AREVA

November 20, 2015
E-43837

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, Supplement to Response to Request for Additional Information (Docket No. 71-9233, TAC Nos. L25001 and L25002)

References: (1) Letter E-43104, dated October 8, 2015, "Application for Renewal and Revision to Certificate of Compliance No. 9233 for the Model No. TN-RAM Transportation Packaging, Response to Request for Additional Information (Docket No. 71-9233, TAC Nos. L25001 and L25002)"

(2) Letter from John Vera (NRC) to Paul Triska (AREVA TN), "Renewal and Amendment Application for Model No. TN-RAM - Request for Supplemental Information," September 14, 2015

Pursuant to request for additional information (RAI) discussions with the NRC, this submittal provides revised responses specific to RAI questions RAI 5-1, RAI 5-2, RAI 5-4 through RAI 5-8, RAI 5-11 and RAI 5-13. Please disregard the original responses for the above-listed RAIs provided in Reference (1).

In support of this supplement, this submittal contains the following enclosures:

- Enclosure 1 provides each RAI item, followed by an AREVA TN revised response.
- Enclosure 2 provides the changed pages for the proprietary version of the TN-RAM Safety Analysis Report (SAR), Revision 15A. These changed areas are indicated by revision bars in the right margin, italics for inserted text, "Rev. 15A" in the page header, and the Revision 15A changes are gray shaded to distinguish them from the changes included in Revision 15.
- Enclosure 3 provides the changed pages for the non-proprietary version of the SAR, Revision 15A. These changed areas are indicated by revision bars in the right margin, italics for inserted text, "Rev. 15A" in the page header, and the Revision 15A changes are gray shaded to distinguish them from the changes included in Revision 15.
- Enclosure 4 provides a listing of the shielding computer files that are contained in Enclosure 5.
- Enclosure 5 provides the computer files supporting the shielding analysis. This enclosure is proprietary.

AREVA TN

AREVA Inc.
7135 Minstrel Way • Suite 300 • Columbia, MD 21045
Tel: 410-910-6900 • Fax: 410-910-6902
www.areva.com/AREVATN

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- Enclosure 6 provides the proposed changes to Certificate of Compliance (CoC) 9233, Revision 12. These changed areas are indicated by revision bars in the right margin, italics for inserted text, and gray shaded to distinguish these from the Enclosure 6 changes included in Reference 1.
- 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.

Based on communications with the NRC during the course of this licensing action, AREVA TN respectfully requests to be notified once the NRC has completed the safety review and determines that no additional information is required for issuance of the CoC, in order to submit a consolidated Revision 16 to the SAR (both the proprietary and the non-proprietary version), which incorporates all the changes completed during the course of this review.

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 W Triska

Paul Triska
Vice President, Technical Services

Norma Garcia Santos, U.S. Nuclear Regulatory Commission

- One electronic copy (computer disk) of this letter and Enclosures 1, 2, 4, 6, and 7
- One electronic copy (computer disk) of Enclosure 5

Enclosures:

1. RAI Responses
2. Changed Pages, TN-RAM SAR, Revision 15A (Proprietary)
3. Changed Pages and Revised Drawings, TN-RAM SAR, Revision 15A (Non-Proprietary)
4. Listing of Computer Files Contained in Enclosure 5
5. One Computer Disk Containing Shielding Computer Files (Proprietary)
6. Proposed Changes to CoC 9233, Revision 12
7. Affidavit Pursuant to 10 CFR 2.390

Enclosure 1 to E-43837

RAI Responses

SHIELDING EVALUATION

RAI 5-1

Discuss if there will be concentration of sources.

All of the shielding analyses performed for the TN-RAM assume that the source is uniformly distributed throughout the content. This assumption becomes non-conservative if a single part of the content is more highly activated than another. The staff notes that in response to RSI 5-1, the applicant stated that it included a specific activity limit in Section 1.2.3 of 10 Ci/kg. In its response it states: *"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."* Although this limit would ensure a certain amount of material to be present per activity, it does not control how the activity would be distributed throughout that content and would not prohibit highly concentrated source material within the presence of other low activity material.

Per the current shielding analyses, within the CoC, the staff will have to prohibit the TN-RAM from transporting concentrated source material and put a condition that contents activity shall be uniformly distributed.

If these requirements are too restrictive to meet the transportation needs for the TN-RAM, the applicant needs to provide additional information/analyses on how activity distribution is controlled. They should include and justify the limits on distribution of the activity and/or include operating procedures within Chapter 7 of the SAR that ensure that highly activated material cannot be concentrated within a single location within the package.

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

AREVA TN Revised Response to RAI 5-1

Activity throughout the package will be controlled by placing the following restriction on the contents: discrete components must have an average specific activity of less than or equal to 10 Ci/kg of Co-60 or equivalent. When computing the specific activity, the mass of low-density materials that contain negligible source (such as boron carbide) is conservatively neglected, as noted in Section 5.2.1 of the SAR.

This restriction will ensure the radioactivity distribution is nearly uniform.

The Co-60 equivalence methodology presented in Section 5.5.3 has been updated to provide equivalence for specific activity (10 Ci/kg) as well as total activity (30,000 Ci).

SAR Impact:

Section 5.5.3 has been revised as described in the response.

RAI 5-2

Specify which bulk materials other than stainless steel that can be shipped as a content in the TN-RAM and either justify that stainless steel is representative or bounding when considering self-shielding or provide analyses with the other self-shielding medium(s).

The current proposed certificate of compliance (CoC) does not include a description of what the contents are made of, only its radioactive properties. The discussion in Section 5.3.1 *"Configuration of Source and Shielding,"* of the SAR states that the four source configurations are all modeled with stainless steel. Since the shielding analyses only model stainless steel, based on this the staff must limit the TN-RAM CoC contents to activated steel. However per Section 1.2.3 of the SAR, some typical contents are made of Zirconium and would be excluded if the staff limited the contents to activated steel. The applicant needs to state all of the bulk materials that could be shipped (excluding materials in trace amounts) and discuss if modeling stainless steel self-shielding is either representative or bounding for all these materials or provide additional or updated shielding analyses including consideration materials' self-shielding.

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

AREVA TN Revised Response to RAI 5-2

The radioactive content will be limited to material which provides at least the attenuation of stainless steel. Materials that shield more effectively than stainless steel are authorized. For example, lead that has become activated would be an allowed content.

Section 5.2.1 of the SAR provides the requirements on source material in regard to self-shielding performance.

SAR Impact:

Section 5.2.1 has been revised as described in the response.

RAI 5-4

Justify the following configurations chosen for the evaluation for the "normally occupied space."

The 5 meter dose rate represents the "normally occupied space" per 10 CFR 71.47(b)(4). The applicant should justify this evaluation is appropriate by addressing the following:

a) Footnote 1 to Table 5-12 of the SAR states: "These tallies are averaged over a large surface to show that an operator in the vicinity of the package will experience less than 2 mrem/h." The applicant should explain what is meant by "large surface" and justify that this is appropriate.

b) For a horizontally oriented cask the "top" and "bottom" dose rates are evaluated. The staff does not understand why the top disk source is not limiting for this evaluation. The applicant should discuss any factors that would cause the homogenized cylinder to produce higher dose rates for this evaluation.

c) The operating procedures discuss vertical shipment of this cask. The applicant should evaluate the dose rate for the "normally occupied space" when the cask is oriented vertically and they also need to justify the choice of the source modeling configuration (top disk, homogenized, etc.).

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

AREVA TN Revised Response to RAI 5-4

a) There is no change to this response. The initial response remains valid.

b) Cases described in Section 5.3.1 were run for a longer period of time to improve convergence. Dose rates for the top disk source now bound the top of the package, as shown in the revision toTable 5-12. More information is contained in Section 5.4.4.7 of the TN-RAM SAR.

c) There is no change to this response. The initial response remains valid.

SAR Impact:

Section 5.4.4.7 and Table 5-12 have been revised as described in the response.

RAI 5-5

Justify the results in Table 5-12 of the SAR.

The applicant needs to provide justification for the following:

a. Staff is not clear on how the homogenized cylinder shows higher radial dose rates than the annulus since the applicant is evaluating dose rate by averaging tallies around the entire radius. Section 5.4.4 of the SAR states: *"There is no angular segmentation for any tally."*

b. The staff expects that the disk at the bottom to produce the highest dose rates calculated at the bottom of the package in all cases, however, Table 5-12 of the SAR shows that the homogenized cylinder gives a higher dose rate at 2 meters. The applicant should justify why the homogenized cylinder shows higher dose rates at the bottom than the bottom disk.

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

AREVA TN Revised Response to RAI 5-5

In response to RAI Items a and b, cases developed and shown in the Section 5.3.1 were run for a longer period of time to improve convergence. Dose rates for the disk bottom now bound the bottom of the package. These revised results are shown in Table 5-12. The homogenized and annular cases have the same radial self-shielding and similar 2 m dose rates. More information is contained in Section 5.4.4.7 of the TN-RAM SAR.

SAR Impact:

Section 5.4.4.7 and Table 5-12 have been revised as described in the response.

RAI 5-6

Justify the source geometry for HAC.

Section 5.3.1 states: *"For the HAC evaluation, the source was placed inside the package using the homogenized source dimensions and location."* Although the staff is aware that there is no self-shielding evaluated during HAC, as discussed in Section 5.3.1 of the SAR, the applicant should justify that this conservatism is enough to compensate for any source concentration that may occur during HAC. Other packages that show large margins to HAC dose rate limits do not credit source distribution (i.e. they use a point or line source as appropriate).

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

AREVA TN Revised Response to RAI 5-6

Section 5.4.4.2 of the TN-RAM SAR has been revised to include additional discussion and analysis in response to this question. New cases have been added where the homogenized case has been compressed by a factor of 3, axially, while taking no credit for self-shielding for the HAC analysis. Results show that the dose rate limits are met, while dose rates increase depending on how the source was concentrated. Increases in the dose rates are the result of source above the top of the radial lead shielding, which is easily seen in Table 5-15. In practice, the secondary container, not credited in this analysis, will prevent source bearing material from reaching this location. Sections 5.1.2, 5.3.1, 5.4.4, and Table 5-15 have been revised with conforming changes in response to this RAI.

SAR Impact:

Sections 5.1.2, 5.3.1, and 5.4.4, and Table 5-15 have been revised as described in the response.

RAI 5-7

Justify the size of the segments for the mesh tallies (detectors) used to evaluate the dose rates and justify that streaming was adequately accounted for under NCT and HAC.

Section 5.4.4 states: *"Radial tallies are segmented axially between 20 and 22 cm. Axial tallies are segmented radially approximately 22 cm."* The applicant should justify that these segments are small enough to evaluate the effects of streaming. The staff is interested in the area in the axial and radial directions between the lead shielding in the cask body and the lid. The area above the lead shielding is of specific importance during HAC shielding evaluation where there is lead slump. In discussing streaming effects, the applicant should justify that the source configuration selected for this evaluation gives the highest dose rate (i.e. a more concentrated source, like the disk source at the top would exaggerate the effects of streaming more than the homogenous source, etc.).

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

AREVA TN Revised Response to RAI 5-7

Lead slump is not credible based on the analysis in Section 2.7.1.1 of the TN-RAM SAR. However, a non-credible lead slump assumption was included in the analysis in Chapter 5 Revision 13 of the TN-RAM SAR, and has subsequently been removed in this revision for consistency.

The dose rates presented in Table 5-15 are sufficient enough to determine streaming exists in the model. Section 5.4.4.9 has been added to the TN-RAM SAR, in response to this question, to explicitly discuss streaming. Sections 5.1.2, 5.3.1, 5.4.4, and Table 5-15 have been revised with conforming changes in response to this RAI.

SAR Impact:

Section 5.4.4.9 has been revised and Sections 5.1.2, 5.3.1, and 5.4.4 have been revised as described in the response.

RAI 5-8

Discuss the use of variance reduction and how this was used in conjunction with the mesh tally and that all locations around the cask (including areas around streaming paths) were appropriately considered in the biasing.

Section 5.4.1 of the SAR states: *"Simple Russian roulette is used as a variance reduction technique for most tallies. The importance of the particles increases as the particles traverse the shielding materials."* The applicant should discuss how the importances were developed for each of the various tally locations (axial, radial, streaming paths, etc.) and justify that the variance reduction does not create any non-physical results.

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

AREVA TN Revised Response to RAI 5-8

The variance reduction technique is a population control method using geometry splitting and Russian roulette. Importances are assigned to cells in the problem. Regions are assigned importances that increase in a geometric progression, doubling for each cell as the particle moves from the source region toward the tally. As the particle moves forward from a cell of less importance and enters the next cell of greater importance, the entering particle is split into two particles. A particle moving back to a cell of less importance is killed with probability proportional to the importance ratio. The importance cells were assigned for every mean free path of an average Co-60 energy gamma ray in steel or lead. No variance reduction was required in air or in the wood of the impact limiters. Experience was used to guide the variance reduction technique. The various TN-RAM configurations are modeled in Monte Carlo N-Particle as concentric, cylindrical volumes, where the importances are increased from the inner to the outer volumes. The importances in this case only serve to accelerate the convergence of the tally, where the associated tally variance indicates whether the tally is well converged or not. Cases described in Section 5.3.1 were recomputed with increased run time to reduce the variance associated with the tally results. Revised results are shown in Table 5-12 with associated variance of less than or equal to two percent for most tallies.

SAR Impact:

Section 5.3.1 and Table 5-12 have been revised as described in the response.

RAI 5-11

Clarify the contents of the package.

The draft CoC includes "2,727 A_2" as an allowable content. A limit of "2,727 A_2" is ambiguous. The gamma source term in the shielding evaluation is based on 30,000 Ci Co-60 with equivalence to other gamma emitting nuclides, as discussed in Section 5.5.3 of the SAR. However, there are no analyses for alpha, beta or neutron sources. Since alpha and beta radiations are typically not challenging to the shielding employed in this package, the staff can only assume that 2,727 A_2 was meant for these radiation sources only.

Based on the shielding analyses as provided, the staff can only approve the following authorized contents in the CoC: 2,727 A_2 for alpha and beta sources only (assuming the additional information requested in RAI 5-13 is provided), with gamma sources limited to 30,000 Ci Co-60 or equivalent.

The applicant should clarify the limit of 2,727 A_2 from the draft CoC, and provide additional analyses justifying the shipment of up to 2,727 A_2 of gamma and neutron sources, if this is what this limit was intended for.

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

AREVA TN Revised Response to RAI 5-11

The proposed draft Certificate of Compliance (CoC) and the SAR have been revised to clarify that the allowable content as a function of A_2 applies to all radionuclides. A limit of 3,000 A_2 has been selected, which is the maximum for a Category II Type B package for containment safety. A_2 values are limits based on external photon dose, external beta dose, inhalation dose, skin dose, and ingestion dose resulting from contamination transfer and submersion dose. The 3,000 A_2 includes the gamma emitting radionuclides as well as alpha, beta, and neutron emitting radionuclides. Justification for this value is provided in new TN-RAM SAR Sections 5.2.3 and 5.4.4.10.

AREVA TN agrees with the staff's proposed limits for gamma emitting sources using the equivalence as described in Section 5.5.3 of the revised TN-RAM SAR.

In addition to this response, the response to RAI 5-12 addresses the analysis for neutron emitters and the response to RAI 5-13 addresses the analysis for beta emitters.

SAR Impact:

Sections 5.3.2 and 5.4.4.10 have been added as described in the response.

RAI 5-13

Justify, with an evaluation, that 2,727 A_2 is an acceptable content quantity limit for beta-emitting nuclides addressing the potential for significant generation of Bremsstrahlung.

For at least some beta-emitting nuclides, Bremsstrahlung may be significant as a source of radiation exposure from the package. This concern is particularly for those nuclides that emit high energy betas and the proposed content quantity limit allows for significant quantities of those nuclides to be transported. An example is P-32 with a maximum beta energy of 1.71 MeV (the average is 695 keV), emitted with each decay, and an A_2 value comparable to that of Co-60 (14 curies vs. 11 curies). A quantitative, as well as qualitative, justification is needed.

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

AREVA TN Revised Response to RAI 5-13

An evaluation was performed for 3,000 A_2 of ^{32}P to quantify the external dose rates as a result of bremsstrahlung radiation. The Bremsstrahlung contribution is small and will not cause external dose rates to exceed the maximum dose rates allowed for NCT or HAC. The TN-RAM SAR has been revised to include this analysis. The source used is discussed in new Section 5.2.3 of the SAR. Results are described in new Section 5.4.4.10 of the SAR. The new A_2 limit is discussed in the response to RAI 5-11.

SAR Impact:

Sections 5.2.3 and 5.4.4.10 have been added as described in the response.

Enclosure 3 to E-43837

Changed Pages, TN-RAM SAR, Revision 15A
(Non-Proprietary)

Non-Proprietary

SAFETY ANALYSIS REPORT
for the
TN-RAM

E-10621

November 2015

Revision *15A*

AREVA Inc.
7135 Minstrel Way, Suite 300
Columbia, Maryland 21045

TN-RAM SAR
REVISION LOG
E-10621

Rev. No.	Date	Description
15A	*11/25/15*	*Revised pages as follows:* *SAR cover sheet* *SAR pages 1-6 and 1-7* *SAR pages 5-i through 5-iii, 5-1, 5-3, 5-4, 5-6, 5-8 through 5-10a, 5-12 through 5-21, 5-23, 5-26, 5-27a, 5-35, 5-36* *New pages as follows:* *Revision Log page 6* *SAR page 5-10b* *Revised drawings as follows:* *None* *New drawings as follows:* *None*

groove machined in the penetration cover. Leak testing of this penetration is accomplished using a vacuum bell as described in Chapter Seven.

1.2.2 Operational Features

There are no complex operational features associated with the TN-RAM. The packaging is designed to accommodate wet or dry loading/unloading operations. Loading/unloading activities can be accomplished with the packaging either horizontal or vertical. The TN-RAM is uprighted from the horizontal transport orientation to the vertical position by lifting at two of the front trunnions and allowing the packaging to pivot about the rear trunnions while supported in the transport cradle. Both impact limiters are removed prior to this handling operation. Cask handling in the vertical position can be accomplished with either pair of opposing top trunnions, or with all four top trunnions if redundancy is required. For horizontal loading/unloading operations, the cask is left in the transport cradle. Significant design features which support wet operations include self-draining bolt holes in the cask body closure flange, two penetrations for draining/drying activities, and smooth stainless steel surfaces to minimize decontamination efforts.

The sequential steps to be followed for cask loading/unloading operations and pre-transport preparations including seal testing are provided in Chapter Seven.

1.2.3 Contents of Packaging

The TN-RAM is designed to transport a payload of 9,500 lbs of dry irradiated and contaminated, non-fuel-bearing solid materials (with only trace quantities of fissile materials present as contamination) in secondary containers. *For each shipment, the cask is normally filled to capacity, which prevents shifting of the contents during transport. If the container is not full, appropriate component spacers or shoring will be used to prevent shifting of the contents.*

The contents limit for all radionuclides is 3,000 A_2. The radioactive material is primarily in the form of neutron activated metals, or metal oxides in solid form. Surface contamination may also be present on the irradiated components. When a wet load procedure (i.e., in-pool) is followed for cask loading, cask cavity draining and drying is performed in order to ensure that free liquids do not remain in the package during transport. The safety analysis of the TN-RAM takes no credit for the containment provided by secondary containers.

The quantity of *gamma emitting* radioactive material is limited to a maximum of 30,000 Ci cobalt-60 or equivalent as described in Section *5.5.3*. The average specific activity of the contents is limited to 10 Ci/kg *of Co-60 or equivalent. Equivalence is described in Section 5.5.3. Materials must have the shielding capability of steel or greater.*

The decay heat load of the radioactive material is limited to a maximum of 500 watts.

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CHAPTER FIVE
SHIELDING EVALUATION

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SHIELDING EVALUATION

The shielding evaluation for the TN-RAM package is performed to demonstrate compliance with 10 CFR 71.47 and 10 CFR 71.51 as applicable.

The TN-RAM package is designed to transport a payload of 9500 lbs. (4309 kg) of dry, irradiated and/or contaminated non-fuel bearing solid materials (with only trace quantities of fissile material as limited by 10 CFR 71.15) in secondary containers containing a maximum of 30,000 Ci of cobalt-60 equivalent as described in this chapter. Material in the secondary container is secured using shoring during transport to prevent movement. No powdered material is authorized for transport. The package is shipped exclusive-use in an open transport vehicle. The cask is designed to be shipped horizontally during transportation with the lid end facing in the direction of travel. The lid end is considered the top in this evaluation. No credit is taken for the presence of the secondary container in this chapter.

The dose rates are computed using MCNP5 v1.40 [5-3].

Maximum dose rates for a normally occupied space which is assumed to be *152 inches* from the top of the TN-RAM package are shown in Table 5-1.

Hypothetical accident conditions (HAC) external dose rates are computed using the surfaces of the cask as the basis for the 1 m distance as prescribed by 10 CFR 71.51(a)(2). Compliance with release doses per 10 CFR 71.51(a)(1) and 71.51(a)(2) is shown in Chapter 4. The maximum external HAC dose rates are shown in Table 5-2.

5.2 RADIATION SOURCE

5.2.1 Gamma Source

The TN-RAM is evaluated to transport 30,000 Ci of cobalt-60 or equivalent consistent with the maximum for Category II packages.

The source is in the form of dry, solid, non-fuel bearing hardware with a cobalt-60 equivalent specific activity ≤ 10 Ci/kg. The specific activity for each item is defined as the total cobalt-60 activity equivalent of the item divided by the mass of source material. Source materials shall be either steel or a material that provides equivalent or superior gamma shielding than steel. Localized regions of low-density material (e.g., B_4C in a control rod blade) are acceptable if the low-density regions contain negligible source. The mass of any low-density regions shall not be credited in the specific activity calculation.

More than 99% of the disintegrations result in two gammas with energy of 1.17 and 1.33 MeV. Lower energy emission is considered to have the energy of the aforementioned gammas which is conservative. The source intensity is as follows:

$$(30\ 000\ \text{Ci})\left(3.7\text{x}10^{10}\ \frac{\text{disintegrations}}{\text{Ci s}}\right)\left(2\ \frac{\gamma}{\text{disintegration}}\right) = 2.22\text{x}10^{15}\ \gamma/\text{s}.$$

In most cases, isotopes other than cobalt-60 will also be present in the waste stream. These isotopes are converted to equivalent quantities of cobalt-60 following the methodology in Section 5.5.3. The equivalence methodology is based upon dose rate considerations.

The source is the same for the NCT and HAC evaluation. The evaluation methodology uses continuous energy cross sections so the energies for the gammas can be input and simulated directly. The energy distribution of the gammas is one half of the total intensity for each energy. The spatial distribution within the various source regions is isotropic in the axial direction and a power law distribution in the radial direction.

5.2.2 Neutron Source

The TN-RAM package is not licensed to transport fissile material greater than the limits prescribed in 10 CFR 71.15. No neutron generating source material beyond an inconsequential amount as a result of surface contamination is to be transported. *However, a source of $1\text{x}10^6$ neutrons per second is evaluated. The distribution of the neutron source is the same as the gamma source. The neutron source is based on a Watt fission spectrum for Cm-244.*

5.2.3 Beta Source

The TN-RAM package is evaluated to transport 3,000 A_2 of beta emitting radionuclides. Beta emitters can create bremsstrahlung radiation as the electrons are attenuated through high Z materials. Therefore, a source of 3,000 A_2 of phosphorus-32 is evaluated to determine the impact of bremsstrahlung. The distribution of the source is radially outward from the inner surface of the inner shell to amplify the effect. The betas are modeled at the maximum emission energy of phosphorus-32: 1.71066 MeV.

A payload mass of 3,000 kg *stainless steel* is considered to be the mass of the source bearing contents for the shielding evaluation. *The source material is limited to a cobalt-60 equivalent specific activity ≤ 10 Ci/kg. Source materials shall be either steel or a material that provides equivalent or superior gamma shielding than steel.*

Four NCT source bearing configurations are modeled. The first configuration is a homogenized cylinder sized to fit the interior of the cavity. *The payload mass of 3,000 kg stainless steel is homogenized within the available cavity volume, with a resulting density of 1.71 g/cm^3.* The dimensions of the homogenized source are shown in Table 5-5.

A disk source is postulated if the source bearing contents are shifted to the top or bottom. The disk is stainless steel at full density and radius to fit inside the cavity. The height is calculated to meet the mass target of 3,000 kg. The second configuration is a disk source placed at the bottom of the cavity; the third configuration is the same disk source placed at the top of the cavity. The disk source dimensions are shown in Table 5-6.

The *fourth* source configuration is an annulus. This source configuration moves the source bearing contents to the edges of the cavity. The height and outer radius of the annular source are sized to fit the cavity. The inner radius was calculated to meet the mass target of 3,000 kg. The center of the annulus was filled with air. The annulus is stainless steel at full density. The dimensions of the annular source are shown in Table 5-7.

The four postulated source configurations are shown in axial views in Figure 5-2 and in radial view in Figure 5-3. The radial views are slices through the approximate center of the respective source region.

For the HAC evaluation, the source was placed inside the package using the homogenized source dimensions and location. An axial cross section view of the TN-RAM package for HAC is shown in Figure 5-4. *Compression of the source was considered for the HAC analysis.*

5.3.2 Material Properties

All the steel in the model is assumed to be stainless steel type 304. The elemental composition and density are shown in Table 5-8 [5-2]. The source bearing material was also assumed to be stainless steel type 304.

The elemental composition and density of dry air used in the model are shown in Table 5-9 [5-2].

5.4 SHIELDING EVALUATION

5.4.1 Methods

The software package, Monte Carlo N-Particle (MCNP5), is used to evaluate the TN-RAM transportation package. MCNP5 is a robust, well-supported Monte Carlo transport code from Los Alamos National Laboratory utilized to compute dose rates for shielding licenses [5-3].

A three-dimensional model is developed that captures all of the relevant design parameters of the package and contents. Dose rates are calculated by tallying the gamma fluxes using mesh tallies in the areas of interest and converting these fluxes to dose rates using flux-to-dose rate conversion factors.

Simple Russian roulette is used as a variance reduction technique for *all* tallies. The importance of the particles increases as the particles traverse the shielding materials. *The mean free path of an average cobalt-60 gamma ray in lead or steel was used as the distance where the importance doubled.* The geometry of the package and contents is modeled in a lower universe. This lower universe is filled in the top-level universe where the geometrically based importance splitting occurs.

No source biasing was used in any model.

The acceptance criterion was the same as specified in the MCNP5 manual: variance below 10% is considered reliable for non-point detector tallies. However, the uncertainty of most dose rate tallies is below 2 %, and the solutions are well converged.

5.4.2 Input and Output Data

A sample input file is provided in *Section* 5.5.2.

5.4.3 Flux-to-Dose-Rate Conversion

The ANSI/ANS 6.1.1-1977 flux-to-dose-rate conversion factors for gamma rays *and neutrons* are used in this evaluation [5-1]. The factors are shown *for gammas* in Table 5-11 *and for neutrons in Table 5-17.*

5.4.4 External Radiation Levels

Dose rates are calculated using the mesh tally feature of MCNP5. *For the homogenized, annulus, disk top, and disk bottom, the radial* tallies are segmented axially between 20 and 22 cm. Axial tallies are segmented radially approximately 22 cm. There is no angular segmentation for any tally. *The beta case used tallies similar to the annulus, disk top, and disk bottom. For the neutron and secondary gamma evaluations, the tallies were segmented axially and angularly to be 4 cm x 4 cm to investigate if streaming exists. Axial tallies were Cartesian with 4 cm x 4 cm voxels, except for the tally for the normally occupied space, which was 8 cm x 8 cm. HAC radial tallies were segmented axially 4 cm with no angular segmentation. HAC axial tallies were segmented radially 4 cm with no angular segmentation.* The cask is angularly symmetric except for the trunnions and the cavity drain. Dose rates for NCT use the impact limiter surfaces as the basis for the top and bottom. The cask body is the basis for the NCT side dose rates. The width of the vehicle is not defined; therefore, the surface of the vehicle is assumed to be coincident with the radial surface of the impact limiters. The ends of the vehicle are assumed to be coincident with the top and bottom of the package. Tallies are shown in Figure 5-7. Red lines denote surface tallies used to show compliance with 10 CFR 71.47(b)(1) and 71.47(b)(2). Blue lines denote 1 m HAC tallies used to show compliance with 10 CFR 71.51(a)(2). Green lines denote 2 m NCT tallies used to shown compliance with 10 CFR 71.47(b)(3). The tally numbers correspond to the sample input file in Section 5.5.2.

Tallies used to develop the response functions for the energy dependent activities were surface tallies. The special tally treatment available in MCNP5 was used to track contributions to the tally based on the source energy weight. Only one case was required to develop response functions for all energies. The tally was a band at 2 m in the approximate center of the cask. The tally was 17 cm tall.

Other than the trunnions and the cavity drain, the radial and bottom lead shielding is not displaced. The lead in the original lid contains a penetration for a vent. However, the vent plug contains more lead axially than the lid so the penetration is of no consequence during transportation. The optional lid has no penetration through the lead shielding. The optional lid contains three steel lifting plugs. These displace some lead in the optional lid. These features were modeled in the comparison described in Section 5.4.4.3.

For HAC, dose rates are taken with the surface of the cask as the basis. While the impact limiters are shown to remain attached to the cask during all postulated accidents as prescribed by 10 CFR 71.73 as applicable (Sections 2.10.2 and 2.10.3), for the purpose of the shielding evaluation, the impact limiters are removed from the HAC model and replaced with air.

5.4.4.1 NCT dose rates

A summary of all the NCT dose rates for all source configurations evaluated is shown in Table 5-12.

For the radial 2 m dose rate, the *homogenized* case has the maximum dose rate of *8.91* mrem/h. This dose rate is below the limit of 10 mrem/h. *T*he relative uncertainty is *0.1 %*, which is approximately 0.*009* mrem/h. The dose rate is below the 10 CFR 71.47(b)(3) limit.

The 2 m top dose rate from the top of the impact limiter maximum was 1.*80* mrem/h with the disk top source configuration. This is below the limit of 10 mrem/h.

The 2 m bottom dose rates from the bottom of the impact limiter maximum was *1.97* mrem/h with the *disk bottom* source configuration, which is below the limit of 10 mrem/h.

The maximum radial surface dose rate occurred with the *disk top source* configuration and was *106 mrem/hr, which is* below the 10 CFR 71.47(b)(1) limit of 200 mrem/h. The dose rate here was on the surface of the cask body *near the lid due to streaming over the side lead*.

The maximum top surface dose rate occurred with the disk top source and is 11.*5* mrem/h, which is below the limit of 200 mrem/h.

The maximum bottom surface dose rate occurred with the disk bottom source *and is 19.3* mrem/h, which is below the limit of 200 mrem/h.

The external surfaces of the package were assumed to be coincident with the external surfaces of the vehicle. These dose rates satisfy both the requirements of 10 CFR 71.47(b)(1) and 10 CFR 71.47(b)(2).

The occupied space for personnel was assumed to be *152 inches* from *the front* end of the package. The maximum dose rate was *0.722* mrem/h with *the disk top* configuration. Therefore, personnel do not have to *conform to the radiation dosimetry* requirements of 10 CFR 20.1502.

5.4.4.2 HAC dose rates

A summary of all the HAC dose rates is shown in Table 5-*15*. All dose rates in this table are taken 1 m from the external surface of the cask. *Compression of the source was investigated for HAC. The original source was the same as the NCT homogenized source. The source was then compressed by a factor of 3 and shifted toward the top or bottom in the axial direction to determine the resulting dose rates at 1 m from the surface of the cask. This reduction in height was from 282.66 cm to 94.22 cm.* The maximum radial dose rate is *752* mrem/h, which is below the 10 CFR 71.51(a)(2) limit of 1,000 mrem/h. *This dose rate occurs above the lead shielding directly below the lid. The secondary container, which was not modeled, would prevent source bearing contents from being in this area.* The maximum top HAC dose rate is *245* mrem/h, which is below the limit of 1,000 mrem/h. *This occurs when the source is compressed towards the top of the cask.* The maximum bottom HAC dose rate is *307* mrem/h, which is below the limit of 1,000 mrem/h. *This occurs when the source is compressed towards the bottom of the cask.*

5.4.4.3 Original lid versus optional lid

A comparison was made between the original and optional lids. The optional lid has 0.2 in. less lead than the original lid, but adds 0.375 in. of steel. Using the homogenized source configuration, both lids were modeled, and the top surface dose rates for NCT were compared. A dose rate distribution for both cases is shown in Figure 5-6. As shown in the figure, the original lid bounds the optional lid. Therefore, the original lid was used in the development of the NCT and HAC dose rates presented in this chapter.

5.4.4.4 Cavity Drain

The cavity drain was modeled explicitly. The cavity drain tube displaces lead directly under the cavity. Bottom dose rates are marginally higher than the top as a result. However, due to the increased distance from the cask and material of the impact limiters during NCT, the dose rates radially are bounding for all configurations. The cavity drain has no appreciable impact on the dose rates.

5.4.4.5 Materials other than steel

In all cases, the source material is modeled as stainless steel. Because less dense source materials (e.g., zirconium, aluminum) would have a lower density than steel, the source-bearing solid materials shall have a density equivalent to or exceeding the density of steel. Localized regions of low-density (e.g., B_4C in a control rod blade) are acceptable if the low-density regions contain negligible source.

5.4.4.6 Normally occupied spaces

The TN-RAM package is transported on a specially designed, three-axle semi-trailer. For the purpose of evaluating the requirements of 10 CFR 71.47(b)(4), the normally occupied space was considered to be at the front end of the trailer, 152 inches from the top end of the package. The package is only transported horizontally, lid end first. No credit is taken for shielding from the prime mover.

5.4.4.7 Self-shielding versus source distribution

Four different source geometries are examined. The self-shielding of the various source geometries are different, as well as the geometrical distribution of the source. The homogenized and annular geometries result in approximately the same radial 2 m dose rate, which is reasonable because each axial unit length of source contains the same mass and source activity. However, the homogenized source bounds the disk source 2 m dose rate by a large margin. For the homogenized source, the gamma mean free path is approximately 7.7 cm, while for the disk sources, the mean free path is approximately 1.6 cm. The difference in mean free path is due to the lower gram-density of the homogenized source compared to the disk source. For instance, a gamma born at the center of the homogenized source travelling in the radial direction will exit the cask at a higher energy than an equivalent gamma born in the disk source that must traverse a much denser source medium. Although the source per unit volume is larger for the disk sources, the mean free path is much smaller, and the net effect is a reduction in dose rate.

In the axial direction, the disk sources bound the homogenized source because the mean distance to a dose point along the axial centerline is always minimized for the disk source. However, the dose rates for the homogenized source at the same locations are quite similar.

For the source geometries considered, the various trade-offs between self-shielding and source geometry are difficult to determine a priori, although the detailed Monte Carlo results presented in this chapter are tightly converged.

5.4.4.8 Neutron and secondary gammas

With a source of $1x10^6$ neutrons/s, the maximum dose rate on the surface of the package is 1.51 mrem/h. However, this dose rate is inside the trunnion due to the nature of the tally. Other dose rates for this system are all less than 0.1 mrem/h. The maximum dose rate as a result of secondary gammas is 4.30E-03 mrem/h. The NCT results are shown in Table 5-16. No HAC evaluation was performed because the effectiveness of the package to shield neutrons is not reduced after the HAC.

Therefore, the neutron limit is acceptable for incidental radionuclide contamination that generates neutrons. No self-shielding was credited in the neutron and secondary gamma analysis.

5.4.4.9 Streaming

There is a streaming path at the top of the side lead where only steel shielding is present, see Figure 5-1. The dose rates are elevated near this streaming path and the effect will be most pronounced close to the package. The side surface dose rate is a maximum for the disk top configuration because the source is the most concentrated near the streaming path in this configuration. This streaming is also observed in the homogenized and annular source models. This streaming effect may be quantified by comparing the top and bottom disk models, because the bottom disk is far from the streaming path. The maximum side dose rate in the top disk model (106 mrem/hr) is significantly larger than the bottom disk model (68.2 mrem/hr). This result indicates that the mesh tallies are of sufficient resolution to resolve the steaming effect. The maximum dose rate is also far from the limit of 200 mrem/hr.

At a distance of 2 m from the side of the vehicle, the radiation due to streaming does not correspond to the maximum dose rate location and the homogenized source is the bounding configuration. This effect may be observed in Figure 5-8, which is a plot of the 2 m side dose rate as a function of axial location for the homogenized source. The maximum 2 m dose rate occurs at z = 167 cm (8.91 mrem/hr), although a distinct discontinuity in the dose rate is observed at z = 286 cm (7.39 mrem/hr). This discontinuity is due to streaming over the lead, although the resolution of the mesh tallies is sufficient to resolve the streaming effect. Therefore, the effect of streaming is properly accounted for in the dose rate results.

In the actual transportation configuration, the presence of the secondary container will help mitigate the streaming effect by providing additional shielding and providing a barrier so that the source will be farther from the streaming path. However, the secondary container is not credited in this analysis.

5.4.4.10 Beta Emission

Beta emission was considered using the source described in Section 5.2.3. The electrons were simulated with MCNP5 applied to the inner surface of the cavity with the maximum emission energy of phosphorus-32. The distribution of the source was isotropic on the surface, but directed radially outward. No self-shielding was included in the model. The source was only modeled radially. High Z materials create bremsstrahlung radiation. The radial dimension of the cask presents the highest opportunity for interaction because the most material is in the radial direction. The maximum dose rate on the radial surface of the cask was 3.08 ± 8% mrem/h. The maximum dose rate 2 m from the radial surface of the package was 0.122 ± 16% mrem/h.

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Proprietary Information Withheld Pursuant to 10 CFR 2.390

5.5.3 Cobalt-60 Equivalence

In order to allow gamma emitting nuclides that are not cobalt-60 in the cask for transportation, energy dependent maximum activities were calculated. The purpose of these activities is to ensure that, regardless of the payload, the dose rates will not exceed the regulatory limits.

The maximum activities are determined by first generating the dose rate response (response function) for various line energies. The dose rate is tallied at 2 m from the side of the package in a band at the same axial location as the maximum 2 m side dose rate reported in Table 5-1. The source configuration is the same as the homogenized case because this configuration results in the limiting 2 m dose rate. The dose rate as a function of line energy is reported in Table 5-14. Based on these results, the 2 m dose rate due to 30,000 Ci cobalt-60, which has line energies of 1.1732 MeV and 1.3325 MeV, is $1.11x10^{15}(1.98x10^{-15} + 6.03x10^{-15}) = 8.90$ mrem/hr, which agrees well with the dose rate reported in Table 5-1.

Based on a dose rate limit of 8.90 mrem/hr, the activity limit for each line energy is computed as 8.90/D, where D is the dose rate for a single source particle. These activity limits are reported in Table 5-14. For all isotopes in the package, a sum of fractions is applied over all source isotopes and all source intensities to ensure the dose rates do not exceed the dose rates from 30,000 Ci cobalt-60:

$$F = \sum_i \frac{S_i(E)}{Activity\ Limit_i(E)} \leq 1$$

Where,

$S_i(E)$ is the line intensity at energy E for isotope i
$Activity\ Limit_i(E)$ is the activity limit at energy E from Table 5-14

This equation results in a summation of 1.0 for 30,000 Ci cobalt-60. Because the line energies for isotopes other than cobalt-60 will not fall exactly on the line energies provided in Table 5-14, the applicable activity limit may conservatively be taken as the next higher energy line in the table. For instance, the activity limit for a 2.1 MeV gamma would be the 2.5 MeV limit from Table 5-14.

In addition to the package limit of 30,000 Ci cobalt-60 equivalent, each item in the package must have a cobalt-60 equivalent specific activity ≤ 10 Ci/kg. The above equation for F may be applied separately for each item to be shipped, where $F = F_1 + F_2 + ... + F_n$, and n is the number of discrete items in the package. The total cobalt-60 equivalent (Ci) for each item is $30,000*F_n$. The cobalt-60 equivalent specific activity for an item of mass M (kg) is then $30,000*F_n/M$. The cobalt-60 equivalent specific activity should be verified for each item in the package.

Table 5-1
Summary of NCT Maximum Dose Rates

	Dose rate (mrem/h)	*Relative 1σ uncertainty*	*Limit (mrem/h)*	*Configuration*
			Surface	
Side	*106*	*0.001*	*200*	*Disk, Top*
Top	*11.5*	*0.01*	*200*	*Disk, Top*
Bottom	*19.3*	*0.01*	*200*	*Disk, Bottom*
			2 m	
Side	*8.91*	*0.001*	*10*	*Homogenized*
Top	*1.80*	*0.01*	*10*	*Disk, Top*
Bottom	*1.97*	*0.01*	*10*	*Disk, Bottom*
			152 in. from the top of the package	
Top	*0.722*	*0.02*	*2*	*Disk, Top*

Table 5-2
Summary of HAC Maximum Dose Rates

	Dose rate (mrem/h)	**Relative 1σ uncertainty**	**Limit (mrem/h)**
		1 m	
Side	*752*	0.01	1000
Top	*245*	*0.07*	1000
Bottom	*307*	*0.09*	1000

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Table 5-12
Summary of All NCT Configurations

	Dose rate (mrem/h)	*Relative 1σ uncertainty*	*Dose rate (mrem/h)*	*Relative 1σ uncertainty*	*Dose rate (mrem/h)*	*Relative 1σ uncertainty*	*Dose rate (mrem/h)*	*Relative 1σ uncertainty*
	Annulus		***Disk, Top***		***Disk, Bottom***		***Homogenized Cylinder***	
	Surface							
Radial max:	*102*	*0.001*	*106*	*0.001*	*68.2*	*0.001*	*98.7*	*0.01*
Top max:	*10.3*	*0.01*	*11.5*	*0.01*	*1.83*	*0.01*	*10.8*	*0.01*
Bottom max:	*17.2*	*0.01*	*3.36*	*0.01*	*19.3*	*0.01*	*18.3*	*0.01*
	2 m							
Radial max:	*8.84*	*0.001*	*5.17*	*0.001*	*2.31*	*0.02*	*8.91*	*0.001*
Top max:	*1.60*	*0.01*	*1.80*	*0.01*	*0.302*	*0.02*	*1.72*	*0.01*
Bottom max:	*1.76*	*0.01*	*0.481*	*0.02*	*1.97*	*0.01*	*1.91*	*0.01*
	152 in. from the top impact limiter							
Top max:	*0.633*	*0.03*	*0.722*	*0.02*	*0.138*	*0.07*	*0.712*	*0.06*

Table 5-14
Response Functions and Activity Limits by Energy

Line Energy (MeV)	*Dose Rate per Source Particle (mrem/hr)*	*Activity Limit (γ/s)*
0.6	1.17E-17	7.62E+17
0.8	7.14E-17	1.25E+17
1.0	4.38E-16	2.03E+16
1.1732	1.98E-15	4.49E+15
1.3325	6.03E-15	1.47E+15
1.5	1.45E-14	6.15E+14
1.75	3.71E-14	2.40E+14
2.0	7.10E-14	1.25E+14
2.5	1.61E-13	5.52E+13
3.0	2.60E-13	3.42E+13
3.5	3.48E-13	2.55E+13
4.0	4.17E-13	2.14E+13
4.5	4.69E-13	1.90E+13
5.0	4.99E-13	1.78E+13
6.0	5.36E-13	1.66E+13
8.0	5.64E-13	1.58E+13
10.0	5.96E-13	1.49E+13

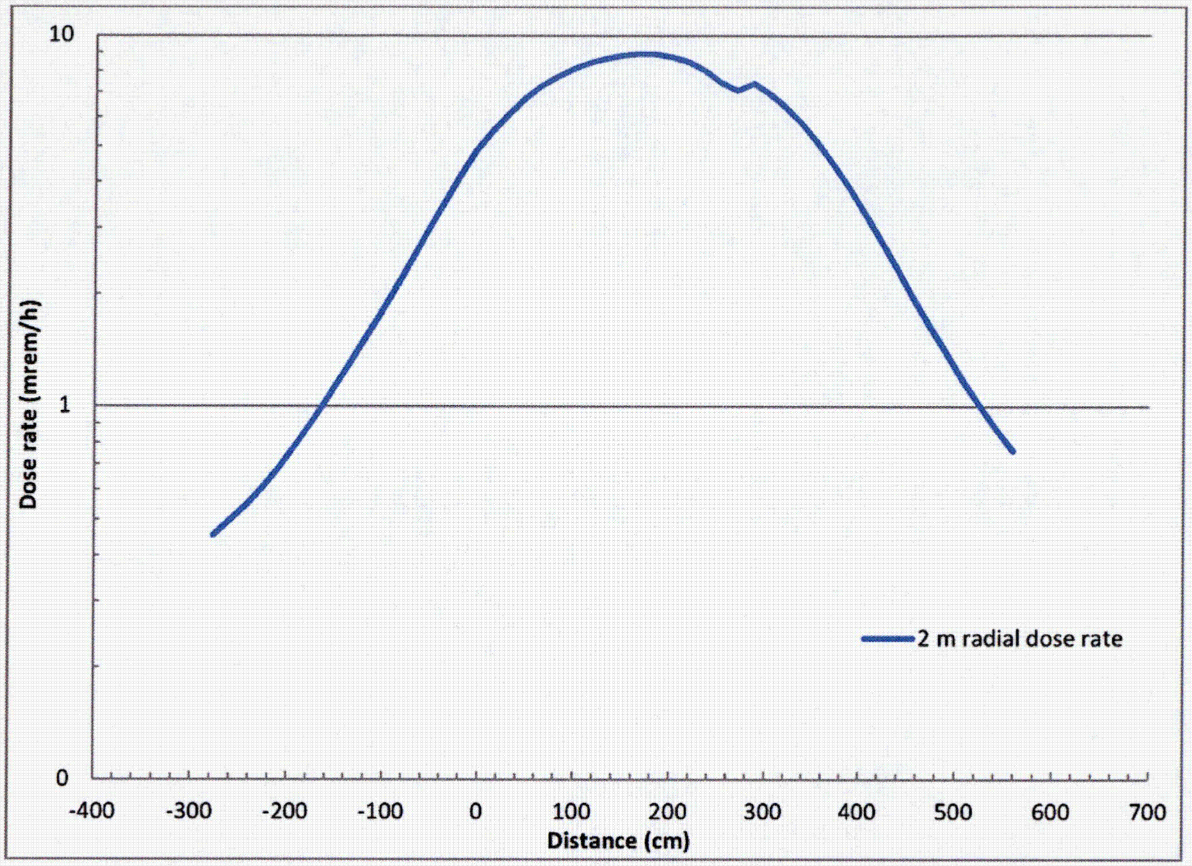

Figure **5-8**
Dose Rate Profile at 2 m from Vehicle Side, Homogenized Source

Figure 5-9
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Enclosure 4 to E-43837

Listing of Computer Files
Contained in Enclosure 5

Listing of Computer Files Contained in Enclosure 5
(All files are Proprietary)

Disk ID No. (size)	Discipline	System/Component	File Series (topics)	Number of files
Enclosure 5 *One computer disk* (1.51 MB)	**Shielding**	TN-RAM NCT	Folder: *homogenized*	3
		TN-RAM NCT	Folder: *annulus*	3
		TN-RAM NCT	Folder: *disk top*	3
		TN-RAM NCT	Folder: *disk bottom*	3
		TN-RAM NCT	Folder: *equivalence*	2

Enclosure 6 to E-43837

Proposed Changes to CoC 9233, Revision 12

NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
9233	~~12~~ $\boxed{13}$	71-9233	USA/9233/B(U)-96	1 OF	3

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)*

AREVA Inc.
7135 Minstrel Way, Suite 300
Columbia, MD 21045

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

~~Transnuclear, Inc.~~ application dated ~~March 8, 2005~~, as supplemented.

AREVA Inc.

March 9, 2015

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 No.: TN-RAM

(2) Description

The package is a steel encased lead shielded cask with wood impact limiters attached at both ends. The cask is a right circular cylinder. The overall dimensions of the packaging are approximately 178 inches long and 92 inches diameter with the impact limiters installed. The cask body is approximately 129 inches long with an outer diameter of 51 inches. The cask cavity has a length of approximately 111 inches and an inside diameter of 35 inches. The cask body is made of a 0.75-inch stainless steel inner shell, a 5.88-inch thick lead annulus, a 1.5-inch thick stainless steel outer shell, a 0.5-inch thick inner bottom plate and a 2.5-inch thick outside bottom plate. The lead shielding is approximately 6 inches thick in the bottom end of the cask. The outer shell of the cask body is covered with a stainless steel thermal shield. The closure lid consists of a 2.5-inch thick outer stainless steel plate and a 0.5-inch thick inner stainless steel plate separated by approximately 6 inches of lead shielding. An optional lid, with the lead shielding in the form of a separate shielding disk, can also be used. The lid is secured by sixteen 1.5-inch diameter closure bolts. Two concentric silicone O-rings are installed in grooves on the underside of the lid. The cask is equipped with a sealed leak test port between the O-rings, a vent port in the closure lid and a sealed drain port in the bottom of the cask. Each impact limiter is attached to the cask by eight 1.75-inch diameter bolts. The cask is equipped with 6 trunnions, four at the top and two at the bottom. The gross weight of the package is approximately 80,000 pounds, including maximum contents of 9,500 pounds.

NRC FORM 618 (8-2000) 10 CFR 71		CERTIFICATE OF COMPLIANCE FOR RADIOACTIVE MATERIAL PACKAGES		U.S. NUCLEAR REGULATORY COMMISSION
a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE / PAGES
9233	~~12~~ 13	71-9233	USA/9233/B(U)-96	2 OF 3

5.(a) Packaging (continued)

(3) Drawings

The packaging is constructed in accordance with Transnuclear, Inc. Drawing Nos. ~~990-701, Rev. 9; 990-702, Rev. 8; 990-703, Rev. 10; 990-704, Rev. 6; 990-705, Rev. 7; 990-706, Rev. 4; 990-707, Rev. 4; 990-708, Rev. 8; 990-709, Rev. 2; and 990-710, Rev. 2.~~

Insert 1(as shown on page 4 of this enclosure

(b) Contents

(1) Type and Form of Material

Dry irradiated and contaminated non-fuel-bearing solid materials contained within a secondary container. No powdered, solid material is authorized.

(2) Maximum quantity of material per package

Greater than Type A quantities of radioactive material which may include fissile material provided that the fissile material does not exceed the mass limits of 10 CFR 71.15. The contents may not exceed ~~1,272 times an A_2 quantity. The decay heat of the contents may not exceed 300 watts. The maximum gross weight of the contents, secondary container, and shoring is limited to 9,500 pounds.~~

Insert **2** (as shown on page **5** of this enclosure.

6. As appropriate, shoring must be used in the secondary container sufficient to prevent significant movement of the contents under accident conditions.

7. Both the inner cask cavity and the secondary container must be free of water when the package is delivered to a carrier for transport.

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

(a) Prior to each shipment, the lid seals must be inspected. The seals must be replaced with new seals if inspection shows any defects or every 12 months, whichever occurs first;

(b) The package shall be prepared for shipment and operated in accordance with the Operating Procedures of Section 7.0 of the application; and

(c) The package must meet the Acceptance Tests and Maintenance Program of Section 8.0 of the application.

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

10. Expiration date: ***TBD***

3000 A_2., Gamma emitting radionuclides are limited to 30,000 Ci of ^{60}Co or equivalent as shown by the following equation:

NRC FORM 618 (8-2000) 10 CFR 71	CERTIFICATE OF COMPLIANCE FOR RADIOACTIVE MATERIAL PACKAGES		U.S. NUCLEAR REGULATORY COMMISSION	
a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE OF PAGES
9233	~~12~~ 13	71-9233	USA/9233/B(U)-96	3 OF 3

AREVA Inc.

REFERENCES

~~Transnuclear, Inc.~~, application dated ~~March 8, 2005.~~ March 9, 2015

~~Supplements dated: May 4, 2007; October 19, 2007; September 30, 2008; February 16, 2009 and March 15, 2010; January 27, 2014, and June 11, 2014.~~

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Timothy Lupold, Acting Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Date: TBD

Insert 1 (for Page 2 of 3 to CoC):

(3) Drawings

990-701	*TN-RAM Packaging Assembly*	*10*
990-702	*Shell Assembly*	*9*
990-703	*Shell Parts List & Details*	*11*
990-704	*Shell Details*	*7*
990-705	*Lid Assembly & Parts List*	*8*
990-706	*Lid Details*	*5*
990-707	*Impact Limiter Assembly*	*5*
990-708	*Impact Limiter Details & Parts List*	*9*
990-709	*Impact Limiter Attachment Bolt*	*2*
990-710	*Optional Lid Details*	*2*

Insert 2 (for Page 2 of 3 to CoC):

$$\sum_i \frac{S_i(E)}{Activity\ Limit_i(E)} \leq 1$$

where E is the weighted average energy of the gamma emitter, $S_i(E)$ is the source strength of the gamma emitter, and $Activity\ Limit_i(E)$ is the limit in gammas per second as a function of energy. Limits can be found in the following table:

Energy (MeV)	Activity Limit (γ/s)
0.6	7.62E+17
0.8	1.25E+17
1	2.03E+16
1.1732	4.49E+15
1.3325	1.47E+15
1.5	6.15E+14
1.75	2.40E+14
2	1.25E+14
2.5	5.52E+13
3	3.42E+13
3.5	2.55E+13
4	2.14E+13
4.5	1.90E+13
5	1.78E+13
6	1.66E+13
8	1.58E+13
10	1.49E+13

The average *specific* activity of discrete components is limited to 10 Ci/kg *of Co-60 or equivalent.*

Materials other than steel must show shielding equivalence or better to steel for Co-60.

The decay heat of the contents may not exceed 500 W.

The maximum gross weight of the contents, which includes the secondary container and shoring, is limited to 9500 lb (4309 kg).

AFFIDAVIT PURSUANT
TO 10 CFR 2.390

AREVA Inc.)
State of Maryland) SS.
County of Howard)

I, Paul Triska, depose and say that I am a Vice President of AREVA Inc., duly authorized to execute this affidavit, and have reviewed or caused to have reviewed the information that is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding this information.

The information for which proprietary treatment is sought is contained in Enclosures 2 and 5 is listed below:

- Enclosure 2 – Portions of the Changed Pages, TN-RAM SAR, Revision 15A
- Enclosure 5 - Shielding Computer Files

These documents have been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures utilized by AREVA Inc. in designating information as a trade secret, privileged, or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1) The information sought to be withheld from public disclosure includes certain portions of the safety analysis report and shielding computer files related to the design of the TN-RAM radioactive material transportation packaging, which are owned and are held in confidence by AREVA Inc.
2) The information is of a type customarily held in confidence by AREVA Inc. and not customarily disclosed to the public. AREVA Inc. has a rational basis for determining the types of information customarily held in confidence by it.
3) Public disclosure of the information is likely to cause substantial harm to the competitive position of AREVA Inc. because the information consists of descriptions of the design and analysis of the TN-RAM radioactive material transportation package, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with AREVA Inc., take marketing or other actions to improve their product's position or impair the position of AREVA Inc.'s product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

Further the deponent sayeth not.

Paul W Triska
Paul Triska
Vice President, AREVA Inc.

Subscribed and sworn before me this 20th day of November, 2015.

Lewis A. Piccolino
Notary Public
My Commission Expires 03/26/2015

LEWIS A. PICCOLINO
NOTARY PUBLIC
MONTGOMERY COUNTY
MARYLAND
MY COMMISSION EXPIRES MARCH 26, 2018