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

December 26, 2018

Mr. Richard W. Boyle, Chief
Sciences Branch
Division of Engineering and Research
Office of Hazardous Materials Safety
U.S. Department of Transportation
1200 New Jersey Ave., S.E.
Washington, DC 20590

SUBJECT: APPLICATION FOR THE MODEL NO. TK-C69 TRANSPORT PACKAGE – SUPPLEMENTAL INFORMATION NEEDED

Dear Mr. Boyle:

By letter dated August 28, 2018 [Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML18256A141], the U.S. Department of Transportation requested that the U.S. Nuclear Regulatory Commission (NRC) staff performs a review of the Competent Authority Certification (CAC) Russian Approval Certificate Number, Revision 1, Model No. TK-C69 transport package, and make a recommendation concerning the revalidation of the package for import and export use. The NRC staff performed an acceptance review of your application to determine whether the application contains sufficient technical information in scope and depth to allow the NRC staff to complete a detailed technical review per the International Atomic Energy Agency Specific Safety Requirements No. 6, "Regulations for the Safe Transport of Radioactive Material," 2012 Edition.

This letter is to advise you that based on our acceptance review, the application does not contain sufficient technical information. The information needed to begin our review is described in the enclosed request for supplemental information (RSI). In order to start our technical review, this information should be provided within 2 weeks from the date of this letter. The staff included observations in the attached RSI, which you do not have to provide a response at this time. However, it is important to note that an observation may be issued as a request of additional information during the technical review of the application. Upon receiving the RSI responses, the NRC staff will evaluate the information to determine whether the supplementary information is responsive to the NRC staff's concerns.

The staff is available for a public meeting if you wish to discuss these issues in more detail prior to deciding on your course of action. Please reference Docket No. 71-3093 and EPID L-2018-NEW-0005 in future correspondence related to this action.

If you have any questions regarding these matters, please contact me at (301) 415-6999.

Sincerely,

/RA/

Norma García Santos, Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-3093
EPID L-2018-NEW-0005

Enclosure:
Request for Supplemental Information
and Observations

SUBJECT: APPLICATION FOR THE MODEL NO. TK-C69 TRANSPORT PACKAGE – SUPPLEMENTAL INFORMATION NEEDED, DOCUMENT DATE: December 26, 2018

DISTRIBUTION: SFST r/f NMSS r/f

http://fusion.nrc.gov/nmss/team/sfst/sfst-licensing/10_cfr_71/tk-c69_reval/Shared Documents/TK-C69_Revalidation_RSI.docx

ADAMS P8 Accession No.: ML18360A620

OFFICE:	DSFM	DSFM	DSFM	DSFM	DSFM	DSFM	DSFM
NAME:	NGarcía Santos	SFigueroa by email	JWise by email	JIreland by email	JChang by email	ARigato by email	VWilson by phone
DATE:	12/10/18	12/17/18	12/10/18	12/11/18	12/11/18	12/10/18	12/13/18
OFFICE:	DSFM	DSFM	DSFM	DSFM	DSFM	DSFM	
NAME:	JTapp by email	MRahimi by email	CBajwa by email	DChung for TTate	PSilva	JMcKirgan	
DATE:	12/11/18	12/14/18	12/18/18	12/21/18	12/21/18	12/26/18	

OFFICIAL RECORD COPY

Request for Supplemental Information and Observations
U.S. Department of Transportation
Russian Approval Certificate Number RUS/3240/AF-96T, Revision 1
Docket No. 71-3093
Model No. TK-C69 Package

REQUEST FOR SUPPLEMENTAL INFORMATION

Containment Evaluation

RSI-Co-4-1 Provide a specific and clear description of the containment system in Chapter 4, "Containment," of the application.

The containment system is defined in paragraph 213 of Atomic Energy Agency Specific Safety Requirements No. 6, "Regulations for the Safe Transport of Radioactive Material," 2012 Edition (thereafter, IAEA SSR-6, 2012 Edition) as the assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport. The definition and description of the containment system is not clear in the information submitted in the application. The following are examples of the information provided in the application:

- Chapter 4 describes the "localization system" as a part of cask design to confine a radioactive content during transportation. Chapter 4 goes on to state, "Fuel rods serve as localization system constituent of the TP TK-C69."

- Section 6.1.1.1, "Containment system," of the application includes a description of the containment system in the transportation package (TP) TK-C69 as the fuel rods.

- Section 6.1.1.2, "Confinement system," of the application includes a description of the confinement system as follows:

  > "[t]he assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority as intended to preserve criticality safety."

  Section 6.1.1.2 goes on to describe the confinement systems of the TP TK-C69 as the cradle and lids.

Based on the information provided in Section 1.2.2, "Characteristics of radioactive contents," of the application, it appears that the radioactive material is the unirradiated FE TVS-K (fuel rods). However, a clear definition of the containment system has not been provided in Chapter 4 of the application.

The staff needs this information to determine compliance with the requirements in paragraph 714 of the IAEA SSR-6, 2012 Edition.

RSI-Co-4-2 Provide a description of the containment system positive fastening device in Chapter 4, “Containment,” of the application, or provide the section of the application that describes the containment system positive fastening device.

Chapter 4 of the application does not describe a positive fastening device to keep the containment system securely closed. Paragraph 641 of SSR-6, 2012 Edition, requires that this device cannot be opened unintentionally or by a pressure that may arise within the package.

Section 6.1.1.2, “Confinement system,” of the application describes the confinement system as the assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority as intended to preserve criticality safety. Section 6.1.1.2 of the application goes on to describe the confinement system of the TP TK-C69 as the cradle and lids.

It is not clear if the cradle and cradle lid(s), or other additional components possibly described in Section 2.4.3, “Trustworthy package closing methods,” form a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.

The staff needs this information to determine compliance with the requirements in paragraph 641 of the IAEA SSR-6, 2012 Edition.

RSI-Co-4-3 In Chapter 4, “Containment,” of the application, specify the sections of the application that demonstrate the following:

a. the containment system for the package prevents loss or dispersal of the radioactive contents under normal conditions of transport (NCT), and,

b. the package contains the contents to ensure subcritical under NCT and hypothetical accident conditions (HAC).

If the containment system is the fuel rods (see RSI-Co-4-1), it is not clearly demonstrated in the application how the fuel rods would prevent loss or dispersal of the radioactive contents under NCT in Chapter 4, “Containment,” of the application.

Chapter 4, “Containment,” of the application describes calculations and tests of full-size package mockups simulating NCT that demonstrated: the integrity of package stays intact, and radioactive contents do not leave the interior of the package. However, the application does not specify the section that describes the calculations and tests to demonstrate that the package contents would not disperse.

Similarly, it was not specified, in Chapter 4 of the application, the sections of the application that summarize how the package contains the contents to ensure subcriticality under both NCT and HAC.

The staff needs this information to determine compliance with the requirements in paragraphs 648 and 673(a) of the IAEA SSR-6, 2012 Edition.

RSI-Co-4-4 Demonstrate that there is no pressure build-up within the containment system under NCT and HAC in Chapter 4, "Containment," of the application.

Section 2.6.1.1, "Review of pressures and temperatures," of the application describes that the TP TK-C69 is not pressurized, that is why no pressure gain occurs inside the package for normal conditions of transport. In Section 3.4.3, "Maximum temperatures and pressures," of the application, the applicant states the following:

> "Rubber sealing gasket at TP base flange prevents penetration of dust, dirt and moisture into the package interior and minimizes the chances of hot gases generated during fire to reach localization system. The rubber gasket may burn out in fire, thus the interior of the package will be vented and no significant pressure gain is expected to occur."

It appears from the descriptions in Sections 2.6.1.1 and 3.4.3 of the application that there will not be a pressure build-up within the containment system during NCT and HAC; however, it is not clear how the design of the TP TK-C69 containment system is not pressurized during NCT and HAC.

Although the application discusses the potential for pressure build-up in portions of the package, the application does not clearly describe how the containment system is not pressurized. For example, the staff notes that the application does not discuss the potential over-pressurization of the fuel cladding in a fire accident. A breach of the cladding containment boundary could cause the fuel to reconfigure to a geometry that is not considered in the criticality analysis.

The staff needs this information to determine compliance with the requirements in paragraphs 641, 673, 726, and 728 of the IAEA SSR-6, 2012 Edition.

RSI-Co-4-5 Demonstrate that any combustible gases generated in the package during a period of one year do not exceed 5% (by volume) of the free gas volume in any confined region of the package, or briefly describe how the generation of combustible gases is not applicable. Include this information in the application.

The application does not address generation of any combustible gases within the package, nor that any combustible gases generated in the package (during a period of one year), does not exceed 5% (by volume) of the free gas volume in any confined region of the package.

The staff needs this information to determine compliance with the requirements in paragraph 644 of the IAEA SSR-6, 2012 Edition.

Criticality Safety Evaluation

RSI-Cr-1 Provide additional information about the S-95TUK computer code, including the following:

a. a code manual that includes a description of the code, in sufficient detail to understand its modeling limitations and the input deck fragments (Table 6-3) within the application;
b. a sample of the input decks for normal and accident conditions;
c. benchmark calculations, such as those presented in Subpart I of Annex 6.9, of S-95TUK using ENDF/B-VI cross section data. [The benchmark calculations in Subpart I of Annex 6.9 submitted in the application use ENDF/B-V (not ENDF/B-VI)];
d. a calculation of the upper subcriticality limit (USL) and discussion of the statistical method used for the treatment of the data;
e. a trending analysis of the benchmark data and a discussion of the methods used for establishing a bias trend; and
f. an area of applicability (AOA) table and a calculation of the subcritical margin to account for extensions in the AOA (if needed).

The staff needs to ensure that proper code validation has been performed. Items a. to f. of this request are discussed in more detail in NUREG/CR-6698, “Guide for Validation of Nuclear Criticality Safety Calculational Methodology,” January 2001 (ADAMS Accession No. ML050250061).

Paragraphs 104, 673(a), 682, 684, and 685 of SSR-6, 2012 Edition, requires maintaining the package subcritical. As stated in Section 6.3.3, "Computer programs and cross-sections,” of the application, the applicant used the S-95TUK computer code and ENDF/B-VI cross section library to calculate the reactivity of the TYK TK-C69 packaging with TVS-K fuel assemblies. The staff does not have experience with this computer code nor does it have access to this code. Therefore, the staff needs more information to determine that this code has been used appropriately for calculating the reactivity of the TYK TK-C69 packaging with TVS-K fuel assemblies.

The staff needs this information to determine compliance with the requirements in paragraphs 104, 673(a), 682, 684, and 685 of the IAEA SSR-6, 2012 Edition.

Materials Evaluation

RSI-M-1 Provide a copy translated in English of all materials standards for the base, cap, and platform of the package.

Tables 1-1 through 1-3 of the application reference GOST (i.e., the National Standard used in the territory of the Russian Federation) materials standard Nos. 7350-77, 5632-72, 4543-71, and 7338-90. For some components (e.g., bolt and nuts), no standard is cited.

The staff requires the materials standards to verify that the design is in accordance with national or international standards and that the mechanical properties used in the structural analyses are appropriate.

The staff needs this information to determine compliance with the requirements in paragraphs 640 and 648 of the IAEA SSR-6, 2012 Edition.

RSI-M-2 Identify, and provide copies translated in English of, the welding fabrication and inspection standards for the welded joints of the package.

SAR Section 8.1.1 states the following:

> "Quality of welded joints is controlled visually and by measurements in accordance with design documents for TP." and

SAR Section 8.1.2 states the following:

> "All the welded joints shall be checked for conformance with relevant requirements and standards, outlined in every technical drawing."

The application did not provide the package drawings that describe the welding requirements and standards. The staff needs the welding requirements and standards (and English versions of the standards) to verify that the design and manufacturing techniques are in accordance with national or international standards and that the package will be fabricated in a manner that allows the package to withstand normal conditions of transport and hypothetical accident conditions.

The staff needs this information to determine compliance with the requirements in paragraphs 640 and 648 of the IAEA SSR-6, 2012 Edition.

Shielding Evaluation

RSI-Sh-1 Confirm that the limits for uranium-235 (^{235}U), ^{232}U, and ^{236}U in Table 1 of the translated version of the Russian Certificate of Competent Authority (certificate) are in weight percent.

Table 1, "main specifications of TVS-K," of the translated certificate lists the allowable amount of ^{235}U, ^{232}U, and ^{236}U as "Mass fraction of uranium-23X isotope to the uranium %, not more than..." The staff has determined that this must mean weight percent otherwise the amount of ^{235}U would be unrealistic and the amount of ^{232}U would exceed the limit for a Type A package. The staff requests that the applicant confirm that this means "weight percent" (wt.%) and not "mass fraction."

The staff needs this information to determine that the package contents are appropriate for a Type AF package per paragraphs 428 and 429(b) of the IAEA SSR-6, 2012 Edition.

Structural Evaluation

RSI-St-1 Provide the LS-DYNA files used for demonstrating the package's ability to withstand normal and accident conditions of transport.

The applicant used LS-DYNA extensively to model both normal and hypothetical accident conditions of transport as it relates to package drop tests. However, the LS-DYNA files have not been provided. The staff needs the analysis files to

determine the ability of the TK-C69 package to withstand normal and hypothetical accident conditions of transport.

The staff needs this information to determine compliance with the requirements in paragraphs 722, 726, and 727 of the IAEA SSR-6, 2012 Edition.

RSI-St-2 Provide the licensing\engineering drawings used to depict the TK-69 package. For example, drawings should include the following information:

a. dimensions, tolerances,
b. materials of construction with corresponding standards,
c. dimensions of the package and it components, and
d. overall arrangement of components.

The application mentions compliance drawings such as KU0894.04.00.000.BO BO (cask 0894.04.00.000. general view). However, none of the drawings related to the Model No. TK-C69 have been provided by the applicant.

The staff needs this information to determine compliance with the requirements in paragraph 836(i) of the IAEA SSR-6, 2012 Edition.

RSI-St-3 Provide the English version of the following references used to demonstrate the package's ability to withstand normal and hypothetical accident conditions of transport:

a. Manufacturing
   i. GOST 14.201-83, "Assurance of manufacturable structures;"
   ii. GOST 14.205-83, "Manufacturability of product structure;"
   iii. GOST 23170-78, "Packages for machine engineering products. General requirements;"
b. Conditions of transport
   i. NP-053-16, "Safety rules to be observed during transport of radioactive materials," Federal Service for environmental, technological, and atomic supervision, Moscow, 2016; NP-061-05, "Safety rules to be observed during storage and transportation of nuclear fuel at the objects implementing atomic energy;"
   ii. NP-063-05, "Nuclear safety rules for the objects of nuclear fuel cycle;"
c. Analyses
   i. NRP-93, "Norms substantiating strength calculations for transportation packaging carrying nuclear fissile materials;"
   ii. PBYA-06-00-96, "Principal branch-wide rules of nuclear safety encompassing usage, recycling, storage and transportation of nuclear-hazardous fissile materials;"
   iii. PBYA-06-09-90, "Nuclear safety rules in the process of storage and transportation of nuclear-hazardous fissile materials;"
   iv. PNAE G-7-002-86, "The Calculation Norms and Strength of Equipment and Pipelines for Nuclear Power Facilities," (Norms

and regulations in nuclear power engineering), Moscow, Energoatomizdat, 1989.

d. Welds and Materials Properties

i. PNAEG-7-009-89, “Equipment and pipelines of atomic energy facilities. Welding and ad-welding. General provisions;”

ii. PNAEG -7-010-89, “Equipment and pipelines of atomic energy facilities;”

iii. “Welded joints and ad-welds. Rules to be observed during control,” International code of marine transportation of hazardous cargo (IMDG-Gode);

iv. “Physico-Mechanical Features of Structural Materials and Some Methods of Studying Them: Reference Book,” Moscow, TPNIIAtomInform, 1982.

These references are used in the design of the package and described in Section 2.1.4 of the application.

The staff needs this information to determine compliance with the requirements in paragraphs 722, 726, and 727 of the IAEA SSR-6, 2012 Edition.

Thermal Evaluation

RSI-Th-1 Provide the decay heat value for the TVS-K fuel assemblies listed as contents for the Model No. TK-C69 transportation package.

In Section 3.1.2, “Decay heat of the contents,” of the application, the applicant noted, that the decay heat is not applicable to the TK-C69 package loaded with unirradiated TVS-K fuel cells.

Even if the decay heat is negligible, the applicant should provide an estimated decay heat in the application in order for the staff to determine that the use of a negligible decay heat is acceptable for the thermal evaluation.

The staff needs this information to determine compliance with the requirements in paragraph 653 of the IAEA SSR-6, 2012 Edition.

RSI-Th-2 Provide an evaluation that demonstrates that the stresses from any interferences between packaging components will not have a negative impact on the package thermal performance under an extreme cold temperature of -40°C in still air and shade.

Paragraph 639 of the SSR-6, 2012 Edition, requires that the design of the package considers temperatures ranging from −40°C to 70°C for the components of the packaging. The applicant should provide an evaluation that demonstrates that the thermal stresses, caused by either spatial temperature gradients in constrained package components or by interference between components due to differential thermal expansion of the components, will not have a negative impact on the thermal performance of the package for an ambient temperature of -40°C (-40°F) in still air and shade.

The staff needs this information to determine compliance with the requirements in paragraph 639 of the IAEA SSR-6, 2012 Edition.

RSI-Th-3 Provide clarification on the convective heat transfer conditions used in the HAC thermal evaluation for the TK-C69 transportation package.

During the hypothetical fire accident, the heat is exchanged through convective and radiative heat transfer between the package surface and the flame for the 30-minute fire and between the package surface and the ambient for the post-fire cooldown. The applicant, in Section 3.5.1.1 of the application, described that the convection heat transfer coefficient ($\square_K$) is derived using heat conductivity, Nusselt number, cylinder diameter, Reynolds number and Grashoff coefficient.

The applicant should provide the convective heat transfer coefficients (a) between the package surface and the fire source for the 30-minute fire and (b) between the package surface and the ambient air for the post-fire cooldown.

The staff needs this information to assure that the convective heat transfer coefficients are used appropriately in the HAC thermal evaluation, consistent with the thermal phenomena.

The staff needs this information to determine compliance with the requirements in paragraph 728 of the IAEA SSR-6, 2012 Edition.

RSI-Th-4 Provide an evaluation of the thermal expansion/stress due to temperature variations between packaging components under the HAC fire. The evaluation of thermal stress should be based on the thermal analysis using emissivities mentioned in thermal RSI-Th-3.

The applicant needs to provide evaluation on thermal expansion caused by temperature variations between packaging components under the HAC fire and assure that the induced thermal stress will not cause negative impact to the package thermal performance under the HAC fire. Evaluation of the thermal expansion/stress should be based on the thermal analysis using emissivities mentioned in thermal RSI-Th-3.

The staff needs this information to determine compliance with the requirements in paragraphs 653(b) and 728 of the IAEA SSR-6, 2012 Edition.

RSI-Th-5 Identify the gaps between the components of the package and clarify whether the gaps between components have been considered and simulated in the thermal model(s) for the HAC fire analysis.

The gap between two adjacent components has the significant impact to the packaging component temperatures during the HAC fire. The tiny gap between components may even disappear due to component thermal expansion (e.g., steel) at an elevated temperature and transfer more heat into the package during the HAC fire.

The applicant should identify gaps in the package and clarify whether the gaps between components are considered and simulated in the HAC thermal model. In general, the staff considers it conservative to assume no gaps between components during the 30-minute fire (to maximize heat input to the package) and then to introduce gaps in the post-fire cooldown analysis.

The staff needs this information to determine compliance with the requirements in paragraphs 653(b) and 728 of the IAEA SSR-6, 2012 Edition.

RSI-Th-6 Provide the basis for the thermal properties of the thermal equivalent TVS-Square (TVS-K) fuel.

The applicant presented the thermo-physical characteristics of the packaging materials in Table 3-2 of the application. Section 3.5.1.1 of the application states that the fuel assembly is modeled as a thermal equivalent (a solid rod with thermal characteristics). The applicant should provide the basis for the thermal properties assigned to the thermal equivalent TVS-Square (TVS-K) fuel, clearly describing how the thermal properties of the simplified fuel model are representative of the TVS-K fuel assembly.

The staff needs this information to determine compliance with the requirements in paragraph 728 of the IAEA SSR-6, 2012 Edition.

Package Operations

RSI-Co-7-1 Specify the closure torque values for the Model No. TK-C69 in Chapter 7, “Package operation,” of the application.

Chapter 7 of the application does not specify torque values. Because licensing drawings were not provided, it is not clear if torque values were provided on the licensing drawings to ensure closure of the package prior to each shipment.

The staff needs this information to determine compliance with the requirements in paragraphs 503(d) and 641 of the IAEA SSR-6, 2012 Edition.

Quality Assurance

QA-RSI-1 Provide a description of the quality assurance program(s) implemented during the design and fabrication activities performed for the packages planned to be transported to the United States.

Section 7 of the certificate issued by the Russian competent authority lists the quality assurance programs and provisions implemented to ensure the quality of the TK-C69 package. However, the application does not provide a description of the applicable programs and corresponding provisions. This information is needed to determine the adequacy of these programs to the related international and national quality assurance standards.

The staff needs this information to determine compliance with the requirements in in paragraph 306 of the IAEA SSR-6, 2012 Edition.

OBSERVATIONS

OBS-OP-1 Specify a section number for the thermal analyses under Section 8.1.7, “Thermal Tests,” of the application.

The applicant should add a section number at the end of the statement, “Estimations of thermal characteristic of TK-C69 in normal and accidental transportation conditions are presented in **Section,**” Section 8.1.7, “Thermal Tests,” of the application.

OBS-M-1 Provide justification that the load-bearing ferritic steel components have adequate resistance to brittle fracture at -40°C.

Section 2.6.2 of the application states that the thermally-treated load-bearing structural steels are not subject to brittle fracture. The staff requires information to justify the absence of toughness testing of the ferritic steels, such as supporting technical references or exceptions to such requirements in applicable codes or standards.

The staff needs this information to determine compliance with the requirements in paragraph 639 of the IAEA SSR-6, 2012 Edition.

OBS-Th-1 Provide a thermal analysis for HAC using an average emissivity coefficient of at least 0.9 for the HAC 30-minute fire and an average emissivity coefficient of less than or equal to 0.8 for the post-fire cooldown.

The applicant noted in Section 3.5.1.1, “Basis of simulations,” of the application that under fire conditions, the emissivities of the package surface and the environment were taken equal to 0.8 and 0.9, respectively. The applicant calculated a reduced emissivity by applying 0.8 and 0.9 to the formula for diffuse, gray, two-surface enclosure for infinite parallel plates and used the reduced emissivity in thermal code ANSYS.

The staff points out that for HAC 30-minute fire, the radiation feature between package surface and flame is different from the radiation feature between two “parallel” plates. Therefore, the formula provided by the applicant in Section 3.5.1.1 is not applicable to HAC (an engulfed fire scenario).

The staff needs this information to determine compliance with the requirements in paragraph 728(a) of IAEA SSR-6, 2012 Edition.

EDITORIAL

1. In Chapter 4, “Containment,” of the application, correct the typo “ration” and change to “radiation.”

2. Correct the use of the word “insulation” in the application to “insolation” or “solar heat”.

The applicant described the solar heat in thermal analyses of the initial conditions of the HAC, and the HAC post-fire cooldown in Attachment 3 of the application, but mistyped “insolation” with “insulation.” The applicant should correct typo “insulation” to either “insolation” or “solar heat” in Attachment 3 (e.g., Sections 3.5.1, Table 3-5, etc.) of the application.