



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 9, 2018

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

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE
MODEL NOS. AOS-25A, AOS-50A, AOS-100A, AOS-100B, AND AOS-100A-S
PACKAGES

Dear Mr. Hedger:

By letter dated July 20, 2018, Alpha-Omega Services, Inc. (AOS) submitted an amendment request to Certificate of Compliance No. 71-9316 for the Model Nos. AOS-25A, AOS-50A, AOS-100A, AOS-100B, and AOS-100A-S packages.

In connection with the staff's review of the application "AOS Radioactive Material Transport Packaging System Safety Analysis Report," Report No. AOS-FM9054, Revision No. H-5, dated July 20, 2018, we need the information identified in the enclosure to this letter. We request that you provide this information by November 13, 2018.

Please reference Docket No. 71-9316 and EPID - L-2018-LLA-0201 in future correspondence related to this licensing action. If you have any questions regarding this matter, please contact me at 301-415-7505.

Sincerely,

/RA/

Pierre Saverot, Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9316
EPID - L-2018-LLA-0201

Enclosure:
Request for Additional Information

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE MODEL NOS. AOS-25A, AOS-50A, AOS-100A, AOS-100B, AND AOS-100A-S PACKAGES, DOCUMENT DATE: October 9, 2018

DISTRIBUTION: SFST r/f RPowell, RI BBonser, RII MKunowski, RIII JKatanic, RIV

G :\\SFST\Saverot\71-9316 AOS\RAI Letter October 2018.doc

ADAMS Accession No.: ML18283B076

OFFICE:	NMSS/DSFM	NMSS/DSFM	NMSS/DSFM	NMSS/DSFM	NMSS/DSFM	
NAME:	PSaverot	MCall	TTate	SFiguroa	JMcKirgan	
DATE:	09/24/2018	10/01/2018	10/01/2018	10/07/2018	10/09/2018	

OFFICIAL RECORD COPY

**Request for Additional Information
ALPHA-OMEGA SERVICES, INC.
Docket No. 71-9316**

Model Nos. AOS-25A, AOS-50A, AOS-100A, AOS-100B, and AOS-100A-S Packages

By application dated July 20, 2018, Alpha-Omega Services, Inc. (AOS) submitted an amendment request for the Model Nos. AOS-25A, AOS-50A, AOS-100A, AOS-100B, and AOS-100A-S packages.

AOS made changes related to the Shipping Cage fastening screws, because of the occurrence of galling, and reduced the torque for these screws from 62.5 ft-lb to 37 ft-lb, which is still appropriate for 1/2"-13 UNC lubricated screws. AOS added an optional material, Nitronic 60 per ASME SA-193, ASTM A193 Grade B8S (UNS S21800) for the Shipping Cage screws, and also added an optional shipping cage closure. AOS requested the addition of new isotopes to the authorized contents to consider beta emitting isotopes and low energy gamma emitting isotopes. AOS added an analysis of the Normal Conditions of Transport (NCT) drop test of the AOS-100A with the Shipping Cage installed and requested that Condition No. 15 be removed from the Certificate of Compliance.

This Request for Additional Information (RAI) identifies information needed by the staff in connection with its review of the "AOS Radioactive Material Transport Packaging System Safety Analysis Report for Model Nos. AOS-025, AOS-050, and AOS-100 Transport Packages," Report No. AOS-FM9054, Revision No. H-5. The requested information is listed by chapter number and title in the applicant's Safety Analysis Report. The staff reviewed the application using the guidance in NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

Each individual RAI section describes information needed by the staff to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements.

CHAPTER 5 SHIELDING EVALUATION

- 5-1 Demonstrate that the contribution to radiation levels from secondary radiation, namely bremsstrahlung, from all beta emitters cannot contribute to package radiation levels, modifying the proposed contents description as necessary.

The applicant proposes to allow shipment of any quantity of radionuclides that only emit beta radiation as long as that quantity does not exceed the decay heat limits for the package. The applicant states that beta particles and their secondary radiation (i.e., bremsstrahlung) cannot penetrate the package shielding to sufficiently contribute to package radiation levels. However, some nuclides emit high energy beta particles, which can result in bremsstrahlung that can contribute a relatively significant amount to the package radiation levels. The staff evaluated the potential contribution to package radiation levels for two beta-emitting radionuclides, which the currently proposed contents changes would allow to be transported in the package, phosphorus-32 and strontium-90 with its yttrium-90 progeny. The staff used the approximate relationship described in Cember's *Introduction to Health Physics*, 3rd Edition (see pages 129-131) to estimate the bremsstrahlung source from these nuclides and calculated the resulting package radiation levels with MicroShield. The results indicate that bremsstrahlung for

these beta-emitting radionuclides in quantities that produce decay heats at the package limit will contribute significantly to package radiation levels (e.g., ~25% and 20% of the regulatory limits for the exposed cask surface – the package surface – and at 1 meter from that surface for the 100B package model). Thus, the applicant should demonstrate that no beta-emitting radionuclides in quantities allowed by the package decay heat limit will contribute to package radiation levels or modify the package contents to limit the quantities of these radionuclides. If the applicant decides to propose quantity limits for beta-emitting radionuclides, and these quantities result in non-negligible contributions to package radiation levels, then the applicant should ensure that all proposed contents descriptions, limits, and shielding evaluations, including for mixtures or radionuclides, are sufficient to ensure that the package containing these nuclides will meet regulatory limits. The basis for evaluating and limiting beta-emitting radionuclide contents should be clearly explained in the application.

This information is needed to confirm compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) 71.33(b)(1), 71.35(a), 71.47 and 71.51(a).

- 5-2 Demonstrate that the package radiation levels do not exceed the non-exclusive limits at the appropriate package surfaces, and at 1 meter from those surfaces, for the contents that have been evaluated for non-exclusive use transport.

The applicant has performed shielding analyses to demonstrate compliance with the non-exclusive use limits in 10 CFR 71.47(a) for the package contents, with the exception of the proposed contents in Table 1-2b of the application. However, the applicant relies on a cage and pallet that, though used with the package, is not part of the packaging. The cage and pallet are relied on to maintain package orientation and distance from the package surface that is the exposed surface of the cask between the package's impact limiters for the 050A and the 100A, A-S, and B package models. The cage is relied on to use the impact limiter radius to define the package surface even where the impact limiters do not cover the cask. Since the pallet and the cage are not part of the packaging, reliance on them in the shielding analysis is inconsistent with demonstrating compliance with the 10 CFR 71.47(a) radiation level limits for non-exclusive use shipments. The applicant's analyses should demonstrate these limits will not be exceeded at any point on the package surface and at one meter from the package surface.

The staff performed calculations using MicroShield for all the contents of the 050A and the 100A, A-S, and B package models. The results of these calculations indicate that the radiation levels at the cask surface (i.e., the package surface between the impact limiters) may be significantly higher (by 3.1 times for the 050A model and 3.5 times for the 100 models) than the radiation levels calculated at the outer radius of the impact limiters at that same location. Noticeable increases may also occur when evaluating radiation levels at one meter from the actual package surface (the exposed cask surface) rather than at one meter from the outer radius of the impact limiter. While the applicant's current analysis indicates that radiation levels are bounding for the contents located in the top corner of the cavity, it is not clear from the information in the application that this is true when the radiation levels at the package side are analyzed at the correct surface on the package side (i.e., the exposed cask surface) and at 1 meter from that surface. Thus, the applicant should provide additional information that justifies the corner configuration for the relevant nuclides still results in bounding package radiation levels. That justification should account for the radiation level increases the

staff identified for the package side configuration. The evaluation should address all package models for which the impact limiters do not cover the entire cask surface (i.e., the 050A model and all three 100 models).

This information is needed to confirm compliance with 10 CFR 71.47.

- 5-3 Ensure the application provides appropriate contents limits for the Co-60-B and Co-60-C contents that are clear and consistent with the evaluated, proposed package use conditions (i.e., exclusive-use or non-exclusive use shipment) for those contents.

The current revision of the certificate of compliance (CoC) includes Condition 15, which limits contents that utilize axial shielding and spacer plates to be shipped by exclusive-use only. This condition appears to affect the Co-60-B and Co-60-C contents, which can only be transported in the 100A and A-S package models. The remaining contents listed in the certificate for the 100A and A-S package models are permitted to be shipped by non-exclusive use. As part of the current application, the applicant proposed separate, additional contents limits for exclusive use shipments in the 100A and A-S package models, including for the Co-60-B and Co-60-C contents. Thus, the currently approved limits for the Co-60-B and Co-60-C contents, which are already limited to exclusive-use shipment, are not needed and should be removed from the non-exclusive use limit tables (Table 1-2 and related tables in Section 5 of the application) or quantity limits should be provided in these tables for these two contents for which compliance with radiation level limits for non-exclusive use shipment is demonstrated. If both exclusive-use quantity limits are kept for these two contents, then they will be limited to the smaller quantity.

This information is needed to confirm compliance with 10 CFR 71.33(b)(1), 71.35(a), and 71.47.

- 5-4 Modify the shielding section (Section 5) of the application to do the following:
- a. Clarify the first paragraph of Section 5.2 of the application regarding the acceptable conditions for loading of niobium-95 with zirconium-95. This paragraph states: "Nb-95 may be loaded with Zr-95 in Models AOS-050 and AOS-100, but only as specified in Subsection 5.2.1." Subsection 5.2.1 is only applicable to non-exclusive use, indicating that niobium-95 may be loaded with zirconium-95 only in non-exclusive use shipments whereas Appendix 5.5.7 and Table 1-2b indicate this is acceptable in exclusive use shipments.
 - b. Modify Section 5.2 to also include reference to Table 1-2b and Appendix 5.5.7 of the application. With the addition of new contents limits, Section 5.2 should address the source specification information for all package contents. For that information that is located in other sections of the application, Section 5.2 should include references to them. The current references in Section 5.2 to other sections of the application do not capture all of the proposed contents information.
 - c. Provide the decay heat data, or the data source, that is acceptable to use when applying the Appendix 5.5.5 method for multiple isotopes with a package that may also contain low-energy gamma-emitter or beta-emitter radionuclides. The data to be used for the Appendix 5.5.5 method is part of that method. Thus, Appendix 5.5.5

should either provide the decay heat data for these nuclides or state the source of the decay heat data to use for these nuclides in this method.

- d. Clearly specify the data to be used to apply the Appendix 5.5.5 method to the package models in addition to the 100A and A-S models. This appendix is referenced within the loading operations section of the application for shipping multiple isotopes in a package, which operations are incorporated into the CoC and, therefore, represents the content specification in the CoC (by incorporation by reference). Therefore this information needs to be clear and unambiguous to a package user. Currently, the first paragraph on page 5-44b of Appendix 5.5.5 states: "Note that this method for mixing isotopes within a single content is applicable to all AOS shipping cask variants, using the dose rate information provided in Subsection 5.4.4..."; however, simply referring to Section 5.4.4 does not provide sufficiently clear guidance as to which information in that section should be used. This statement needs to be modified to refer to the specific information in Section 5.4.4 that is to be used, or the relevant information should be provided in Appendix 5.5.5.
- e. Provide the minimum spacing from the package centerline to the back end of the trailer evaluated in the exclusive use analysis in Appendix 5.5.7 of the application. The current evaluation only specifies the distance to the trailer side from the package centerline. The same limit at 2 meters from the trailer side also applies to the planar surface that is 2 meters from the back end of the trailer. If the distance from the package centerline to the back end of the trailer is less than the distance used for the analysis for 2 meters from the trailer side, then the current analysis is not sufficient to address that configuration and an additional, or new, 'NCT 2m from Trailer Surface' location and radiation level analysis will be needed for Table 5-39 to address radiation levels at 2 meters from the back end of the trailer.
- f. Clarify if the tallies for the analyses for the arc source described in Appendix 5.5.7 are divided both axially and azimuthally, providing the axial division for the azimuthally divided tallies. Since the source is finite in both the axial and azimuthal direction, the tallies should be segmented in both directions to ensure the calculated radiation level is not artificially reduced by the inclusion of surface areas that receive little to no radiation from the source in the tally segment. Similar clarification should be provided for the cylinder source analyses described in that appendix.
- g. Modify the discussion on page 5-20 of the application about the 1-meter radiation level limit from 10 CFR 71.47(a) to correctly restate the limit. The limit of 10 mrem/hr (or a transport index limit of 10) for conditions normally incident to transport for non-exclusive use shipments is at 1 meter from the package surface, not 1 meter from the shipping cage since the cage is not a part of the package.
- h. Modify Section 1.2.2, the shielding section (e.g., in Section 5.2 or Appendix 5.5.5) and the package operations (Section 7) of the application to clearly state that the limits in Table 1-2a should be used for non-exclusive use shipments of packages containing only iridium-192 and iridium-194 versus the method in Appendix 5.5.5 for shipments of multiple isotopes. The current application appears to give two means for determining acceptability of packages to be offered for non-exclusive use shipment that contain these nuclides, the limits in Table 1-2a and the method in Appendix 5.5.5. The applicant has already established limits for packages under

non-exclusive use that contain only these nuclides; those limits are in Table 1-2a of the application and in the certificate of compliance.

This information is needed to confirm compliance with 10 CFR 71.33(b)(1), 71.47, and 71.51(a).

- 5-5 Provide appropriate evaluations and supporting decay heat and radiation level data for allowing shipments of exclusive use content limits and for allowing inclusion of low-energy gamma and beta-only emitting nuclides in the contents for all package models for which these contents specifications are applicable.

The application currently provides evaluations and decay heat and radiation level data for allowing low-energy gamma-emitting radionuclides, beta-emitting radionuclides, and for setting exclusive use content limits for only the 100A and A-S package models (see Appendices 5.5.6 through 5.5.7 of the application); however, language in these sections appears to indicate that they apply to all the other package models (e.g., see the text at the bottom of page 5-44d of the application).

The applicant should clarify if it is proposing that these contents specifications also apply to the other package models. If these contents are to be included in more than just the 100A and A-S package models, the applicant should provide the supporting evaluations and data. Otherwise, these content specifications will be limited to only the 100A and A-S package models in the certificate.

This information is needed to confirm compliance with 10 CFR 71.33(b)(1), 71.35(a), 71.47, and 71.51(a).

- 5-6 Justify the acceptability of rounding up the radionuclide quantities analyzed to meet radiation level and package decay heat limits to create the quantity limits for the analyzed nuclides.

Many of the proposed quantity limits for the package contents are rounded up from the values that were shown to just meet the radiation level and package decay heat limits. Thus, the proposed limits result in radiation levels or package decay heats that, by the analysis, would exceed the limits for these parameters. This is of particular concern for quantity limits that are based on the package decay heat limit. Rounding up the allowable quantity (from the analyzed quantity) results in the package decay heat limit being exceeded. The staff recognizes that the applicant has chosen to use radiation level limits that are 10% less than the regulatory limits; so, while rounding up of the allowable quantity will result in the applicant's limits being exceeded, the margin to the regulatory limits should ensure the regulatory limits will not be exceeded.

This information is needed to confirm compliance with 10 CFR 71.35(a), 71.47, and 71.51(a).

- 5-7 Modify the package operations in Section 7 of the application to provide the necessary method details and data to be used by the package user to confirm the contents of its particular shipment meet the requirements of the CoC, as evaluated in the shielding section of the application.

1. Demonstrate that the contribution to radiation levels from secondary radiation, namely bremsstrahlung, from all beta emitters cannot contribute to package radiation levels, modifying the proposed contents description as necessary.

The applicant proposes to allow shipment of any quantity of radionuclides that only emit beta radiation as long as that quantity does not exceed the decay heat limits for the package. The applicant states that beta particles and their secondary radiation (i.e., bremsstrahlung) cannot penetrate the package shielding to sufficiently contribute to package radiation levels. However, some nuclides emit high energy beta particles, which can result in bremsstrahlung that can contribute a relatively significant amount to the package radiation levels. The staff evaluated the potential contribution to package radiation levels for two beta-emitting radionuclides, which the currently proposed contents changes would allow to be transported in the package, phosphorus-32 and strontium-90 with its yttrium-90 progeny. The staff used the approximate relationship described in Cember's Introduction to Health Physics, 3rd Edition (see pages 129-131) to estimate the bremsstrahlung source from these nuclides and calculated the resulting package radiation levels with MicroShield. The results indicate that bremsstrahlung for these beta-emitting radionuclides in quantities that produce decay heats at the package limit will contribute significantly to package radiation levels (e.g., ~25% and 20% of the regulatory limits for the exposed cask surface – the package surface – and at 1 meter from that surface for the 100B package model).

Thus, the applicant should demonstrate that no beta-emitting radionuclides in quantities allowed by the package decay heat limit will contribute to package radiation levels or modify the package contents to limit the quantities of these radionuclides. If the applicant decides to propose quantity limits for beta-emitting radionuclides, and these quantities result in non-negligible contributions to package radiation levels, then the applicant should ensure that all proposed contents descriptions, limits, and shielding evaluations, including for mixtures or radionuclides, are sufficient to ensure that the package containing these nuclides will meet regulatory limits. The basis for evaluating and limiting beta-emitting radionuclide contents should be clearly explained in the application.

This information is needed to confirm compliance with 10 CFR 71.33(b)(1), 71.35(a), 71.47 and 71.51(a).

2. Demonstrate that the package radiation levels do not exceed the non-exclusive limits at the appropriate package surfaces, and at 1 meter from those surfaces, for the contents that have been evaluated for non-exclusive use and exclusive use shipments

The package operations descriptions in Section 7 of the application should be sufficient in detail to enable the package user to operate the package as designed, including ensuring that the contents for a particular shipment meet the conditions of the CoC. The applicant should provide the following information in the section for loading contents:

- a. the allowable radionuclides and quantities for non-exclusive use and exclusive use shipments;

- b. requirements for low-energy gamma emitter radionuclides and for 'pure' beta emitter radionuclides, including quantity limits and the decay heat data (or data source) to use to demonstrate compliance with these requirements;

and, for mixtures of nuclides:

- c. information for radiation level data and decay heat data and equations (and definition of terms in the equations) for analyzed nuclides for non-exclusive use and exclusive-use shipments,
- d. the decay heat data (or data source) for low-energy gamma emitters and for beta emitters, and
- e. the criteria for use of shield and spacer plates.

While some information appears to be in the package operations, it does not appear to be complete. For example, Appendix 7.5.1, referred to in the contents loading section, does not address loading of a single low-energy gamma emitter or a beta emitter as package contents, nor does it appear to clearly address quantity limits for a single radionuclide under exclusive use limits.

This information is needed to ensure compliance with 10 CFR 71.87 and that the package will be operated consistent with its design and evaluations for compliance with 10 CFR 71.47 and 71.51(a).

5-8 Modify the information in the Package Operations Chapter (Chapter 7) and the Acceptance Tests and Maintenance Program Chapter (Chapter 8) of the application to do the following:

- a. Modify the sequence of operations in Section 7.1.3.4 to ensure that radiation level and contamination level measurements for regulatory compliance in Section 7.1.3.4, item (j) are performed on all appropriate package surfaces and confirm compliance with the cited regulations. The current sequence of operations in Section 7.1.3.4 doesn't allow for measurements to comply with the cited requirements because the package is installed on the pallet and the cage is installed (both of which are not part of the package) prior to the radiation and contamination measurements.
- b. Section 7.2 items e and f refer to the limits and drawings within Chapter 1 of the application. Although these application limits currently coincide with the CoC limits, the governing limits and drawings are those that are specified in the CoC and therefore this section needs to be modified to refer to the limits and drawings in the CoC and the appropriate sections of the package operations section of the application (which are incorporated by reference into the CoC).
- c. Revise the activity limits in Section 7.2, item e to capture all appropriate content limits for non-exclusive use and exclusive-use shipments for individual nuclides and mixtures of nuclides, including contents that have low-energy gamma-emitting or beta-emitting nuclides. The current Section 7.2, item e does not appear to address all the content limits which may apply to any given shipment of

the package. References to limits should be to the limits in the CoC and the appropriate sections of the package operations section of the application.

- d. Clarify how performance of the actions in Section 7.1.1.1 and Section 7.2.1, particularly items b and c, in reference to the radiation and contamination levels being in compliance with regulations, is to be done prior to removal of the shipping cage, which is not part of the package. Revise the steps as necessary.

This information is needed to confirm compliance with 10 CFR 71.85 and 71.87.