



Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

Global Nuclear Fuel

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Ms. Huda Akhavannik
Licensing Branch – Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTN: Document Control Desk

Dear Ms. Akhavannik:

Subject: GNF-A Safety Analysis Report Update for Model No. NPC Package

References: 1) Docket Number 71-9294
2) NRC Certificate of Compliance (CoC) USA/9294/AF-85, Rev 6
3) GNF-A Request for Revision to the CoC for the NPC Package – Material Classification, 5/29/13

Attached is are revised pages to Chapter 6 – “Criticality Safety Evaluation” of the NPC Safety Analysis Report (SAR) which incorporate additional information regarding material classification.

Please contact me on (910) 819-5950 if you have any questions or would like to discuss this matter further.

Sincerely,

Scott P. Murray, Manager
Facility Licensing

Commitments: None

Attachment: Revised Pages – Chapter 6 NPC Safety Analysis Report

6.0 CRITICALITY SAFETY EVALUATION

6.1 GENERAL DESCRIPTION

This criticality safety analysis is performed to demonstrate safety of the New Powder Container (NPC). This transport package meets applicable IAEA and 10 CFR 71 requirements for a Type A fissile material-shipping container for homogeneous and heterogeneous uranium compounds enriched to a maximum of 5.00 wt. percent U-235.

The NPC transport package design features include an internal 3x3 array of stainless steel Inner Containment Canister Assemblies (ICCA) enclosed in a near cubic stainless steel reinforced Outer Confinement Assembly (OCA) as described in Section 1.2, *Package Description*.

The uranium contents are contained within 8.515” (21.63-cm) maximum ID stainless steel canisters internally spaced on nominal 12.0” (30.48-cm) center-to-center positions within the OCA. Manufacturing tolerance effects on package models are addressed in Section 6.3.1, *General Model*.

Water exclusion from the ICCAs is not required for this package design. Each cylindrical inner container within the package is analyzed in both undamaged and damaged container arrays under optimal moderation conditions and is demonstrated to be a favorable geometry.

This analysis is performed at a maximum enrichment of 5.00 wt. percent U-235 for both homogeneous UO₂ powder and heterogeneous UO₂ in the form of pellets, and cylindrical elements to represent unrestricted particle size (e.g., outer diameter, OD, is varied through optimum). The most reactive condition is therefore modeled for each authorized payload to demonstrate safety. The following Table 6.1 summarizes the uranium mass limits per ICCA and per package for the NPC container. Other uranium compounds complying with the requirements stated in Table 6.1 are acceptable for shipment provided that the equivalent uranium payloads are not exceeded.

Table 6.1 - Uranium Equivalent Mass Limits* per NPC Package

Material Form (≤ 5.00 wt.% U-235)	Particle Size Restriction: Minimum OD (Inches)	Maximum Loading per ICCA (kgs)		Maximum Loading per NPC (kgs)	
		Net	Uranium	Net	Uranium
Homogeneous Uranium Oxides/Compounds	N/A	60.0	52.89	540.0	476.1
Heterogeneous UO ₂ Pellets (BWR)	0.342	60.0	40.54	540.0	364.8
Heterogeneous UO ₂ Pellets (PWR)	0.300	60.0	40.54	540.0	364.8
Heterogeneous Uranium Compounds	Unrestricted particle size	60.0	40.54	540.0	364.8

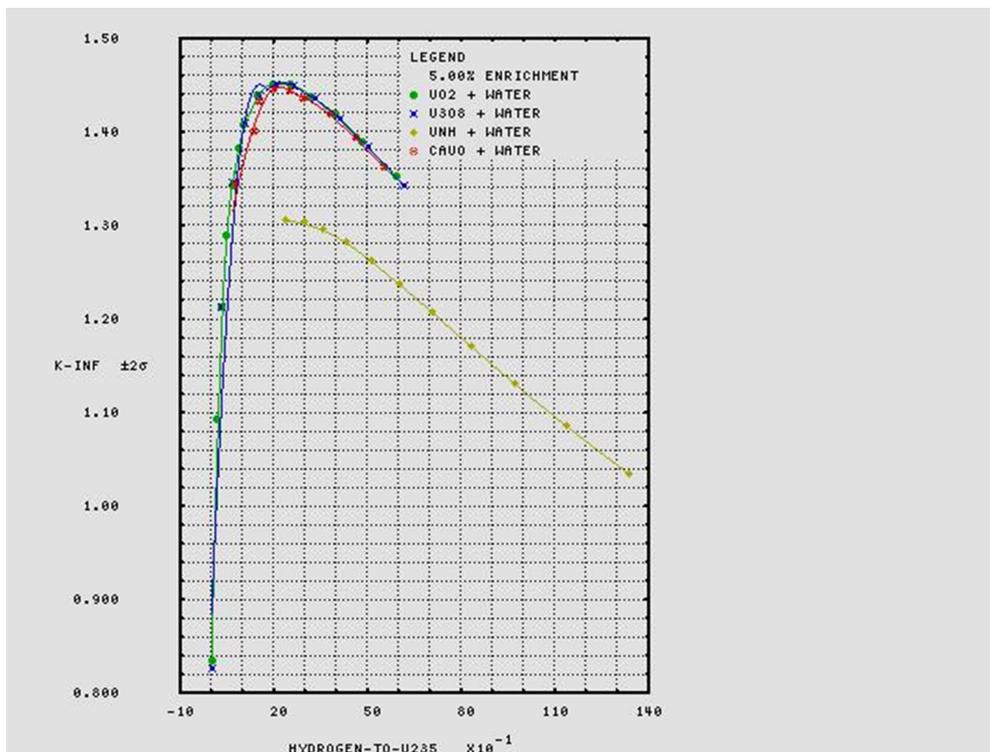
*For U-235 enrichments ≤ 5.00 wt. %.

The “Material Form” column in Table 6.1 includes both homogeneous and heterogeneous uranium compounds in the form of solids, or solidified or dried materials. All homogeneous and heterogeneous compounds are restricted to material forms having a bulk density ≤ 10.96 g/cc (theoretical UO_2), with a percent uranium content ≤ 0.88144 .

This specifically includes homogeneous uranium compounds with a maximum particle size of 0.059 inches (1.5 mm)¹ and limited to (UO_2 , U_3O_8 , or $UO_x, x>2$), dried (calcium containing) sludges, nitrates, uranyl nitrate hexahydrate (UNH, chemical formula $UO_2(NO_3)_2 \cdot 6H_2O$, with a theoretical density of 2.807 gm/cm³), and uranium oxide bearing ash from combustible waste incineration.

A reactivity comparison between 5% enriched theoretical UO_2 , U_3O_8 , UNH, and $CaU_6O_{19} \cdot 11H_2O$ compounds with water is provided in Figure 6.0 demonstrating that the theoretical mixture of UO_2 and water is conservative relative to other homogeneous uranium compounds. For k-infinite reactivity comparisons, refer Appendix 6.11 for a more complete material specification listing of uranium compounds evaluated.

Figure 6.0 K-infinite Comparison of U-compounds



¹ GNF-A has determined that uranium compounds with a particle size of less than 1.5 mm have an acceptably small heterogeneous effect and can be effectively treated as a homogeneous system. Ref. GNF-A proprietary report: JAERI Heterogeneous Effect Method, DCP-CSA No. 1320.05, rev. 2, 8/12/1996.

This also specifically includes heterogeneous uranium oxides (UO_2 , U_3O_8 , or $\text{UO}_{x, x>2}$) and UO_2 pellets present in standard BWR and PWR reactor fuel assembly lattices designs (e.g., PWR: 17X17; BWR: 10X10, 9X9, 8X8 nuclear fuel assemblies). This analysis demonstrates safety for uranium compounds through optimal heterogeneity (unrestricted or unlimited particle size). As such, the specified pellets having diameters greater than or equal to the “Minimum” value specified in the table may be safely transported in the NPC package provided the tabulated UO_2 (or equivalent uranium) material contents per ICCA and package are met.

Uranium-bearing contents may be moderated by water or carbon to any degree and may be mixed with other non-fissile materials with the exception of deuterium, tritium and beryllium. Materials such as uranium metal and uranium metal alloys are not covered by this analysis.

For this package, undamaged packages have been analyzed in infinite arrays and hence pursuant to 10 CFR §71.59(a)(2) the more restrictive value of “N” is derived from the damaged array calculations. The Criticality Safety Index for criticality control is then derived from this value of “N” per 10 CFR §71.59(b).

This analysis demonstrates safety for $2N=150$ packages. The corresponding Criticality Safety Index (CSI) for criticality control of non-exclusive vehicles is given by $\text{CSI} = 50/N$. Since $2N = 150$, it follows that $N = 75$, and $\text{CSI} = 50/75 = 0.6667 \approx 0.7$ [rounded up to nearest tenth]. Using the rounded Criticality Safety Index result, the maximum allowable number of packages per non-exclusive use vehicle is $50/0.7 = 71$.