Attachment 2 to Holtec Letter 5021061

HI-STORM UMAX Amendment Request #3

RAI Responses – Non-Proprietary

RAI-1 Proprietary RAI

RAI-2 Proprietary RAI

RAI-3 Proprietary RAI

RAI-4 Proprietary RAI

RAI-5 Proprietary RAI

RAI-6 Proprietary RAI

RAI-7 Proprietary RAI

RAI-8 Proprietary RAI

RAI-9 Proprietary RAI

RAI-10 Proprietary RAI

RAI-11 Clarify how the maximum g-load sustained by the 24PT1-DSC canister in the HI-STORM UMAX Vertical Ventilated Module (VVM) ensures nuclear criticality safety has been achieved when compared to its original licensing basis.

Section I.3.7 of the final safety analysis report (FSAR) states in part:

The criticality safety of the stored 24PT1-DSC is ensured by demonstrating that the maximum g-load sustained by the Canister stored inside the HI-STORM UMAX VVMs is less than its licensing basis value. This conclusion satisfies the requirement of 10 CFR 72.124(a), with respect to structural margins of safety for SSCs [structure, system, and component] important to nuclear criticality safety.

However, it is unclear how g-loads alone are able to ensure that structural margins of safety for SSCs important to nuclear criticality since the boundary conditions of the 24PT1-DSC in its original NUHOMS® module are not like those in the HI-STORM UMAX. Specifically, the 24PT1-DSC canister in the NUHOMS® module lies on its side and is supported along its length continuously, where the 24PT1-DSC in the HI-STORM UMAX is oriented vertically and is constrained at its ends. Stresses in the 24PT1-DSC and its contents due to seismic loads will result in different safety margins for both scenarios which have not been described. Clarify the safety margins and update the FSAR as necessary for the 24 PT1 in a vertical orientation in the HI-STORM UMAX VVM.

This information is needed to determine compliance with 10 CFR 72.124(a) and 10 CFR 72.236(l).

Holtec Response:

Nuclear criticality safety of the 24PT1-DSC is ensured due to the fact that the maximum g-load sustained by the canister in the HI-STORM UMAX VVM, due to the Most Severe Earthquake (MSE), is approximately one-tenth of the design basis g-load evaluated in the Advanced NUHOMS UFSAR [I.1.2.1] for the cask side drop. Specifically, the maximum horizontal acceleration of the 24PT1-DSC due to the MSE event is 7.48g per FSAR Table I.3.4.4 versus an applied load of 75g in Section 3.6.1.1.7 of [I.1.2.1] for the cask side drop event. Moreover, the MSE earthquake and the cask side drop are both accident level events, and therefore the acceptance criteria for these two events are identical.

Holtec recognizes that the external boundary conditions for the 24PT1-DSC are different when it is inside the HI-STORM UMAX VVM versus the transfer cask. However, the primary shear and bending stresses in the 24PT1-DSC canister shell are a small fraction of the material yield strength under the MSE loading, indicating that the 24PT1-DSC internal basket assembly and the stored fuel are well supported against lateral loading. This is demonstrated by considering the 24PT1-DSC canister as a simply supported beam, with its total weight uniformly distributed along its length, and subjecting it to a static g-load of 7.48g. The resulting primary shear stress and bending stress in the 5/8" thick cylindrical shell are only 2.32 ksi and 6.63 ksi, respectively. Meanwhile, the allowable shear and primary membrane stresses (at 500°F) for the 24PT1-DSC shell assembly, under accident conditions, are 30.1 ksi and 43.2 ksi, respectively. This additional calculation has been added to Holtec report HI-2167337 (see Calculation No. 4 in HI-2167337 Rev. 1).

RAI-12 Proprietary RAI

RAI-13 Proprietary RAI

RAI-14 Proprietary RAI

RAI-16 Justify how the top seismic restraint assembly and divider shell appurtenance assembly will restrain the 24PT1-DSC canister in the UMAX VVM when subjected to seismic loads.

The top seismic restraint assembly and divider shell appurtenance assembly, transfer lateral/vertical loads to the 24PT1-DSC canister when it is in the UMAX VVM and subjected to seismic loadings. Full contact between these components has been assumed throughout the seismic event. Some calculations which consider contact/friction forces have been provided to support the design of the top seismic restraint assembly system, but they do not consider the full dynamic interaction between the cavity enclosure container (C.E.C.) of the UMAX VVM, the 24PT1-DSC, and the top seismic restrain system. Dynamic seismic analyses conducted in LS-DYNA do not include the top seismic restraint assembly or the divider shell appurtenance assembly explicitly.

Staff is concerned that the calculations provided do not consider gaps forming between the top seismic restraint assembly, the C.E.C, and the 24PT1-DSC during a seismic event which could allow the 24PT1-DSC to be subjected to pounding. A query of the output files indicates that the diameter of the C.E.C. itself "expands" and "contracts" during the seismic analyses, which could imply that the top seismic restraint assembly is not in contact with the 24PT1-DSC. Similar findings have been noted with regards to the divider shell appurtenance assembly.

Note that the canister and the C.E.C. of the UMAX VVM most likely are not uniformly round due to manufacturing, and that as the system continues to cool, additional gaps could form between the top seismic restraint assembly and/or divider shell appurtenance assembly, the C.E.C., and the 24PT1-DSC canister as a function of time. Gaps formed by manufacturing and potentially non-uniform expansion should be considered in the evaluation of the top seismic restraint assembly and the divider shell appurtenance assembly. Update the LS-DYNA models and supporting details in the FSAR as necessary.

This information is needed to determine compliance with 10 CFR 72.236(l).

Holtec Response:

The tapered design of the top seismic restraint assembly (TSRA), along with the independent vertical movement of the support arms, ensures that the 24PT1-DSC will be laterally restrained when subject to seismic loads.

Per drawings 10574 and 10576, there is a one-to-one correspondence between the DSC spacer blocks on the TSRA and the divider shell appurtenance assemblies (DSAA), with eight of each equally spaced around the circumference of the 24PT1-DSC at 45 degree intervals. The TSRA and DSAA together provide a direct radial pathway for the seismic reaction loads to be transmitted from the 24PT1-DSC to the CEC shell, which in turn is fully backed by 3,000 psi concrete for the HI-STORM UMAX Version MSE (see FSAR Table 2.3.10).

The tapered profile of the DSC spacer blocks (items 2 and 4 on drawing 10574) and the interfacing wedge blocks on the DSAA (see drawing 10576) are specifically designed to overcome varying radial gap sizes due to slightly eccentric positioning of the 24PT1-DSC inside the UMAX VVM, out-of-roundness of the 24PT1-DSC shell, manufacturing tolerances, etc.. Since each DSC spacer block support (item 2 on drawing 10574) hangs freely from a slotted hole in the shield ring (item 1 on drawing 10574), each one can independently find its natural resting position as it is being lowered. In other words, if the radial gaps are different after the 24PT1-DSC is set in place inside the UMAX VVM, then the eight (8) DSC spacer blocks will come to rest at slightly different vertical elevations and close the gap at each location. For this to happen, the DSC spacer block supports (item 1 on drawing 10574) must be sufficiently long to guarantee that the spacer blocks will come to rest between the 24PT1-DSC shell and the DSAA wedge blocks before the shield ring (item 1 on drawing 10574) lands on the TSRA support lugs (see drawing 10576). This design feature also enables the DSC spacer blocks to lower themselves further, under gravity, as the 24PT1-DSC canister cools over time and the gap sizes grow due to due to thermal shrinkage.

Finally, the calculations performed in Holtec report HI-2167337 (see Calculation No. 2) show that the 11-degree tapered angle associated with the DSC spacer blocks, and the wedge blocks on the DSAA, is small enough to prevent the DSC spacer blocks from being displaced or dislodged when subjected to seismic loads. This is because when the seismic load is resolved into two orthogonal components, one normal and one parallel to the DSC spacer block/wedge interface, the parallel component is not capable of overcoming the interface friction at shallow angles.

To summarize, the DSC spacer blocks and the DSAA have been carefully engineered to accommodate varying initial gap conditions, to self-adjust over time as the canister cools, and to remain in place under seismic loads.

RAI-17 Proprietary RAI

RAI-18 Proprietary RAI

RAI-19 Proprietary RAI