ES-3100 Shipping Package

Certificate: USA/9315/B(U)F-96

Holder: U.S. Department of Energy

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U.S. Nuclear Regulatory Commission

Rockville, Maryland

Y-12 National Security Complex

NNSA National Nuclear Security Administration

Meeting Objectives

- Establish a consensus on approach to resolving the latest RAIs - received on January 12
- B&W Y-12 will present an approach to each RAI
- Seek agreement on approach

RAI Review Order

6-4 to 6-7	John DeClue
3-3	Sanford Bloom
3-1	Monty Goins
6-1 to 6-3	John DeClue

RAI 6-4 Provide justification for allowing hydrogenous material to be stored with the broken metal of unspecified shapes.

- "cha" model — first-order approximation model for broken metal used in the SAR to establish fissile mass loading limits.
- "fl" and "fd" models — more realistic representation of broken metal with 500 g polyethylene developed to address questions raised in RAIs 6-5 and 6-11.
- Calculation results presented in Tables 6.9.6-11b and 6.9.6-11c demonstrate that results for the "cha" model evaluated without polyethylene bounds results for the more realistic "fl" and "fd" models evaluated with 500 g polyethylene.
- If loadings were based on the more realistic "fl" and "fd" models with 500 g polyethylene, the allowable loadings for metal would increase, and the number of calculations in the SAR would increase significantly.
- Rather than take this approach, the decision was made to retain the very conservative loading limits established based on the first-order "cha" model recognizing that reliance on the first-order approach incorporates a considerable margin of subcriticality.
- Adding polyethylene to the conservative "cha" model would result in an unnecessary level of conservatism.

RAI 6-5 Revise the criticality analysis for uranium oxide powders to consider low density powders.

- A parametric evaluation of density will be conducted over the range of 2 to 6.54 g/cm3 to establish the behavior of k*eff* for a variety of potential oxides that could be shipped.

- Given monotonic behavior is demonstrated, Y-12 will re-run the criticality calculations for minimum bulk density of HEU product oxide based on content loadings of 4-5 kg per 2.3 liter convenience can (12-15 kg HEU oxide per package).

RAI 6-6 Revise the criticality analysis to define the "unidentified material" that may be present in the skull oxide content.

- Table 6.9.3.1-3c describes 10 models for skull oxide used in the criticality evaluation

  a. 8 representative compositions for the 292 samples of canned skull oxide.

  b. 2 compositions derived from sample data where unidentified material is treated as U-235 and the carbon content is either maximized (Model 9) or minimized (Model 10).

- Essentially, the fissile mass loading limits for skull oxide are determined based on the limiting calculation results of Model 9

- Treatment of the unidentified material as fissile material in the criticality analysis assures that its presence in skull oxide will not increase reactivity beyond what was determined by the current analysis.

- An additional package content loading restriction will be added to Sect. 6.2.4 to address the 10 CFR 71.83 requirement for dealing with unknown trace constituents.

RAI 6-7 Revise the benchmarking analysis in Section 6.8 of the SAR to ensure that the single calculated upper subcritical limit (USL) of 0.925 is appropriate for all of the evaluated contents for the Model No. ES-3100.

- Section 6.8.3 will be revised to justify that the USL used in the calculations (0.925) is appropriate for all contents of the ES-3100. Discussion will be added referencing the validation report in Appendix 6.9.8 for derivation of the bias.

RAI 3-3 Provide the basis for the hydrogen generation model contained in Appendix 3.6.7.

(A) Provide justification for the applicability of the ORNL model.

$G(H_2)$ Values Derived From Alpha Radiolysis Experiments	
Description	**$G(H_2)$ molecules/100 eV**
Reported in NUREG/CR-6773, 2000, Table D.1	
Burns and Sims, 1981 6.4 MeV He++	1.10
Bibler, 1974 Cm-244 alpha (5.8 MeV)	1.30
Spinks and Woods, 1976 5.3 MeV alpha pH=0.5	1.60
Icenhour and Toth, ORNL/TM-2003/172, 2003	
Fig. 3.3. Samp A-2-2, UO_3 10% H_2O 350°C	0.77
Fig. 3.5. Samp A-4-1 U_3O_8 2% H_2O 650°C	0.28
Icenhour et. al., ORNL/TM-2003/194, 2004	
Fig. 4.12. Samp Al 3, NpO_2 8% H_2O 650°C	0.69
Fig. 4.11. Samp Al 2, NpO_2 1% H_2O 650°C	1.02
Fig. 4.13. Samp Al 4, NpO_2 1% H_2O 800°C	0.29
Fig. 4.14. Samp Al 5, NpO_2 0.5% H_2O 650°C	0.42

- ORNL experiments are recent (2003). Newer methods tend to be more accurate
- Mean and standard deviation of ORNL values are 0.58 and 0.30

  One standard deviation range is 0.28 to 0.88
- G(H2) = 0.88 is suggested based on the ORNL experiments
- Loadings for UNX and oxide are reduced accordingly

(B) Provide the experimental validation of the gas generation model.

Available experimental data is in two ORNL reports. One was provided with first RAI response. The other, ORNL/TM-2003/194, is now being provided.

(C) Justify the margin for the compliance of the hydrogen concentration limit.

Time span will be increased from 1 to 1.25 years, to add margin of 25%. Loadings are reduced.

(D) Provide the operating procedures in handling potential flammable gas generation.

Chapter 7 of the SAR will include a statement to the effect that if a package containing oxide or UNX is sealed for more than one year, hydrogen build-up above 5% may have occurred in the sealed CV, and appropriate measures should be taken when opening the CV.

RAI 3-1 Explain and justify the basis for the limit of 1500 g of off-gassing material and add this information to the SAR.

- An upper limit of 1490 g was needed to meet the needs of shippers for the use of Teflon bottles as convenience containers in the ES-3100. This limit is a combination of 3 Teflon bottles (990 g) and the 500 g allowance for off-gassing material that is already authorized in the CoC.
- The 1490 g limit was then used in calculations pertaining to CV pressure, radioactive material leakage criteria, and criticality control.
- Off-gassing of 1490 g of material during NCT and HAC was one source of pressure build-up in the CV that was accounted for in the safety basis.
- SAR sections will be revised to add this rationale for the 1490 g limit.

RAI 6-1 Clarify mass loading limits for the square bars.

- Add footnote “h” to the mass loading limit for square bars given in Table 1.3
- Change the mass loading limit for broken metal at < 60% enrichment from “35.32” to “35.2” consistent with footnote “h”

RAI 6-2 Provide clarifying information on enrichment and mass limits for the slug configurations. Provide clarification on geometric arrangement of ≤80% enriched slugs.

(A) Change “>80” to “>80, ≤ 95” for slugs in the Enrichment column of Table 1.3

Column headings for Table 6.1b give evaluation limits for U235 at enrichment and can spacer configuration.

Example, pg. 6-12, Column 4 of header row: slugs with can spacers evaluated in the enrichment range between 80% and 100%, where the U235 does not exceed 36,555 g.

Evaluation limits are not necessarily the fissile mass loading limits given in Table 6.2a as summarized from Table 6.1b
Pg. 6-12, Column 4, Row 4 for CSI= 0.0: In the enrichment range between 80% and 100%, the content must be load-limited to 24,324 g U235 and canned spacers used.

The 25th paragraph of Sect. 6.4.1 (on pg. 6-73) will be modified to correct the misconception that slugs are evaluated only at 100 % enrichment.

(B) Same general response as for 6-2a

The column headings for Table 6.1b give evaluation limits for U235 at enrichment and can spacer configuration. These limits are not the lower fissile mass loading limits given in Table 6.2a which are derived from the results of the package array analysis.

(C) Clarification will be given in the 25th paragraph of Sect. 6.4.1 (on pg. 6-73)

(D) The loading arrangement of slugs described for Case **ncia5est11_2_2_5_3** on pg. 6-104c is depicted in Case **cvcr5est11_2_2** of Fig. 6.9.1-4b on pg. 6-103a

(E) The case name **ncf15est12_2_2_7_3** appearing as a typographical error on pg. 6-104c should be **ncf15est11_2_2_7_3**.
The loading arrangement of slugs described for Case **ncf15est11_2_2_7_3** is depicted in Case **cvcr5est11_2_2** of Fig. 6.9.1-4b on pg. 6-103a.

The case name "**ncf15est12_2_2_7_3**" for slugs 80%< enr. ≤95% and CSI=0.4 listed in Table 6.2a appears as a typographical error and should be "**ncf15est11_2_2_7_3**".

(F) The loading arrangement of slugs described for Case **ncf15est11_2_2_5_3** is depicted in Case **cvcr5est11_2_2** of Fig. 6.9.1-4b on pg. 6-103a.

The error noted in Table 1.3 was corrected in Revision 2, Page Change 2 of the SAR.

RAI 6-3 Provide clarifying information on the mass and modeled configuration for cylinders of diameters ≤4.25 inches.

- Description on pg. 6-104a for case **nciacyct11_15_1_3** was reviewed and determined to be accurate. However, both the dimension of the content and case description given for case **nciacyct11_25_2_3** on pg. 6-104b contain typographical errors. This will be corrected.

- The per-package HEU mass loadings considered in the criticality evaluation ranged from 1 kg to 36 kg for uranium metal, in this case 4.25-in.-diam cylinders. Thus, the evaluation limit is 36 kg U235. (Ref: 1st paragraph of Sect. 6.2.1) The various masses given in the rows of Table 6.1a are the potential fissile mass loading corresponding to the condition evaluated. A general explanation appears in the second paragraph on pg. 6-3b.