Global Nuclear Fuel

Pre-Submittal Meeting for the New Powder Container Safety Analysis Report Revision

June 5, 2019

Non-Proprietary Information

Meeting Agenda

Non-Proprietary Discussion

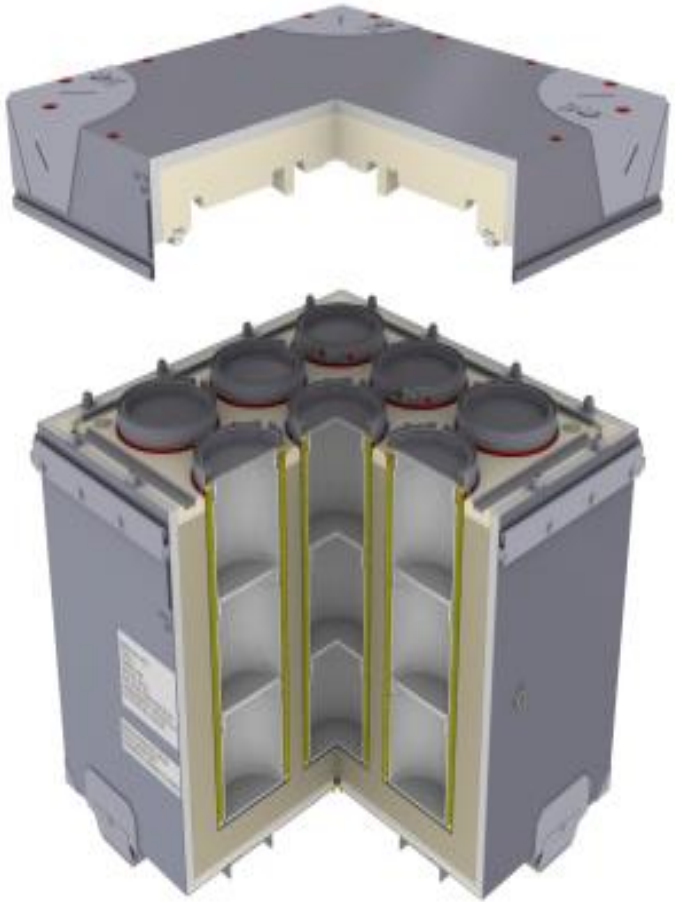
- Introductions
- Purpose of Meeting
- Overview of the Most Recent New Powder Container (NPC) Licensing Activities
- Technical Approach to Address NRC Requests for Additional Information (RAIs)
- NPC Safety Analysis Report (SAR) Modifications to Resolve RAIs

Proprietary Discussion

- Submittal Strategy and Timing
- Proprietary Questions and Answers

Purpose

- Review the technical approach for revising the NPC SAR NEDO-33881 Rev. 6 [ML17186A290] to address outstand NRC RAIs [ML18107A753].



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Overview of the Most Recent NPC Licensing Activities

- Monday, June 19, 2017 [ML17170A025]
  - GNF submits NEDO-33881 Rev. 6 to expand authorized NPC uranium content and re-instate the previously approved Boiling Water Reactor (BWR) and Pressurized Water Reactor (PWR) pellet payload.
- Tuesday, August 15, 2017 [ML17235B131]
  - GNF and NRC meeting to discuss NEDO-33881 Rev. 6 changes.
- Tuesday, April 24, 2018 [ML18123A385]
  - GNF and NRC meeting to discuss NRC RAIs for NEDO-33881 Rev. 6.
  - NRC issues RAIs on Wednesday, April 25 2018.
- Tuesday, October 30, 2018 [ML18303A245]
  - GNF withdraws NEDO-33881 Rev. 6 license application.

Overview of Modifications to NPC NEDO-33881

- No package or hardware modifications.
- No drawing or package description changes.
- No changes to structural (Chapter 2), thermal (Chapter 3), containment (Chapter 4), shielding (Chapter 5), or acceptance testing and maintenance (Chapter 8).
- Modified to expand authorized NPC uranium content and re-instate the previously approved BWR and PWR pellet payloads.
  - BWR and PWR payload demonstrations are in the current NRC approved NEDO-33881 Rev. 5 [ML15042A187 and ML15042A199].
- All outstanding NRC RAIs will be incorporated into NEDO-33881.

Chapter 1 – RAI 1.1

- RAI 1.1: "*Revise Table 1.1 of the SAR to include the compositions of the dried calcium-containing sludges, dried (sodium containing) sludges, and other uranium compounds. […]*"
- Approach: The approved uranium compound descriptions were removed from the footnotes below Table 1.1 and moved to Table 6.21 in Chapter 6. The following footnotes below Table 1.1 were modified to state:

2) *"Homogeneous compound material forms limited to solid uranium compounds with a Uranium Weight Fraction (UFACT) less than or equal to theoretical UO_2 (UFACT ≤ 0.88144). Details of authorized uranium compounds are provided in Table 6.21."*

3) *"Heterogeneous compounds limited to the same criteria as homogeneous material forms in (2) above."*

Chapter 1 – RAI 1.2

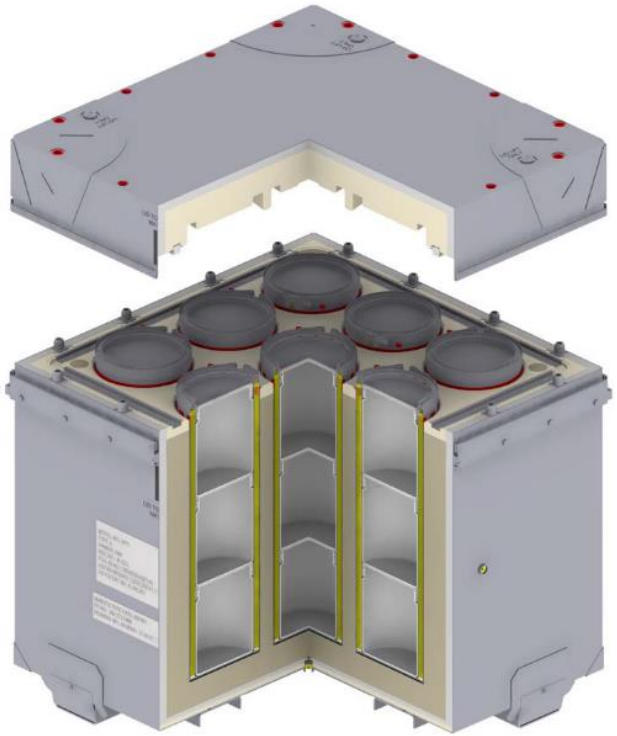
- RAI 1.2: "*Demonstrate that uranium tetrafluoride (UF_4) reactions will not cause significant corrosion of the Inner Containment Canister Assembly (ICCA), deterioration of the silicon gasket, or generate flammable gas. […]*"
- Approach: Provide a detailed explanation in the RAI response.
  - There is negligible amount of hydrofluoric (HF) produced (~10^{-6} ppm) from the solid UF4 due to the moisture in the air (~10^{-4} g/cm^3) and low UF_4 solubility (~10^{-7} mole/cm^3).
  - The negligible amount of HF from air moisture causes minimal to no damage to the ICCA or silicon gasket and will not cause an over-pressurization event.
  - The water immersion test in NEDO-33881 Section 2.7.6 demonstrates that there is no leakage of water into the ICCA.
  - Prior to each shipment and annually (if NPC is not in use), a thorough inspection of each NPC and ICCA is required and documented as required in Chapter 7 and 8 of NEDO-33881.
  - GNF will provide the NRC supplemental references with the RAI response to support this conclusion.

Chapter 2 and 3

- No legacy RAIs for Chapter 2 or 3.
- No amendments to package gross weight limits or structural components.
- No amendments to structural evaluation.
- No amendment to thermal analyses or thermal testing.
- No amendments to Chapter 2 or 3.

Chapter 4 and 5

- No legacy RAIs for Chapter 4 or 5.
- No changes to container confinement boundary.
- No changes to the Type-A uranium compound limits.
- No amendments to Chapter 4 or 5.



Chapter 6 – RAI 6.1

- RAI 6.1: "*Provide criticality safety analyses for each of the proposed contents or demonstrate that the analyses presented in the current version of the SAR bound the proposed new contents, including the new contents provide by the applicant in response to RAI 1.1. […]*"
- Approach: Provide additional qualitative information about the material property reactivity comparisons presented in Figure 6.28 for the approved uranium compounds in Table 6.21.
  - Figures 6.0, 6.27, and 6.28 are k-infinite material reactivity demonstrations to compare all approved uranium compounds from Table 6.21.
  - These demonstration uses the uranium compound's theoretical density to determine the optimal U-235-to-Hydrogen (U-235/H) Ratio.
  - This sensitivity study is independent of NPC container proprieties and compound mass.
  - For a more direct uranium compound comparison, the UFACT of each compound is determined to find the most bounding UFACT value.
  - Figures 6.0, 6.27, and 6.28 demonstrate that the uranium compound with the highest UFACT (UO_2) is the most bounding.

Chapter 6 – RAI 6.2

- RAI 6.2: "*Demonstrate that it is conservative to neglect the plastic bags, bottles, and/or cans that are used inside the ICCAs in the criticality evaluation of the prosed new homogenous uranium compounds and revise the search for the most reactive content presented in Figure 6.0 if necessary. […]*"
- Approach: Provide sensitivity study in NEDO-33881 Section 6.12 to demonstrate that neglecting the packing materials is more conservative.
  - Evaluate BWR, PWR, and optimal particle size payloads to determine optimal H/U-235 Ratio.
  - 5x5x6 damaged package array with and without High-Density Polyethylene (HDPE).

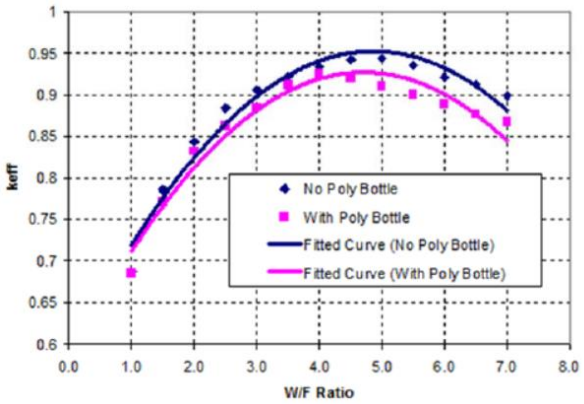
Table 6.24 Reactivity for Cases with and without HDPE in ICCA

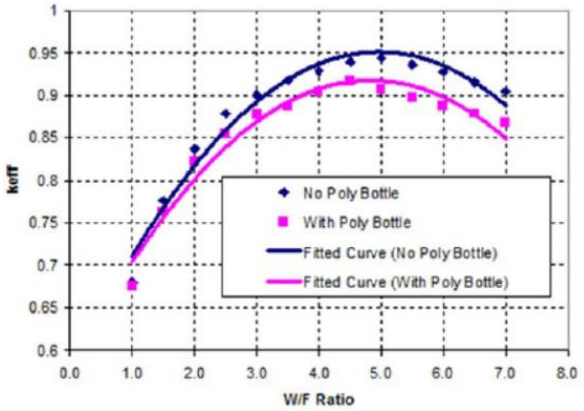
Case ID (with poly bottle)	Sphere Diameter (inch)	UO_2 Mass (kg)	U Mass (kg)	Comparison Maximum k_{eff}	
				Without HDPE	With HDPE
t15a-40.in	0.342	55	48.48	0.9438	0.9248
t15a-50.in	0.300	53	46.71	0.9442	0.9162
t15a-50.in	0.150[a]	46	40.54	0.9319	0.9113

[a] Optimal size for unrestricted spherical particle treatment.

Chapter 6 – RAI 6.3

- RAI 6.3: "*Either provide a minimum weight limit for packaging materials with a hydrogen atom density greater than that of water or demonstrate that the package and the increased BWR/PWR pellet payloads remain subcritical in the absence of these packaging materials. […]*"
- Approach: Remove weight limit for packaging materials for a hydrogen density less than water.
  - As shown in RAI 6.2, modeling the HDPE packaging materials is less reactive than including them. Additional sensitivity studies will be provided in NEDO-33881 Section 6.12.
  - NEDE-33881P Table 1.1 Note 4 was revised to remove the HDPE limit to state: "*Mass of plastic bags or poly bottles used for inner packaging is unrestricted provided the mean hydrogen atom density of the material contents to be shipped inside the inner volume of each ICCA is not greater than water.*"

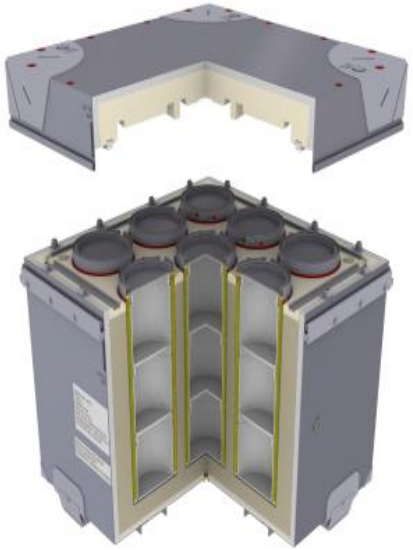




Chapter 6 – RAI 6.4

- RAI 6.4: "*Demonstrate that the package with the proposed new contents remains subcritical when uranium-bearing contents are moderated by carbon to any degree. […]*"
- Approach: Remove carbon as a moderator from Page 6-3.

"*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.*"

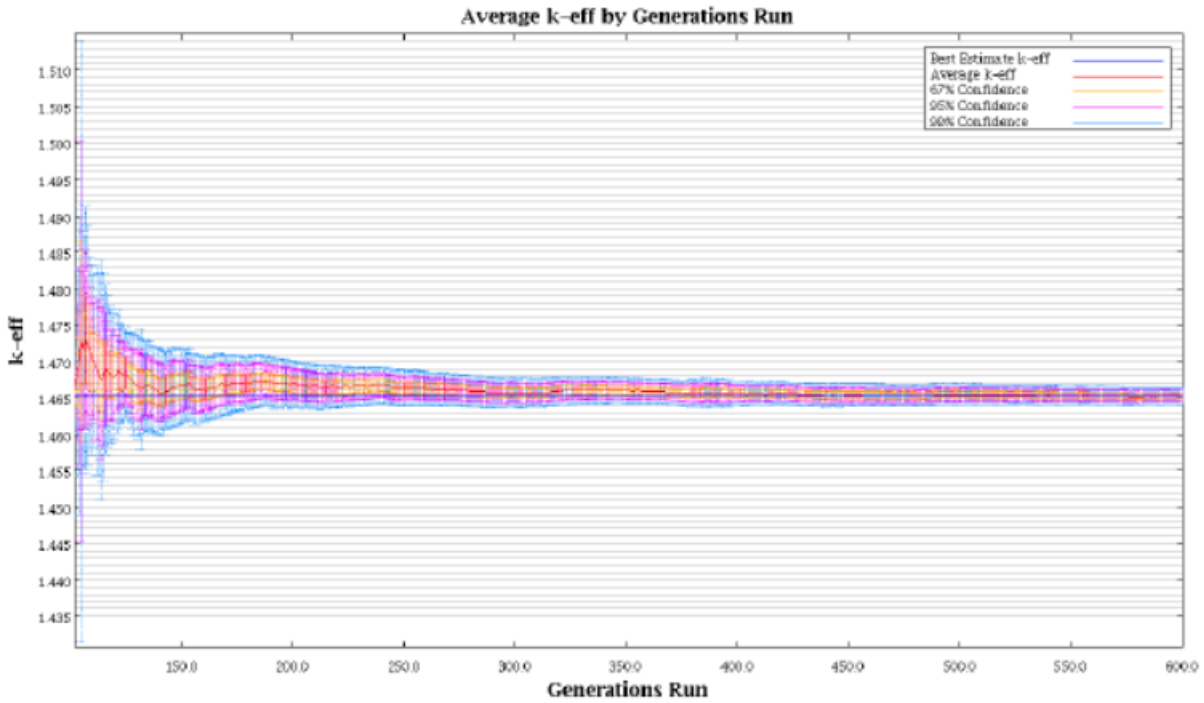


Chapter 6 – RAI 6.4

- RAI 6.4: "*Revise the chemical formulas for the proposed new compounds listed in Table 6.21 using correct chemical notation for the proposed new compounds and provide information that demonstrates that the data presented in SAR Table 6.21 are accurate. […]*"
- Approach: Revise NEDO-33881 Section 6.11 Table 6.21 and provide the NRC additional references.
  - NEDO-33881 Section 6.11 Table 6.21 was revised to provide a more consistent representation of the uranium compound chemical formulas.
  - GNF will provide the NRC Staff with additional references to support the new compounds listed in Table 6.21.

Chapter 6 – RAI 6.6

- RAI 6.6: "*Demonstrate that the Monte Carlo calculations converge. […]*"
- Approach: Update Figure 6.10e to show GEMER code convergence.
  - The current set of GEMER convergence figures are a composite illustration of the batches run and the batches skipped. Where the left-half of the figure is for the batches executed and the right-half is for the batches skipped.



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Chapter 7 – RAI 7.1

- RAI 7.1: *"Pertaining to loading of various contents: a) Clarify which uranium payloads […] require packaging in plastic bottles and/or bags prior to loading in the ICCAs. […] b) Provide the maximum particle size for homogenous uranium compounds to enable differentiation between homogenous and heterogeneous […] compounds. […]"*
- Approach: Revise Chapter 7 to provide guidance on which uranium payloads require packaging materials.
  - NEDO-33881 Chapter 7 will be revised to state that shipment of powdered material will always contain three polyethylene bottles and/or appropriate dunnage to prevent internal movement for partial loads [ML071760085].
  - The proactive GNF decision to provide a particle size limit for homogeneous material in the NPC is no longer required [ML13134A395].
  - Based on previous NRC and GNF discussion, it was determined that this limit was unnecessary and therefore not included in the NPC Certificate of Compliance [ML13273A177].

Summary of the NEDO-33881 Modifications

- No package or hardware modifications required for new uranium compounds and expanded payload.
- No changes to structural, thermal, containment, shielding, or acceptance testing and maintenance.
- The k-infinite material demonstrations in NEDO-33881 Chapter 6 prove that the uranium compound with the highest UFACT bounds all other approved uranium compounds.
- Neglecting HDPE packaging material is more conservative.
- A weight limit is not required for packaging materials with a mean hydrogen atom density less than water.

Submittal Strategy and Schedule