Request for Additional Information
U.S. Department of Transportation
Japanese Approval Certificate No. J/2044/B(U)F
Docket No. 71-3004
Certificate of Compliance No. 3004
Model No. JMS-87Y-18.5T

By letter dated April 3, 2023 (Agencywide Documents Access and Management System [ADAMS] Accession Number ML23101A035), you submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for the review of the Japanese Certificate of Competent Authority No. J/2044/B(U)F, Model No. JMS-87Y-18.5T package. In your application you requested that the NRC provides a recommendation to revalidate the Model No. JMS-87Y-18.5T.

This request for additional information (RAI) identifies information needed by the NRC staff (the staff) in connection with its review of the application. The staff used International Atomic Energy Agency (IAEA) Specific Safety Requirements No. 6 (SSR-6), "Regulations for the Safe Transport of Radioactive Material," 2018 Edition, in its review of the application.

The RAI 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 of the IAEA SSR-6, 2018 Edition.

GENERAL INFORMATION

RAI-GEN-1 Replace all references to the IAEA transport safety regulations in the safety analysis report (SAR) for the Model No. JMS-87Y-18.5T to appropriately reflect the IAEA SSR-6, Revision 1 (2018 Edition).

For example, in Revision 1 of the SAR for the Model No. JMS-87Y-18.5T SAR, on page (II)-A-410, reference (29) is listed as "IAEA/Radio active material safety transportation regulations (1985 transaction) safety series No. 6." However, since the SAR has been revised to meet the requirements of the IAEA SSR-6, Revision 1 (2018) and the SAR should accurately reference the applicable version or revision of the SSR-6 that the application complies with.

This information is needed to determine compliancet with the requirements in Paragraph 102 the IAEA SSR-6, 2018 Edition.

MATERIALS EVALUATION

RAI-Ma-1 Provide a description of any national or international codes, standards, and/or other methods, programs, or procedures that are implemented to ensure that package maintenance activities (including visual inspections, screening and evaluation of visual indications, and corrective actions such as component repairs and replacements) are adequate to manage the effects of aging in metallic package components that would see long-term use, such that the package components are capable of performing their requisite safety functions throughout the period of use.

The staff requests that this description address the following criteria:

a. Inspection methods (e.g., bare metal visual exams and/or other types of nondestructive exams such as liquid penetrant exams or ultrasonic exams) for detection, characterization, and sizing of localized aging effects such as cracks, pits, and crevice corrosion.

b. Inspection equipment and personnel qualification requirements (e.g., lighting and visual acuity requirements for performing visual exams) to ensure reliable inspections that can adequately detect and characterize indications of localized aging effects prior to component failure or loss of safety function.

c. Acceptance criteria for aging effects such as early stage fatigue cracks and localized corrosion of stainless steel components, such as chloride induced stress corrosion cracking (SCC), pitting, and crevice corrosion. Examples of visual indications that may indicate potential localized corrosion of stainless steel components include the accumulation of atmospheric deposits such as salts, buildup of corrosion products, rust-colored stains or deposits, and surface discontinuities or flaws associated with pitting, crevice corrosion, and/or SCC.

d. Describe any surface cleaning requirements that are implemented to ensure that bare metal visual inspections of component surfaces are capable of detecting surface flaws, and for ensuring adequate removal of atmospheric deposits such as salts or other chemical compounds that may contribute to localized corrosion of stainless steel components.

e. Describe any flaw evaluation methods (such as flaw sizing and flaw analysis methods) and associated flaw acceptance criteria that may be used to determine whether components containing flaws are acceptable for continued service.

Per IAEA SSG-26, "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material," 2018 Edition, Paragraph 613A.3:

> "For packagings intended for repeated use, the effects of ageing mechanisms on the package should be evaluated during the design phase in the demonstration of compliance with the Transport Regulations. Based on this evaluation, an inspection and maintenance programme should be developed. The programme should be structure so that the assumptions (e.g., thickness of containment wall, leaktightness, neutron absorber effectiveness) used in the demonstration of compliance of the package are confirmed to be valid through the lifetime of the packaging."

The staff was not able to locate a detailed description of national or international codes, standards, and/or other methods, programs, or procedures that are implemented to ensure that package maintenance activities are adequate to manage the effects of aging in metallic package components that would see long-term use.

This information is needed to determine compliance with requirements in Paragraphs 503(e), 613A, and 809(f) of the IAEA SSR-6, 2018 Edition.

RAI-Ma-2 Provide an evaluation of abrasion as an aging mechanism for the JMS-87Y-18.5T package.

Per IAEA SSG-26, 2018 Edition, Paragraph 613A.1:

> "The designer of a package should evaluate the potential degradation phenomena over time, such as corrosion, abrasion, fatigue, crack propagation, changes of material compositions or mechanical properties due to thermal loadings or radiation, generation of decomposition gases and the impact of these phenomena on performance of safety functions."

The staff was not able to locate a discussion on abrasion being evaluated as an aging mechanism.

This information is needed to determine compliance with the requirements in Paragraph 613A of the IAEA SSR-6, 2018 Edition.

RAI-Ma-3 Provide the aging management program (per the structure and procedure in IAEA SSG-26, Paragraph 613A.3 (2018 Edition)) and gap analysis program.

Per IAEA SSG-26, Paragraph 613A.5:

> "For designs of Type B(U), B(M) and Type C packages these programmes are required to be included in the application for approval of packages for shipment after storage (see paras 809(f) and (k) of the Transport Regulations). The results of the ageing management programme and the gap analysis programme should be taken into account when preparing an inspection plan prior to transport."

The staff was not able to locate an aging management program or gap analysis program as required by IAEA SSR-6, Paragraphs 809(f) and (k).

This information is needed to determine compliance with the requirements in Paragraphs 809(f) and (k) of the IAEA SSR-6, 2018 Edition.

RAI-Ma-4 Provide the basis for the evaluation of the wood in the impact limiter including the analyzed range of temperatures. Also, revise the SAR, as necessary, to address two inconsistencies identified between the maximum temperatures identified for the wood impact limiter in Section B.4.2 and SAR Section F.2 of the SAR.

In Section F.2, Table(II)-F.2, of the SAR, the applicant states that the maximum temperature identified at the surface of the package is **[Withheld per 10 CFR 2.390]** during transportation. However, in SAR Section B.4.2, Table (II)-B.15 and B.16, the highest temperature listed is **[Withheld per 10 CFR 2.390]**. Secondly, the applicant states in Table(II)-F.2 of the SAR that, based on te results of analysis, “the temperature inside the shock absorber (wood) during actual transportation is estimated to be below about 40°C.” In the same table, the applicant later states that the average temperature data of the shock absorber of another package with a track record of transportation of spent fuel was evaluated and shown to be around 40°C to 70°C, which contradicts the previous temperature estimate.

This information is needed to determine compliance with requirements in Paragraphs 613A, 616, and 639 of the IAEA SSR-6, 2018 Edition.

RAI-Ma-5 Explain how the impact of potential water absorption by the shock absorber

In Section F.2 of the SAR, the applicant described the corrosion that could affect the shock absorber material. In SAR Table III-B.1, a visual inspection is described but does not include any mention of inspection of the welds or areas adjacent to the welds, nor is any specific acceptance criteria described.

This information is neede to determine compliance with requirements in Paragraph 613A of the IAEA SSR-6, 2018 Edition.

RAI-Ma-6 Provide a comparison between the maximum temperature expected during transport to the qualified temperature limit for the **[Withheld per 10 CFR 2.390]** cladding material.

In SAR Section F.2, the applicant describes heat related aging mechanisms that can affect the aluminum alloy, stating that thermal analysis indicated a substantial temperature difference between the maximum temperature expected during transport and the melting temperature of the aluminum alloy. However, the **[Withheld per 10 CFR 2.390]** cladding material has a much lower melting temperature.

This information is needed to determine compliance with requirements in Paragraph 613A of the IAEA SSR-6, 2018 Edition.

STRUCTURAL EVALUATION

RAI St-1 Provide clarification on how stress concentration effects (higher stresses in the surrounding region of local geometric discontinuities of the component parts) have been accounted for in the fatigue evaluations for the reusable package components. Justify omission of or consider stress concentration effects, where it is applicable.

The application evaluates fatigue for the lifting devices, containment device and tie-down attachments in Sections (II)-A.4.4.3.3, (II)-A.10.5, (II)-A.10.6.3(11) and (II)-A.10.6.4(3) of the SAR. However, the staff could not locate any discussion on consideration of stress concentration factor to account for the effect of any irregularities or discontinuities of the component parts or justification thereof for not considering in the components’ fatigue evaluations. The stress concentration factor is typically used to account for the effect of discontinuities such as holes, grooves or notches, bolt threads, and head fillets that are not represented in detail in the finite element analysis (FEA) model.

This information is needed to determine compliance with the requirements in Paragraphs 613A and 809(f) of the IAEA SSR-6, 2018 Edition.

RAI St-2 Justify the values of the maximum repetitive stress for the cask body lifting lugs considered in Section (II)-A.4.4.3.3 of the SAR.

Based on the stress intensity (s) calculation at the hole of the lifting lug in Section (II)-A.4.4.3.1, the staff finds that the maximum repetitive stress should be **[Withheld per 10 CFR 2.390]** N/mm^2 instead of **[Withheld per 10 CFR 2.390]** N/mm^2 considered by the applicant in the evaluation of the cask body lifting lug.

This information is needed to determine compliance with the requirements in Paragraphs 613A and 809(f) of the IAEA SSR-6, 2018 Edition.

RAI St-3 Verify and confirm that the stress amplitudes corresponding to the number of stress cycles from the design fatigue curves are properly adjusted for differences between the moduli of elasticity on the design fatigue curvesand that is used in the analysis of the component parts to determine allowable repeated peak stress intensity in Section (II)-A.10.5 and possibly other Sections of the SAR. Revise the SAR, as necessary.

Section (II)-A.10.5 of the SAR, evaluates containment devices for the combined repeated peak stress intensity. In this evaluation, the allowable repeated peak stress intensity is determined by multiplying the stress amplitude corresponding to the number of stress cycles from the design fatigue curves by the ratio of modulus of elasticity on the fatigue curves to the modulus of elasticity used in the analysis. Instead, it appears to the staff that the allowable peak stress intensity should be determined by multiplying the stress amplitude by the ratio of modulus of elasticity used in the analysis to the modulus of elasticity on the fatigue curves.

This information is needed to determine compliance with the requirements of the Paragraphs 613A of the IAEA SSR-6, 2018 Edition.

RAI St-4 Justify values in the “Repeated Peak Allowable Stress Intensity” column of the Table (II)-A.31 and confirm if they are values of the allowable stress intensity range or values of the alternating component, which is half of the allowable stress intensity range. Update this table as necessary, which needs to be addressed in conjunction with the resolution of other RAIs ,as applicable.

Section (II)-A.10.5 of the SAR, evaluates the containment device and basket components for the combined repeated peak stress intensity. Although conservative, it appears to the staff that the values in the “Repeated Peak Allowable Stress Intensity” column of the Table (II)-A.31 are values for the alternating component, which is half of the allowable stress intensity range from the applicable design fatigue curves. The values in this column are compared against the combined repeated peak stress intensity values per the analysis and used to derive margin of safety in the design of the components.

This information is needed to determine compliance with the requirements of the Paragraphs 613A of the IAEA SSR-6, 2018 Edition.

RAI St-5 Provide a complete evaluation of fatigue for the reusable package components for the 40-year period of use that considers the combined effects of all applicable types of accumulated stress cycles in components during normal service conditions, including the following cycle types (as described in this question):

a. Lifting cycles

b. Pressurization cycles

c. Thermal stress cycles

d. Vibration cycles

The staff needs a complete fatigue evaluation that considers the combined effects of all applicable types of stress cycles during normal service, including consideration of the cycle types listed above. Also, the appropriate number of cycles need to be considered in fatigue evaluation depending upon the type of cycle being evaluated. If certain types of stress cycles are not applicable or negligible for certain components, explain why these are not applicable or are negligible.

If such a complete fatigue evaluation cannot be performed, or if the fatigue evaluation cannot show adequate protection against fatigue failure considering the combined effects of all applicable types of accumulated stress cycles in components, provide the following information:

a.1 a description about how periodic maintenance inspections will be used to identify and address fatigue cracks in components of the package.

b.1 A description of the corrective actions that will be taken for any detected fatigue cracks, such as analytical flaw evaluation with follow-up inspections, repair/replacement of components with cracks, etc.

The following items provide additional descriptions about accumulated stress cycles as provided in the application:

1. <u>Lifting cycles</u> – The staff recognizes that these cycles are already evaluated in Section (II)-A.4.4.3.3 for the cask body and lid lifting device, Section (II)-A.10.6.4(3) for the skid lifting device and table (II)-F.2 of the SAR. However, the staff noted that the lifting cycles are evaluated without considering the other types of stress cycles that may also be accumulated by the lifting devices for the cask body and the lid. To perform an adequate analytical evaluation that demonstrates sufficient safety margin against fatigue failure of these components, the combined effects of accumulated lifting cycles along with other applicable types of accumulated stress cycles in these components (including consideration

of cycle types listed herein) on the potential for fatigue of lifting devices should be considered.

2. <u>Pressurization and thermal stress cycles</u> – The staff recognize that pressure and thermal cycles are already evaluated in Sections (II)-A.10.5 and table II-F.2 for the containment device (i.e., cask body, lid and connecting bolts). However, the staff noted that the containment device pressurization and thermal cycles are evaluated for 1,000 cycles (times) over 30 years, which is contrary to the 40-year service life considered for the components' fatigue evaluations elsewhere. Also, the staff noted that thermal stress cycles may occur in components due to cyclical fluctuation of spatial temperature gradients within components, which could exceed 1,000 cycles over 40-year service life. In addition, the staff noted that this evaluation does not address the potential for fatigue of package components due to the combined effects of other types of stress cycles that may also be accumulated by the containment device components. To perform an adequate analytical evaluation that demonstrates sufficient safety margin against fatigue failure of these components, the combined effects of accumulated pressurization and thermal cycles along with other applicable types of accumulated stress cycles in these components (including consideration of cycle types listed herein) on the potential for fatigue of containment device components should be considered.

3. <u>Vibration cycles</u> – The staff noted that Section (II)-A.4.7 provide an evaluation that demonstrates that package resonance is a not a concern considering package vibration caused by vehicle transport. The staff also recognizes that the tie-down attachments are already evaluated in Section (II)-A.10.6.3(11) of the SAR for fatigue cycles. However, the staff noted that the tie-down attachment components are evaluated for 4,000 cycles, which the applicant has inappropriately considered as lifting cycles, and not as vibratory cycles. The package components could experience many vibration cycles from numerous vehicle transports by road during the 40-year service life, which may exceed 4,000 lifting cycles considered in the fatigue evaluation. In addition, the staff noted that this evaluation does not address the potential for fatigue of package components due to the combined effects of the accumulation of many vibration cycles resulting from the allowed transports of the package over 40-year service life, along with the accumulation of other applicable types of stress cycles, including consideration of the cycle types listed herein.

To determine that fatigue as not an aging concern, as indicated in Section (II)-F of the application, the staff needs a complete fatigue evaluation that considers the combined effects of all applicable types of stress cycles during normal service, including consideration of the cycle types listed above. Also, the appropriate number of cycles need to be considered in fatigue evaluation depending upon the type of cycle being evaluated.

This information is requested to determine compliance with the requirements in Paragraphs 503(e), 613, 613A, and 809(f) of the IAEA SSR-6, 2018 Edition.