High-Level Purpose of BEA Research Reactor SAR Revision 19 Updates:

- To include irradiated LEU research reactor fuels as part of authorized BRRC payloads, thus complementing existing HEU fuels. This includes ATR, MITR, and MURR fuel types using the LEU design. Fuel physical envelopes are identical to the HEU versions, but fuel weight increases. Overall package gross weight remains the same at 32,000 lb., by noting a reduced upper bounding packaging weight of 31,100 lb from current 31,230 lb. This weight is supported by fabrication records on the originally built BRR packaging cask body. The body represents over 80% of the packaging weight. The reduction of 130 lb. in the packaging weight offsets the increase in MURR loaded basket weight by the same amount. Overall decay heat is maintained by ensuring source is decayed sufficiently to offset the revised sources.
- To include segmented LEU commercial PWR and BWR rods of varying enrichments/burnups within encapsulated stainless-steel tubes known as Rod-in-Tubes (RITs). RITs are placed within aluminum RIT Canisters (RITCs) which act as holder sleeves, each RITC containing up to three RITs. The RITCs in turn are placed within an aluminum RITC basket. The RIT, RITC and RITC basket structurally support shielding positioning assumptions for NCT while only the RIT is relied upon for containing the rod segments under HAC. The shielding analysis states these assumptions, and the structural analysis validates the structures for this intended safety function. The total thermal load of 180 watts overall is bounded by the existing MURR decay heat of 1264 watts.

Principal overarching changes for SAR:

LEU Research/Test Reactor Fuels

Revise BRRC SAR for fuel weight (LEU fuel is about twice as heavy as HEU fuel), different source terms (including different decay heat for ATR fuel), and differences in fissile material.

RITs in RITC Baskets

Revise BRRC SAR for the new hardware (RITs, RITCs, and RITC basket) and include the new generic source for a variety of commercial rod segments. Update the Structural, Thermal, Shielding, Criticality chapters to reflect the changes.

General SAR Chapter changes:

LEU Research/Test Reactor Fuels	
Subject	**Overview**
Basket Structural	The original structural basket evaluations are updated for the heavier LEU fuel elements and includes a simplified Code Case N-284 buckling table in SAR Section 2.12.8.
Package Structural	The closure lid, closure bolts, weight and C.G. evaluations are updated for SAR Chapter 2 (Sections 2.6.7 and 2.7.1).
Package FEA Structural	The original FEA structural evaluation is updated for weight. This supports SAR Section 2.12.4.

Package Thermal	A new thermal evaluation. By managing minimum decay time, the MURR and MITR decay heats remain the same as for HEU fuel. The decay heat for ATR fuel is four times greater than HEU, but still less than the bounding MURR decay heat. Supports SAR Chapter 3.
Package Shielding	A new shielding Appendix 5.9 develops the source terms from the maximum allowable decay heat isotope quantities. Maximum dose rates on the package are only slightly higher than the HEU versions of the fuel and still significantly below the 10 CFR 71.47 and 71.51 regulatory limits.
Package Criticality	A new criticality evaluation in Section 6.11 examines the LEU fuel versions of the MURR, MITR and ATR fuels. Conservative evaluations for the higher U-235 fissile mass of each of these LEU versions are conducted with total U-235 increasing by 92%, 88% and 52% for MURR, MITR and ATR fuels, respectively.

New RITs, RITCs and RITC Basket	
Subject	**Overview**
RIT, RITC and RITC Basket Structural	New Chapter 2 RIT, RITC and RITC basket structural evaluations are included to assess the structural performance of the new hardware. Bounding 120g HAC loads from BRR free drop accelerations are applied to components. Consistent with current SAR assumptions, the HAC loads bound those of the NCT by a factor of 3. Aluminum allowables of RITC and RITC basket are adjusted to account for temperatures attained from thermal analysis (~ 240°F). RITC and RITC basket evaluated using 'Other Safety' related components in Table 1.1 of NUREG/CR-3854. Thermal expansion of the new aluminum basket is added ensuring no adverse stresses caused by transportation heat loads. Structural considerations support source separation for shielding, by: 1. Ensuring separation of two 3.5-in. OD RITC basket tubes under NCT, 2. Ensuring RITs in stacked RITCs cannot double up next to each other in NCT, and 3. Ensuring rod segments stay within the RIT tubes for both NCT and HAC.
Package Thermal	A new thermal SAR Section 3.7 for NCT determines RITC hardware component temperatures, verifying they remain under acceptance limits and providing input to the structural evaluations. Due to the low decay heat loads of 180 Watts for the RITC basket, the HAC case is considered bounded by the existing MURR payloads of over 1200 Watts per MURR basket. Therefore, HAC thermal evaluations are not included in SAR Chapter 3 for the RITC basket.
Package Shielding	A new shielding Appendix 5.10 develops the dose rates on the package based on bounding maximum source terms. GE 7×7 BWR and B&W 15×15 PWR fuel assemblies were used by INL to generate bounding commercial source term equations based on a linear relationship between burnup and enrichment. Neutron doses during NCT on the side of the package are controlling.
Package Criticality	A revised criticality evaluation in Section 6.10 examines the rod segments using the maximum content of fissile material and enrichment from the RITC basket rod segments, increasing the uranium mass 33% over the previous commercial fuel rod payloads in the ATR basket.