Holtec Response to Request for Additional Information (Batch 1 and Partial Batch 2)

Docket No. 72-1014
Holtec International
HI-STORM 100
Multipurpose Canister Storage System
Certificate of Compliance No. 1014
Amendment No. 16

RAI 4-1

(A) Justify the use of concrete conductivity of 1.50 Btu/hr-ft-°F for the HI-STORM 100 unventilated with high density concrete (UVH) overpack and (B) describe how conduction test is determined and performed at the site for using a higher concrete conductivity (>1.50 Btu/hr-ft-°F) for the UVH overpack.

The applicant listed a minimum concrete conductivity of 1.50 Btu/hr-ft-°F in the proposed final safety analysis report (FSAR) table 1.D.1 for the UVH overpack and stated in Note 3 of table 1.D.1 that "the listed value of thermal conductivity is a lower bound and is considered to be acceptable a' priori as in most cases it would likely be exceeded. A higher conductivity of plain concrete may be used in a site-specific safety qualification if supported by appropriate conduction tests."

(A) A concrete conductivity of 1.05 Btu/hr-ft-°F (FSAR Revision 20 [ADAMS Accession No. ML20167A018] table 4.2.2) was used for the ventilated overpack. Justify the use of the concrete conductivity of 1.50 Btu/hr-ft-°F for the UVH overpack. Using a higher concrete conductivity (≥1.50 Btu/hr-ft-°F) for the UVH overpack is considered less conservative for analysis.

(B) Describe how the conduction test is determined and performed at the site for using a higher concrete conductivity (>1.50 Btu/hr-ft-°F) for the UVH overpack.

The staff needs this information to determine compliance with 10 CFR 72.236(f).

Holtec RAI Response:

(A) Table 1.D.1 of the HI-STORM 100 FSAR notes that the minimum concrete thermal conductivity for the unventilated overpack is 1.5 Btu/hr-ft-Deg. F. This is accomplished by using a minimum concrete density of 200 pcf (the 'H' in 'UVH" stands for high density concrete). In comparison, the generally allowable minimum density for the ventilated overpacks is 140 pcf for which the corresponding thermal conductivity is 1.05 Btu/hr-ft-Deg. F. Holtec performed thermal conductivity tests on various samples of high-density concrete at different temperatures. The minimum measured conductivity is adopted in Table 1.D.1 of the FSAR. The thermal conductivity test data for the concrete with 200 pcf density is presented in Holtec report HI-2210007.

(B) The statements "A higher conductivity of plain concrete may be used in a site-specific safety qualification if supported by appropriate conduction tests. The conductivity value used in Chapter 4 controls and must be demonstrated for a site-specific application by testing." have been removed from FSAR Table 1.D.1 Note 3.

RAI 4-2

Justify in the application: (A) the different temperature limits for overpack inner shell and remainder of the overpack steel structure ONLY under long-term normal condition of storage and (B) the temperature limit of the multipurpose canister (MPC) baseplate is changed from 400°F (Amendment No. 15, FSAR Revision 22 [ML21221A329]) to 440°F in the proposed FSAR table 2.2.3 for long-term normal condition of storage.

(A) The proposed FSAR Table 2.2.3 shows that both overpack inner shell and remainder of the overpack steel structure share the same temperature limits of 700°F, 800°F, and 450°F for shortterm events, off-normal condition, and accident condition, respectively, but have different temperature limits for longterm normal condition (475°F for overpack inner shell and 400°F for remainder of the overpack inner shell) while both components are made of steel. Justify the different temperature limits used for overpack inner shell and remainder of the overpack steel structure under long-term normal condition of storage.

(B) Justify the temperature limit of the MPC baseplate is changed from 400°F (Amendment No. 15) to 440°F in the proposed FSAR Table 2.2.3 for long-term normal condition of storage while the temperature limits remain unchanged for off-normal and accident conditions of storage.

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

<u>Holtec RAI Response:</u>

(A) The reviewer's observation is correct that the long-term normal condition temperature limit for the overpack inner shell is different from the rest of the overpack steel structure although they are made of the same material. This is because of the following reasons:

a. The calculated maximum temperatures from FSAR design basis thermal evaluations are greater for the overpack inner shell compared to the rest of the overpack steel structure, and raising the limit for inner shell under long-term normal conditions ensures that sufficient margin is maintained.
b. The structural evaluations of overpack performed in Subsections 3.4.3 and 3.4.4 indicate significantly lower stresses in the overpack inner shell compared to the rest of the overpack (lid, baseplate, outer shell, etc.). Therefore, robust structural safety margins exist for the overpack inner shell even with the reduced allowable stress at the increased temperature.
c. The long-term normal condition material temperature limits in the FSAR are conservatively set at or below the ASME BPVC Section II and III temperature limits (minimum of 700 °F).

(B) The temperature limit for the MPC baseplate is increased from 400F to 440F for long-term normal condition in order to provide a conservative safety evaluation. In other words, higher (bounding) component temperature implies lower stress limits for the structural components thereby underestimating the structural safety margins which renders conservatism to the analysis. The structural evaluation presented in Holtec Report HI-2210241 (Holtec Letter 5014917 Attachment 16, NRC ADAMS Accession Number ML21068A360), in support of this amendment, uses the governing temperature limits for the safety evaluations under normal conditions. Since the temperature limits for the off-normal and accident conditions are already bounding, no changes are considered for these loading conditions.

<u>RAI 4-3</u>

Demonstrate the initial backfill pressure limits for MPC helium and annulus air pressure, shown in the proposed FSAR table 4.IV.1.3, are adequate for heat removal for MPC-32M and MPC-68M stored in HI-STORM UVH overpack.

The applicant provided initial backfill pressure limits for MPC helium and annulus air, in the proposed FSAR table 4.IV.1.3, for MPC-32M and MPC-68M stored in the UVH overpack. The applicant needs to provide derivations (e.g., calculations) in the application to demonstrate the initial backfill pressure limits in the proposed FSAR table 4.IV.1.3 are adequate for heat removal for the UVH overpack.

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

Holtec RAI Response:

A. MPC Initial helium backfill pressure: The methodology and derivations for initial backfill pressure limits for MPC helium are exactly same as those presented for the ventilated systems, which is basically using the ideal gas law. The detailed methodology to compute the MPC cavity pressure under operating conditions from the initial backfill pressure limits is presented in Section 7.4 of HI-2210138. The section also describes how the minimum and maximum initial backfill pressures are used in the CFD computations. The initial backfill limits are chosen such that the MPC cavity pressure remains below its design limits under all operating conditions.

B. Annulus Initial backfill pressure: Note-2 of Table 4.IV.1.3 indicates that the annulus is backfilled to atmospheric conditions. Since the internal heat load of the cask results in a rise in temperature of all components including the annulus, the steady-state pressure of the annulus under all operating conditions is more than the atmospheric pressure. Atmospheric pressure and the corresponding thermophysical properties of air are used for the annulus cell zone in the 3D CFD model. That is, the thermal safety evaluations conservatively ignore the increase in air pressure in the annulus which could potentially enhance convective heat transfer thereby resulting in lower PCT and component temperatures.

   The annulus can be backfilled with air or other non-oxidizing gases such as nitrogen and argon. Since the thermal conductivity of nitrogen and argon rises with a rise in temperature and pressure just like that of air, there will not be any negative impact on the heat removal capacity of the UVH overpack with the use of these gases.

RAI 4-4

Provide information to Questions (A) and (B) below for using nitrogen (or another non-oxidizing gas) for backfill gas within MPC and annulus of the UVH overpack.

The applicant stated, in the proposed FSAR section 8.IV.1.7, step 7, that evacuate air within the MPC and the annulus of the UVH overpack and replace air with dry nitrogen (or another non-oxidizing gas) using couplings provided in the small penetrations in the cask body. The applicant provided the description of the UVH overpack annulus evacuation system and the nitrogen (or another non-oxidizing gas) backfill system in the proposed FSAR table 8.IV.1.6. The applicant also stated, in FSAR section 8.IV.1.7, step 7, that the target fill pressure of the non-oxidizing fill gas shall be as indicated in table 4.IV.1.3.

(A) Nitrogen (or another non-oxidizing gas) has different material properties from helium (e.g., viscosity, thermal conductivity, etc.), and the difference in properties may cause changes in flow pattern and heat removal capacity within the MPC. With differences existing in material properties between helium and nitrogen (or another non-oxidizing gas), justify the target backfill pressure limits of the non-oxidizing fill gas remain the same as the backfill pressure limits for the helium, as indicated in table 4.IV.1.3, set for the MPC and the annulus for MPC32M and MPC-68M stored within the UVH overpack.

(B) Clarify whether the annulus of the UVH overpack can be filled with the air when the MPC is backfilled with nitrogen (or another non-oxidizing gas) for storage.

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

Holtec RAI Response:

(A) The procedure for loading the HI-STORM 100 UVH system into storage has now been updated. Accordingly, Step 7 of the section has been removed.

   Holtec recognizes that the step 7 phrasing in the previously proposed FSAR section 8.IV.1.7 can be confusing. The “MPC/HI-STORM 100UVH annulus” should have been phrased as “the annulus space between the MPC and HI-STORM UVH”. It must be noted that only helium gas is allowed for the MPC initial backfill. However, the annulus between the MPC and HI-STORM 100UVH can be backfilled with air, nitrogen, or argon. The licensing basis calculations are performed with helium as the MPC backfill medium and air as the annulus medium. A sensitivity study with argon as the annulus medium has been documented as a new Section 4.IV.1.5 of the FSAR.

It is accurately noted by the reviewer that the use of other non-oxidizing gases in the annulus could potentially result in a reduction in the heat removal capacity of the HI-STORM 100 UVH cask. To address this, the options of the non-oxidizing gas have been limited to argon and nitrogen based on operational expectations (see changes to FSAR Supplement 8.IV). FSAR Chapter 4 has been updated to include thermophysical properties of Argon. A sensitivity study for the bounding scenario, i.e., MPC-32M in HI-STORM 100 UVH at design basis heat load, is performed with annulus backfilled with Argon. Since Argon’s thermal conductivity is lower than nitrogen, the conclusions from this sensitivity analysis are also applicable for the scenario where the annulus is backfilled with nitrogen. This has been documented in Holtec report HI-2210138 and demonstrates that there is no loss in heat removal capacity with either of the options. All components meet their temperature and pressure limits under all conditions of storage. Additionally, the structural evaluations documented in HI-2200641 use component temperatures and pressures that bound those with argon annulus backfill and hence are not impacted.

(B) As stated in response to (A), the MPC shall always be backfilled with helium. There is no provision for the MPC to be backfilled with any other gas under storage conditions.

RAI 8-1

Revise the proposed FSAR section 8.IV.1.7 to provide clear step-by-step instructions on the installation of lid studs, washers, and hex nuts after the lid is placed on top of the gasket, prior to movement of the storage cask to the ISFSI pad.

In HI-STORM 100 Amendment No. 16 proposed FSAR, section 8.IV.0, “Introduction,” states:

> “The operations associated with the use of the HI-STORM 100 UVH system, are like the operations for the standard HI-STORM 100 system. The following sections describe those operations that are, in any respect, unique to the HISTORM 100 UVH system and thus supplement the information presented in Chapter 8. Where practical, the section numbers used below directly reference the corresponding sections in Chapter 8. For example, Section 8.IV.3.5 supplements the operations described in Subsection 8.3.5. The guidance provided in this supplement shall be used along with the operations procedures provided in Chapter 8 to develop the site-specific operating procedures for the HI-STORM 100 UVH.”

The proposed FSAR section 8.IV.1.7, “Placement of HI-STORM 100 UVH into Storage,” states that it shall incorporate the following instructions as additional steps to the generic guidance in section 8.1.6 (should be 8.1.7) on loading operations for unventilated cask models in the official HI-STORM 100 FSAR revision 23 (ML22108A277).

- The proposed FSAR section 8.IV.1.7 step 1 states, “Before installing the Closure Lid on the cask body, the lid gasket is placed on the top of the cask’s top ring.”
- The proposed FSAR section 8.IV.1.7 step 3 states, “Place cask lid on top of the gasket.”
- The proposed FSAR section 8.IV.1.7 step 5 states, “After the cask is placed in its storage location on the ISFSI pad install lid studs, washers, and hex nuts onto the cask.”
- The proposed FSAR section 8.IV.1.7 step 6 states, “Tighten lid hex nuts to the point of contact with the washer. Then loosen nut to provide a nominal axial gap of 0.5 inches.”

In the official HI-STORM 100 FSAR revision 23, the existing section 8.1.7, “Placement of HI-STORM into Storage,” step 18.a states: “Remove the alignment device.” Step 18.e states: “Install the HI-STORM lid and the lid studs and nuts or lid closure bolts. See Table 8.1.5 for bolting Requirements.” Step 18.i states: “Secure HI-STORM to the transporter device as necessary.” Step 20 states: “Transfer the HISTORM to its designated storage location at the appropriate pitch.”

It is clear from the existing instruction in FSAR section 8.1.7, steps 18.a, 18.e, 18.i and 20, that a ventilated overpack lid must be mechanically fastened down (attached) to the overpack body prior to transferring the HI-STORM 100 to its storage location at an ISFSI. However, it is not clear whether the cask lid for the UVH is to be mechanically fastened down (attached) to the overpack body after placing the lid on top of the gasket prior to transferring the MPC loaded HI-STORM 100 UVH to its storage location at an ISFSI. The proposed FSAR section 8.IV.1.7 step 5 only states that after the UVH cask is in its storage location on the ISFSI pad to install the lid studs, washers, and hex nuts onto the cask.

With the lid resting on the UVH cask without fastening it to the cask during cask transport is an unanalyzed condition. The UVH cask cannot be transported to its final location on a ISFSI pad after the stack up operation and having its lid placed on the top of the gasket without being mechanically fastened (attached) to the UVH cask. If a transport trailer is used to transport a MPC loaded UVH cask, the cask lid must first be mechanically attached to the UVH cask. Provide clear new step-by-step instructions in FSAR section 8.IV.1.7 that after the lid is placed on the top of the gasket, how will the lid studs, washers, and hex nuts be installed and the lid hex nuts hand tightened to contact the washers. Only after the UVH cask is at its final ISFSI location shall the nuts be loosened to provide a 0.5-inch axial gap.

If a Vertical Cask Transporter (VCT) is used to transport a MPC loaded UVH cask, revise the proposed FSAR section 8.IV.1.7 to provide procedural steps on how to attach the VCT special lifting devices so that the mechanical connection does not crush the gasket under the lid. If a VCT is used for transport, only after the UVH cask is at its final location on the ISFSI pad and the VCT special lifting devices removed, invoke new section 8.IV.1.7 steps 5 and 6.

This information is needed to determine compliance with 10 CFR 72.234(f).

Holtec RAI Response:

The NRC is correct in the assertion that the HI-STORM needs to be transported to the ISFSI using the VCT with the lid secured in place. In reviewing the RAI and associated FSAR text, Holtec has identified that additional clarification is needed with respect to the transport conditions for moving the HI-STORM with the VCT. Chapter 8, Section 8.1.7, has been revised to note that when transporting the HI-STORM with the VCT, the Lid Bolts/Studs and Nuts are not installed and instead the HI-STORM lid is secured by the HI-STORM Lift Brackets and associated Lift Studs. The Lid Studs/Nuts or Lid Bolts are then installed to secure the lid in place after the cask is set in position on the ISFSI. Likewise, the HI-STORM 100 UVH is also transported with the lid secured in place by the HI-STORM Lift Brackets and associated Lift Studs. The difference when transporting the HI-STORM UVH is that the drain line plugs are removed to prevent pressure from building in the cask during the cask movement. Once the HI-STORM is placed on the pad, the lid is secured using the HI-STORM Lid Studs/Nuts or Lid Bolts with a small gap to allow for the lid to lift if the pressure is excessive and the drain plugs are installed to limit the potential for material to enter the cask cavity under normal conditions. Sections 8.1.7 and 8.IV.1.7 have been revised to reflect this step.

While Holtec does not feel that damage to the seal is likely to happen, guidance has been added regarding pre-load of the bolt/stud. The seal is not credited with maintaining the annulus as an isolated cavity. The thermal analyses adopt atmospheric pressure in the annulus and demonstrate that all components meet their temperature and pressure limits under all conditions of storage regardless of whether the annulus contains air, nitrogen, or argon (See RAI 4-4 response above). Therefore, any damage to the seal does not impact the thermal evaluations. The UVH overpack inner cavity and MPC stored in a UVH overpack are subject to essentially the same Aging Management Plan (AMP) as would be applied when using a ventilated overpack (See RAI 14-2 response below).

RAI 14-1

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]

Holtec RAI Response:

[PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390]

RAI 14-2

Provide the basis for the assumption that the sheltered environment within the UVH overpack will remain a non-oxidizing gas throughout the period of extended operation of the renewed CoC.

Section 3.2.2.2 of the Holtec Report HI-2210316, "Aging Management Evaluation for the HI-STORM 100 Version UVH Dry Storage System," states that the sheltered environment of the UVH overpack is non-oxidizing gases. That environment was considered in the aging management review that concluded that the overpack internal surfaces were not subject to aging effects.

However, neither the SAR nor the above aging management report provide a basis for the ability of the gasket to maintain the non-oxidizing gas environment over the period of extended operation. The SAR does not identify the gasket material, nor does it include criteria to demonstrate the gasket is qualified to maintain the internal environment and preclude adverse galvanic or other corrosive reactions over the extended storage term.

If the gasket is credited to maintain the internal overpack environment as a nonoxidizing gas, additional information is needed to demonstrate the gasket is capable of doing so, including information to demonstrate the gasket and the overpack lid sealing surfaces will not undergo corrosive reactions that could adversely affect the gasket's sealing performance. Alternatively, revise the aging management review to reflect the potential for the ingress of oxidizing gases (and, if credible, airborne contaminants) into the overpack cavity.

This information is required to demonstrate compliance with 10 CFR 72.240.

Holtec RAI Response:

The Version UVH overpack is designed with a gasket and without vents which limits the exposure of the overpack inner cavity (also referred to as the annulus between the MPC and overpack inner shell) to the external environment. Furthermore, this annulus can be backfilled with nitrogen (or another non-oxidizing gas) to further protect the MPC and overpack internals from SCC. While the design of the UVH overpack gasket is such that it is expected to largely prevent exposure of the annulus to the outside air, it cannot be relied on to do so in all scenarios.

For instance, FSAR subsection 1.IV.2.1.2.1 describes how, in the event the air in the overpack were to pressurize, the weight of the lid is counteracted allowing the gas in the annulus to escape. In this event, the annulus is not isolated from the external environment and some amount of outside air may enter the annulus. Rather than attempt to quantify how much external may enter the annulus during this event, Holtec has revised the Aging Management Evaluation (HI-2210316) to reflect the potential ingress of oxidizing gasses into the overpack inner cavity as suggested. Therefore, the UVH overpack inner cavity and MPC stored in a UVH overpack are subject to essentially the same Aging Management Plan (AMP) as would be applied when using a ventilated overpack with minor differences in how certain inspection activities would be implemented (see discussion below in response to RAI 14-3).

Furthermore, discussions in the following FSAR sections and table have also been updated: 9.A.1.7, Table 9.A.1-6, 1.IV.1, 1.IV.2.1.2.1, 2.IV.0, 9.IV.1.3, 9.IV.1.4.2.

RAI 14-3

Revise the aging management review and HI-STORM 100 MPC aging management program to address how the use of the UVH overpack affects the aging of the MPCs.

Neither the SAR nor Holtec Report HI-2210316 address how the use of the UVH overpack affects the aging management of the MPCs. Given the lack of vents in the overpack, the proposed MPC inspection activities described in the proposed SAR section 9.A.1.1, “MPC AMP” appear to no longer be viable.

The proposed MPC inspections described in SAR section 9.A.1.1 and SAR table 9.A.1-1, “MPC AMP,” include the use of a borescope (or equivalent) visual examinations and potential volumetric follow-up examinations to manage the identified aging effects of the MPC external surfaces.

Clarify if the use of the UVH overpack is considered to eliminate the credibility of aging of the MPC surfaces and, if so, revise Holtec Report HI-2210316 and the proposed MPC AMP accordingly. Alternatively, describe how the MPC AMP activities can be performed with the use of the UVH overpack.

This information is required to demonstrate compliance with 10 CFR 72.240.

Holtec RAI Response:

As Holtec has withdrawn any contention crediting the UVH overpack for providing a sequestered and/or inert atmosphere for the MPC (See RAI 4-4, 8-1, and 14-2 responses), the AMP for the UVH overpack and any MPC’s contained within should be identical to the existing AMPs for the HI-STORM 100. The HI-STORM UVH overpack lid can be raised or removed to access the UVH overpack cavity for the MPC AMP inspections as detailed in SAR Table 9.A.1-1.

Editorial Changes

Consider the following editorial changes to the HI-STORM 100 Amendment No. 16 proposed FSAR:

A) In section 8.IV.1 paragraph, change “Subsection 8.1.1 through 8.1.5” to “Subsection 8.1.1 through 8.1.6.”
B) In section 8.IV.1.7 first paragraph change “Section 8.1.6” to “Section 8.1.7.”
C) Table 8.IV.1.8 should reference main table 8.1.8 instead of table 8.2.3.
D) The paragraph in section 8.IV.4 should reference section 8.4 instead of section 8.3.
E) The first sentence of the section 8.IV.5 paragraph should read: “When the MPC is received from transport and transferred to a HI-STORM 100 UVH Overpack the procedures from Section 8.5 are used.” The current statement is incorrect.
F) The paragraph in section 9.IV.2 should reference Supplement IV, not #I.
G) The sentence in section 9.IV.2.3 should read: “The HI-STORM 100 UVH does not have vents and will not have the option of a monitoring system which must be maintained.”

Holtec RAI Response:

A) Changed to “8.1.6”
B) Changed to “8.1.7”
C) Changed to Table 8.1.8".
D) Changed to “8.4”
E) Changed as requested
F) Changed to “IV”
G) Added “of”