the pre-shipment leakage rate test in Section 7.1.3.3 of the SAR. The staff finds the pre-shipment leakage rate test acceptance criterion of no detected leakage for Test A1 of the SAR, the gas pressure rise, and Test A2 of the SAR, the gas pressure drop, to be consistent with ANSI N14.5 when tested to a sensitivity of

at least 1×10^{-3} ref-cm^3/s. The staff finds the pre-shipment leakage rate test options described for Test B of the SAR, the gas filled envelope in A.5.3 of ANSI N14.5, or evacuated envelope in A.5.4 of ANSI N14.5, have the nominal sensitivity to meet the leaktight acceptance criterion of 1×10^{-7} ref cm^3/s, with a sensitivity of at least 5×10^{-8} ref cm^3/s.

The staff reviewed the leakage rate testing clarifications to the fabrication leakage rate test in Section 8.1.4 of the SAR. The staff finds the fabrication leakage rate test acceptance criterion to meet the leaktight acceptance criterion of 1×10^{-7} ref cm^3/s, with a sensitivity of at least 5×10^{-8} ref cm^3/s, and it describes testing the entire containment boundary. The staff finds that the fabrication leakage rate test description meets ANSI N14.5 2014. However, to add clarification to the applicant's note in Section 8.1.4 of the SAR that describes that fabrication leakage rate testing on packages manufactured prior to April 2016 may have been performed in accordance with the 1997 edition of ANSI N14.5, the staff notes that only clarifications were made to the description of the fabrication leakage rate test in ANSI N14.5 2014 as compared to ANSI N14.5 1997. Therefore, there should not be any difference between the fabrication leakage rate testing performed to ANSI N14.5 1997 and ANSI N14.5 2014.

The staff reviewed the leakage rate testing clarifications to the maintenance leakage rate test in Section 8.2.2 of the SAR. The staff finds the maintenance leakage rate test acceptance criterion to meet the leaktight acceptance criterion of 1×10^{-7} ref cm^3/s, with a sensitivity of at least 5×10^{-8} ref cm^3/s. The staff finds that the maintenance test description meets ANSI N14.5 2014. However, to add clarification to the applicant's note in Section 8.2.2 of the SAR that describes that maintenance leakage rate testing on packages fabricated prior to April 2016 may have been performed in accordance with the 1997 edition of ANSI N14.5, the staff notes that only clarifications were made to the description of the maintenance leakage rate test in ANSI N14.5 2014 as compared to ANSI N14.5 1997. Therefore, there should not be any difference between the maintenance leakage rate testing performed to ANSI N14.5 1997 and ANSI N14.5 2014.

The staff reviewed the leakage rate testing clarifications to the periodic leakage rate tests in Section 8.2.2 of the SAR. The staff finds the periodic leakage rate test acceptance criterion meets the leaktight acceptance criterion of 1×10^{-7} ref cm^3/s, with a sensitivity of at least 5×10^{-8} ref cm^3/s, and based on Section 7.5.2 of ANSI N14.5 2014, this test shall be performed within 12 months prior to each shipment on the seals and threaded plugs. The staff concludes that the periodic leakage rate test frequency described in Section 8.2.2 of the SAR as, prior to the transportation package's first use, after its third use, annually, and/or prior to the transport package being used after a storage period of more than one year, is conservative.

The staff notes that the description of the periodic leakage rate test appears to include concepts from ANSI N14.5 1987 (e.g., after its third use), which is not included in ANSI N14.5 2014. The staff also notes that the AOS packages are not approved for storage of contents under 10 CFR Part 72, although it is possible that the SAR implied that the storage period was while the package was empty. The staff finds that the periodic leakage rate test description meets ANSI N14.5 2014. However, to add clarification to the applicant's note in Section 8.2.2 of the SAR that describes that periodic leakage rate testing on packages fabricated prior to April 2016 may have been performed in accordance with the 1997 edition of ANSI N14.5, the staff notes that only clarifications were made to the description of the periodic leakage rate test in ANSI N14.5 2014 as compared to ANSI N14.5 1997. Therefore, there should not be any difference between the periodic leakage rate testing performed to ANSI N14.5 1997 and ANSI N14.5 2014.

The applicant provided vacuum drying clarifications in Chapter 7 of the SAR. The staff reviewed the vacuum drying clarifications in Section 7.1.3.1 of the SAR and finds the change that the cavity pressure must remain at or below 3 Torr for at least 30 minutes with the vacuum source

isolated to be consistent with the guidance in NUREG 2215, “Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities.”

2. Evaluation Findings

Based on review of the statements and representations in the application, the NRC staff concludes that the package has been adequately described and evaluated to demonstrate that it satisfies the containment requirements of 10 CFR Part 71.

3. References

(1) Parker Hannifin Corporation, Parker O-Ring Handbook, ORD 5700, 2018.

CONDITIONS

The conditions specified in the Certificate of Compliance No. 9316 have been revised as indicated below:

Item No. 3(b) was revised to include the latest Revision J-1 of the application, as supplemented.

Condition No. 15 extends the use of Revision 10 of the certificate until July 31, 2022.

The expiration date of the certificate is not modified.

The References section of the certificate was updated to include Revision J-1 of the application, and the supplement Revision J-2

CONCLUSION

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the design of the Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S packages has been adequately described and evaluated.

The staff concludes that the changes indicated do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9316, Revision No. 11.