AREVA Federal Services LLC
Draft Responses to BRR Cask RAIs Issued March 31, 2016

(Note: these responses are intended to facilitate the phone call scheduled for April 7, and do not represent the final response from AREVA Federal Services LLC).

Sh-5-1$_2$

a. The plutonium activity is extracted from the same TRITON models used to generate the gamma and neutron source terms and is tabulated in Table 1.2-5 for each payload. The largest plutonium production is for the PULSTAR fuel element with 4% enrichment because low enrichments favor plutonium production. The shielding dose rate results for the various fuel element types are presented in Tables 5.4-3 through 5.4-9. Any plutonium present is included in the source term and thus is included in the dose rate results.
b. SCALE6/TRITON is used to compute the source terms and plutonium production. The modeling assumptions are discussed in Section 5.2, *Source Specification*.
c. SCALE6/TRITON is state-of-the-art software provided by ORNL. A comprehensive list of SCALE benchmarks may be found here: http://scale.ornl.gov/validation_spent.shtml
d. Since the source terms already include the plutonium source, no revision is required.

Sh-5-2$_2$

Drawing 1910-01-01-SAR shows that the shield plug forms the top surface of the payload cavity. It is not the containment boundary, but it defines the upper position limit for each of the baskets, as well as the fuel elements, loose plate box, and the loose plates. The loose plate box is designed to position the loose plates as close as practical to the top surface of the basket, and consequently there is relatively little clearance between the top of the loose fuel plates and the position limiting function of the shield plug. For this reason, no cover to the loose plate box is required. See the figure at the end of this document for the general arrangement of the basket, loose plate box, and loose plates inside the BRR cask. The structural integrity of the loose plate box is demonstrated in Section 2.12.8.6. Thus, there is no way for any loose plate or any dunnage plate to slide out from the volume defined by the interior cavity of the loose plate box, because the loose plates are confined between the loose plate box floor plate and the bottom surface of the shield plug. Consequently, the shielding and criticality calculations (which are based on the loose plates remaining inside the cavity of the loose plate box) are correct.

Cr-6-1$_2$

As noted in RAI Sh-5-2$_2$, the dunnage is made of aluminum and inserted beside the loose plates. Thus, the dunnage is located beside, and parallel to, the loose fuel plates. In this position, it has no role except to take up space in the loose plate box, and it can only experience any load in a through-thickness direction in compression. Thus, there is no way that the dunnage can fail or reconfigure to allow a different geometry of the loose plates. As described in the draft response to RAI Sh-5-2$_2$, the loose plates are maintained in position by the robust loose plate box and shield plug, and cannot move from this position by any NCT or HAC.
a. For the reason stated above, no drawings or specifications of the dunnage are necessary – the material only takes up space.
b. As stated above, the dunnage does not perform any safety function.

Cr-6-2$_2$

Only 3 loose plate types are authorized for the loose plate box: U-Florida, U-Mass(Al), and Purdue. U-Florida bounds U-Mass(Al) and Purdue so calculations are performed only for the bounding U-Florida plate. This is stated in Section 6.4.1.2, *HAC Single Package Configuration*. The loose plate results with less than 31 fuel plates are provided in Table 6.4-7. It is demonstrated that reactivity decreases when less than 31 plates are in the loose plate box.

The criticality safety limitations are as follows:

- U-Florida loose plates: ≤ 31 per loose plate box
- U-Mass(Al) loose plates: ≤ 31 per loose plate box
- Purdue loose plates: ≤ 31 per loose plate box

It is true that for U-Florida, 31 plates will not fit in the loose plate box. However, 17 is not a criticality safety limit, it is a geometrical limit.

The following responses are in regard to the additional 71.55(b) comments. (1) When the number of plates is increasing or decreasing it is bounded by 31 plates, as indicated in Table 6.4-7. (2) The most reactive condition is with 31 fuel plates, as indicated in Table 6.4-7. Loading less fuel plates is less reactive. (3) All models include 8 loose plate boxes (fully loaded). Removing a loose plate box would have little effect on moderation *within* a loose plate box but would cause a drop in system reactivity due to the loss of fissile material.

Cr-6-3$_2$

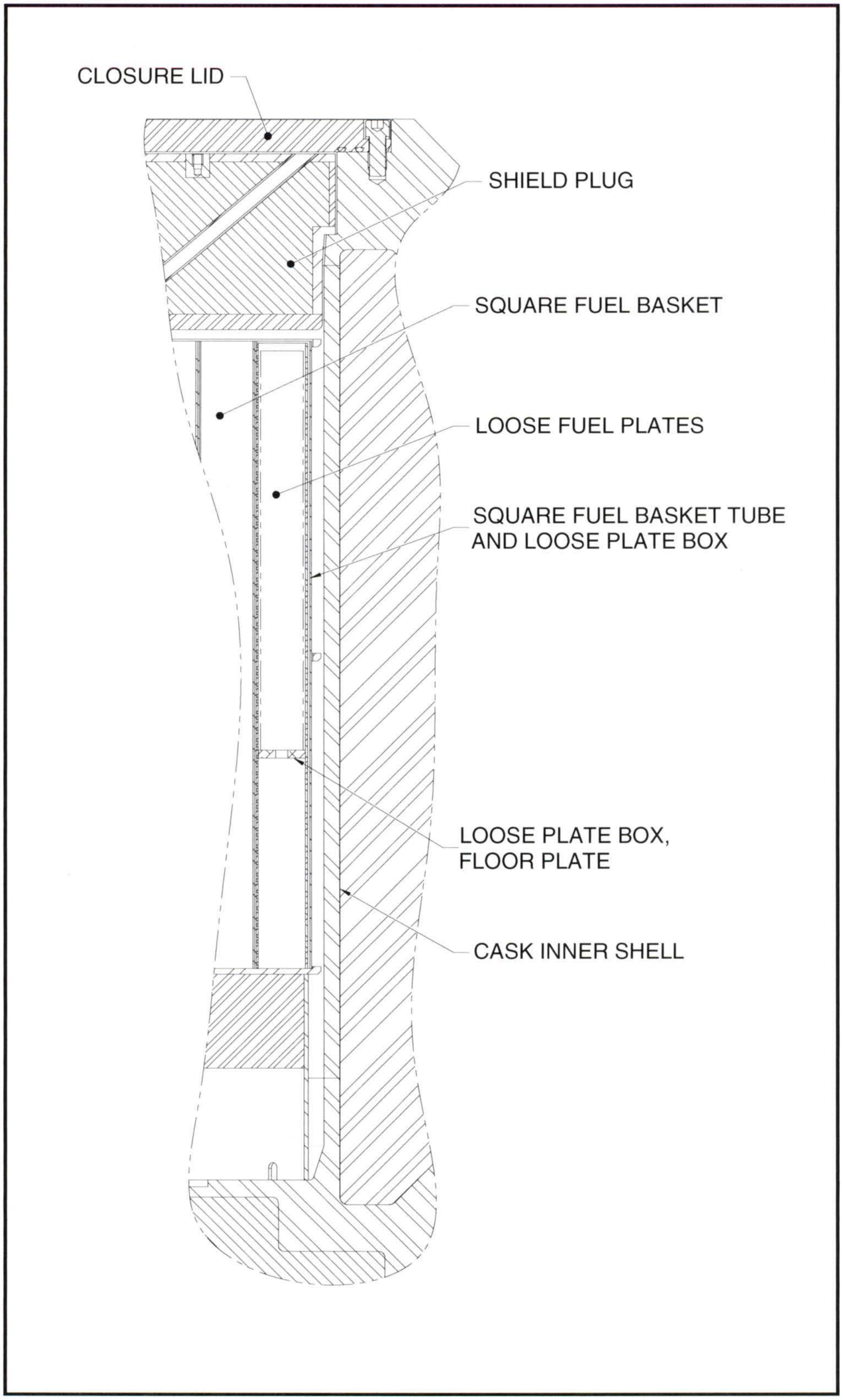
The loose plate cases were actually run for 5000 neutrons per generation for 250 generations, skipping the first 50. (2500 neutrons per generation is the *minimum* and refers to the original ATR, MITR-II, and MURR cases). A check on Shannon entropy is not available for MCNP5.1.30, which is the version of MCNP used in the SAR. To check the Shannon entropy for each case would require redoing the benchmarking for a later version of MCNP, generating a new USL, and rerunning all of the loose plate cases. The maximum k_s for the loose plate box cases is only 0.648, which is quite low.

The most reactive loose plate box case has been run in MCNP5.1.51 to spot-check the Shannon entropy. For MCNP5.1.51, $k_s = 0.647$ and the Shannon entropy check passed on cycle 2 (see screen shot below). Because k_s is essentially the same between both versions of MCNP, and because k_s is far below the USL, and because the Shannon entropy converged quickly for the most reactive case, the number of cycles used in the SAR analysis is sufficient.

```
  250   0.64839    191.62  6.25E+00        200    0.64607    0.00080         4202

 source distribution written to file srctp        cycle=    250
 run terminated when      250 kcode cycles were done.
 comment.
 comment. Average fission-source entropy for the last half of cycles:
 comment.       H=  6.22E+00  with population std.dev.=  2.65E-02
 comment.
 comment.
 comment. Cycle    2 is the first cycle having fission-source
 comment.   entropy within 1 std.dev. of the average
 comment.   entropy for the last half of cycles.
 comment.   At least this many cycles should be discarded.
 comment.
 comment. Source entropy convergence check passed.
 comment.

 final k(col/abs/trk len) = 0.64585     std dev = 0.00074


                              ctm =       191.62   nrn =        1546718025
 dump    2 on file runtpe   nps =     1248615   coll =        124248071
 mcrun  is done

C:\Users\rmigliore\Documents\2BRR2014\RAI2>
```

OP-7-1

It is important to note that the aluminum spacer of step 11.b. of Section 7.1.2.1 is different from the aluminum dunnage of step 12.b. The aluminum spacer of step 11.b. is credited in the criticality analysis, and is shown in Figures 6.4-7 to 6.4-11 of the application as noted in the question. It is required by the text of step 11.b: "…place an aluminum spacer…" This step is not optional. However, the aluminum dunnage of step 12.b. is not credited in any criticality analysis. It is present only as dunnage, to reduce the free space available to the loose plates, and does not perform any safety function. Thus, the aluminum dunnage may be placed as necessary. Consequently, AFS believes that no revision to the Operating Procedures is necessary.



Cross Section View of BRR Cask Showing Basket, Loose Plate Box, and Loose Plates