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July 1, 2019
E-54606

U.S. Department of Transportation
Attn: Mr. Richard W. Boyle, Chief
Pipeline & Hazardous Materials Safety Administration
Radioactive Materials Branch
1200 New Jersey Avenue, S.E.
East Building, PHH-20
Washington, DC 20590

Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for the Model No. TNF-XI, RAI Response Revision, (Docket no. 71-3092) (EPID L-2018-LLA-0170)

Reference:

[1] TN Americas LLC Letter E-51440, dated June 7, 2018, “Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for Validation of French Competent Authority Certificate F/381/AF-96 for the Model No. TNF-XI.”

[2] TN Americas LLC Letter E-52430, dated August 20, 2018, “Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for the Model No. TNF-XI, Supplemental Information Needed, EPID L-2018-LLA-0170.”

[3] TN Americas LLC Letter E-52912, dated October 22, 2018, “Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for the Model No. TNF-XI, Revision 1 to RSI-1, EPID L-2018-LLA-0170.”

[4] TN Americas LLC Letter E-53665, dated February 21, 2019, “Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for the Model No. TNF-XI, Revision 1 to RSI-1, EPID L-2018-LLA-0170.”

[5] Letter dated March 29,2019, from Norma Garcia Santos (U.S. Nuclear Regulatory Commission) to Richard W. Boyle (U.S. Department of Transportation), “Subject: Application for Revising the Model No. TNF-XI – Accepted for Review (EPID: L-2018-LLA-0170)”

[6] Letter from Norma Garcia Santos (U.S. Nuclear Regulatory Commission) to Richard W. Boyle (U.S. Department of Transportation), "Subject: Request for Additional Information for the review of the Revalidation of the Model No. TNF-XI Packaging (Docket No. 71-3092) (EPID L-0018-LLA-0170)."

[7] TN Americas LLC Letter E-54474, dated June 19, 2019, "Subject: Application for Revision to Competent Authority Certification, USA/0653/AF-96 for the Model No. TNF-XI, RAI Response, (Docket no. 71-3092) (EPID L-2018-LLA-0170)."

[8] U.S. Nuclear Regulatory Commission Converstaion Record, "Subject: 6/20/19--Conference Call with DOT\ORANO (U.S.\International, France)--Discuss RAIs Responses Regarding the Revalidation of the French Package No. TNF-XI (Docket No. 71-3092)."

[9] Competent Authority Certification for a Type AF Fissile Radioactive Materials Package Design Certificate USA/0653/AF-96, Revision 11, Revalidation of French Competent Authority Certificate F/381/AF-96, dated May 12, 2017

Dear Mr. Boyle:

By TN Americas LLC letter dated June 7, 2018 [1], as supplemented by TN Americas LLC on July 30, 2018, August 20, 2018, October 22, 2018, and February 21, 2019 [2, 3, and 4], the NRC accepted the request to perform a review of French Approval Certificate Number F/381/AF-96, Revision Dk, ro revision to Competent Authority Certification (CAC) USA/0653/AF-96, Model No. TNF-XI transport package, and make a recommendation concerning the revalidation of the package for import and export use [5]. The NRC requested additional information to perform the review [6], and TN Americas LLC further supplemented the application on June 19, 2019 [7] to provide responses to NRC Request for Additional Information (RAI). During a conference call with NRC on June 20,2019 [8], TN Americas reviewed these RAI Responses Regarding the Revalidation of the French Package No. TNF-XI (Docket No. 71-3092). TN Americas hereby provides revisions to the RAI responses as Enclosure 1.

The certificate F/381/AF-96 (Dk) for the request for US revalidation is based on the revision 9 of the TNF-XI SAR. The NRC requested to incorporate some of the responses to RAI in a revision to the TNF-XI SAR. Any revision SAR requires validation of the French competent authority. The French competent authority validation a revision to the SAR would require at least 6 months, which would result in prolonging the NRC technical reviews. The delay in issuing the

US revalidation of certificate F/381/AF-96 (Dk) would impact shipments scheduled for September 2019. A revision to the SAR to include information provided in the RAI responses will be provided to the French competent authority for the next prolongation of the TNF-XI French certificates.

TN Americas LLC respectfully requests a to continue the review of the application for issuing Revision 12 of the TNF-XI CAC [9] to include the continued revalidation for Contents No. 2 and 7 per French Certificate of Approval, certificate F/381/AF-96, Revision Di, and the addition of Content No. 8 per French Certificate of Approval, Certificate F/381/AF-96, Revision Dk, on or before July 31, 2019 in order to support shipments in September 2019.

Should you or your staff have any questions or require additional information to support review of this application, please contact Mr. Peter Vescovi by telephone at 336-420-8325, or by e-mail at Peter.Vescovi@Orano.group.

Sincerely,

Digitally signed by Jay Thomas
Date: 2019.07.01 06:12:48 -04'00'

Jay Thomas
Director of Transportation
TN Americas LLC

cc: Michael Conroy, U.S. Department of Transportation

Enclosures:

1. COR-19-021733-000 vers. 2.0, “Subject: request for additional information for review of the revalidation of the model no. TNF-XI packaging (docket no. 71-3092) (epid I-2018-lla-0170)”
2. TN International Statement of Proprietary Information Pursuant to 49 CFR 7.14, 49 CFR 105.30, and 10 CFR 2.390, dated June 28, 2019
3. NF F 16-101:1988-10 French Standard, Railway rolling stock Fire behviour Choice of Materials (Proprietary)
4. NF P 92-507:2004-02 French Standard, Fire safety, Building – fitting materials (Proprietary)

Enclosure 1 to E-54606

COR-19-021733-000 vers. 2.0, “Subject: request for additional information for review of the revalidation of the model no. TNF-XI packaging (docket no. 71-3092) (epid I-2018-lla-0170)”

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Ref. : COR-19-021733-000 vers. 2.0

Montigny-le Bretonneux, le mardi 28 juin 2019

Subject: request for additional information for review of the revalidation of the model no. TNF-XI packaging (docket no. 71-3092) (epid I-2018-lla-0170)

Competent Authority Certification (CAC) USA/0653/AF-96
Revision Dk
Model No. TNF-XI

References

[1] "Qualification of form CRISTAL V1 – Presentation of the selected reference experiences" – DSU/SEC/T/04-522 Indice A
[2] "Contribution to the qualification of the "standard route" APOLLO-MORET4 of the criticality CRISTAL form" – DSU/SEC/T/2005-518 Ind A
[3] "International Handbook of Evaluated Criticality Safety Benchmark Experiments". Nuclear Energy Agency. NEA/NSC/DOC(95)03
[4] NUREG/CR-6673 – UCRL-ID-13852 "Hydrogen generation in TRU waste transportation packages"

Enclosed documents

(1) Calculation note "Qualification status of the standard path of the CRISTAL v1.2 criticality package for contents loaded in the TNF-XI packaging" ref. CAL-15-00163520-002-01
(2) "Transnucleaire Bora Resin data sheet" reference 12986-R-08 Revision 2
(3) "Summary of compression tests carried out at a temperature on samples of phenolic foam" ref. R&DDT001-26-B-2 (NTC-05-00014262-000 rev. 1 – 7th April 2004)
(4) EPDM Technical data sheet 47DRL13 indice B (French version)
(5) "Summary statement in ageing at temperature of phenolic foams" ref. 10608-B-1 (NTC-05-00014263-000 – 30th October 2001)

TN International
S.A au capital de 30 291 000 Euros
SIREN 602 039 299 - APE 7112B
N° Intracommunautaire :
FR 25 602 039 299

CRITICALITY SAFETY REVIEWER

RAI-Cr-1

Provide the benchmark analysis and validation of the MORET4 code to justify the applicability of this monte carlo code in evaluating the subcriticality of 20 weight percent (wt%) of Uranium-235 (^{235}U).

The applicant has requested an increase in the overall enrichment (i.e., from 5.0 wt% ^{235}U to 20.0 wt% ^{235}U) allowed to be transported in the Model No. TNF-XI as content No. 8. However, the criticality analysis provided by the applicant in Reference No. DOS-06-00037028-500, Revision 6, has no benchmarking analysis or validation provided that would indicate that the MORET4 code with the macroscopic cross-sections obtained from the APOLLO2 code is valid in this increased enrichment region. The validation provided should comply with the guidance in SSG-27, "Criticality Safety in the Handling of Fissile Material", and ANSI/ANS-8.24-2017, "Validation of Neutron Transport Methods for Nuclear Criticality Safety."

This information is needed to determine compliance with paragraphs 104(c), 501(c), 673, and 836(k)(iii) of IAEA SSR-6, 2012 Edition.

The criticality-safety studies of the TNF-XI packaging have been conducted using the standard APOLLO2-MORET4 path of the CRISTAL V1.2 criticality package. The qualification status of the standard path of the CRISTAL V1.2 criticality package for contents with ^{235}U enrichment up to 5 wt% loaded in the TNF-XI packaging is provided in the enclosed document (1).

Criticality safety analysis of the TNF-XI package loaded with the content No. 8 (uranium under form of uranium oxides, uranyl nitrate, sodium diuranates, or ammonium diuranates) have been equally performed with the "standard route" APOLLO-MORET4 of the CRISTAL V1.2 criticality package. The "standard route" APOLLO-MORET4 is based on the use of the multigroup cross section library CEA93-V6 based on the JEF2.2 European evaluation.

The considered fissile media in the context of the criticality safety analysis of the TNF-XI package loaded with the content No. 8 is metallic form of uranium enriched at 20 wt.% in ^{235}U, moderated by polyethylene and reflected by different reflectors (BeO, Be, H2O, graphite, steel, aluminum, concrete, lead and water).

The maximum reactivity is obtained for a U metal media moderated by CH_2 and reflected by BeO and is equal to:

$$k_{eff} + 3\sigma \ (\sigma = 100 \text{ pcm}) = 0.759$$

The maximum reactivity obtained shows that an important safety margins exists regarding the acceptance criterion retained for the study: $k_{eff} + 3\sigma < 0.950$.

Nevertheless, the basis of the validation [1] and the validation report [2] of the "standard route" APOLLO-MORET4 of the CRISTAL V1.2 provides the validation for an uranium fissile media in thermal spectrum with / without beryllium reflection. The experiences that have been used to the qualification of the "standard route"

APOLLO-MORET4 of the CRISTAL V1.2 form are based on the "International Handbook of Evaluated Criticality Safety Benchmark Experiments" (ICSBEP) [3].

Descriptions of the experiences are described here below:

Serial	***Description***	***Reflector***	***Laboratory***
IEU-COMP-THERM -003	*Experiences TRIGA – Array of rods U-ZrH (20% ^{235}U) in a core configuration*	*H_2O*	*Jozef Stefan Institute*
IEU-SOL-THERM-004	*Solution UO_2SO_4 – U(14,7%^{235}U) – Reflective spherical tank*	*BeO*	*LANL*

The table below shows the results of the qualification of the "standard route" APOLLO-MORET4 of the CRISTAL V1.2 form [2] for the selected experiences in the context of the study of the TNF-XI package loaded with content No. 8:

IEU-COMP-THERM									
Série	Cas	q	BENCHMARK		CRISTAL V1.2		$3\sigma_{comb}$	C-E	Moyenne C-E
			k_{eff}	Δk_{eff}	k_{eff}	σ_{calc}		(pcm)	et écart-type associé
003	01	0.9038	1.00060	560*	1.00066	30	567	6	44 (54)
	02	0.9034	1.00460	560*	1.00542	30	567	82	

IEU-SOL-THERM									
Série	Cas	q	BENCHMARK		CRISTAL V1.2		$3\sigma_{comb}$	C-E	Moyenne C-E
			k_{eff}	Δk_{eff}	k_{eff}	σ_{calc}		(pcm)	et écart-type associé
004	01	0.9295	1.00190	410	1.01102	30	1233	912	912

Δk_{eff}: experimental uncertainty in pcm

σ_{comb} (combinated) is obtained by combination of the experimental and calculation uncertainty:

$$\sigma_{comb} = \sqrt{\sigma_{benchmark}^2 + \sigma_{calcul}^2}$$

The obtained k_{eff} for the selected benchmarks in the context of the present study shows that:

- for a media made of uranium enriched at 20 wt.% in ^{235}U in thermal spectrum reflected by water, the calculates k_{eff} with "standard route" (APOLLO-MORET4) of the CRISTAL V1.2 form, tends towards overestimate the calculated k_{eff} and are in concordance with the benchmarks;
- for a media made of uranium enriched at 20 wt.% in ^{235}U in thermal spectrum reflected by BeO, the "standard route" (APOLLO-MORET4) of the CRISTAL V1.2 form, tends towards overestimate the calculated k_{eff}.

RAI-Cr-2

Provide justification in Reference No. DOS-06-00037028-503 to indicate that the weld analysis on the borated steel ring is applicable to the new TNF-XI content No. 8 at 20 wt% ^{235}U.

The referenced document was performed for the most limiting original contents at 5 wt% ^{235}U. The new enrichment limit requires justification that these welds have no significant impact on the criticality safety of the TNF-XI package with content No. 8 at 20 wt% 235U.

This information is needed to determine compliance with paragraph 673(a)(ii) of IAEA SSR-6, 2012 Edition.

As explained in the chapter 5A-6 (DOS-06-00037028-506), the criticality safety analysis of the TNF-XI package loaded with content No. 8 has been performed on a simplified model of the package. This simplified model consists of the modelling of only one cavity of the cask without considering the borated ring in a penalizing manner.

Therefore, as the borated ring has not been modelled in the calculations related to content No. 8, the Chapter 5A-3 (DOS-06-00037028-503) is not applicable.

MATERIALS EVALUATION

RAI M-1

Provide appropriate references (e.g., material or design specifications, test reports, design or fabrication standards) to verify the following statements or conclusions in the application. If the reference document has already been provided to the NRC, then, identify the specific section/location in the application where the supporting information is provided.

a. Regarding the proprietary polyester-based Bora resin (neutron absorber material):

i) *Chapter 0, Section 7.4, of the application states that the "workable" temperature range for the Bora material is -40 °C [-40 °F] and 150°C [302 °F]. In support of this conclusion, the applicant cited Reference No. 12986-R-08, Revision 2, "Transnucleaire Bora Resin Data Sheet", which does not appear to have been included in the application. The staff needs this information to verify the applicant's conclusion of adequate performance of the Bora material in the temperature range of interest per IAEA SSR-6 Regulations 501, 639, and 679. The applicant should ensure that the acceptable temperature range defined in the reference document is consistent with the chemical composition of the Bora material, as defined in Section 7.4 of the application.*

The reference 12986-R-08, Revision 2 is given in enclosed documents (2). The chemical composition in this document is consistent with the chemical composition of the Bora material as defined in Section 7.4.
In the temperature range [-40°C; +20°C], no variation of the chemical composition is expected.
In the TN International manufacturing specifications, the minimal requested density is 1.75. Between +20°C and 150°C, is has been measured a loss of mass about 0.05% that lead to consider in a penalizing manner a density equal to 1.741. This is bounded by the criticality assumptions that consider a density equal to 1.74.

It is reminded that the maximum Bora temperature is lower than 150°C:
- in Normal Conditions of Transport, 62°C (see Chapter 2-1),
- and in Accidental Conditions of Transport and 117°C (see Chapter 2).

ii) Chapter 0, Section 7.6, of the application states that the Bora neutron absorber resin is confined in stainless steel components in a dry environment. Therefore, the applicant concluded that corrosion is not credible in that encased environment. The applicant is asked to identify the design drawing that defines both (1) the material specification for the Bora material (per the chemical composition defined in Chapter 0, Section 7.4 of the application) and (2) the closure/encasing requirements for the Bora material in the stainless-steel component. The staff needs this information to verify the *applicant's conclusion of adequate performance of the stainless-steel material adjacent to the Bora material per IAEA SSR-6 Regulation 501 and 614.*

The conformity of the package model is ensured through the designs drawings and trough the prescriptive chapters of the Safety Analysis Report (i.e. chapters 0, 0-1, 0A, 6A, 7A and 8A).

Designs drawings do not define material specification for the Bora material as this data is already given in the prescriptive chapter 0.

Dimension of the Bora casing is given in the section H-H and in the partial section D-D and of the design drawing 12986-01 revision K. Internal diameter of the cavity is 354 mm. Both internal and external shells have a 1mm thickness. The material is given in the chapter 0 (stainless-steel X2CrNi 18.09).

The Bora shell (item 7) is first casted in a mold. After polymerization, the Bora shell is enclosed in a stainless-steel casing made of welded steel parts. The welds numbering related to the casing are S1, S2 and S3 are shown in the drawing 12986-01 revision K and are detailed in the Table 0.1 of the Chapter 0. The nondestructive tests are detailed in the same table. It is equally reminded that Chapter 7A-1 provides inspections to be carried out during the manufacture of the packages.

b. Regarding the phenolic resin (impact limiter/ fire retardant material):

i) Chapter 0, Section 7.4, of the application states that the phenolic foam has a "M1-F1" chlorine-free classification with a moisture content less than 20%. The applicant did not provide the reference for the "M1-F1" standard specification nor for the as-fabricated moisture content specification. The applicant also did not specify if the maximum moisture content is specified by weight, or by an alternate measure. The applicant is asked to provide the "M1-F1" standard specification, test results that demonstrate the expected residual water content, and the design drawing that defines the material specification for the phenolic resin material (per the chemical composition and allowable residual moisture defined in Chapter 0, Section 7.4 of the application). The staff needs this information to verify the assumed properties and fabrication standards for the phenolic resin per IAEA SSR-6 regulations 501, 614, and 640. If the references and design drawing are not provided, the staff may need to propose a condition for revalidation that requires compliance with Chapter 0, Section 7 of the application.

The references for the "M1-F1" standard specifications are NF P 92-507 (EN 13501-1) and NF F 16-101. These French standards exist in English version.

NF P 92-507 standard is to set out the rules for classifying fitting materials according to how they react to fire (M index). Five classes, M0 to M4 are defined in the standard, M0 being the highest class. M1 means that it does not spread heat or flame.

NF F 16-101 standard is, among others, to provide the "smoke index", noted "F". Six classes, F0 to F5, are defined in the standard, F0 being the highest class. F1 means that it emits virtually no black and toxic smoke.

As described in Chapter 2, two oven tests have been performed and examination of the packages has demonstrated the behavior of the phenolic foam under fire conditions.

According to the TN International manufacturing specifications, the chlorine content is below 20 ppm (0.002 %). As explained in the Chapter 0, no trace of corrosion was observed on the stainless steel sheet in contact with the same type of phenolic foam (same humidity and composition) in a TN-UO2 package which was manufactured in 2001 and opened in 2008.

The moisture content (given by weight) of the phenolic foam is at least equal to 20 wt%. This minimal value is given in the TN International manufacturing specification. During manufacturing of the packages, tests have been performed on the phenolic foam in order to demonstrate the expected residual water content. For information, the density of the phenolic foam is bounded by tolerances given in the TN International manufacturing specifications.

Moreover, as explained in the RAI M-1 a. ii), the conformity of the package model is ensured through the designs drawings and through the prescriptive chapters of the Safety Analysis Report. Design drawings do not define material specification.

ii) Chapter 2, Appendix 4, of the application defines the chemical composition of the phenolic resin material at fabrication (i.e., carbon, hydrogen, and oxygen contents), which was used in the criticality safety analyses. However, per Chapter 0 of the application, the package design incorporated three types of phenolic resin. The application does not clearly identify that all three types of phenolic resin have the same chemical composition, and whether the material density is the only difference between the resin types. Further, the application does not provide the design drawing where the material specification requirements at fabrication for the three different types of phenolic resin are defined. The staff needs this information to verify the assumed properties and fabrication standards for the phenolic resin per IAEA SSR-6 Regulations 501, 614, and 640.

As detailed in the answer to the question RAI-Cr-2, the safety-criticality analysis performed for the content No. 8 in the chapter 5A-6 is based on a simplified model. In a penalizing way, this model does not consider the phenolic foam. Therefore, the calculated $k_{eff} + 3\sigma = 0.881$ ($\sigma = 100$ pcm) does not depend on the phenolic chemical composition and is conservative.

iii) *Chapter 1, Section 2.1 of the application states that the phenolic foam can adequately perform within the temperature range of -200°C [-328 °F] to 120°C [248 °F]. In support of this statement, the applicant referenced Chapter 1, Appendix 2, "Phenolic Foam Test Report" (Reference No. 12986-Z-1-2, Revision 0, dated November 30, 2001), which only addresses the mechanical properties (i.e., compressive strength) of the phenolic foam (Type 1 and Type 2) at the low temperature requirement per IAEA SSR-6 regulations 639 and 679. The staff notes that the applicant did not justify adequate mechanical performance at temperatures as low as -200°C [-328°F], as discussed in the Chapter 1, Section 2.1, of the application; however, the staff recognizes that this justification is not necessary for compliance with IAEA SSR-6 regulations.*

Although the applicant addressed the low-temperature mechanical performance of the phenolic resin, the applicant did not provide justification of adequate performance for the range of temperatures per IAEA SSR-6 regulations 639 and 679 (i.e., temperatures exceeding -40°C [-40 °F] up to 70°C [158 °F]). Per the discussion in Chapter 1, Appendices 1.1 and 1.2, this justification appears to be provided in either References 9 or 10 of Chapter 1 (i.e., Reference No. R&DDT001-26-B-2, Revision 1, "Synthèse d'essais de compression effectués en température sur des échantillons de mousse phénolique" or Reference No. NTC-05-00014263-000, Revision 0, "Note récapitulative sur le vieillissement en température des mousses phénoliques"). English translations of these references do not appear to have been included in the application. The staff needs this information to verify the applicant's conclusion of adequate performance of the phenolic resin material in the temperature range of interest per IAEA SSR-6 regulations 639 and 679.

References <9> and <10> of chapter 1 and the corresponding translations are given in enclosed documents (3) and (5).

Within the scope of the prolongation of the current certificates of the TNF-XI package (certificates valid until end of 2021), the behavior of the phenolic foam is being updated. Thus, new thermal and ageing tests have been carried out and currently, results are being analyzed. Conclusions of these tests will be provided for the next prolongation request.

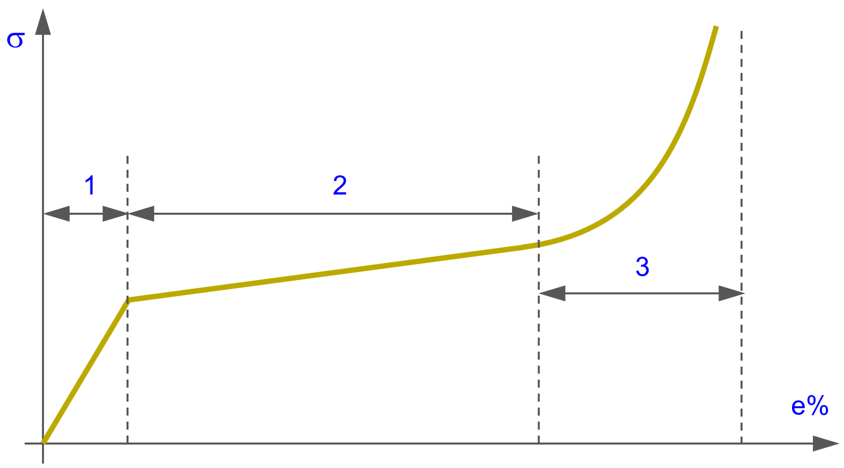
In addition, Chapter 0, Section 4.3, of the application states that each upper plug protecting the primary lids contains two thermal insulating disks with phenolic foam which provide thermal insulation and shock absorption. Per Chapter 0, Table 0.2, the phenolic foam for these disks is Type 3, which has a lower density and lower compressive strength than Type 1 and Type 2 used elsewhere in the package. The application does not justify the mechanical properties in Chapter 0, Table 0.2, per test results or a standard specification that demonstrate that the assumed values in the structural evaluation are valid for temperature range of interest per IAEA SSR-6 regulations 639 and 679.

In chapter 0, the mechanical properties of the phenolic foam given are given for temperature equal to 20°C. In the structural evaluation chapter 1 – appendix 1.1, it is assessed the behavior of the package for a drop onto an upper corner in function of the temperature. This assessment is based on the data given in the reference 9 of Chapter 1, given in enclosed document (3).

iv) *Chapter 1, Section 2.1, of the application states that cracking of the phenolic resin was not observed in compression tests conducted at -40°C [-40 °F]). The applicant referenced Chapter 1, Appendix 2, "Phenolic Foam Test Report" (Reference No. 12986-Z-1-2, Revision 0, dated November 30, 2001). The discussion in this reference does not appear to support this observation at the lowest temperature of interest per IAEA SSR-6 regulations 639 and 679.*

Compression curves presented in Chapter 1-2 show the behavior of the phenolic foam during compression test at -40°C. The shape of the compression curves at -40°C is identical to the shape of the compression curves à 20°C. The curves show three zones corresponding to the expected foam behavior under compressive stress:

1- Elastic zone
2- Plastic zone
3- Crushing zone



For the stress-strain responses in compression tests, a region of linear elasticity at low stresses is followed by a long collapse plateau in which the stresses do not vary a lot, truncated by a region of densification in which the stress rises steeply. Plastic collapse characteristic of closed cell phenolic foam gives a long, approximately horizontal, plateau to the stress-strain response. Advantage from the long stress plateau is taken in impact protection, since the energy absorption per unit of volume is defined as the area under the stress-strain responses. The absence of irregular or sudden drops in the compressive stress (σ) in the plastic zone is evidence that no alteration of the foam (no cracks) has occurred at low temperature.

c. Regarding ethylene propylene diene monomer (EPDM) material:

Chapter 1, Section 2.1, of the application states that the EPDM seal used for the primary containment lid (in each of the four containment wells inside the package) is an elastomer whose vitreous transition temperature is lower than – 40 °C [-40 °F] with adequate performance at temperatures higher than 75 °C [167 °F]. Further, Chapter 1, Section 7.4, defines hardness requirement for the EPDM seal and states adequate performance for an operating temperature range between – 40 °C [-40 °F] and 100 °C [212 °F]. The staff is unable to locate the appropriate references (e.g., material or design specification, test reports, design or fabrication standards) that support these assertions and the adequacy of the mechanical properties for the temperature range of interest per IAEA SSR-6 regulations 639 and 679. If these references are not provided, the staff may need to propose a condition, for revalidation that requires compliance with Chapter 0, Section 7, of the application.

As the chapter 0 is prescriptive, all requested acceptance criteria given in this chapter must be fulfilled.

Supplier data are given in the enclosed document (4), which shows that the EPDM gasket can be used between -55°Cand 170°C without difficulties.

d. Regarding the minimum boron-10 contents in the Bora neutron poison material and the borated steel material:

Chapter 0, Sections 7.3 and 7.4, of the application define minimum boron-10 requirements for both the borated steel material and the polyester-based Bora material, which were used in the criticality safety analyses. Drawing No. 12986-01, Revision K, does not identify these requirements. The applicant is asked to identify and provide the pertinent drawing(s), which identifies these acceptance requirements. If these drawings are not provided, the staff may need to include a condition for revalidation that requires compliance with Chapter 0, Section 7, of the application. The information is needed to ensure compliance with IAEA SSR-6 regulation 501.

The information is needed to ensure compliance with paragraphs 501, 614, 639, 640, and 679 of IAEA SSR-6, 2012 Edition.

Materials data are not given on the design drawings as the prescriptive chapter 0 gather all the acceptance requirements and the Chapter 7A-1 provides inspections to be carried out during the manufacture.

RAI M-2

Provide appropriate references to support the thermal conductivities provided in the application for the various packaging materials.

Chapter 0, Table 0.2, of the application defines the thermal conductivities of the various packaging materials, used as input parameters in the thermal analyses in Chapter 2 of the application. Chapter 0 and Chapter 2 do not identify the appropriate references to support these values. The applicant needs to identify and provide these references to verify these values for the temperature range of interest.

This information is needed to determine compliance with paragraphs 639 and 679 of IAEA SSR-6, 2012 Edition.

After review of the chapter 1, it appears that the thermal conductivity of material X2CrNi 18-9 (36 W/m/K) in the Table 0.2 is wrong. Indeed, the typical value given in ASME code for this type of material is 14.8 W/m/K at 20°C. The value considered in the thermal calculation is 19.2 W/m/K at 20°C (see appendix 1 of the chapter 2-1, interpolated value between 126.85 K and 326.85 K). As the parts of the TNF-XI package made of X2CrNi 18-9 are thin steel components, the difference between considered value in Chapters 2 and in ASME code will not have significant impact on the conclusions given in the Chapter 2.

The thermal conductivity of the material 2017A given in the Chapter 0 (150 W/m/K at 20°C) is the typical value according to « Metals refence book » Smithells 5th edition. In the thermal Chapters, a conservative value of 134 W/m/K at 20°C has been considered (see appendix 1 of the chapter 2-1).

A certificate of conformity to the technical data sheet of the phenolic foam guarantees the conformity of the physico-chemical properties. It is reminded that the numerical thermal analyses and temperatures assessment in Chapter 2 are based on thermal tests. Thermal properties of the phenolic foams have been adjusted in the numerical model to reproduce the thermal behavior of the packages during oven tests.

The thermal conductivity of the BORA resin is given in the enclosed document (2).

RAI M-3

Provide design drawings that identify the weld requirements and non-destructive test requirements identified in Table 7A-1.1 of the application, per the safety categorization in Section 3 of Appendix 7A-1 of the application.

Drawing No. 12986-01, Revision K, does not identify weld requirements and non-destructive test requirements defined elsewhere in the application. Further, the "as-built" drawings of the qualification test specimens used for the drop and thermal tests, as provided in Chapter 1, Appendix 4, of the application, do not identify these requirements.

The staff recognizes that these requirements are individually identified in Chapter 0, Table 0.4 of the application. If the applicant chooses not to provide the design drawings with the appropriate weld and test requirements, the staff may need to propose a condition for revalidation that requires compliance with Chapter 0, Table 0.4, of the application.

This information is needed to determine compliance with paragraph 501 of IAEA SSR-6, 2012 Edition.

Concerning the welding, the requirements are given in the chapter 0 and especially in the Table 0.4. The compliance with requirements given in this chapter is requested.

The difference between prototypes and packages are given in the Chapter 1-3, especially for the welds. Applicable tests requirements for welds of the prototypes are identical to the ones for the packages.

RAI M-4
Provide an evaluation to support the conclusion that flammable gas generation due to radiolysis in the package is negligible.

Chapter 0A, Section 3.1, of the application states that there is no risk of radiolysis in the package as the thermal power of Contents No. 8 is negligible. The applicant's conclusion is not supported by a bounding evaluation. The staff needs this information to ensure that generation of flammable gases due to radiolysis is not credible.

This information is needed to determine compliance with paragraphs 501, 614, and 644 of IAEA SSR-6, 2012 Edition.

As described in the French certificate F/381/AF-96 (Dk) the thermal power "P" of the content No. 8 is lower than 0.5 mW per cavity.

The gas generation η_g due to radiolysis is assessed below from experimental coefficients available in the literature and is defined by the following equation:

$$\eta_g = P.F.G.C = G_{eff}(T).P.C \qquad (1)$$

With:

η_g	Formation gas speed (moles/s)
P	Thermal power (W)
F	Fraction of ionizing radiation absorbed by the materials surrounding the uranium content
G	Number of gas molecules formed per 100 eV absorbed; the value of G is a constant for a given material and a given temperature
$G_{eff}(T)$	Effective number of gas molecules produced per 100 eV emitted at the temperature of the target material
C (constant)	$1{,}04.10^{-7}$ moles. 100 eV / molecule.W.s

F is considered equal to 1 in a penalizing way: it is assumed that all the energy is absorbed by the materials with the maximum G factor.

Value of G depends on temperature and activation energy "Ea" of the material. Temperature correction is carried out according to the Arrhenius' law from known values at 21 °C.

$$G_{eff}(T) = G_{eff}(T_0) \cdot e^{\left(\frac{Ea}{R} \cdot \frac{T-T_0}{T \cdot T_0}\right)} \quad (2)$$

With:

T_0	294 (K)

T	Average temperature of the materials (K)
Ea	Activation energy of target materials (J / mole)
$G_{eff}(T_0)$	Effective value of G at T_0 (number of gas molecules formed for an energy of 100 eV absorbed by the target materials at T_0)
R	Gas constant, 8,31 J/mole/K

The effective value of G_{eff} is given by:

$$G_{eff} = \sum_{M} (F_M \times G_M) \times F_P$$

Values of G and the corresponding gas generation "η_g" are given in the table below for different materials representative of allowed hydrogenated material in the content No. 8 at ambient temperature T_0 and at 75°C (348.15°C), that corresponds to the maximal temperature of the package in Normal conditions of Transport. "η_g" is given in mole/year that is a penalizing value for the transportation duration.

	G values (molecules / 100 eV at 21°C) Ref. [4]		Activation energy Ref. [4] (J / mole)	G(*) at 75°C	η_g (10^{-3}mole/year)
Material	H_2	Gas total		H_2	
Water	1.6	2.4	0	1.6	2.62
Polyethylene	4.1	4.1	$3.34.10^3$	5.1	8.32
Polyvinyl chloride	0.7	2.6	$3.39.10^4$	6.1	9.94
Cellulose	3.2	10.2	$8.79.10^3$	5.6	9.18

(*) Calculated according to equation (2)

The maximal gas generation is obtained for the Polyvinyl chloride (PVC).

In a penalizing way, the minimum air volume in the cavity is calculated hereafter in order to define the maximal concentration of H_2 gas after one year of transport.

$$V_{air\ min} = V_{cavity} - V_{3\ pails}$$

With:

$$V_{cavity} = \frac{\pi \cdot d_{cavity}^2}{4} \cdot h_{cavity}$$

And

$$V_{3\ pails} = 3 \cdot \frac{\pi \cdot d_{pail}^2}{4} \cdot h_{pail}$$

Parameters	Value (mm)	References
d_{cavity}	354	drawing 12986-01 revision K

h_{cavity}	674	
d_{pail}	287.4	Chapter 0
h_{pail}	224.7	h_{cavity} / 3 in a penalizing way

$$V_{air\ min} = 22.61\ dm^3$$

The number "n_{air}" of air moles in the cavity at T_0 is therefore equal to:

$$n_{air} = \frac{V_{air\ min}}{Vm} = \frac{22.61}{22.4} = 1.01\ \text{mole}$$

Therefore, the maximal concentration of H_2 in the cavity after one year is equal to:

$$\frac{n_{g\ PVC}}{n_{air}} = 0.98\%$$

As the flammable limit for H_2 is about 4%, there is no subsidiary risk due to radiolysis in the TNF-XI package.

STRUCTURAL EVALUATION

RAI-St-1

Clarify the change bars located in Chapter 1 of the TNF-X1 SAR, Revision 9, and their relationship to the new proposed content No. 8.

In Chapter 1 of the TNF-XI SAR, Revision 9, located in Enclosure 6 of Transmittal Letter E-51440, a number of change bars are found throughout the chapter. These change bars are not identified as part of the "List of Changes" located in Enclosure 5 of the same letter. The change bars appear to be related, in part, to updates in the drop test evaluation of the primary lid.

This information is needed to determine compliance with paragraphs 220, 722 and 727 of SSR6 of IAEA SSR-6, 2012 Edition.

The change bars located in Chapter 1 of the TNF-XI SAR, Revision 9, are not related to the content No. 8 application. Indeed, the Chapter 1, Revision 2 is dated 15th of July 2015, whereas the application for content No. 8 has been applied in 2018.

The mechanical analysis presented in the Chapter 1 is applicable to the content No. 8 as this content is similar to other content from a mechanical point of view.

It is reminded that this structural analysis has not changed since the last validation for content No. 7.

RAI-St-2

Provide the criteria used to select which of the two primary lid designs will be used.

In SAR Chapter 1, Appendix 1-8, the applicant refers to two primary lid designs. On the first one, the bayonets are machined with the primary lid. On the second one, the bayonets are welded to the primary lid. The latter is labeled as Option 1. In the same appendix, the applicant refers to Chapter 0 for additional descriptions. The staff reviewed the aforementioned Chapter 0 and attached Drawing 12986-01 and could not find any information related to the criteria or conditions for the use of each design.

This information is needed to determine compliance with paragraphs 220 and 727 of SSR6 of IAEA SSR-6, 2012 Edition.

Including optional configurations in engineering drawing for package approval is consistent with the guidance provided in NRC ISG-20 to allow a degree of flexibility in the package design. There are no specific criteria or conditions for the design with the bayonets machined with the primary lid or welded to the primary lid.. Technical evaluations in the SAR consider any effect of the design options on the safety function of the primary lid. Either design option for the primary lid bayonet as shown on Drawing 12986-01 is intended to be an approved design option that can be specified for fabrication.

RAI-St-3

Provide and justify the criteria and assumptions used to perform the analysis in Appendix 1-8. Also, explain how the criteria and assumptions are conservative.

It is first reminded that analysis in Appendix 1-8 is valid for all the contents, including content No. 8. This mechanical analysis, performed before current application, has not been updated since the last prolongation.

In Appendix 1-8, the applicant discusses a simplified model to evaluate the "good mechanical behavior of the primary lid during the 9-meter drop test considering the most penalizing off-centering of the content." The following information is not entirely clear to the staff:

a. Accelerations of 300 g and 500 g were used to validate the analysis. The staff was unable to accurately determine the criteria used to select these acceleration values.

In Chapter 1, Appendix 1.2 it is assessed the maximum acceleration during the 9 m drop on the corner, taking into account the effect of ageing on the foam characteristics. This assessment leads to consider the maximum acceleration equal to 340 g.

In Appendix 1-8, two different values of acceleration bounded the 340 g has been used in the calculations in order to study the sensitivity on the behavior during the 9 m drop (300 g and 500 g). It has been then demonstrated that the acceleration has no significant impact on the mechanical behavior of the lid. Therefore, the value of 500 g (covering the maximal acceleration calculated in the chapter 1) has been retained for the study.

b. Figure 2 of Appendix 1-8 illustrates a top-down drop onto the primary lid. The applicant did not justify how this was the governing drop orientation.

The aim of the mechanical analysis in Appendix 1-8 is to demonstrate the mechanical behavior of the primary lid under different accelerations (300g and 500g). It is demonstrated in the chapter 1 that the accelerations perpendicular to the lid under ACT remain below these accelerations. Moreover, it has been tested centered and off-centered location of the primary lid in the cavity in order to identify the most penalizing conditions. Indeed, testing these both locations ensures covering both flat and corner drops orientations.

Moreover, in the worst case analyzed in the chapter 1, the acceleration perpendicular to the lid is equal to:

$$340 \times \cos(30°) \cong 300g$$

With 340 the maximal acceleration of the package in ACT and 30° the angle of the package during the corner drop.

The maximal acceleration perpendicular to the lid in ACT is also below the maximal acceleration tested in the chapter 1-8, which proved the good mechanical behavior of the lid in ACT.

c. In Appendix 1-8, section 3.1, the applicant states the following:

> *"…study is only dealing with the mechanical strength of the primary lid under imposed acceleration"*
> *and describes characteristics of the simplified model. The staff was unable to find sufficient justification within the application that supports the use of a simplified model.*
> *This information is needed to determine compliance with paragraph 727 of IAEA SSR-6, 2012 Edition.*

The use of a simplified model is justified by the fact that drop acceleration is set through the mechanical properties of the damping material. Section 2 explains that "*The acceleration during drop tests is obtained via a cylinder made of damping material. The crushing stress of this damping material is set in order to reproduce the acceleration due to the foam and steel structure*".

Therefore, as the drop acceleration is led by the damping material, a complete model including phenolic foam and steel structure is not needed to assess the stresses on the primary lid during regulatory drop test.

Enclosure 2 to E-54606

TN International Statement of Proprietary Information Pursuant to 49 CFR 7.14, 49 CFR 105.30, and 10 CFR 2.390, dated June 28, 2019

TN INTERNATIONAL
STATEMENT OF PROPRIETARY INFORMATION
PURSUANT TO 49 CFR 7.14, 49 CFR 105.30, AND 10 CFR 2.390

I, Eric Delaunay, depose and say that I am the Vice President of Nuclear Logistic Operation of TN International, duly authorized to execute this statement of proprietary information and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. TN Americas LLC on behalf of TN International, is submitting this statement of proprietary information in conformance with the provisions of 49 CFR 7.14 and 49 CFR 105.30 of the U. S. Department of Transportation's (U.S. DOT) regulations, and with the provisions of 10 CFR 2.390 of the Nuclear Regulatory Commission's (NRC) regulations. This information is exempt from public disclosure under the Freedom of Information Act, 5 U.S.C. 552, as amended, for withholding this information.

The information for which proprietary treatment is sought is contained in Enclosures 3 and 4, as listed below:

- Enclosure 3 NF F 16-101:1988-10 French Standard, Railway rolling stock Fire behavior Choice of Materials
- Enclosure 4 NF P 92-507:2004-02 French Standard, Fire safety, Building – fitting materials

Pursuant to the provisions of paragraph 7.14 of Part 7 and paragraph (a) (3) of Part 105 of the U.S.DOT regulations, and the provisions of paragraph (b) (4) of Section 2.390 of the NRC regulations the following is furnished for consideration by the U.S.DOT and by the NRC 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 is intended for the exclusive and non collective use of ORANO and designated as the property of Association Française de Normalisation (AFNOR) and cannot be used, reproduced or communicated without ORANO authorization.

2) The information is of a type customarily held in confidence by TN International and not customarily disclosed to the public. TN International has a rational basis for determining the types of information that is customarily held in confidence by it.

3) Public disclosure of the information is likely to cause substantial harm to the competitive position of TN International because the information consists of material specification standards for the TNF-XI Packaging, as well as company business sensitive information, 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 TN International, take marketing or other actions to improve their product's position or impair the position of TN International's product, and avoid developing similar data and analyses in support of their processes, methods, or apparatus.

Further the deponent sayeth not.

Po Schmidt · 2019/06/28

Eric Delaunay (Signature and date)
Vice President, Nuclear Logistic Operation
TN International

Witnessed by

B Latour 2019/06/28

Name: (Signature and date)
TN International

Enclosure 3 to E-54606

NF F 16-101:1988-10 French Standard, Railway rolling stock Fire behavior Choice of Materials (Proprietary)

Enclosure 4 to E-54606

NF P 92-507:2004-02 French Standard, Fire safety, Building – fitting materials (Proprietary)