Request for Supplemental Information

Docket No. 72-1014
Certificate of Compliance No. 1014
Amendment No. 15 to the HI-STORM 100 Multipurpose Canister Storage System

Chapter 3 - Structural Evaluation

3-1 Justify the structural qualifications of MPC-32M.

The applicant proposed the inclusion of MPC-32M (Proposed change #2). Supplement II contains structural analyses for the MPC-32M, including the non-mechanistic tipover analysis of the HI_STORM Version E overpack with MPC-32M. It is not clear to the staff if the non-mechanistic tipover analysis presented in Supplement II and associated calculation package (Report HI-2188448R0) have adequately addressed different azimuthal orientations of the MPC-32M fuel basket during the drop. Regarding the non-mechanistic tipover analysis:

a. Clarify the orientation used in the analysis
b. Clarify why the current analysis represents the bounding scenario for the MP-32M.

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

<u>Holtec Response:</u>

The MPC-32M fuel basket is made from Metamic-HT panels similar to the MPC-68M fuel basket. In contrast, the MPC-32 Version 1 and MPC-68 Version 1 are fabricated using Alloy X stainless steel (similar to the original MPC-32 and MPC-68 designs). Owing to their different fabrication materials, the acceptance criteria, as well as the method of analysis, are different for the Metamic-HT fuel baskets versus the stainless steel (Alloy X) fuel baskets. The differing acceptance criteria are discussed in Sections 2.II.2.4 and 2.II.2.6 of Supplement 2.II.

With regard to the analysis, the structural qualification of the MPC-32M fuel basket for the non-mechanistic tipover event follows the approach previously used in Supplement 3.III to qualify the MPC-68M fuel basket. In particular, the MPC-32M (like the MPC-68M) is only analyzed for the most limiting basket orientation – the so-called 0 degree orientation. The reason why the 0-degree orientation is most limiting for Metamic-HT baskets, including the MPC-68M and the MPC-32M, is explained in Subsection 3.III.4.4.3.1 of Supplement 3.III, which states:

> “The 60g deceleration is applied to the model with the basket in the so-called 0º orientation (see Figure 3.III.5). This orientation is chosen for analysis because it maximizes the lateral load on a single basket panel, which in turn maximizes the lateral deflection of the panel. In the 0º orientation, the amplified weight of each stored fuel

assembly (during the 60g impact event) bears entirely on one basket panel. Conversely, in the 45º orientation, the amplified weight of each stored fuel assembly is equally supported by two basket panels. The difference in loading between these two basket orientations is pictorially shown in Figure 3.III.5, where "m" denotes the fuel assembly mass, "a" denotes the maximum lateral deceleration, and "d" denotes the enveloping size of the fuel assembly. For comparison purposes, the pressure loads on the basket panels are defined as "p" and "q", respectively, for the 0º and 45º orientations. From the figure, the pressure load p that develops in the 0º orientation is 41% greater than the pressure load q that develops in the 45º orientation. Hence, the lateral deflection of a basket panel is much greater for the 0º orientation (which is why it is chosen for detailed analysis). It is also noted that the 90º corners where the basket panels intersect do not provide any additional moment resistance because of the slotted joint construction (see Figure 1.III.1); therefore, the 45º orientation (or any other orientation between 0º and 45º) does not give rise to any prying loads at the cell corners."

It is noted that the 60g deceleration referred to in the above paragraph is a bounding impact deceleration used for analysis of the MPC-68M fuel basket, which conservatively exceeds the design basis limit of 45g associated with the HI-STORM 100, HI-STORM 100S, and HI-STORM 100S Version B overpacks. The HI-STORM 100S Version E overpack does not have a pre-established design basis deceleration limit (see response to RAI 3-5). Instead the impact deceleration is determined directly via the comprehensive LS-DYNA tipover model, which is depicted in Figure 3.II.4.8, and the results for the MPC-32M fuel basket are compared against the applicable acceptance criteria (see Section 2.II.2.4).

In summary, the MPC-32M fuel basket is analyzed for the same limiting orientation (0-degree) as previously analyzed for the MPC-68M fuel basket and approved by the NRC staff. Subsection 3.II.4.4.2 in Supplement 3.II has been revised to clearly indicate the fuel basket orientation analyzed for the MPC-32M and its underlying basis. Lastly, the MPC-32M was incorrectly referred to as the "MPC-32" at several places in Subsection 3.II.4.4.2, which have now been corrected.

3-6 Justify the changes resulting from Proposed Change #9.

In Proposed Change #9 the applicant proposes to remove the dose rate evaluation from the accident analyses for the non-mechanistic tipover event. The applicant claims that the basis for this removal is that the event is not credible. The staff notes that performing the tipover accident analysis, as documented in applicable sections of Chapter 11.II and 3.II, provides additional assurance that the design will maintain confinement, criticality, and shielding during storage. In addition, potential tipover could be caused by misloading or mishandling as evidenced in the past operating experiences. The regulatory requirements in 10 CFR 72.106(b) states any individual located on or beyond the nearest boundary of the controlled area may not receive from any design basis accident the more limiting of the Part 20 dose limits. NUREG-1536 Section 2.5.2.2(s) "Accident conditions," states that the cask tipover is considered a design basis event that should be evaluated. Based on the aforementioned statements, the staff requests that the applicant:

a. Provide a definition for "non-credible" event and justify that the tipover event is a

"non-credible" event. The staff currently does not have guidance on the definition of "non-credible" for dry storage systems; however, the staff would consider guidance in other areas for consistency, such as NUREG-1520, "Standard Review Plan for the Review of License Application for a Fuel cycle Facility." For example, 10 CFR 70.65(b)(9) requires that applicants for a license for special nuclear material provide a definition for likely, highly unlikely (non-credible), and credible, and NUREG-1520 provides staff review guidance and acceptance criteria for the definitions.

OR

b. Provide the following information:
   i. Provide the dose rate evaluation associated with the non-mechanistic tipover event.
   ii. Take credit for the analysis that demonstrates the MPC is designed to withstand credible drops and non-mechanistic tipovers by referencing it in applicable portions of Table 7.II.1.4 of the application, and provide justification that the HI-STROM 100 will maintain confinement considering the cask tipover design basis event.

This information is needed so that the staff can make a determination on whether this system meets 10 CFR 72.236(d) and (l).

Holtec Response:

The request in Amd 15 is that the accident chapter does not need to include a dose rate for the tipover analysis. Consistent with all other Holtec applications and NUREG-1536, the tipover is a non-mechanistic event, where the initiators (tornado missile, seismic, etc) in combination with the cask design are non-credible, and it meets the NUREG-1520 criteria, so demonstrating compliance with 72.106 with a specific number in the FSAR is not necessary.

Per the guidance in NUREG-1520, an event can be considered as non-credible if it has a frequency of occurrence that can conservatively be estimated as less than once in a million years (i.e., annual probability of exceedance less than $1x10^{-6}$).

According to the Nuclear Energy Agency (NEA) [1], the return period corresponding to the SSE peak ground acceleration defined in nuclear seismic standards is based on the 0.5% to 0.05% probability of exceedance in 50 years (e.g., 10,000 to 100,000 years return period), which is equivalent to an earthquake with a maximum probability of exceedance of no more than $1x10^{-4}$ per year. Using Appendix C to U.S. Department of Energy (DOE) Standard 1020-2002 [2], the NRC staff determined the risk reduction factor to be 10 for Performance Category 4 (i.e., commercial nuclear power plants), which means that the target performance goal for a nuclear structure is survivability (i.e., no significant damage) for an earthquake of $1x10^{-5}$ per year or less.

The stability of a freestanding HI-STORM overpack under seismic loading is discussed in Sections 2.2.3.7 and 3.4.7 of the HI-STORM 100 FSAR. In order for a HI-STORM overpack to be deployed in a freestanding manner, the SSE conditions at the site must satisfy the following conservative inequality:

$$G_V \leq 1 - \frac{H}{r} G_H$$

where: G_V is the zero period acceleration (ZPA) of the site's design basis earthquake in the vertical direction;
G_H is the resultant horizontal ZPA of the site's design basis earthquake (vectorial sum of two horizontal components);
H is the center of gravity height of the HI-STORM overpack;
r is the radius of the HI-STORM base.

The above static inequality insures that incipient tipping will not occur (i.e., no lift off) due to a design basis seismic event, which is a much more restrictive criterion than, for example, requiring that the calculated cask rocking angle is less than the critical overturning angle (i.e., when the cask center of gravity is positioned directly above the baseplate perimeter). Thus, the stability criterion defined in the HI-STORM 100 FSAR imparts an additional margin of safety against tipover, which reduces the probability of occurrence even further. Given that the HI-STORM 100 FSAR requires no incipient tipping under SSE conditions, the probability of the cask overturning is essentially zero. However, for evaluation purposes the probability of a cask tipover due to an SSE event is conservatively set at less than 10% ($1x10^{-1}$). When combined with the annual exceedance probability of $1x10^{-5}$ for an SSE event at a nuclear facility, the likelihood of a freestanding HI-STORM overpack tipping over due to an SSE event is less than $1x10^{-6}$, which meets the definition of a non-credible event per NUREG-1520. Furthermore, since the tipover event is non-credible, there is no need to include an explicit dose rate evaluation for this event in Chapter 11 of the FSAR.

Other accidents such as misloading or mishandling are separately evaluated in the HI-STORM 100 System. Those accidents consider, as appropriate, the impact on the cask from that event, and Holtec is not requesting changes to those accident scenarios in this amendment. For example, the HI-STORM 100 system evaluates the consequences of a mishandling event, and limits carrying heights or requires stringent handling equipment requirements based on that evaluation, to maintain the safety of the system. That scenario is already addressed separately from the tipover event, in accordance with NUREG-1536, and is unchanged by the tipover discussion above.

References:

[1] NEA/CSNI/R(2007)17, "Differences in Approach Between Nuclear and Conventional Seismic Standards with Regard to Hazard Definition", Nuclear Energy Agency, February 1, 2008.

[2] DOE-STD-1020-2002, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," U.S. Department of Energy, January 2002.