

**Enclosure 3 to E-36014**

**Replacement Pages**  
**for the SAR**  
**(Non-Proprietary Version)**

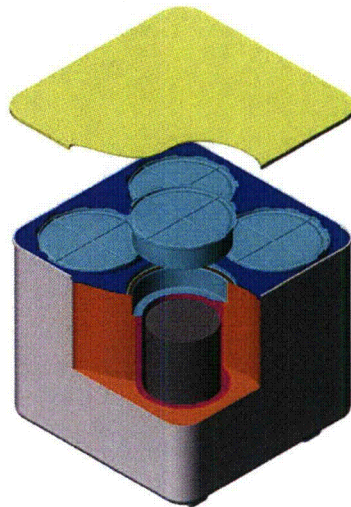
**NON-PROPRIETARY**



**AREVA**

**TRANSNUCLEAR, INC.**

# **TNF-XI Package**



## **SAFETY ANALYSIS REPORT**

**Docket Number 71-9301**

Revision 9  
July 2013

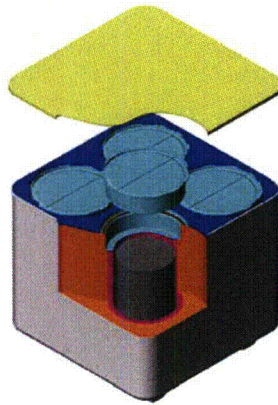
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**NON-PROPRIETARY**

**TNF-XI  
Package**

Docket Number  
71-9301

**Safety  
Analysis  
Report**



**AREVA**

**TRANSNUCLEAR, INC.**

## 6.0 CRITICALITY SAFETY EVALUATION

### 6.1 General Description

This criticality safety analysis is performed to demonstrate safety of the Transnuclear, Inc. (TN) TNF-XI package. This package meets applicable 10 CFR 71 [1] and IAEA [2] requirements for a Type A fissile material shipping container for homogeneous and heterogeneous uranium dioxide enriched to a maximum of 5.0% <sup>235</sup>U.

The packaging consists of a stainless steel outer shell and lid that encases a body of phenolic foam. Four individually sealed stainless steel inner wells are located in the body. The uranium oxide powder/compounds are positioned within these inner wells in pails.

Water exclusion from the package under accident conditions is not required for this package design. The contents of the package are analyzed in the damaged container under optimal moderation conditions and favorable geometry.

This analysis is performed for an enrichment range of 4.05 to 5.0 wt. percent <sup>235</sup>U for homogeneous UO<sub>2</sub> powder, *such as fine powder*, and heterogeneous UO<sub>2</sub> material, *such as coarse powder, pellet, and scrap*. This work demonstrates safety for a maximum homogeneous UO<sub>2</sub> powder or heterogeneous UO<sub>2</sub> material loading with water moderation (moderation provided by materials with a hydrogen content less than or equal to that provided by water) per TNF-XI package as shown in Table 6-1. A separate criticality evaluation to determine the Uranium loading limits that allows for the use of up to 390 grams of polyethylene (or materials with a hydrogen content less than or equal to that of polyethylene) per cavity of the TNF-XI package is documented in Appendix A.6. Other oxide forms (e.g., U<sub>3</sub>O<sub>8</sub> or UO<sub>x, x>2</sub>) are also equally valid provided the UO<sub>2</sub> equivalent total payload is not violated.

**Table 6-1.** Uranium Dioxide Weight Limits per TNF-XI Package

<sup>235</sup> U Enrichment	Homogeneous UO <sub>2</sub> Powder Maximum Loading, kg (Particle size < 0.50 mm in diameter)	Heterogeneous UO <sub>2</sub> Material Maximum Loading, kg (Particle size > 0.50 mm in diameter)
4.05%	300	300
4.10%	300	293
4.15%	300	287
4.25%	300	271
4.35%	300	259
4.45%	300	247
4.55%	294	238
4.65%	281	228
4.75%	265	219
4.85%	255	208
4.95%	244	202
5.00%	239	197

Table A.6-3 TNF-XI Allowable UO<sub>2</sub> Masses

Max <sup>235</sup> U Enrichment (weight percent)	Homogeneous UO <sub>2</sub> Powder Maximum Loading (kg) <i>(Particle size &lt; 0.50 mm in diameter)</i>	Heterogeneous UO <sub>2</sub> Material (Pellet and Scrap) Maximum Loading (kg) <i>(Particle size &gt; 0.50 mm in diameter)</i>
≤ 4.05	300	300
4.15		284
4.25		271
4.35		256
4.45		247
4.55	286	236
4.65	271	224
4.75	259	216
4.85	248	208
4.95	238	202
5.0	232	196

Table A.6-4 KENO Mixture Numbers

Mixture Number	Powder	Pellets and Scrap
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Proprietary Information Withheld Pursuant to 10 CFR 2.390

### 7.1.2 Loading the Payload into the TNF-XI

1. The uranium oxide payload will be contained in pails. Prior to the loading of the payload into the pails, visually verify that an undamaged boronated ring is correctly installed in each pail as shown in the drawings of Section 1.3. *The fissile material shall be divided by mass as evenly as practical in the pails and the contents of each pail shall not exceed 25 kg of uranium oxide at a maximum enrichment of 5 % <sup>235</sup>U.*
2. A maximum of three pails may be loaded into a single well and *the pails shall be placed so that the total mass of the payload material is distributed as evenly as practical among the four wells of the packaging. The maximum loading of any one well shall not exceed 25% of the maximum loading mass for the specific enrichment and type of content; Homogeneous UO<sub>2</sub> powder or Heterogeneous UO<sub>2</sub> material, per Table 6-1 or Table A.6-3.*
3. After loading the *pails* into each well, the primary lid shall be placed into the well and rotated to engage the bayonets.
4. Secure the primary lid locker for each primary lid.
5. Lower each upper plug into position and rotate to engage the bayonets.
6. Install the securing plate after all upper plugs are in place.
7. Install safety cover.

### 7.1.3 Final Package Preparations for Transport

1. Install the tamper-indicating seal.
2. Not Used.
3. Monitor external radiation for each package per 49CFR §173.441<sup>1</sup>.
4. Determine the surface contamination levels for each TNF-XI package per 49CFR §173.443.
5. Determine the criticality safety index for the loaded TNF-XI package per 49 CFR §173.403.

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<sup>1</sup> Title 49, Code of Federal regulations Part 173 (49CFR 173), *Shippers – General Requirements for Shipments and Packagings*, 1-1-97 Edition