Request for Supplemental Information
and Observation
for the
Model No. HI-STAR PBT Package
Docket No. 71-9386

This request for supplemental information (RSI) identifies information needed by the staff in connection with its acceptance review of the National Nuclear Security Administration (NNSA) Model No. HI-STAR PBT (Purpose Built Tritium) package. The application is for a new package design to be used by NNSA to perform its Tritium Modernization Program mission.

Request for Supplemental Information

RSI-1 Provide expanded test data for the prototype impact limiter and expanded test data for the prototype foam material.

The applicant proposed using three distinct prototype tests of either other packages or components to benchmark the LS DYNA methodology for the Model No. HI-STAR PBT package, with the intent that these separate tests would provide a sufficient basis, in aggregate, to justify the use of the LS DYNA modeling of the HI-STAR PBT to accurately replicate the deceleration time history as well as gross structural damage of the impact limiter.

To benchmark LS DYNA models for the Model No. HI-STAR PBT package, the applicant relied in part on:

(1) physical testing of a similar package from published literature which was evaluated for a side drop and a Center of Gravity (CG) over corner drop,

(2) a geometrically dissimilar package with foam impact absorbing material for an end drop, and

(3) foam specimen (1-inch cubes) test performed by the foam manufacturer to document performance characteristics of their product.

This approach was necessary because the applicant did not perform prototype testing of the proposed PBT impact limiter design and thus relied on these existing tests as a surrogate for prototype testing of the HI-STAR PBT.

In past NRC approvals for similar designs, this evaluation approach was found to be acceptable because of the high degree of similarity of the geometry and materials of construction of the proposed impact limiter design (e.g., HI-STAR 180) and the previously tested and approved impact limiter (e.g., HI-STAR 100), and because the

applicant had a complete set of physical testing data for the previously reviewed and approved impact limiter designs.

However, for this application:

(1) the applicant does not have a full set of design information or test data for the impact limiter designs used in the proposed benchmarking tests,

(2) there is an insufficient range of drop orientations for a test with a high degree of similarity to the HI-STAR PBT, and

(3) the tests do not adequately capture all relevant behavior of the impact limiter including the component foam material as used in the HI-STAR PBT package.

As a result, the staff is not able to conclude that the benchmarking approach is sufficiently robust and capable of producing analytical results for the proposed impact limiter that would be consistent with results produced in a physical test.

A robust testing protocol would address, at a minimum, the aforementioned deficiencies.

The analysis of testing results would also need to address (i) any scaling effects of the testing range, as well as foam component specimens, (ii) the effect of confining the foam material in a stainless-steel skin, and (iii) strain rate effects for the entire range expected for the foam impact limiter.

This information is necessary to determine compliance with 10 CFR 71.73.

RSI-2 Provide expanded test data to justify the assumption that only localized damage to the impact limiter stainless steel skin seam welds will occur and that only minimal impact limiter foam material will be consumed by combustion.

The applicant claims that combustion of the foam impact limiter is not a credible event based on expected stainless steel skin material behavior, structural evaluations, and test results from the HI-STAR 100 package with an impact limiter with a different design, which showed that seam weld ruptures in the impact limiter skin would be localized and limited to a finite length.

However, the applicant has not provided an analysis of the dissimilarities between the two impact limiter designs sufficient to justify that the conclusions for the HI-STAR 100 can be generally applied to the Hi-STAR PBT package, nor has the applicant provided a thorough justification that seam weld splits would be localized and limited. Further, there is no justification presented which demonstrates that even if the seam weld failures were localized, a subsequent combustion of the foam would also be localized.

This information is necessary to determine compliance with 10 CFR 71.73.

RSI-3 Provide justifications and additional explanations in Section 3.4.2 of the HI-STAR PBT safety analysis report (SAR) on how the four papers in Attachments A – D of the Holtec Report No. HI-2200641, Revision 0, provide an accurate representation of the material properties (e.g., thermal conductivity, density, specific heat) for the polyurethane foam, foam char, and air, as well as the quantity of foam char for the HI-STAR PBT impact limiter material during the regulatory fire and post-fire hypothetical accident conditions (HAC). Alternatively, provide HAC fire testing results of the HI-STAR PBT impact limiter with the foam that demonstrates the material assumptions in the HAC thermal model are accurate. In addition, the type of foam should be specified on the licensing drawings.

Section 8.3 of Holtec Report No. HI-2200641, Revision 0, references Holtec Report No. HI-2200912, Revision 2, indicating that no breach of the impact limiter enclosure stainless steel skin under any analyzed scenario during the 9-meter drop event and any potential seam weld rupture would be localized and limited to a finite length; however, based on the RSI-2 above, this has not been demonstrated.

Section 8.3 of Holtec Report No. HI-2200641, Revision 0, states that the puncture results in a square-shaped penetration of 6” (each side) through the outer skin and through the foam centered on the axial location of the seals, which has also not been demonstrated.

The results of the 9-meter drop (per 10 CFR 71.73(c)(1)) and puncture test (per 10 CFR 71.73(c)(3)) have an impact on the regulatory fire test (per 10 CFR 71.73(c)(4)), and it has not been demonstrated that the papers in Attachments A - D of the Holtec Report No. HI-2200641, Revision 0, provide an accurate representation of the material properties for the polyurethane foam or the quantity of foam char for the HI-STAR PBT impact limiter.

The paper in Attachment A of Holtec Report No. HI-2200641, Revision 0, discusses the mechanism of intumescence for pour in-place polyurethane foam; however, this paper does not specifically connect any results to the foam material used in the impact limiter.

The paper in Attachment B of Holtec Report No. HI-2200641, Revision 0, discusses the thermal response of polyurethane foam-filled small-scale systems, when exposed to fire-like heat fluxes; however, this paper does not specifically connect any results to the foam material used in the impact limiter, or to the 10 CFR 71 regulatory fire hypothetical accident conditions, or address how the scaling is appropriate for the impact limiter.

The paper in Attachment C discusses the thermal transfer, intumescence, burn distance, and plastics memory of compressed General Plastics Manufacturing Company’s LAST-A-FOAM FR-3700 series foam at different densities for small-scale blocks; however, this paper did not specifically connect any results to the foam material used in the impact limiter because different foam densities were used, or how the scaling is appropriate for the impact limiter.

The paper in Attachment D discusses 19 liter or “5 gallon” pail fire tests and provides results for extinguish time and recession distance; however, this paper did not specifically connect any results to the foam material used in the impact limiter, or how the scaling is appropriate for the impact limiter.

The staff also notes that the licensing drawings (e.g., Licensing Drawing No. 11856, Revision 4) do not specify the type of foam in the impact limiter, which would connect that foam to thermal material properties such as, thermal conductivity, density (there is currently a range of densities specified in Table 8.1.3 of the application), and specific heat used in the thermal analysis. This information is needed to ensure the impact limiter material is accurately modeled.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(v), 71.35(a), and 71.73(c)(4).