AREVA

AFS-09-0359

November 5, 2009

ATTN: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: RESPONSE TO REQUESTS FOR ADDITIONAL INFORMATION IN VARIOUS EMAILS FOR THE BRR PACKAGE, DOCKET No. 71-9341

Sirs:

AREVA Federal Services LLC hereby submits responses to the NRC requests for additional information (RAI) and the corresponding revised Safety Analysis Report (SAR) pages, which constitute Revision 2 of the SAR. The individual responses to each RAI are given in Attachment A to this letter. Revised page remove/replace instructions are given in Attachment B. Included with this letter are the following documents:

- One paper copy of the revised pages of the Safety Analysis Report for updating the previously submitted three ring binder to Revision 2.
- One electronic copy of Revision 2 of the SAR is provided in PDF format on one CD, filename: 001 BRR Package SAR R2 Complete.pdf.

The electronic copy is contained within an envelope labeled "BRR Package Docket 71-9341, Electronic Copy of Documents, Revision 2, November 2009." A description of the electronic file follows:

Title	Media Type	Contents
"BRR Package Docket 71-9341, Electronic Copy of Documents, Revision 2, November 2009"	CD	Entire BRR Package SAR, Revision 2 File name: "001 BRR Package SAR R2 Complete.pdf" (15.1 MB, 551 pgs)

If there are any questions or comments please contact me at (253) 552-1367 or by email at charles.temus@areva.com.

Very Truly Yours,
Areva Federal Services LLC

Phil Noss for CJT

Charles J. Temus
Project Manager

Encl: as noted
cc: Chris Staab, NRC-NMSS

NMSS01

ATTACHMENT A

Docket No. 71-9341, Model No. BRR Package
Responses to NRC Requests for Additional Information
Delivered per email since 8-6-09

This document contains AFS responses to questions raised by the NRC staff on several different occaisions:

- E-mail of 8-20-09 (operations question)
- E-mail of 9-3-09 (structural questions from David Tang)
- E-mail of 9-4-09 (material questions from David Tarentino)
- E-mail of 9-8-09 (radiation source question)

There are also two changes requested by AFS:

- Revise Section 7.1.3, step 3
- Revise ring diameter on TRIGA basket

These issues are addressed in order as follows.

8-20-09 email:

One of our reviewers is finalizing the containment SER for the BRR package and desires to clarify one issue in the Package Operations section (Chapter 7.1.2 Loading of Contents). To prevent potential leaking in the valve, the reviewer recommends that step 30 should read:

Step 30: Connect a vacuum pump to the vent port tool and evacuate the cavity until the interal pressure is 1-2 torr. <u>Isolate vacuum pump by shutting valve and shutting off the vacuum pump; or if they prefer to keep vacuum pump running, isolate the vacuum pump by shutting valve and venting suction line to atmosphere.</u>

Response: Section 7.1.2, step 30, will be revised to read:

"Connect a vacuum pump and a shutoff valve to the vent port tool, and evacuate the cavity until the internal pressure is 1 – 2 torr. Isolate the vacuum pump from the cask body cavity by closing the shutoff valve and shutting off the vacuum pump, closing the shutoff valve and venting the suction line to atmosphere, or other appropriate means that does not maintain a vacuum on the outlet of the shutoff valve."

9-3-09 e-mail (David Tang questions)

1. <u>P 2.1-2</u>. (1) In the 3rd bullet, remove impact limiter shells from the list of components governed by Subsection NF and (2) In Section 2.1.2..2, add specific language to identify also the foam strain limits as a design criterion for the impact limiters.

   Response: (1) The impact limiter shells will be removed from the list of components governed by NF. The SAR drawing will continue to show the impact limiter shell welds as inspected to the requirements of NF. (2) The choice of foam strain limit will of necessity be somewhat arbitrary, since there is no obvious point of "going hard" with foam. The stress-strain curve of foam gradually steepens with increasing strain, but unlike aluminum honeycomb, there is no point which clearly divides "effective" from "ineffective". Also, the orientation makes a difference. A given strain for an end drop, where all of the foam is at a high strain, may be worse than a higher strain for a corner drop, where only a small amount of foam is highly strained. Since the calculated force utilizes the actual bounding stress-strain curve of the foam, then the force-deflection curve itself is the measure of whether the impact limiter remains effective. As shown on the warm case curve of Figure 2.12.5-3 (which governs the maximum strain case), the curve trend at the maximum deformation of approximately 16 inches is gently upward, with no evidence of becoming "hard". Therefore, since foam strain limits cannot be unambiguously established, and because the force-deflection curve can be readily evaluated for assurance against "going hard", AFS prefers to leave Section 2.1.2.2 as-is.

2. <u>P 2.7-1</u>. The comparison made on referenced impact decelerations of calculated 72.2 g and measured full-scale 81.g is **misleading**. This is a major mischaracterization by stating, "[T]he half-scale test impacts were generally lower than predicted with one **exception** (emphasis added)."

    - A number of misleading statements come from using results from Test D2, in lieu of Test D2R, as the basis for the Section 2.12.5, "Impact Limiter Performance Evaluation," including:
        i. Oversight on the validity of the test results
            - The test data may not be valid for benchmarking because compete failure of the impact limiter attachments
            - The measured primary impact levels are markedly higher than the secondary impact levels, by about 25%
    - The test data should further be low-pass filtered at about 400 hz to obtain peak rigid body motion. This will allow a proper interpretation of test results
    - Should provide appropriate rationale to use **Test D2R** for benchmarking by recognizing:
        i. The impact limiter attachment assemblage were less damaged or were not damaged with any significant structural consequence
        ii. The secondary impact is more severe than the primary impact as it should be.
    - The underscored typos should be corrected:

      "[t]he prediction was for an impact of <u>72.2</u> g, whereas the full-scale equivalent impact was <u>81.5</u> g."

      Table 2.12.5-24 lists the values of 71.0 g and 81.6 g, respectively.

Response: Test D2 was chosen over D2R to represent the slapdown orientation because, while the attachments failed in both of these tests (the attachments were successfully tested in test D2C), test D2 had a higher overall impact than test D2R. However, as pointed out in the question, test D2 appears somewhat anomalous due to the fact that the primary impact is significantly higher than the secondary impact, rather than the other way around, which would be expected. When corrected for location according to Section 2.12.5.3, the D2R secondary impact test result is slightly higher than that of the primary impact. AFS agrees that the substitution of D2R for D2 as the "official" result will make more sense and add clarity to the presentation. Therefore the SAR will be changed to substitute test D2R for test D2. The impact limiter test appendix (Section 2.12.3) will still document all of the results obtained. AFS would like to point out, however, that the question of which test to identify as the official result is of secondary importance, since the impact used in the stress analysis is 50% higher than even the maximum D2 result. This conservative margin is very considerable.

AFS agrees that the filter cutoff of 1019 Hz is higher than necessary. It is the rigid body impact, and not the vibratory responses of the accelerometer mounting or test cask that are sought. The peak values reported in Section 2.12.3 are therefore somewhat higher than necessary, adding a degree of implicit conservatism to the result. Since there may be some value to knowing how much conservatism has been added, a table will be added to Section 2.12.3.7 which compares each peak curve result with an estimate formed by visual evaluation of the curve. The difference between the reported peak result and the estimated rigid body result will be used (after conversion to full scale) in Table 2.12.5-24, which compares the test results to the impact limiter analysis results.

The identified typographical errors will be corrected.

3. P 2.12.3-3. Were the accelerometer calibration constants, such as those between 0.89 and 0.97 mV/g, a part of direct input to the "signal conditioning" before the test? When was the accelerometers calibrated, before or after the drop test? Was the calibration done with appropriate QA procedure?

   Response: The accelerometer calibration constants were not entered in to the signal conditioner, which was calibrated to a uniform 1 mV/g input. Therefore, the manual adjustment of the peak values after the test was appropriate. The accelerometers were calibrated before the test using the subcontractor's standard QA procedure. Section 2.12.3.4.1 will be revised to state that the accelerometer calibration constants were not entered in to the signal conditioner before the test.

4. P 2.12.3-5. The slapdown, D2, test may have to be considered invalid because of the markedly higher primary impact level of 140 g than the secondary impact of 107 g, which is complete opposed to the general observations and those would have predicted by the SLAPDOWN code.

   - Suggest use Test D2R for the evaluation. See also comments for Item 1 above.

   Response: The SAR will be changed as discussed in the response to question no. 2 above.

5. P 2.12.3-6. Should the average secondary impact be 119 g instead?

   - $(113+111+106+124)/4/\cos(17^{o}) = 119$ g
   - Note that the secondary impact of 119 g is greater than the primary impact of 115 g, as it should be.
   - Suggest consider the data low-pass filtered at 400 hz to obtain the rigid body deceleration for further data interpretation. See also comments for Item 1 above.
   - Suggest use Test D2R as the official crush results by revising the first sentence in the first paragraph of Page 2.12.3-7.

   Response: The cos(17) correction is appropriate only for the primary impact, which occurred at that orientation. The secondary impact occurred at essentially zero degrees orientation, so the correction factor is unity.

6. P 2.12.5-7. For the NCT free drop, the Section 2.12.5.2.2 statement, "[T]he maximum impact acceleration occurs in the 45° slapdown orientation," is misleading. It should be revised to reconcile with the Section 2.12.5.2.1 statements, for the HAC free drop, "[T]he overall maximum impact acceleration occurs in the secondary impact, cold case, for a primary impact orientation of 15°."

   - Both NCT and HAC free drop should result in the same conclusion that the15° slapdown drop will produce the highest deceleration associated with the secondary impact.
   - The referenced Figure 2.12.5-16 prediction for the NCT 45° slapdown drop appears to be a misuse of the Table 2.12.5-6 data for dynamic strength of the impact limiter at different drop angles.
   - The dynamic strength data are identically captured in Rev. 0 and Rev. 1 of the application. Therefore, identical results are expected from the SALPDOWN calculation to demonstrate that the 15° slapdown drop governs.
   - Consistent with the discussion above, the deceleration vs. impact angle plot needs to be revised, as appropriate, to continue to show that the 15° slapdown drop governs.

   Response: AFS does not agree that the NCT and HAC cases should necessarily be dominated by the same impact orientation. It is true that the force-deflection curves are identical in both cases, but the energy and impact speed are not the same. The NCT case, while admittedly dynamic, is closer to a hard set-down case, or, for unstable orientations, a tip-over. The HAC impact is very different. In addition, the final deformation point on the force-deflection curve is different.

   However, investigation of the 45° case revealed a small error in the SLAPDOWN input which caused it to be reported as the worst NCT case. All of the other orientations were checked, and several small errors were found in both HAC and NCT results. The largest change to the HAC cases was a decrease of 2.2g for the cold, 45° impact orientation. However, the maximum impact of 86.8g and the maximum deformation of 15.9 inches did not change. The largest change to the NCT cases was a decrease of 2.9g for the cold, 45° impact orientation. The governing NCT orientation is now the cold end drop, which did not change its magnitude. The affected tables and plots in Section 2.12.5 have been revised accordingly. In addition, a statement will be added to Section 2.12.5.2.2 to explain why HAC and NCT governing cases do not need to be the same.

   AFS notes that, as for the HAC cases, the maximum NCT impact of 32.2g is well below the bounding impact of 40g used for stress analysis.

7. P 2.12.5-9. In the 4th paragraph, suggest revise to recognize the results associated with Test D2R, as appropriate.

   - See also comments for Item 1 above

   Response: See the response to question no. 2 above.

8. P 2.12.5-10. Revise the text to recognize the maximum NCT impact associated with the 15° slapdown drop.

   The 45° slapdown drop appears to a mischaracterization of the test/predicted results.

   Response: See the response to question no. 6 above.

9. Table 2.12.5-24. Revise the table by considering Test D2R, in lieu of D2, as the reference case for correlating the test results with the predicted by the SLAPDOWN modeling. The misleading information conveyed by the table includes the following:

   - Contrary to the calculated results, the tested secondary impact of 68.4 g is shown much less than the primary of 81.6 g. The calculated results are based on the theoretical formulation, which will predict a higher deceleration secondary impact than the primary impact
   - For the primary impact, the calculated crush distance of 10.6 inch is markedly larger than the tested at 7.8 inches. However, the corresponding calculated acceleration of 71.0 g is seen much smaller than the tested at 81.6 g, however.

   Response: See the response to question no. 2 above.

9-4-09 email (David Tarentino questions)

Q1. What condition is specified for material item number 30? Drawing number 1910-01-01-SAR, sheet 1 of 4, Item number 30, (BAR, RD, 1.5-inch DIA.) of the "List of Materials" is shown to be covered by the American Society for Testing and Materials (ASTM) specification A276 and is to be of Type 304.

Paragraph 4 (Manufacture) of ASTM A276 states that the bars shall be furnished in one of the following conditions listed in the Mechanical Requirements Table 4: *Condition A*-Annealed, *Condition H*-Hardened and tempered at a relatively low temperature, *Condition T*-Hardened and tempered at a relatively high temperature, *Condition S-Strain Hardened*-Relatively light cold work and *Condition B*-Relatively severe cold work. Furthermore, Table 4 lists Type 304 as being offered in Conditions A, B and S only.

This information is required to ensure compliance with 10 CFR 71.33(a)(5), 71.39.

Response: Any of the conditions A, B, or S is acceptable. Its function as the lifting point for the shield plug will not be affected by any of these conditions.

Q2. What specification supersedes MIL-DTL-26074, Revision F, Class 1, Grade B. General note 18 of drawing number 1910-01-01-SAR, sheet 1 of 4 states to electroless nickel plate in accordance with MIL-DTL-26074, Revision F, Class 1, Grade B.

Military specification MIL-DTL-26074 Revision F, Coatings, Electroless Nickel covers the requirements for electroless (autocatalytic chemical reduction) deposition of nickel or nickel coatings on metal surfaces and was cancelled in February of 2003.

This information is required to ensure compliance with 10 CFR 71.39.

Response: Our supplier of bolts for the BRR package has stated that the use of the cancelled specification for nickel plating is very common and presents no problems either for them or for the plating. However, to ensure that an active specification is also approved for use, flag note 18 on drawing 1910-01-01-SAR, sheet 1 has been revised to add the option to plate the bolts in accordance with a currently supported specification which is equivalent to the MIL spec given in flag note 18.

Q3. Are all vacuum grease chemistries/properties identical? How is the applicant reasonably assured that vacuum grease will not be detrimental to O-ring seal fit or function without requiring a minimum level of material properties? General note 19 of drawing number 1910-01-01-SAR, sheet 1 of 4 states prior to assembly, optionally coat each O-ring with a thin coat of vacuum grease.

Vacuum grease is a lubricant with low volatility for use in low pressure environments. Viscosity selection may be the most important factor in providing the utmost lubricant effectiveness. Various other factors to consider are additive type, thickener type, consistency, base chemistry, service temperature, specific gravity, melting point, vapor pressure, relative density, resistance to radiation, lubricity, outgassing, coefficient of expansion and thermal conductivity. A shortened lubricant lifecycle may be an outcome of overlooking one or more of these properties. Associations such as American Gear Manufacturing Association (AGMA) and National Lubricating Grease Institute (NLGI) may provide useful input.

This information is required to ensure compliance with 10 CFR 71.39, 71.43(d).

Response: The vacuum grease used for transportation packages is, as stated in the question, a low volatility grease designed to assist in proper assembly and seating of the O–ring seal during installation of the closure lid. Vacuum greases, such as Dow Corning® High–Vacuum Grease, are silicone–based compounds especially designed for high vacuum applications, and typically have a service temperature range between -40 °F and 400 °F. Vacuum greases have been used with butyl rubber containment O–ring seals for many years without incident. The principal example of this application is the large Type B transportation package fleet used by WIPP, e.g., TRUPACT–II, HalfPACT, and 72B packages, which have seen thousands of transports without any degradation of the seals or sealing surfaces due to contact with the grease, nor have any other detrimental effects of the grease been identified. Many other examples exist. Consequently, AFS feels that added specification detail of the vacuum grease would fulfill no purpose.

Q4. Are all low halogen, nickel based lubricants identical? How is the applicant reasonably assured that any low halogen, nickel based lubricant procured will not be detrimental to the operation of the closure bolts? What is meant by "nuclear grade" lubricant, how is it obtained and what does a nuclear grade provide beyond various other grades? How low is low halogen? General note 20 of drawing number 1910-01-01-SAR, sheet 1 of 4 states to coat closure bolt threads with a low halogen, nickel based nuclear grade lubricant prior to assembly.

The proper lubricant should meet several essential needs for threaded connections. First, is to control friction for obtaining true torque values. Further, correct lubrication and tightening of critical connections ensures proper assembly seating. Second, is to protect against corrosion by opposing oxidation and many chemicals. In addition, they should reduce the destructive contact between dissimilar metals and withstand greater temperature stresses. And third, they should allow for nondestructive disassembly saving labor and equipment costs.

Halogens, salt formers, are particularly active chemically. When a halogen combines with another element the resulting compound is called a halide. Halogens all form binary compounds with hydrogen known as the hydrogen halides, a series of especially strong acids. Halogen elements share similar properties and their chemical tendency to gain electrons makes them all good oxidizers. The addition of nickel contributes to a longer service life by providing a low friction coefficient to aid in prevention of galling and/or seizing, good corrosion and wear resistance and increased operating temperatures.

This information is required to ensure compliance with 10 CFR 71.39, 71.43(d).

Response: The thread lubricant specified for the closure bolts in General Note 20 of drawing 1910-01-01-SAR, sheet 1 is designed primarily to provide for a consistent friction environment to promote uniform seating of the bolts during tightening. Since the cask is stainless steel and the carbon steel bolts are nickel plated, and the bolts are used only after the cask is dry, there is no corrosive environment. The lubricant does not need to protect against general or galvanic corrosion under these circumstances. It is only required that the lubricant not be itself corrosive. A low-halogen lubricant ensures this condition. Commercially available nuclear grade lubricants typically have halogen levels below 200 – 300 parts per million (ppm), with some brands as low as 50 ppm. The lubricants may contain nickel, copper, and/or graphite as the primary anti–seize lubricating component with minimal trace elements. Examples of nuclear grade lubricants are: FelPro N5000 Nuclear–Grade High Purity Anti–Seize Lubricant, and Bostik Never-Seez® Nickel Special Nuclear Grade.

A low–halogen, nickel–based nuclear grade lubricant is expressly designed for use under nuclear service conditions. Nuclear grade lubricants were specifically developed for use in the nuclear steam supply systems (NSSS) of nuclear power plants and naval reactors, which require the prevention of halogens in a high temperature (up to 2,400 °F), wet environment, and have been utilized for over 40 years. The lubricants have also been used in spent fuel pools, which require no introduction of corrosive materials that could affect the spent fuel integrity. This spent fuel restriction is important for the BRR cask operation since lubricant residues may be introduced into the various pools into which the cask is placed for loading and unloading operations.

A generic specification of a nuclear grade, nickel–based thread lubricant for the closure bolt lubricant is important to ensure that the conditions of the Certificate of Compliance can be met even if a specific manufacturer ceases production or goes out of business. Nuclear grade thread lubricants of the specified generic type have not created any problems in NRC–certified transportation packages of which AFS is aware.

Q5. What effect will the removal of lead shielding, up to 1/2-inch square in way of adjacent welds, have on external radiation dose? Why allow the option whether to fill the annular region with ceramic rope or whether to use a backing bar? Which material ceramic rope or steel offer the greatest radiation shielding? On a complete penetration joint (one-side weld) how is the applicant reasonably assured of complete weld integrity on the backside of the joint? General note 27 of drawing number 1910-01-01-SAR, sheet 1 of 4 states an annular region of lead up to 1/2-inch square may be removed adjacent to the weld to prevent lead contamination. Space may be filled with ceramic rope or equivalent. A weld backing bar may be used.

Gamma-ray shielding effectiveness is commonly described in terms of the half value layer (HVL) or the tenth value layer (TVL). Both these terms describe the required thickness of a material absorber that will reduce gamma radiation to one-half and one-tenth of its original intensity, respectively. For example, 1/2-inch of lead shielding thickness will reduce gamma radiation from a Cobalt-60 source to one-half its original value or is equal to one HVL. In addition, the backside of the weld will be subjected to oxidation which could potentially affect integrity of the weld without the use of a backside purge, or the ability to backgouge, or use of a permanent backing bar. Requiring the use of a backing bar would eliminate oxidation of the weld backside and provide radiation shielding within the annular region.

This information is required to ensure compliance with 10 CFR 71.39, 71.47(a).

Response: The integrity of the weld is ensured, as is the case for all single–sided complete joint penetration (CJP) welds, by means of the specified nondestructive examination (NDE) methods and the required weld procedure qualification (WPS) that is used to make the weld. The purpose of the optional lead removal is to inhibit any contamination of the root pass with lead, which might melt under welding conditions. The note only provides for an optional method; other techniques may be used, such as placing the weld prep groove in the cask body rather than in the bottom plate. In any case, the plate will be installed with the cask body upside down as further insurance that any molten lead flows away from the weld joint region.

The removed area of lead is minimal relative to the cask size and the thickness of the bottom shield. Also, it is on the corner of the rectangular cross section of the shield, where the pathway of gamma rays through the lead is naturally the longest, and can best afford to be reduced. Thus, the increase in dose at the corner, if this technique is used, is inconsequential.

9-8-09 e-mail:

5.2.2 Radiation Source

Query: 5.1 Provide the basis for the additional 25% margin to compensate any potential non-conservative in the ORIGEN2. The proposed additional 25% margin appears to be arbitrary and no basis is provided for the use of this specific value.

On Page 5.4-2 of the SAR, the applicant states: "The reported dose rates are the values computed by MCNP, increased an additional 25%. This additional margin compensates for any potential non-conservatism in the ORIGEN2 program used to generate the source."

This information is needed pursuant to the requirements of 10 CFR 71.47.

The following text provides additional discussion on staff's basis for Query 5.1 regarding the use of PWR libraries to analyze non-PWR systems (research reactors)

The use of cross-section libraries representative to pressurized water reactor (PWR) configurations to characterize the source terms for research reactors spent fuel is inappropriate, given the large level of dissimilarity between these two types of reactor systems. Notable differences between these two types of reactor systems are:

- fuel characteristics (low enriched uranium with enrichment less than 5 wt% U-235 for PWRs vs. high enriched uranium with enrichment of approximately 90 wt% U-235 for research reactors.

- different fuel matrix (uranium dioxide for PWRs vs. aluminum-based dispersed fuel for research reactors).

- degree of heterogeneity (large size, relatively uniform cores for PWRs vs. small size, highly-heterogeneous cores, both radially and axially for research reactors).

- larger specific power density for research reactors that contribute to the large difference in the neutron flux spectrum (both energy dependence and spatial dependence).

The PWR cross section libraries in ORIGEN were generated, irrespective of the version of the code, using a neutron flux spectrum typical of a PWR (LEU fuel). These libraries were validated for fuels and assemblies typical to PWR (enrichment less than 5 wt% 235U) and their use for fuel with characteristics and designs far from this range would be incorrect. As mentioned in the SCALE 6 manual, page D1.A.11, with respect to generation of libraries for ORIGEN, "Note that extension of the methods and data beyond 5 wt % enrichment has not been widely investigated at ORNL because of a lack of accessible validation data for non-commercial reactor fuels. Such applications of the methodology should be tested carefully and validated. Note that the parameter ranges used as examples are not necessarily appropriate to non-LWR applications, and will need to be modified for different reactor types and fuel designs."

Additional discussion points are provided in the following paragraph.

The argument that the use of ORIGEN 2.2 thermal library is appropriate "because experience at MURR has shown that this library produces conservatives values for the isotopes routinely produced at the reactor" and "measured heat dissipation rates are typically less than half of the value computed by ORIGEN 2.2" is flawed, as it provides no physical or computational basis. If other library (let's say typical of MAGNOX) would provide larger decay heat values than the ones measured at MURR, would that mean that these libraries are appropriate to use for simulations for MURR?

- The improvements in ORIGEN-S have two main components: improvement in computational methodology and improvement in nuclear data libraries. With respect to methodology, as stated on page F7.1.1 of the SCALE6 manual, "the most significant improvement has been the ability to develop and utilize problem-dependent multigroup cross-section data for a burnup simulation process using fuel assembly design information, material compositions, and reactor operating conditions specified by the user." In addition, significant methodology updates concern the neutron source strengths and energy spectra (see section F7.2.8 of SCALE 6 manual), which include neutrons produced from spontaneous fission, (α,n) reactions, and delayed (β−,n) neutron emission. Of particular importance is the treatment for (α,n) production, which varies significantly with the composition of the medium. ORIGEN-S includes three (α,n) source options: (1) a UO2 fuel matrix, (2) a borosilicate glass matrix, and (3) an arbitrary problem-dependent matrix defined by the user input compositions; in the last option, the code determines the matrix compositions from the input. With respect to improvement in nuclear data (details on page F6.1.1 in SCALE 6 manual) "significant advancements have been made in the development of improved nuclear decay data, cross-section data, and photon yield data." With release of SCALE 5 the majority of the nuclear decay and cross-section data were upgraded to ENDF/B-VI. Explicitly represented fission product yields are included for 30 actinides with neutron-induced fission yields in ENDF/B-VI, compared to yields data for up to five actinides in previous libraries. "The addition of neutron-induced fission yields for most of the fissionable actinides with evaluated yields greatly increases the versatility and range of application of the code, particularly for advanced fuel design and transmutation studies." (page F6.1.1)

- The fact that the use of ORIGEN 2.2 PWRS library "generates actinides and fission product concentrations that, when input to a criticality program, result in computed reactivities to within 0.2% of measured reactivities" is not a measure of accuracy in the predicted MITR-II fuel element depletion and fission product buildup. The uncertainty in reactivity in the criticality calculation includes other components; in addition to the uncertainty in the isotopic composition (what guarantees that there is not a cancellation of errors?). Therefore, this cannot serve as a measure for the uncertainty in isotopic composition data. The isotopics are likely seriously in error and the criticality analogy is without basis for this application.

- ATR states: "For ATR fuel, ORIGEN2.1 and ORIGEN 2.2 generate the same source within 0.1%. Therefore, ORIGEN 2.1 results are used, even though this is an older version of the program". This argument refers only to a difference between two calculated values with two different codes. It does not provide a basis for the correctness of the use of the associated libraries.

It seems that in this case, the radiation source was calculated with ORIGEN2 and the data used further in MCNP for dose calculation. The proposed additional 25% margin is, or appears to be arbitrary and no basis is provided for the use of this specific value. Note that a 25% penalty is completely arbitrary and likely adequate for the dose rate dominated by Cs-137 or other fission products generated directly by fission; however, this has not been shown by the applicant. In addition, it is not entirely clear what the specifics of the application are (cooling times, etc.) that could impact accuracy.

Response: New neutron and gamma source terms for MURR, MITR-II, and ATR have been generated using the TRITON sequence of the SCALE6 code package. The MCNP shielding models have been rerun with the new source terms. The TRITON models use a 238 group ENDF/B-VII cross section library so that no PWR libraries are utilized. Each TRITON model is unique for the research reactor being modeled. No arbitrary scaling factors (i.e., 25%) are utilized to modify the final results. The computed dose rates remain below the limits with wide margins.

As noted in the SCALE6 manual, extension of these methods beyond 5% enriched reactor fuel has not been widely investigated by ORNL. However, the spectra of these research reactors are similar to PWR spectra (per the university staff), and the gamma source terms for MURR and MITR-II computed by TRITON are quite similar to the gamma source terms computed by ORIGEN2. The gamma dose rates for MITR-II increased 10~25%, and the MURR gamma dose rates are approximately the same compared to Rev. 0 of the SAR.

The gamma source terms generated by TRITON for ATR cannot be directly compared to the original ORIGEN2 results because the irradiation and decay parameters have changed. For ATR, it was decided to increase the burnup to bound all potential fuel rather than only a subset of the fuel. The increased burnup results in an increase in the cooling time to maintain a decay heat of 30 W.

During the TRITON analysis, an error was discovered in the ORIGEN2 input file for MITR-II. Basically, the source term had been computed at a decay time of 930 days, and not the intended 30 days. In Rev. 2 of the SAR, the MITR-II decay time is changed to 930 days so that the decay heat remains below 30 W. This also allows the source term to be compared with the original ORIGEN2 source, if desired, since the irradiation and decay parameters are the same.

For all three reactors, the neutron source is significantly larger using TRITON than ORIGEN2. Pu-238 (α,n) reactions comprise ~80% of the neutron source for MITR-II and ATR, and ~55% of the neutron source for MURR. Because the MURR ORIGEN2 calculation used the thermal library and showed essentially no plutonium production or neutron source, it may be inferred that TRITON computes a harder neutron spectrum than the PWR spectra used in ORIGEN2, resulting in more plutonium generation and hence a larger neutron source.

In addition, a significant improvement with SCALE6 is that the (α,n) neutron source is properly generated using aluminum as a target nucleus. In ORIGEN2, the target nucleus is assumed to be oxygen, which is not appropriate for these aluminum matrix fuels.

Additional SAR Change Requested by AFS:

Section 7.1.3, step 3, has been revised by adding the following to the end of the existing text:

"The lifting holes in the cask body may be optionally plugged."

Additional SAR Drawing Change requested by AFS:

Drawing 1910-01-03-SAR, sheet 3, has been revised in Zone A3-4 to show a slightly smaller diameter for the ring which supports the TRIGA fuel basket. The original size, 13.0 inches, has been reduced to 12.5 inches to permit proper welding of the ring to the lower plate. The diameter of the ring is not part of any safety analyses, and this small change to the diameter will have no effect on the safety function of the TRIGA basket. This change is shown in zone A3 of sheet 3 of drawing 1910-01-03-SAR.

ATTACHMENT B

Revised Pages

Page Changes	
Remove Rev. 1	**Insert Rev. 2**
Cover page & spine	Cover page & spine
i to v	i to v
1.2-5 – 1.2-9	1.2-5 – 1.2-9
1910-01-01-SAR R1	1910-01-01-SAR R2
1910-01-03-SAR R1	1910-01-03-SAR R2
2.1-2	2.1-2
2.7-1 – 2.7-2	2.7-1 – 2.7-2
2.7-14	2.7-14
2.7-26	2.7-26
2.12.3-3 – 2.12.3-12	2.12.3-3 – 2.12.3-12
2.12.3-40 – 2.12.3-54	2.12.3-40 – 2.12.3-55
2.12.5-3	2.12.5-3
2.12.5-7 – 2.12.5-10	2.12.5-7 – 2.12.5-10
2.12.5-17 – 2.12.5-21	2.12.5-17 – 2.12.5-21
2.12.5-29 – 2.12.5-32	2.12.5-29 – 2.12.5-32
5.1-1 – 5.1-2	5.1-1 – 5.1-2
5.2-1 – 5.2-10	5.2-1 – 5.2-15
5.3-1 – 5.3-3	5.3-1 – 5.3-3
5.4-1 – 5.4-3	5.4-1 – 5.4-3
5.4-5 – 5.4-10	5.4-5 – 5.4-10
5.5-1 – 5.5-19	5.5-1 – 5.5-21
7.1-3 – 7.1-5	7.1-3 – 7.1-5