June 11, 2014

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, D.C. 20590

SUBJECT: REVALIDATION OF THE FRENCH CERTIFICATE OF APPROVAL NO. F/379/B(U)F-96 FOR THE MODEL NO. TN-106 PACKAGE

Dear Mr. Boyle:

This is in response to your letter dated June 14, 2013, requesting our assistance in evaluating the Model No. TN-106 package, authorized by the French Certificate of Approval No. F/379/B(U)F-96, Revision Ct. The review was limited to Content No. 26. We acknowledged receipt of your request on July 25, 2013, and issued a first request for additional information (RAI) letter on November 26, 2013. On February 11, 2014, you provided the responses to the RAIs. On May 15, 2014, you provided the additional information requested on April 9, 2014, to complete our detailed technical review.

Based upon our review, the statements and representations contained in the safety analysis report for the Model No. TN-106 package, referenced DOS-08-00126114-011, Revision No. 2, as supplemented on February 11 and May 15, 2014, and for the reasons stated in the enclosed safety evaluation report, we recommend revalidation of the French Certificate of Approval No. F/379/B(U)F-96, Revision Ct, with the following conditions:

Condition No. 1: Only packagings with serial number TN-106 N° 01 or serial number TN-106 N° 02 can be used.

Condition No. 2: The maximum allowable combined uranium and plutonium content mass is 42 grams.

Condition No. 3: The total activity of the contents must not exceed 5 TBq.

Condition No. 4: The content's decay heat must not exceed 206 W/m.

Condition No. 5: Only dry loading and unloading of contents are authorized.

Condition No. 6: Prior to loading, the package must be demonstrated to meet the "leaktight" test criterion of 10^{-7} ref cm^3/sec, per ANSI N14.5. Subsequent periodic and maintenance leakage tests must also meet the "leaktight" leakage test criteria of 10^{-7} ref cm^3/sec, per ANSI N14.5. These leakage tests shall not be based on the pressure rise method. After loading, the package must be demonstrated to meet the pre-shipment leakage test criterion of 10^{-3} ref cm^3/sec, per ANSI N14.5.

Condition No. 7: All seals shall be replaced at an interval not to exceed one year.

Condition No. 8: Transport by air is not authorized.

Condition No. 9: Packages must be transported as exclusive use. A covered conveyance is not authorized.

If you have any questions regarding this matter, please contact Pierre Saverot of my staff at (301) 287-0759.

Sincerely,

/RA/ B. H. White For

Michele M. Sampson, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-3075
TAC No. L24762

Enclosure: Safety Evaluation Report

Condition No. 6: Prior to loading, the package must be demonstrated to meet the "leaktight" test criterion of 10^{-7} ref cm^3/sec, per ANSI N14.5. Subsequent periodic and maintenance leakage tests must also meet the "leaktight" leakage test criteria of 10^{-7} ref cm^3/sec, per ANSI N14.5. These leakage tests shall not be based on the pressure rise method. After loading, the package must be demonstrated to meet the pre-shipment leakage test criterion of 10^{-3} ref cm^3/sec, per ANSI N14.5.

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Condition No. 7: All seals shall be replaced at an interval not to exceed one year.

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SAFETY EVALUATION REPORT
Model No. TN-106
French Certificate of Approval No F/379/B(U)F-96, Revision Ct.
Docket No. 71-3075

By letter dated June 14, 2013, the U.S. Department of Transportation (DOT) requested the Nuclear Regulatory Commission (NRC) staff's assistance in evaluating the Model No. TN-106 package, as authorized by the French Certificate of Approval No. F/379/B(U)F-96, Revision Ct, to provide a recommendation concerning the revalidation of the certificate for import and export use.

DOT requested that the review be limited to the addition of content No. 26, i.e., fuels, whether irradiated or not, composed of uranium, plutonium, americium or neptunium in metallic or nitride form, and/or metallic technetium. DOT provided the safety analysis report (SAR) for the TN-106 package model, referenced DOS-08-00126114-011, Revision No. 2, as supplemented on February 11 and May 15, 2014, in response to two requests for additional information (RAI) dated November 26, 2013 and April 9, 2014, respectively.

The staff evaluated the Model No. TN-106 package for the new contents against the standards in the International Atomic Energy Agency (IAEA), "Regulations for the Safe Transport of Radioactive Material," Safety Standards Series No. TS-R-1, 2009 edition.

Based upon the statements and representations contained in the SAR and supplemental information received on February 11 and May 15, 2014, the staff recommends revalidation of the French Certificate of Approval No. F/379/B(U)F-96, Revision Ct, with the following conditions:

Condition No. 1: Only packagings with serial number TN-106 N° 01 or serial number TN-106 N° 02 can be used.

Condition No. 2: The maximum allowable combined uranium and plutonium content mass is 42 grams.

Condition No. 3: The total activity of the contents must not exceed 5 TBq.

Condition No. 4: The content's decay heat must not exceed 206 W/m.

Condition No. 5: Only dry loading and unloading of contents are authorized.

Condition No. 6: Prior to loading, the package must be demonstrated to meet the "leaktight" test criterion of 10^{-7} ref cm^3/sec, per ANSI N14.5. Subsequent periodic and maintenance leakage tests must also meet the "leaktight" leakage test criteria of 10^{-7} ref cm^3/sec, per ANSI N14.5. These leakage tests shall not be based on the pressure rise method. After loading, the

package must be demonstrated to meet the pre-shipment leakage test criterion of 10^{-3} ref cm^3/sec, per ANSI N14.5.

Condition No. 7: All seals shall be replaced at an interval not to exceed one year.

Condition No. 8: Transport by air is not authorized.

Condition No. 9: Packages must be transported as exclusive use. A covered conveyance is not authorized.

1.0 GENERAL INFORMATION

1.1 Packaging

The packaging is formed of a body, a top end, a bottom end, and two shock-absorbing covers. The packaging's body delimits a cylindrical cavity with a length between 2200 and 2400 mm and a diameter of 203 mm.

The overall external dimensions of the packaging are as follows:

- total length: between 3624 mm and 3824 mm.
- length without shock-absorbing covers: between 2978 mm and 3178 mm.
- diameter with shock-absorbing covers: 1458 mm.
- diameter without shock-absorbing covers: 958 mm at the level of the trunnions.
- exterior diameter of the body: 820 mm.

The maximal mass for the loaded package (with the covers) is between 11,620 kg and 12,300 kg.

The packaging’s body is successively made up of (i) an internal stainless steel sheet envelope, (ii) a primary biological shield (gamma shielding) made of lead, (iii) a secondary biological shielding (neutron shielding) in Type F borated resin, and (iv) an external stainless steel sheet envelope including a bed plate as well as handling and stowage devices.

The top end of the packaging is made of a stainless steel flange welded to the shell to which the following is fitted: (i) a revolving lead plug which provides access to the cavity, (ii) two screwed metal clamps that hold the revolving plug in place, (iii) a revolving plug control orifice with a protective plug, (iv) a front lid for revolving plug maintenance, (v) a front closure plate to load the contents and (vi) a vent orifice (orifice A).

The back end of the packaging consists of a stainless steel flange welded to the shell to which the following is fitted: (i) a stainless steel pushing device, equipped with a shielding disk, (ii) a back closure plate providing access to the pushing device, and (iii) a fill and drain orifice.

Two removable covers, made of wood, covered in a steel envelope, serve as shock absorbers.

Containment is ensured by the containment shell of the packaging which is made up of the front lid with its internal gasket, the front closure plate and its internal gasket, the orifice A closure plate and its internal gasket, the orifice B closure plate and its internal gasket, the revolving plug closure plate and its internal gasket, the back closure plate and its internal gasket, the front and rear flanges and the welds between the flanges, and the internal shell.

1.2 Contents

While this package has been designed to hold a variety of radioactive materials, only content No. 26 was requested for this review and recommendation. Content No. 26 is a fissile plutonium and/or uranium-based metallic or nitride material, with a ratio Pu total / (U+Pu) less than or equal to 100% and a ^{235}U enrichment level of less than or equal to 10% by mass, and potentially containing americium, neptunium, or technetium, with a minimum cooling time of 1 year.

1.3 Criticality Safety Index

As described in Section 6.0 of this safety evaluation report, the criticality safety of the package was evaluated with an infinite number of damaged and undamaged packages. Therefore, the criticality safety index (CSI) is 0.0, as described in paragraph 528 of IAEA TS-R-1.

2.0 STRUCTURAL EVALUATION

2.1 Structural Evaluation

AREVA TN requested the removal of Condition No. 2 from the March 14, 2006, recommendation for revalidation of the French certificate of Approval No. F/379/B(U)F-96 (Aa) (ML060750153). Condition No. 2 stated: "For transport in the United States, trunnions shall not be used for tie-down attachments. A transport skid that cradles the package shell that is designed to meet the accelerations factors of 2 g in the vertical direction, 5 g in the lateral direction, and 10 g in the longitudinal direction, shall be used."

The staff reviewed the mechanical strength of the trunnions during transport, as described in the report referenced, NTC-13-00075982-000, Rev. 0, provided as Enclosure 6 of the application. According to the cited standard, the minimum yield strength for "Stainless Steel Type B," which is the material used in the fabrication of the trunnions, is 377MPa at 85°C. The staff identified that this minimum yield strength is insufficient to meet the yield strength requirement from the analysis of the trunnions of 436MPa at 85°C.

The analysis provided in Enclosure 6 of the application uses values interpolated from the minimum yield strengths from the manufacturing report of packages with serial number TN-106 N° 01 and TN-106 N° 02, which shows that the minimum yield strength of the "Stainless Steel Type B" in those packages are sufficient at 455MPa and 449MPa respectively – values that meet the 436MPa yield strength requirement.

The staff reviewed an excerpt of the manufacturing report provided by AREVA TN, as part of an RAI response, and agrees that the trunnions on packages with serial number TN-106 N° 01 and TN-106 N° 02 have demonstrated acceptable minimum yield strength. However, this manufacturing report does not ensure the acceptability of future procurements of the trunnions.

In an RAI, the staff requested AREVA TN to provide a condition to the specifications to ensure that the required minimum yield strength of the stainless steel used in the construction of the trunnions will be met. In its response to this RAI, AREVA TN noted that there are no plans to fabricate new TN-106 packages, and requested that a condition be added as part of this revalidation request. The staff finds this response to be acceptable because the manufacturing reports have shown that the material used in the actual manufacturing of the trunnions of the two aforementioned packages have demonstrated a minimum real yield strength that meets the

yield strength requirement, and because this condition ensures that new packages cannot be transported under this revalidation.

Staff recommends the following condition be included in the DOT certificate to ensure that the minimum yield strength of the trunnions is maintained:

Condition No. 1: *Only packagings with serial number TN-106 N° 01 or serial number TN-106 N° 02 can be used.*

The staff performed a structural review of the remainder of this revalidation request and finds that there are no other changes that affect the structural performance of the TN-106 package. The staff therefore refers to the conclusions of the previous structural evaluation of the TN-106 package (ML0607750153) and finds the structural aspects of this revalidation, with the addition of the above noted condition, to be acceptable.

2.2 Materials Evaluation

Staff's review was focused on the EDPM seals, the cladding material, and the sodium residues.

2.2.1 EDPM seals

AREVA TN claimed that the maximum temperature exposure of 179°C to the EPDM seals is acceptable, due to a "thermal criterion" of 220°C. AREVA TN stated this criterion was reached with a "level of damage formula," specified in paragraph 11 of Chapter 2 of the application. However, the staff found that this formula did not explicitly address the maximum allowable temperature of the seal.

In addition, a materials compatibility guide provided by AREVA TN indicates a range of 150°C to 200°C for the EDPM maximum allowable temperatures. Staff believes that, even at these temperatures, the seals would only hold for "short term use." The staff requested AREVA TN to provide a reference that would clearly state the maximum allowable temperature for the EPDM seals. In its response to this second round of RAIs, AREVA TN provided seal test data at temperatures ranging from 200 to 230°C, but the staff still held that the seal maximum temperatures should fall between the well-accepted and published range of 150°C to 200°C.

This leads to the recommendation of Condition No. 4 to limit the decay heat to 206 W/m, as explained in Chapter 3 of the SER below, to reduce the seal temperature.

The staff also requested AREVA TN to provide the rationale for replacing the seals every three years as part of the periodic maintenance of the packaging, as stated in Chapter 7A of the application. The staff believes that the response given was neither sufficient nor conclusive. Thus, staff recommends Condition No. 8, i.e., replacement of the seals every 12 months.

AREVA TN was also asked to clarify whether the seals should be part of the classification plan found in Chapter 7A, Appendix 1. The classification plan includes components which can affect the safety function of the package. Seals are important components to ensure containment but it did not appear to staff that the seals were listed in Table 7A-1.1 of the application.

In its response to the first round of RAIs (RAI 4-5), AREVA TN stated the following: "The seals should effectively be part of the classification plan found in Chapter 7A, Appendix 1."

Despite this statement, AREVA TN also explained that the following controls are completed on each lot of EPDM gaskets of a same order (with a "lot" being defined as same lots of materials, with the same heat treatment, the same torus diameter, and the same type):

- A control of good appearance for each gasket of the lot.
- A dimensional control of the gaskets, based on a sampling method.
- A control of material properties (hardness, tensile characteristics, etc.) performed on a master gasket.

The staff does question the exclusion of the seals, "important to safety" components, from the Classification Plan. As a result, the staff recommends that AREVA TN updates the SAR before any future revalidation request. This update should include, at a minimum, the seals in the classification plan (Table 7A-1.1, found in Chapter 7A, Appendix 1 of the SAR), and would affirm that seals are components which may affect the safety function of the package. Furthermore, the function, importance to safety, maintenance, and type(s) of inspection of the seals should be specified, as should be the case for the information given for the components listed in the classification plan.

Additionally, the bulleted list provided in the May 15, 2014, RAI 4-5 response requires more details in the form of numerical criteria. Terms such as, "a control of good appearance," "dimensional control," and, "hardness, tensile characteristics, etc." need to be further defined by stating values the applicant would be looking for.

Staff acknowledges that the current version of the SAR provides the working temperature range for the seals, a hardness value, and leak tightness maintenance testing, as presented in Table 7A.2 of the SAR, to ensure the seals perform their intended function. However, numerical criteria for the bulleted list provided in the RAI 4-5 response were not provided. As such, the staff believes that (i) the seals should be added to the classification plan, and (ii) the classification plan should be updated and included in Chapter 7 of the SAR before any future revalidation request.

2.2.2 Cladding material

The staff asked AREVA TN to (i) justify the use of a 500°C maximum temperature and assess the stress on cladding, and (ii) provide more information on the alloy used, specifically the stress of the alloy as a function of temperature, and published yield stress values of the cladding material used.

After the second round of RAIs, in particular from the May 15, 2014, RAI 2-2 response, the staff was still unable to determine if the cladding stress during normal conditions of transport (NCT) and hypothetical accident conditions (HAC) was below the allowable values found in the figures. The application indicated that the fuel is individually placed within enclosures, or baskets, prior to loading within the package, thereby limiting the effects of failed fuel. The RAI response also indicated that the application's analyses had considered the conditions of failed fuel.

2.2.3 Sodium Residue

The staff asked AREVA TN to analyze the potential for degradation due to both sodium residue, if present outside of the fuel rods, and the release of sodium if rod failure were to occur. The staff wanted to confirm whether there would be any adverse effect to the canister and/or the seals. The possibility of liquid metal embrittlement was also discussed.

The May 15, 2014, response to RAI 2-3 elaborated on the cleaning procedures that would take place. The staff was assured that, according to the RAI response, Part a, "there is no sodium residue external to the cladding. The pins have been cleaned according to procedure PA6585 XD 99612 E, which is provided in Enclosure 4…Prior to shipment, each fuel pin is also inspected and confirmed to have no cladding failure."

Part b of the RAI 2-3 response continues to read: "The content No. 26 rods are placed within a storage basket, the ET-004. This placement mitigates sodium from the rod being released and coming in contact with the package in the event of a rod failure. Any sodium from the rods would be contained by the storage tubes in the ET-004."

The staff found this response and the supplemental cleaning procedure to be acceptable.

3.0 THERMAL EVALUATION

The package's content No. 26 includes non-Light Water Reactor fuel assemblies. The maximum decay heat is defined as 206 W/m linear power, per the May 15, 2014, RAI 2-2 response, with a maximum useable length of 2.4 m. The fuel pins are enclosed within a canister or jacket; these enclosures are then loaded into the TN-106 package. The enclosures prevent the fuel from being in direct contact with the package's interior surfaces.

The NCT and HAC thermal analyses, provided by AREVA TN, were based on models generated from I-DEAS/TMG computational codes. AREVA TN stated that the materials used in the package do not degrade at temperatures down to -40°C. In addition, NCT thermal analyses at high ambient temperatures show that component temperatures were below allowable values. The maximum package surface temperature, without thermal input from solar insolation, was 79.7°C, thus requiring exclusive use shipments.

The maximum normal operating pressure was 1.46 bar. AREVA TN stated that the package could withstand 43 bars in exceptional service situations, i.e., HAC. The HAC thermal analyses indicated that the lead shielding temperature of 152.2°C was below the 327°C melting point.

Analyses showed that package temperatures did not significantly change whether the package was in the horizontal or vertical orientation. Likewise, an analysis showed that package temperatures did not significantly increase when the neutron shield's resin was simulated to be partially degraded by the fire.

Additional HAC thermal analyses, which assumed damage of the wood impact limiter due to the HAC puncture tests, showed a maximum temperature of the seals of 179°C, which is less than the EPDM seal's short term maximum allowable temperature of 200°C, according to the O-ring manufacturer documentation.

Although the May 15, 2014, RAI 3-1 response indicated that seal temperatures could reach 209°C for decay heats of 300 W/m, a condition in the DOT certificate to limit the decay heat to

206 W/m would reduce seal temperatures to below the above-mentioned short term maximum allowable temperature of 200°C.

Staff recommends the following condition be included in the DOT certificate in order to reduce the package temperatures below those that were analyzed assuming a 300 W/m decay heat.

Condition No. 4: The content's decay heat must not exceed 206 W/m.

As part of the May 15, 2014, RAI 3-1 response, NRC staff received a thermal analysis showing a 30°C (54°F) increase in seal temperature, from 179°C to 209°C. The 209°C is only 11°C (20°F) lower than the allowable seal temperature from the test data (220°C) provided by AREVA TN. The 20°F margin is based on a 300 W/m decay heat. Staff notes also that the RAI 2-2 response indicated that the Futurix pins will have a 206 W/m decay heat.

Staff recommends a condition to reduce the decay heat from 300 W/m to 206 W/m, which would reduce the seal temperature to within the 150°C to 200°C short term high temperature limit indicated by the seal manufacturer data provided in the February 11, 2014, RAI response.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 7: All seals shall be replaced at an interval not to exceed one year.

The February 11, 2014, response to RAI 4-4 was not sufficient for NRC staff to agree on a seal replacement every three years. The response did not address the synergistic effects of radiation and temperature, as well as of the long term compression set, etc. Therefore, staff recommends that seals must be replaced at an interval not to exceed one year.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 9: Packages must be transported as exclusive use. A covered conveyance is not authorized.

AREVA TN stated that the package surface temperature during NCT is 79.7°C, as shown in page 8/18 of Chapter 2 of the application. Such a temperature is above 50°C and, therefore, the package must be shipped as exclusive use.

In addition, the package should not be covered because the thermal analysis did not consider a package in an ISO container, i.e., a covered conveyance. The staff could not evaluate if the component temperatures (seal, cladding, etc.) would be below allowable values for NCT and HAC if the package was inside an ISO container. This condition is also included in the French Certificate of Approval No. F/379/B(U)F-96, Revision Ct , as described on page 4/12.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 8: Transport by air is not authorized.

The contents contain plutonium and the application does not satisfy conditions for air transport of plutonium.

4.0 CONTAINMENT EVALUATION

The current review is limited to content No. 26, which includes non-Light Water Reactor fuel assemblies with an activity less than 5 TBq, according to the information presented in the May 15, 2014, response to RAI 4-2. Air transport is not allowed.

Because of the potential for a sodium residue (< 50 gram) within the package's inner cavity, loading and unloading of content must be performed dry; in addition, the package's inner cavity is backfilled with nitrogen to 0.2 bar. There is no significant radiolysis and hydrogen generation because failed rods that may contain water are excluded from the authorized contents. EPDM O-rings, which must be replaced every 12 months, are used to seal the front lid, back lid, revolving plug closure plate, orifice closure plate A, and orifice closure plate B. The orifice closure plates cover and seal quick-disconnect coupling valves.

The May 15, 2014, responses to RAI 2-1 and 3-1 indicated that seal temperatures at NCT and HAC remain below their maximum allowable values. Although the maximum normal operating pressure is 1.46 bar, AREVA TN indicated that the containment system can withstand 24 to 43 bars of internal pressure and an external pressure of 20 bars. Analyses in the application were used to justify the strength of the containment and closure systems during simulated drops, such that the A2 per week HAC release requirement was met.

The May 15, 2014, RAI response indicated that fabrication, maintenance, periodic, and HAC leakage tests of the package will demonstrate that the leak rate is less than or equal to 10^{-7} ref cm^3/sec (air), in accordance with the ANSI N14.5 definition of "leaktight". Therefore, detailed containment calculations that include release fractions were no longer necessary. The fabrication, maintenance, and periodic leakage tests are based on pulling vacuum and detecting an helium tracer gas.

In addition, there is a preshipment leakage test to ensure that the total leakage rate of the gaskets associated with the front lid, front closer plate, the back lid, the revolving plug closure plate, the orifice closure plate A, and the orifice closure plate B is less than 10^{-3} ref cm^3/sec (or 6.65×10^{-4} ref cm^3/sec, per Section 2.2 of Chapter 6A). Leak testing is performed by personnel certified according to EN473 standards.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 6: *Prior to loading, the package must be demonstrated to meet the "leaktight" test criterion of 10^{-7} ref cm^3/sec, per ANSI N14.5. Subsequent periodic and maintenance leakage tests must also meet the "leaktight" leakage test criteria of 10^{-7} ref cm^3/sec, per ANSI N14.5. These leakage tests shall not be based on the pressure rise method. After loading, the package must be demonstrated to meet the pre-shipment leakage test criterion of 10^{-3} ref cm^3/sec, per ANSI N14.5.*

Per the May 15, 2014, response to RAI 4-1, the fabrication, maintenance, periodic, and HAC leakage tests will have leaktight criteria of 1×10^{-7} ref cm^3/sec, per ANSI N14.5.

Staff notes that the RAI response also indicated that the maintenance leakage test will be based on the pressure rise method. However, according to ANSI N14.5, the pressure rise methodology does not have a sufficient sensitivity to detect 1×10^{-7} ref cm^3/sec.

5.0 SHIELDING EVALUATION

The package is designed to be transported in the horizontal position with fissile materials consisting of fuel pins or rods containing UO_2 , fuel elements containing uranium, plutonium, americium, neptunium and/or technetium under metallic or nitride form, alone or in inert matrix such as Zr and all other inert materials.

The package is a cylindrical cask with an effective diameter of the interval cavity of 203 mm and a length of cavity up to maximum of 3200 mm. It has an inner stainless steel shell with a thickness of 23.5 mm, 145 mm of lead, 120 mm of resin, and a 20 mm stainless steel outer shell. A revolving plug, made of stainless steel and lead, located at the top of the package is used to open the package. The bottom of the package is made of stainless steel and tungsten.

While this package has been designed to hold a variety of different fuels, the only fuel that was evaluated in this review was content No. 26, i.e., fissile plutonium and/or uranium-based metallic or nitride material with a ratio Pu total / (U+Pu) $\leq$100% and a ^{235}U enrichment level of less than or equal to 10% by mass, potentially containing americium, neptunium, or technetium.

In response to a staff's RAI, AREVA TN provided the source term calculations. Staff used the ORIGEN-ARP module from SCALE 6.1 to determine the source term for content No. 26 for different enrichments up to 4.3wt% ^{235}U, as described in the characteristics of this content with a cooling time of 1 year for both NCT and HAC. The staff found that the resulting dose rates from these calculations were less than the IAEA limits of 2 mSv/hr on contact, 0.1 mSv/hr at one meter for NCT, and less than 10 mSv/hr at one meter for HAC.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 3: The total activity of the contents must not exceed 5 TBq.

AREVA TN indicated that the activity should be lower than 75xU1 (in PBq), where U1 is the useful cavity length in meters. Thus, the package's total activity must be less than 180 PBq with a cavity 2.4 meters long. However, the staff found discrepancies between the activity of the contents, as mentioned in Section 3.16 (page 44/56) of the application, which is much less than 180 PBq and the activity mentioned in the report referenced DOS-08-00126114-401, Rev. 2, which shows a maximum activity of 360 TBq.

AREVA TN stated in its May 15, 2014, response to RAI 4-2 that the total activity for the revalidation request was less than 5 TBq. Any higher total activity, such as 180 PBq as originally included in the application, is not supported by the current shielding analysis.

Based upon staff's review and confirmatory calculations, staff has reasonable assurance that the dose rates from the packages to be shipped will be within the limits of IAEA Transport Regulations paras. 530, 531, 532, 573(c), and 657(b)(ii)(i) for content No. 26, with a minimum cooling time of 1 year.

6.0 CRITICALITY EVALUATION

Staff evaluated the adequacy of the package for the transportation of uranium, plutonium, americium, neptunium in either metallic or hydride form, and/or technetium, defined as content No. 26 in the application.

AREVA TN performed confirmatory calculations based on information initially provided in support of the French Certificate of Approval No. F/379/B(U)F-96 for the packaging design. The allowable amounts of content No. 26, permitted for the TN-106 package, are described in Chapter 5A – Appendix 11 (Ref. DOS-08-00126114-511) of the application. The maximum allowable combined mass of uranium and plutonium is 42 grams. The maximum allowable amounts of americium and neptunium are 6.2 grams and 2.1 grams, respectively.

AREVA TN used a conservative approach in its evaluation methodology. As part of the analysis, AREVA TN assumed that the entire amount of material within the package consisted of ^{239}Pu. In other words, AREVA TN assumed the entire amount of uranium and plutonium was in the form of ^{239}Pu.

However, in order to account for the allowable amounts of americium and neptunium of 6.2 grams and 2.1 grams, respectively, AREVA TN used a method in which the ratio of critical masses was used to determine the combined equivalent mass of both in terms of ^{239}Pu. This equates to 288 grams of ^{239}Pu in addition to the 42 grams already considered to be ^{239}Pu as part of this analysis. The staff determined this approach to be conservative in evaluating the proposed contents.

In addition, AREVA TN also considered moderation effects as a result of filling certain void spaces within the package with water and then comparing those results with those replacing water with steel within the cavity.

NRC staff reviewed calculations from AREVA TN confirming the results provided within the French Certificate of Approval No. F/379/B(U)F-96. Staff was able to re-analyze a number of cases from the information provided by AREVA TN in order to confirm the earlier assertion that steel provided the most reactive cases.

The bounding case, demonstrated in Section 6.2 of Calculation No. 21220-0600, evaluated an infinite array of TN-106 packages maintained at the most reactive fissile solution column height of 25.5 cm. This resulted in a $k_{eff}+2\sigma$ of 0.9162 which is below the established USL of 0.9397.

In view of the conservative assumptions applied in this criticality evaluation and the overall methodology used by AREVA TN, the staff has reasonable assurance that the package, containing content No. 26, as specified in Ref. DOS-08-00126114-511, Rev. 0, and Calculation No. 21220-0600, will remain subcritical during transport.

Although staff determined that the methodology used was acceptable, staff recommends the following condition be included in the DOT certificate:

Condition No. 2: *The maximum allowable combined uranium and plutonium content mass is 42 grams.*

7.0 PACKAGE OPERATIONS

The application includes the conditions for use of the packaging, describing the loading of the package in a cell or in a pool, the preparation and inspection prior to shipment, the drying of the cavity, the leaktightness verification prior to transport, the unloading operations, and the decontamination of the package after loading.

Staff recommends the following condition be included in the DOT certificate:

Condition No. 5: *Only dry loading and unloading of contents are authorized.*

Because of the potential for a sodium residue (< 50 gram) within the package's inner cavity, loading and unloading of content must be performed under dry conditions only. In its February 11, 2014, response to RAI 1-1, AREVA TN concurred with staff and requested a statement be added to the Competent Authority Certificate to convey the following regarding content No. 26: "For content No. 26: The loading and unloading process will occur under dry conditions only."

As stated in this safety evaluation report, the staff recommends the following conditions be included in the DOT certificate:

Condition No. 1: *Only packagings with serial number TN-106 N° 01 or serial number TN-106 N° 02 can be used.*

Condition No. 5: *Only dry loading and unloading of contents are authorized.*

Condition No. 8: *Transport by air is not authorized.*

Condition No. 9: *Packages must be transported as exclusive use. A covered conveyance is not authorized.*

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The application includes instructions for a maintenance program and specifications for periodic maintenance.

As stated in Chapters 2 and 3 of this safety evaluation report, the staff recommends the following conditions be included in the DOT certificate:

Condition No. 6: *Prior to loading, the package must be demonstrated to meet the "leaktight" test criterion of 10^{-7} ref cm^3/sec, per ANSI N14.5. Subsequent periodic and maintenance leakage tests must also meet the "leaktight" leakage test criteria of 10^{-7} ref cm^3/sec, per ANSI N14.5. These leakage tests shall not be based on the pressure rise method. After loading, the package must be demonstrated to meet the pre-shipment leakage test criterion of 10^{-3} ref cm^3/sec, per ANSI N14.5.*

Condition No. 7: *All seals shall be replaced at an interval not to exceed one year.*

CONCLUSION

Based on the review of the statements and representations contained in the application, as supplemented on February 11 and May 15, 2014, and for the reasons stated in this safety evaluation report, the staff agrees that the Model No. TN-106 package, authorized by the French Certificate of Approval No F/379/B(U)F-96, Revision Ct, meets the requirements of IAEA Safety Standard Series No. TS-R-1, 2009.

The staff recommends revalidation of the package with the conditions stated in the safety evaluation report.

Issued with letter to R. Boyle, Department of Transportation,
on June 11, 2014.