Observations following Holtec/NRC meeting on January 26, 2024
For HI-STORM FW Amendment 7

During the meeting on January 26, Holtec presented LS-DYNA modeling enhancements that it is planning to make to the fuel basket analyses for HI-STORM FW Amendment 7. These enhancements included 1) use of a thick shell element with a more robust numerical formulation; and 2) increasing the discretization of the fuel basket temperature-dependent zones, increasing from 4 to 13. Holtec had performed the analysis using this "enhanced" LS-DYNA model for the MPC-37-CBS fuel basket and presented some promising results, showing that the basket permanent deflections and corresponding stress results met the corresponding acceptance criteria described in the current version of the SAR.

Holtec confirmed that it plans to provide the results of one fuel basket analysis, those of the MPC-37-CBS, in order to qualify all other fuel baskets currently employed for the FW system. It believes that, based on the MPC-37-CBS basket geometry and fuel assembly weight, it will experience the highest loading demands. Holtec plans to establish a parameter based on a combination of the fuel basket cell width, basket thickness, and fuel assembly weight that will indicate the bounding basket, and this parameter will show that, by comparison, the other baskets are bounded by the MPC-37-CBS results.

During the meeting, the NRC asked whether any sensitivity studies that employ the enhanced analyses of additional fuel baskets were planned to validate Holtec's proposed bounding parameter comparison. The NRC noted that a review of the stress contour plots for the baskets submitted in November 2023 indicate that some show much higher stress results than those of the MPC-37-CBS basket. Holtec indicated it was receptive to performing a sensitivity study with other basket types to support the bounding basket parameter.

Since the January 26 meeting, the NRC has observations on the proposed methodology that the staff believes Holtec should consider in determining the fuel basket that will produce the bounding deflection and stress results:

a. The temperature magnitudes and distribution of temperature zones affect the structural behavior and capacity of the fuel baskets but do not appear to be accounted for in the proposed bounding fuel basket parameter. Higher temperatures decrease the structural capacity of the basket material and change the mechanical behavior. It seems possible that a basket might not be identified as bounding when considering only its slenderness and fuel weight but could actually be the bounding basket if subjected to higher design temperatures.

   For example, the MPC-37-CBS basket's maximum temperature was reduced from 380 °C to 360 °C and the resulting stresses were reduced. Additionally, there are other baskets with temperature zones that have maximum temperatures of 380 °C and 365 °C which have reduced stress allowables compared to the 360 °C and may not be bounded by the 360 °C enhanced analysis of the MPC-37-CBS basket.

b. The weight and stiffness of other cask components could affect the structural behavior of the fuel baskets but were not discussed in regard to the proposed bounding fuel basket parameter. Increasing the stiffness of components in the load path and the weight of other cask components, particularly the overpack, could increase the structural demand on the fuel basket.

   For example, the MPC-37-CBS basket is indicated as only compatible with the Standard and Version E overpacks and not the Version UVH overpack. A review of the current vertical decelerations reported for the tip-over of various overpack/fuel basket pairings indicate that the UVH has a substantially higher acceleration (~90 g) than those of the Standard and Version E overpacks (~50-70 g). However, the proposed bounding fuel basket parameter does not account for the impact energy levels imparted to the fuel baskets, particularly those associated with differences in overpacks.

The staff is providing these observations for Holtec's consideration in its proposed method for identifying a bounding fuel basket.