AREVA

May 21, 2015
E-41950

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Application for Renewal and Revision to Certificate of Compliance No. 9233 for the Model No. TN-RAM Transportation Packaging, Response to Request for Supplemental Information (Docket No. 71-9233, TAC Nos. L25001 and L25002)

References: Letter from John Vera (NRC) to Paul Triska (AREVA Inc.), "Renewal and Amendment Application for Model No. TN-RAM - Request for Supplemental Information," May 1, 2015.

Letter E-41224, dated March 9, 2015, "Application for Revision 13 to Certificate of Compliance No. 9233 for the Model No. TN-RAM Transportation Packaging, Docket No. 71-9233."

This submittal provides responses to the request for supplemental information (RSI) forwarded by the NRC letter referenced above.

This submittal contains the following enclosures:

- Enclosure 1 provides each RSI item, followed by an AREVA Inc. response.
- Enclosure 2 provides the changed pages for the proprietary version of the TN-RAM Safety Analysis Report (SAR), Revision 14. The latest changed areas are indicated by revision bars in the right margin and italics for inserted text, with "Rev. 14" in the page header.
- Enclosure 3 provides the changed pages for the non-proprietary version of the SAR, Revision 14. The latest changed areas are indicated by revision bars in the right margin and italics for inserted text, with "Rev. 14" in the page header, with the proprietary information redacted.
- Enclosure 4 provides a listing of the thermal and shielding computer files that are contained in Enclosure 5.
- Enclosure 5 provides the computer files supporting the thermal and shielding analysis. This enclosure is proprietary.
- Enclosure 6 provides the proposed changes to CoC 9233, Revision 12.
- Enclosure 7 provides an affidavit, in accordance with 10 CFR 2.390, specifically requesting that you withhold proprietary information included in Enclosures 2 and 5 of this submittal from public disclosure. That information may not be used for any purpose other than to support the review of the application for revision to the TN-RAM CoC.

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NMSS01

Should the NRC staff require additional information to support review of this application, please do not hesitate to contact Mr. Glenn Mathues at 410-910-6538, or me at 410-910-6820.

Sincerely,

Paul A Triska

Paul Triska
Vice President, Technical Services

cc: John A. Vera, U.S. Nuclear Regulatory Commission
- One electronic copy (DVD) of this letter and Enclosures 1, 2, 4, 6, and 7
- One electronic copy (DVD) of Enclosure 5

Enclosures:

1. RSI Responses
2. Changed Pages, TN-RAM SAR, Revision 14 (Proprietary)
3. Changed Pages, TN-RAM SAR, Revision 14 (Non-Proprietary)
4. Listing of Computer Files Contained in Enclosure 5
5. One DVD Containing Thermal and Shielding Computer Files (Proprietary)
6. Proposed Changes to CoC 9233, Revision 12
7. Affidavit Pursuant to 10 CFR 2.390

Enclosure 1 to E-41950

RSI Responses

THERMAL EVALUATION

RSI 3-1

Identify and provide cask component temperature limits.

The safety analysis report (SAR) Chapter 3, provides the thermal analysis results of the cask components but does not provide any specified thermal limits of these components to be compared to. These limits should be clearly identified so staff can perform a thermal evaluation.

This information is required to determine compliance with 10 CFR 71.33 and 71.43.

TN Response to RSI 3-1

The explicit temperature limits for cask components discussed in Section 3.1 are revised to include additional information regarding the seal and lead temperature limits. These limits are also added in SAR Tables 3-1, 3-4, and 3-7.

The temperature range for the Parker O-ring is also updated in SAR Section 3.3 according to its material report (Ref. 3-6 in SAR Section 3.6).

Explicit temperature limits are not defined for the other cask components, because:

- For the components in SAR Tables 3-1, 3-4, and 3-7 without specified temperature limits, the thermal design functions of the components do not have a specific temperature limit that would degrade their heat transfer characteristics.
- For the remaining components that have a structural and/or confinement function such as the outer shell, inner shell, and lid, the structural evaluations in SAR Sections 2.6 and 2.7 account for the maximum temperatures determined in the thermal evaluation to ensure that structural and/or confinement function is preserved under all conditions transport.

Notes regarding the components without an explicit temperature limit are also added in SAR Tables 3-1, 3-4, and 3-7 for completeness.

RSI 3-2

Clarify if the vent and drain port seals are captured in the term "lid seals" in the analysis and results.

a. SAR Table 3-1 provides a Summary of Results of cask components including "Lid Seals". It is not clear if this term includes vent and drain port seals in addition to the cask closure lid seals. The applicant should clarify if this term includes the vent and drain port seals so the staff can perform a thermal evaluation.

b. If the term "lid seals" does not include the vent and drain port seals, temperature limits and maximum temperatures under normal conditions of transport (NCT) and hypothetical accident conditions (HAC) should be provided for these seals so staff can perform a thermal evaluation.

This information is required to determine compliance with 10 CFR 71.33 and 71.43.

TN Response to RSI 3-2

The terms "Lid Seals" or "Seals" in Safety Analysis Report (SAR) Tables 3-1, 3-4, and 3-7 do not include the vent and drain port seals. Temperature limits and maximum temperatures under NCT and HAC are added for the vent and drain port seals in SAR Sections 3.3 and 3.4.6, and SAR Tables 3-1, 3-4, and 3-7.

SAR Figure 3-8 is also revised to include the temperature history of the vent and drain port seals for HAC.

RSI 3-3

Explain how a maximum temperature of 115°F, for all package components, without insolation was determined in SAR Section 3.4.4.

SAR Section 3.4.4 states that "A review of the TN-RAM cask thermal evaluation without solar insolation shows that the maximum temperature among all the cask components is 115°F and is only 15°F higher than the ambient temperature of 100°F." SAR Table 3-4 shows the maximum temperature among all cask components under NCT is 148°F with insolation. The staff needs to understand how a maximum temperature of 115°F without insolation was determined so a review can be performed.

This information is required to determine compliance with 10 CFR 71.43.

TN Response to RSI 3-3

The maximum temperature of the cask components without insolation is determined by re-evaluating the thermal model described in Safety Analysis Report (SAR) Section 3.4.1. For this evaluation, the heat flux due to the solar insolation was reduced to zero. The statement in SAR Section 3.4.4 is revised as "The result from the thermal evaluation of the TN-RAM cask under NCT without solar insolation shows that the maximum temperature among all the cask components is 115 °F and is only 15 °F higher than the ambient temperature of 100 °F."

In addition, the computational model of this load case is submitted for NRC review.

RSI 3-4

Provide the temperature of the contents in the thermal analysis so that a review can be performed.

SAR page 3-11 states "Because the contents of the packaging are irradiated solid materials with a low decay heat load, the temperature of the contents is not a major concern and is not evaluated. Therefore, the cavity liner is not included in the model." The decay heat load of the contents is 500 watts, which is relatively high and warrants a determination of content temperature.

This information is required to determine compliance with 10 CFR 71.43.

TN Response to RSI 3-4

As described in Safety Analysis Report (SAR) Section 1.2.3, the TN-RAM is designed for the shipment of a payload of 9500 lbs of various types of dry irradiated reactor hardware. The payload will vary from shipment to shipment and will consist of predominantly the following components either individually or in combinations:

1. Boiling water reactor (BWR) control rod blades
2. BWR local power range monitors (LPRMs)
3. BWR fuel channels
4. BWR poison curtains
5. Pressurized water reactor (PWR) burnable poison rod assemblies (BPRAs)

As such, there is no temperature limit for the payload in the SAR. A removable canister called cavity liner (or secondary container) is used for safe and convenient loading and unloading of the payload to and from the TN-RAM cask.

To calculate the maximum temperature of the payload inside the second container/cavity liner, thermal evaluation is performed by considering the homogenized payload for NCT.

The effective thermal conductivities of the homogenized payload are calculated by multiplying the steel properties listed in SAR Table 3-2 with the solid payload volume ratio of 0.295, calculated as volume of payload without a cavity liner divided by volume of homogenized payload. Total heat load of 500 W is applied as homogenized heat generation rate within the homogenized payload.

The comparison of cask components temperatures with and without the homogenized payload content (including cavity liner) is shown in the table below:

TN Response to RSI 3-4 (con't)

Components	**TN-RAM modeled without Payload** at NCT with 500 W and 24 hrs average insolation	**TN-RAM modeled with homogenized Payload** at NCT with 500 W and 24 hrs average insolation	**$\Delta T = T_{Paylod} - T_{No\_Payload}$** (°F)
	$T_{No\_Payload}$ (°F)	$T_{Payload}$ (°F)	
Outer Surface	143	140	-3
Outer Shell	144	141	-3
Lead	148	143	-5
Inner Shell/Cavity Wall	146	142	-4
Lid	146	141	-5
Lid Seals	145	141	-4
Vent Port Seal	146	141	-5
Drain Port Seal	144	141	-3
Homogenized Payload	--	163	

As shown in the above table, the maximum temperature of the contents (payload/cavity liner) in thermal analysis is 163 °F and is about 21 °F higher than the maximum cask inner shell temperature.

However, the maximum temperatures of cask components with homogenized payload are bounded by thermal evaluation without payload.

Therefore, thermal evaluation in SAR Chapter 3, based on thermal analysis without payload content, remains bounding.

The computational model of this load case is submitted for NRC review.

RSI 3-5

Clarify the term "cavity liner" and explain why it was not included in the model.

SAR page 3-11, states "Because the contents of the packaging are irradiated solid materials with a low decay heat load, the temperature of the contents is not a major concern and is not evaluated. Therefore, the cavity liner is not included in the model."

a. Clarify the term "cavity liner." The heat flux is applied to the cask body inner shell which is typically the most inner cask component. Explain what the "cavity liner" is.

b. If the "cavity liner" is another layer of material that fits inside the inner shell and is most adjacent to the contents, explain why it is not included in the model, recognizing that cask components that are closest to the contents will be the hottest and, generally, should be included in the model.

This information is required to determine compliance with 10 CFR 71.43.

TN Response to RSI 3-5

The TN-RAM cavity liner (or secondary container) is a removable canister designed for safe and convenient loading and unloading irradiated metal components to and from the TN-RAM cask. The cavity liner does not provide any structural, thermal, or criticality control or containment functions. There is no temperature criteria associated with the cavity liner and the self-weight is included in the maximum allowable payload weight of 9,500 lbs.

See the Response to NRC RSI 3-4 for component temperatures for analyses with and without the cavity liner.

SHIELDING EVALUATION

RSI 5-1

Demonstrate that the shielding analyses bound the contents that are to be shipped.

The analyzed contents in the shielding analysis (SAR Chapter 5) do not appear to bound the description of the proposed description of the contents in Section 5(b) within the draft certificate of compliance (CoC) in Enclosure 7 to the application's transmittal letter. For example, there is no description of the size and geometry of the contents within the draft CoC, however, in all analyzed configurations for the shielding analyses, some volume of stainless steel is assumed and self-shielding is credited in some way. Based on the contents description in Section 1.2.3 of the SAR, the proposed contents do not appear to be concentrated point sources; however the description in the CoC would not prohibit a concentrated point source from being shipped in the TN-RAM. Either include specifications for the proposed contents that match the assumptions in the shielding analysis or revise the shielding analysis in Chapter 5 of the SAR to be more generalized (i.e., a point or line source that credits no geometry or self-shielding).

This information is needed to determine compliance with 10 CFR 71.33(b), 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

TN Response to RSI 5-1

Section 1.2.3 of the TN-RAM SAR is revised to include a specific activity limit for the contents in the TN-RAM transportation package. The purpose of this limit is to quantify the self-shielding credit taken in the analysis for normal conditions of transport (NCT). During loading, operators would calculate the total activity of the contents divided by the total mass of the contents. The result must be less than the limit of 10 Ci/kg. This limit is also added to the proposed CoC. Full compliance with regulatory dose rates is demonstrated.

RSI 5-2

Discuss the use of the secondary container in the shielding analyses. Provide drawings of this component as necessary.

SAR Section 1.2.3 states: "The TN-RAM is designed to transport a payload of 9,500 lb of dry irradiated and contaminated, non-fuel-bearing solid materials (with only trace quantities of fissile materials present a contamination) in secondary containers. The safety analysis of the TN-RAM takes no credit for the containment provided by secondary containers." Section 5.1 states: "No credit is taken for the secondary container in the TN-RAM package to meet the shielding requirements." However Section 5.3.1 states that: "All source configurations are contained in a postulated 1 inch thick secondary container. The secondary container is modeled as air; however, the secondary container is part of the contents and the 9,500 lb (4309 kg) maximum payload... The secondary container was assumed to be 108 inches tall and sits on the bottom of the cask cavity. Some space is expected to remain at the top for the secondary container lid and handling equipment."

The staff finds the discussions about the secondary container to be contradictory. Although it appears as though the secondary container's shielding properties are not credited for radiation attenuation, it is still credited to contain the material under NCT and its geometry is also credited in shoring the material. This may be beneficial to safety as it appears that there could be radiation streaming over the lead shielding at the top of the cask side and if the material is assumed to stay within the secondary container, it is held below this streaming path.

In addition, if the secondary container fails, material could migrate around the cask during transport and find its way in a less conservative position than it is currently analyzed, perhaps near a streaming path or into the bottom cavity drain. If the secondary container is not credited for shoring material in this manner, the possibility of material migration in a less conservative position should be addressed and analyzed, and the shielding analyses should demonstrate that the failure of this component would not cause NCT dose rates to increase beyond regulatory limits. If the secondary container is necessary, a licensing drawing incorporating the container into the design needs to be provided, as well as a discussion addressing the structural effects of NCT on this component.

This information is needed to determine compliance with 10 CFR 71.33(a), 10 CFR 71.47(b) and 10 CFR 71.47(a)(2).

TN Response to RSI 5-2

Chapter 5 of the TN-RAM SAR is revised to address this question. Geometric credit for the secondary container has been removed in the analysis. Full compliance with regulatory dose rates is demonstrated.

RSI 5-3

Provide additional information on establishing package activity limits for nuclides with gamma energies higher than that of Co-60.

SAR Section 1.2.3 states that radioactive contents are: "maximum of 30,000 Ci Cobalt-60 or equivalent. Equivalency to other radionuclides is determined by the total energy in its spectrum." Section 5.2.1 shows how this equivalency is determined. It appears that the goal of this conversion is to preserve the energy per second, however it does not provide any information about how the non-Co-60 material is attenuated by the package shielding. There is a lower probability of lower energy gammas escaping the package than higher energy gammas. If the gamma energy is lower than that of the average Co-60 gammas, than the conversion to energy per second is conservative, however if it is higher it is non-conservative. Discuss additional measures needed to ensure non-Co-60 nuclides would meet package limits. Specifically address those nuclides with higher energy gammas.

This information is needed to determine compliance with 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

TN Response to RSI 5-3

Chapter 5 of the TN-RAM Safety Analysis Report (SAR) is revised to address this question. A new analysis is added, which calculates the maximum activity as a function of energy for gamma emission from 1-10 MeV. For radionuclides other than cobalt-60, the maximum activity is limited depending on the weighted average emission energy. Further explanation is provided in Section 5.5.3 of the SAR. A condensed version of the Table 5-14 is included in the proposed Certificate of Compliance (CoC). Full compliance with regulatory dose rates is demonstrated.