Safety Analysis Report (SAR), Chapter 2, "Site Characterization"

RAI 2-7-S-1: Provide the basis of each assumption taken in assessing the explosion hazards and consequences to structures or systems important to safety at the proposed CISF from a rupture of any pipeline resulting in release and subsequent ignition of the natural gas (SAR Section 2.2.2, "Pipelines"). At a minimum, the bases for the following assumptions should be provided and clarified:

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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11) Provide the correct URL to access the PHMSA Pipeline Incident Data.

This information is necessary to determine compliance with 10 CFR 72.24(a), 72.90(a) through (d), 72.94, and 72.122.

Holtec Response

[

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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Updates have been made to SAR Section 2.2.2 to align with the updates to the analysis as described above.

RAI 2-14-S-1: Justify the following assumptions in SAR Section 2.2.4, Ground Transportation, and HI-2210620, "HI-STORE Highway 62/180 Hazardous Chemicals Risk Evaluation," that hazardous cargos while being transported by the 62/180 Highway using tank trucks near the proposed site would not pose any credible hazard to the proposed CISF:

[

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

]

2) Justify the wind directions selected for ALOHA analysis.

3) Provide correct URL to access the relevant data from the accident/incident database from the Federal Railroad Administration.

This information is necessary to determine compliance with 10 CFR 72.24(a), 72.90(a) through (d), 72.94, and 72.122.

Holtec Response

[PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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Answers to specific concerns noted above are provided below:

[

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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2) As noted in response to question 1, the dispersion analysis using ALOHA is not included in the updated analysis. However, the wind direction information is still used as a part of the probability assessment.

   The wind directions used in the updated analysis are based on the Lea County Regional Airport Station All Wind Rose (12/02/1948 – 12/31/2014) data and the location of the rail line with respect to the proposed CISF. Based on the wind rose:

   - winds are calm (less than 1.3 mph) ~8.4 percent of the time – winds in this range could create a potentially hazardous atmosphere near and around the release point but are not associated with a specific direction of travel and are considered too low to transport the release away from the release site
   - blows from the southeast to northwest ~3 percent of the time
   - blows from the south-southeast to the north-northwest ~2 percent of the time
   - blows from the east-southeast to the west-northwest ~3 percent of the time
   - blows from the northwest to the southeast ~8 percent of the time
   - blows from the north-northwest to the south-southeast ~9 percent of the time
   - blows from the west-northwest to the east-southeast ~6 percent of the time

   The winds in the vicinity of the Facility blow from southeast to northwest (the direction from the highway towards the Facility) about 3 percent of the time. For conservatism, the percentage of time the wind is blowing from the south-southeast to the north-northwest (~2%) and from the east-southeast to the west-northwest (~3%) are also included in the total probability that the wind is blowing the cloud towards the Facility. Therefore, the probability that the wind is blowing in the required direction is conservatively set to 0.08 (8 percent of the time).

3) This report did not rely on the FRA URL as indicated in the RAI but used information from the Department of Transportation website. Directions for accessing the relevant data from the Department of Transportation incident statistics database have been

added into Section 7.0 of the analysis. The computer files associated with this report include a download from the Hazmat Incident Report Search Tool that was obtained by performing the following steps:

- Access the PHMSA website at: https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics
- Select "Hazmat Incident Report Search Tool" under the Search the Hazmat Incident Database section
- Enter the Dates 01/01/2010 – 01/01/2021 in the HAZMAT Incident Prompts Form Line 3
- Select "Highway" on the HAZMAT Incident Prompts Form Line 8 for Mode of Transportation
- Click on **Apply** button at bottom of form – this will generate the information and display the first entries associated with the request
- Under the "Report Links" section, click on the **download** link to download the report
- This will download the data into a csv file with the name "Incident Report All fields included in Form 5800.csv"
- Open this file using Excel and save in the Excel file format.

Updates have been made to SAR Section 2.2.4 to align with the updates to the analysis as described above.

RAI 2-15-S: Justify the following assumptions in SAR Section 2.2.4, "Ground Transportation," and HI-2210619, "HI-STORE Railway Hazardous Chemicals Risk Evaluation," that hazardous cargos while being transported by rail cars near the proposed site would not pose any credible hazard to the proposed CISF:

1) Define the terms accident and incident associated with railway mishaps as used in the SAR and HI-221019.

2) [

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3) Provide correct URL to access the relevant data from the accident/incident database from the Federal Railroad Administration.

This information is necessary to determine compliance with 10 CFR 72.24(a), 72.90(a) through (d), 72.94, and 72.122.

Holtec Response

Holtec has updated HI-2210619, "HI-STORE Railway Hazardous Chemicals Risk Evaluation." [

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

]

Answers to specific concerns noted above are provided below:

1) The definitions of accident and incident, shown below, associated with railway operations as used in HI-221019 have been included in the updated evaluation. Only the term incident is used in the SAR since the updated evaluation conservatively uses the incident data statistics since in the risk evaluation since these statistics include all railway incidents/accidents regardless of the monetary damage amount and encompass the accident data statistics.
    - The US DOT FRA defines a train accident as a safety-related event involving on-track rail equipment (both standing and moving), causing monetary damage to the rail equipment and track above a prescribed amount, and defines a train incident as any impact between a rail and highway user (both motor vehicles and other users) of the crossings at a designated crossing site, including walkways, sidewalks, etc., associated with the crossing. Since a transportation-related incident, which includes railway incidents, is defined as any unintentional release of a hazardous material during transportation, loading or unloading, or temporary storage related to transportation, and is not reliant on a dollar threshold, railway incident data is used in this analysis.

2) [
   PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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3) Directions for accessing the relevant data from the accident/incident database from the Federal Railroad Administration have been added into Section 7.0 of the analysis. In particular, the computer files associated with this report include a download from the Hazmat Incident Report Search Tool that was obtained by performing the following steps:
    - Access the PHMSA website at: https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics
    - Select "Hazmat Incident Report Search Tool" under the Search the Hazmat Incident Database section
    - Enter the Dates 01/01/2010 – 01/01/2021 in the HAZMAT Incident Prompts Form Line 3

- Select “Rail” on the HAZMAT Incident Prompts Form Line 8 for Mode of Transportation
- Click on **Apply** button at bottom of form – this will generate the information and display the first entries associated with the request
- Under the “Report Links” section, click on the **download** link to download the report
- This will download the data into a csv file with the name “Incident Report All fields included in Form 5800.csv”
- Open this file using Excel and save in the Excel file format.

Updates have been made to SAR Section 2.2.4 to align with the updates to the analysis as described above.

RAI 2-16-S-3: Provide a technical basis and additional information to justify that the selected probable maximum precipitations (PMPs) are resulted from corresponding probable maximum storms (PMSs) for all PMP durations.

The applicant identified the PMPs of various duration according to two methods – the National Weather Service Hydrometeorological Report (HMR) 51/52 [National Oceanic and Atmospheric Administration, 1980 and 1982] and the CO-NM [Colorado Division of Water Resources, 2018] methods. In calculating the HMR 51/52 PMPs, the applicant placed the storm center at the centroid of the entire watershed, which is comprised of five subbasins contributing to potential flooding events at the proposed CISF site. The U.S. Army Corps of Engineers user’s manual for the HMR52 software [USACE, 1987] suggested that the center of the storm, in additional to storm size and orientation, be adjusted to assure the precipitation as calculated by the software is the PMP. Additionally, determination of the controlling PMP should be based on the probable maximum flood (PMF) water level. The applicant should clearly identify the model parameters and hydraulic modeling results in its justification for the selection of the controlling PMP. The applicant should also provide the hydrologic and hydraulic model input files, for verification of the controlling PMP by the staff.

This information is necessary to determine compliance with 10 CFR 72.90(b) through (c), 10 CFR 72.92(a) through (b), 72.98(a), and 72.122(b)(2)(i)(A) through (B).

Holtec Response

As an additional evaluation step in the updated PMP/PMF analysis report [1] the HMR cases were run with the storm centered over the HI-STORE basin and compared to the HMR storm centered over the overall watershed and the CO-NM storm. Once the controlling method was determined for each storm duration (6,24, 48, 72hr), each storm was run all the way through the hydraulic model to determine the controlling PMP based on resulting flood water depth at the site. Table 3 in the revised report provides the flood water depths for each storm at the center of the ISFSI. The 72 hour HMR storm centered over the overall watershed produced the greatest flood water heights at the HI-STORE site and is considered as the controlling storm for the PMP/PMF analysis. Details of these evaluations and results can be found in CIS-RP-003-03 [1]. Inputs and outputs for all model runs will be provided.

Section 2.4.3 of the HI-STORE SAR has been updated to reflect this change.

References:

1. GEI Consultants, Inc., Report CIS – RP 003 – 03, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 3, April 2022
2.

RAI 2-16-S-4: Provide additional technical basis to justify that the Clark Unit Hydrograph method results in the highest probable maximum flood (PMF) water level.

The applicant examined three rainfall to surface runoff transformation methods, namely the Clark Unit Hydrograph (CUH), the Soil Conservation Service (SCS) Hydrograph, and the U. S. Bureau of Reclamation Flood Hydrology Manual Method [GEI Consultants, 2021]. The applicant reported that the CUH produced the highest peak of flow [Figure 12, GEI Consultants, 2021]. It is important to note that PMF water level is a more important indicator of flood impact to onsite structure, system, and components (SSC) important to safety than flow rate. In particular, Figure 12 suggests that the SCS method resulted in later peak arrival but higher total water volume among the three hydrographs tested. The applicant should provide additional information, e.g., comparison of PMF water levels at various SSC locations using the three unit hydrographs, including the parameters used for calculating the flow rates and water levels.

This information is necessary to determine compliance with 10 CFR 72.90(a), 72.90(b), and 72.92(c).

Holtec Response

The PMP/PMF analysis report [1] has been updated and no longer considers any transformation methods, initial losses, or constant losses. Instead, it considers no precipitation losses and instantaneous translation across the watersheds [1]. As such the Clark unit Hydrograph is no longer used in the analysis and the transform methods no longer effects the PMP/PMF for the HI-STORE site.

The revised report no longer considers a transform method as runoff is considered to instantaneously transport to the site [1]. Nevertheless, the CUH method is the recommended method given the modeling location and parameters. Three transform methods had been evaluated to identify the method that produced the most conservative and appropriate approach: Soil Conservation Service (SCS), Clark Unit Hydrograph, and U.S. Bureau of Reclamation Flood Hydrology Manual methodology. The 72-hr PMP was modeled for the Existing Condition for the three transform methods. The Clark Unit Hydrograph was selected as the most appropriate for the site. The selection is confirmed by the State of New Mexico, which considers that the Clark Unit Hydrograph as a suitable method for use in performing hydrologic studies. The SCS Unit Hydrograph, was ruled out for several reasons including the fact that SCS unit hydrograph methods were designed for watersheds from 0 to 2,000 acres (~ 3.1 square miles), smaller than the watersheds in the HI-STORE study, which ranged in size from 4 to 119 square miles with a total drainage area of 245 square miles. Furthermore, SCS was developed as a "simplified procedure" (i.e., subset of Technical Release 20 or TR-20 model runs) based on averages of unit hydrographs derived from gaged rainfall and runoff for small agricultural watersheds based on information in the U.S. SCS Technical Report 55 [2]. The HI-STORE site and drainage area land cover consists of mostly scrub shrub and the land use, currently undeveloped, is dissimilar to agricultural land.

Section 2.4.3 of the HI-STORE SAR has been updated to reflect this change.

<u>References:</u>

1. GEI Consultants, Inc., Report CIS – RP 003 – 03, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 3, April 2022
2. USDA, Urban Hydrology for Small Watersheds, TR-55, June 1986.

RAI 2-18-S-1: Provide additional technical basis to justify the use of the initial and constant loss method in determining rainfall excess.

In the hydrologic models of the CISF, the applicant selected, among others, the initial and constant loss method to determine rainfall loss and thus rainfall excess that was subsequently transformed to surface runoff. However, the applicant provided little justification as to why the method is applicable, for example, to the antecedent soil moisture content, to the depth of soil profiles that may accommodate a constant loss rate, and to restrictive layer of soil or formation beneath land surface. The applicant cited the New Mexico Office of State Engineer [NMOSE, 2008] and selected constant loss rates referenced in the publication for various soil groups. The applicant should provide additional information to justify the selection of the 'median' constant loss rates without determining the sensitivity of model results to this particular model parameter. The applicant should also justify model assumptions, its selection of model parameters, and subsequently compare model calculated rainfall excess against standard engineering practices, for example, the 2008 NMOSE hydrologic modeling guidelines.

This information is necessary to determine compliance with 10 CFR 72.90(a), 72.90(b), and 72.92(c).

<u>**Holtec Response**</u>

The PMP/PMF analysis report [1] has been updated and no longer considers any transformation methods, initial losses, or constant losses. Instead, it considers no precipitation losses and instantaneous translation across the watersheds. As such the initial and constant loss method is no longer used in the analysis and the selections no longer effect the PMP/PMF for the HI-STORE site [1].

Nevertheless, as discussed in the previous revision on the report the initial and constant loss method was consistent with common engineering practice and recommended by the NMOSE for all areas in NM. The previous report ran sensitivity studies on initial loss coefficient, constant loss coefficient, and the percent of impervious land in the watershed showing that the impact on the model was less significant than the adjustments to the parameters. Appendix G of CIS-RP-003-03 [1], which presents supplemental model details that are no longer applicable to the design PMP/PMF, includes loss parameter constant with the most conservative values in the NMOSE suggested range.

Section 2.4.3 of the HI-STORE SAR has been updated to reflect this change.

References:
1. GEI Consultants, Inc., Report CIS – RP 003 – 03, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 3, April 2022

RAI 2-18-S-2: Provide technical basis to justify the outflow structure parameters and outflow curve at the three large playas, Lagunas Gatuna, Plata, and Tonto, used in the hydrologic models.

The applicant used a broad-crested dam as the outflow structure for Lagunas Gatuna and Tonto, and an outflow curve for Laguna Plata in the hydrologic model. The applicant indicated that the selection of these model inputs was based on digital elevation models obtained from the United States Geological Survey. However, no information can be found in the SAR or the GEI report indicating the outflow area geometry and the relevant parameters used to obtain the outflow curve for Laguna Plata. The applicant should provide additional information to justify the use of these input values.

This information is necessary to determine compliance with 10 CFR 72.90(a), 72.90(b), and 72.92(c).

Holtec Response

Appendix A of the report [1] provides Stage Storage Tables used to develop the stage storage curves for each of the three lagunas.

Lagunas Tonto and Gatuna are modeled as "in-line" structures in the HEC-HMS model and broad crested spillways were considered the most representative outflow structure type based on topography represented in USGS maps, the DEM model, and google earth imagery. Appendix C displays the stage storage curves and representative outflow structure size (again approximated based on DEM, etc. topography) for Lagunas Tonto and Gatuna.

In order to model the potential effects of backwater at the site, downstream discharge from Laguna Plata was represented in the HEC-HMS model by a stage-storage-discharge relationship developed in the HEC-RAS 2D hydraulic model based on the terrain, hydraulic characteristics of the channel and Plata's outlet, and preliminary routing. Shown in Appendix C, the stage-storage and storage-discharge relationships for Laguna Plata were input as HEC-HMS "paired data curves."

Lagunas Tonto and Gatuna were not represented as outflow curves as they were modeled to convey water to the HI-STORE site and were not part of the 2D hydraulic model.

The DEM model is included in the supporting information provided with this response.

References:
1. GEI Consultants, Inc., Report CIS – RP 003 – 03, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 3, April 2022

RAI 2-18-S-3: Add probable maximum seiche wave height to PMF water level.

Surge and seiche affect sites adjacent to large water bodies or the oceans. The CISF site is adjacent to the large Laguna Gatuna playa. The applicant's hydrologic and hydraulic calculations indicated that the western boundary of Laguna Gatuna reaches the CISF under the 72-hour PMP condition. The applicant should calculate the seiche wave height under this condition and add the result to the PMF water level.

This information is necessary to determine compliance with 10 CFR 72.90(a), 72.90(b), and 72.92(c).

Holtec Response

Calculations were performed to determine the oscillation period of the laguna from seiche and wind. These periods were significantly different. Therefore, the appropriate conditions for seiche flooding do not exist at the HI-STORE site [1]. Additionally, the calculations conservatively consider the longer dimension of the laguna, which is perpendicular to the wind direction needed to affect the HI-STORE CISF site. These detailed calculations can be reviewed in CIS-RP-003-03 Appendix E [1].

Section 2.4.5 of the HI-STORE SAR has been updated to further discuss this.

References:

1. GEI Consultants, Inc., Report CIS – RP 003 – 03, “Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico,” Revision 3, April 2022

RAI 2-18-S-4: Justify the exclusion of ice flooding given the large playa Laguna Gatuna is adjacent to the site boundary.

Winter precipitation has been recorded in the area surrounding the site. For example, the applicant reported that the maximum recorded snow accumulation for Hobbs, NM, is 12.2 inches. It is also likely that freezing of the water retained in nearby Laguna Gatuna can occur in the winter. The applicant should provide additional information to justify that ice flooding would not impact the onsite structure, system, and component important to safety.

This information is necessary to determine compliance with 10 CFR 72.122(b)(2)(i)(A) and (B).

Holtec Response

The potential for ice flooding at the HI-STORE site was considered by evaluation of hydroclimatic conditions, review of historical records, and the hierarchical hazard assessment (HHA) framework for evaluation of other flood causing mechanisms. While there is occasionally snow accumulation in the area, the information below discusses why this does not lead to ice flooding conditions [1].

The review of hydroclimatic conditions shows minimal opportunity for the sustained freezing conditions needed for the formation of frazil ice. There are also no sources of turbulent or in-stream water flows at the site to allow its formation in the extremely infrequent freezing conditions.

Review of historical ice jams in New Mexico found only 4 events in the US Army Corps of Engineers Ice Jam Database [2]. All of these historical events occurred in the northern regions of the state where weather conditions are cooler and occurred on major rivers/reservoirs, which the lagunas are not. The conditions for these events cannot be replicated at the HI-STORE site.

NUREG 7046 [3] indicates that ice events may be disregarded if another flood causing mechanism is likely to exceed that resulting from an ice event. The PMP/PMF event would likely result in much greater flooding at the HI-STORE site due to the assumed initial conditions and rainfall events that are not present for an ice event.

Section 2.4.7 of the HI-STORE SAR has been updated to further discuss this.

References:

1. GEI Consultants, Inc., Report CIS – RP 003 – 03, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 3, April 2022
2. U.S. Army Corps of Engineers (USACE) (2022). Ice Jam Database. Accessed March 21, 2022, from https://icejam.sec.usace.army.mil/ords
3. U.S. Nuclear Regulatory Commission (NRC) (2011). Design Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America, NUREG/CR 7046, November 2011.
4.

RAI 2-33-S: Provide the material properties of each stratigraphic layer of the subgrade used in estimating the immediate and long-term (consolidation) settlement of the storage pads and the Canister Transfer Facility (CTF) in HI-2188143, Revision 2, "HI-STORE Bearing Capacity and Settlement Calculations." Provide details of the approach used in determining the required properties if not directly measured in the field or in the laboratory.

This information is necessary to determine compliance with 10 CFR 72.24(a), 72.103, and 72.122.

Holtec Response

Material properties of each layer, and the source of the property values, can be found in Table 5.3 of Holtec Report No. HI-2188143, Revision 3. A two-layer system, consisting of the Residual Soil and Chinle Formation, is used in both settlement calculations. For conservatism, the Chinle Formation is further broken down into six sub-layers in the long-term settlement calculations, which can be found in Appendices A and B of HI-2188143.

RAI 2-42-S-1: Justify the following assumptions regarding Report No. HI–2188143, Revision 1, "HI-STORE Bearing Capacity and Settlement Calculations":

1) Justify whether a two-layer or a three-layer subsurface would be appropriate for estimating the bearing capacity and settlement (both immediate and long-term) of the storage pads and the Canister Transfer Facility (CTF). Update Table 5.3 of document HI-2188143 accordingly.

2) Provide details of the methods used to estimate the bearing capacity and the immediate and long-term settlements of the storage pads and the CTF.

3) Describe the approach selected to demonstrate that the maximum long-term settlement of the storage pads at the proposed HI-STORE facility would be bounded by the limiting maximum long-term settlement of the UMAX FSAR.

4) The HI-STORM UMAX FSAR considers a 5 × 5 array of vertical ventilated modules (VVMs) to determine the design long-term settlement (0.2 inch) of the storage pad; however, in the proposed CISF, each storage pad will have a 25 × 10 array of VVMs instead. Provide the rationale for whether the comparison should be at a 5 × 5 array of VVMs (proposed CISF represented by an equivalent 5 × 5 array) or the UMAX FSAR 5 × 5 VVMs array converted to an equivalent 25 × 10 VVMs array.

This information is necessary to determine compliance with 10 CFR 72.24, 72.103, and 72.122.

Holtec Response

1) A two-layer system has been chosen for determination of the settlements. The two layers are the Residual Soil and the Chinle Formation. The Residual Soil is a granular material which has a low moisture content, is above the water table, and is not saturated. Therefore, the settlement in the Residual Soil will occur immediately upon loading and will not contribute to long-term settlement. The Chinle Formation is a single stratum with the top of the formation between elevations 3499 and 3502 and the bottom of the formation between elevations 3322 and 3321. There is no geologic distinction between "Chinle Formation clay" and "Chinle Formation mudstone." The distinction between clay and mudstone in the boring logs is due to the sampling method, i.e. mudstone is called out when material becomes hard enough to core around elevation 3467-3469 on average. The justification provided in this response has been included in Section 2.3 of Holtec Report No. HI-218143, Revision 3. Table 5.3 of HI-2188143 has also been updated to align with the two-layer system.

2) Soil bearing capacities are estimated based on commonly accepted soil mechanics theories as detailed in AASHTO 2012 (Ref. [1] in HI-2188143). Details for the calculations can be found in Appendices A and B of HI-2188143. The ultimate bearing capacities, based on the modified cohesion and friction angle values, are calculated using equation 10.6.3.1.2a-1 of AASHTO.

   Immediate/Elastic settlement is based on theories/methodologies found in Section 5-6 of J.E. Bowles' "Foundation Analysis and Design" (Ref. [8] in HI-2188143). Equation 5-16 is the basis for the elastic settlement calculation. Variables and factors found in the equation are defined in Appendices A and B of HI-2188143.

   Long-term consolidation settlement is based on previously accepted methodologies established in the generic HI-STORM UMAX FSAR. These methodologies are informed by Holtec Position Paper DS-338, which is incorporated by reference in the HI-STORM UMAX FSAR (see 3.4.4.1.2.C and Table 3.3.5 in FSAR). Within DS-388, the settlement equation uses the soil compression index to compute the result. The Geotechnical Report (Ref. [2] in HI-2188143) includes swell test results, which provide a direct measure of the soil compression ratio. Empirical relationships are then used in HI-2188143 to convert the measured compression ratio to a corresponding compression index. The long-term consolidation settlement occurs only in the Chinle Formation. To estimate the long-term settlement as precisely as possible, the Chinle Formation is broken into 6 separate sublayers in the calculation.

3) The approach used to calculate the long-term settlement of the storage pads at the proposed HI-STORE facility is consistent with the established approach in the generic

HI-STORM UMAX FSAR. Since the HI-STORE SAR relies upon the generic HI-STORM UMAX FSAR for the design, qualification, and licensing of the storage pads, the long-term settlement of the storage pads must be calculated using the same licensing basis method. The detailed approach is presented in Holtec Position Paper DS-338, which is incorporated by reference in the HI-STORM UMAX FSAR (see 3.4.4.1.2.C and Table 3.3.5 in FSAR) and has been submitted to the NRC under Docket No. 72-1040. For the storage pads at the proposed HI-STORE facility, the long-term settlement calculation is informed by the site-specific soil properties obtained from the Geotechnical Report (Ref. [2] in HI-2188143) versus the generic soil properties used in the HI-STORM UMAX FSAR (see Table 3.3.5). The maximum long-term settlement of the HI-STORE storage pads, per calculations in Appendix A of HI-2188143, is 0.151 inches, which is below the limit value of 0.2 inches per Table 2.3.2 of the HI-STORM UMAX FSAR.

4) The rationale for why the calculated long-term settlement for the proposed CISF is normalized to a 5x5 array size is explained below.

   First, the Design Basis Seismic Model presented in Chapter 3 of the HI-STORM UMAX FSAR, which is used to analyze the effects of dead, live, and seismic loads, is a representative 5x5 HI-STORM UMAX Vertical Ventilated Module (VVM) array. That being said, there are no limitations in the HI-STORM UMAX FSAR or CoC that restrict the size of the VVM array that can be constructed under the generic license. The basis for this approach traces back to the earlier licensing of the HI-STORM 100U underground system. This is confirmed by the following statements in Section 3.4 of the HI-STORM UMAX FSAR:

   > "Following the approach used in the safety evaluation of HI-STORM 100U, the reference VVM assemblage used in the seismic qualification is a 5 by 5 array. The actual array size, as noted in the HI-STORM 100U (docket number 72-1014) may be much larger."

   In line with the above, the maximum long-term settlement value calculated in Chapter 3 of the HI-STORM UMAX, and the limit value specified in FSAR Table 2.3.2 (i.e., 0.2 inches), are also based on the same 5x5 VVM array size.

   Second, the 5x5 array size is the more appropriate choice for comparison with the FSAR limit because the differential settlement (or settlement gradient) is more critical to the ISFSI structure than the maximum absolute settlement. Stated differently, a uniform settlement of 2 inches over an entire 25x10 VVM array poses minimal risk to the structure, but a differential settlement exceeding more than 0.2 inches over a span of five VVMS could challenge the structure. Thus, the permissible long-term settlement of 0.2 inches given in Table 2.3.2 of the HI-STORM UMAX FSAR is in effect a differential settlement limit normalized to a 5x5 array size.

   In summary, the long-term settlement for the proposed CISF is calculated based on a representative 5x5 array size to (a) accord with the design basis model used in the HI-STORM UMAX FSAR and (b) provide an indication of the differential settlement for the larger array size, which is a greater risk to the ISFSI structure.

Safety Analysis Report (SAR). Chapter 5. "Structural and Installation Evaluation"

RAI 5-27: Verify and describe in Section 1.0, "Purpose", of Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," if the CTB roof design considered wet load of concrete for the composite roof during construction.

If the corrugated steel is used as a form work, the wet concrete will deflect during pouring of the concrete while rebars are not bonded. The staff needs this information to confirm the roof slab will not fail during construction.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

The CTB roof design does take into consideration the wet load of the concrete during construction. This is done through the proper selection of the corrugated steel decking, which serves as the form work for the 6-inch thick concrete roof slab. There are numerous manufacturer's of steel decking for composite roof systems, and the load rating of the steel decking products varies based on the shape of the corrugation, the gage thickness of the metal decking, the steel material, and the clear span between roof supports.

The licensing drawing for the CTB depicts the corrugated steel decking (see sheet 6 of drawing 10912), but it does not specify its exact shape or thickness. That is because the final selection of the corrugated roof decking is delegated to the CTB constructor per the notes on sheet 1 of the licensing drawing (10912). In other words, the constructor's engineer shall select the roof decking based on the relevant design parameters for the roof system and the governing building requirements for the site location.

Even though the precise details of the corrugated steel decking are not known at this time, the weight assigned to the concrete roof slab in the ANSYS model of the CTB is expected to bound the final configuration by a large margin. The reason is that the weight density assigned to the concrete roof slab in ANSYS (which is modeled as 6" thick) is amplified by 50% with respect to normal weight density concrete (150 pcf), which generously compensates for the steel decking and the additional concrete that occupies the corrugated channels.

The purpose and modeling approach for the corrugated metal decking has been clarified in Section 1.0 and Table H2-2 of the calculation package for the HI-STORE CTB (Holtec Report No. HI-2210576). A statement regarding the wet load of concrete during roof construction has also been added in SAR paragraph 5.3.2.4.1.

RAI 5-28: Identify the design basis ACI codes in HI-STORE SAR Chapter 4.

SAR Section 4.6.2 does not list ACI 349-06. However, Section 2.0 of Holtec Report No. HI- 2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," lists ACI 349-06. Also, there are two ACI 318 design code revisions (Revision -05 and -14) listed in the calculation. The staff is not clear which of these codes corresponds to the design basis codes for the facility. Identify code sections and/or provisions where applicable for the SSCs in the SAR.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

SAR Section 4.6.2 has been updated to align with Section 2.0 of the CTB calculation package (Holtec Report No. HI-2210576, Rev. 1), which gives consideration to ACI 349-06 for the governing load combinations and reinforced concrete capacity calculations only.

Previous references to ACI 318-05 in SAR Chapter 4, as well as the CTB calculation package, have been updated to ACI 318-14 since IBC 2015, which is the applicable building code in the state of New Mexico, invokes ACI 318-14 for the design of reinforced concrete structures. This change has no effect on the design or analysis of the CTB since the previous revision of the CTB calculation package cited both ACI 318-05 and ACI 318-14 as design basis codes.

RAI 5-29: Explain the comparison of the mesh size selection described in Section 3.4, "Static Analysis" of Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building."

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This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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RAI 5-30: Provide the expected engineered fill properties that will be used for the CTB analysis, including thickness of the fill.

Section 4.0, "Assumptions", of Item #4 in Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," does not provide the expected engineered fill properties that will be used for the CTB analysis, including thickness of the fill. These properties are required inputs to both the dynamic and static analyses. Also, include these properties in the SAR for the staff safety finding.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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RAI 5-31: Explain how the rail car's assumed weight in Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," will be controlled in the final design.

Section 4.0, "Assumptions", Item #6, of the Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," assumes a weight for the rail car. Explain how the rail car's assumed weight will be controlled in the final design. This information is needed in the SAR for the final design/as-built verification of the CTB.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

The maximum rail car weight has been added in SAR Table 4.6.2 as a design input parameter for the CTB slab. The listed weight of 229 kips is an upper bound value, which aligns with the empty weight of the Atlas rail car developed by the Department of Energy (DOE) for shipment of transport casks. The addition of this information in the SAR insures proper control of the rail car weight in the final design via the requirements of 10 CFR 72 and Holtec's quality assurance program.

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RAI 5-32: Justify why lateral braces need not be considered in the analyses in Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer

Building."

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

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Section 4.0, "Assumptions", and Appendix C of Holtec Report No. HI-2210576 have been revised to include the additional information presented above. SAR paragraph 5.3.2.4.1 has also been updated to describe and justify the modelling approach for the lateral bracing.

RAI 5-33: Provide additional justification and discussion for the CTB overhead crane runway beam.

Section 4.0, "Assumptions", Item #10 (Page 18 of 386), of Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," assumes that the overhead crane runway beam is not part of the CTB analysis. The staff needs to confirm the beam design is adequate to support the design bases loads and load path to the CTB. The staff cannot verify how loads are distributed from the beam into the structure under different crane operating conditions. Discuss how the assumption is supported by the analysis. Update the SAR to include the crane loads that will be transferred to the structure. Include the demand vs capacity ratios for the critical columns and the connection between the columns and the basemat.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

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RAI 5-34: Revise Chapter 5 of HI-STORE SAR to include additional information and references from Holtec Report No. HI-2210576, Rev. 0, “Structural Analysis of HI-STORE Cask Transfer Building.”

SAR Chapter 5 should be revised to include tables similar to Table 9-1 (Page 22 of 386), “Summary of Minimum Safety Factors under Static Load Combination” of Holtec Report No. HI- 2210576, Rev. 0. In addition, include other critical information required for the staff’s safety finding within SAR Chapter 5, including, but not limited to, critical sections of the CTB, such as the walls, base-slab, and roof. The staff’s safety findings should reference the SAR as much as possible and minimize reference materials from Holtec Report No. HI-2210576, Rev. 0.

This information is necessary to determine compliance with 10 CFR 72.122(b).

<u>Holtec Response</u>
Per the staff’s request, Section 5.3.2 of SAR Chapter 5 has been updated to expand the general description of the CTB analysis and include more information from Holtec Report No. HI-2210576. Also, a summary of minimum safety factors (similar to Table 9-1 in HI-2210576) has been added to SAR Chapter 5 in new Table 5.3.3.

RAI 5-35: Justify the exclusion of selected time histories in Figures 3-1 to 3-3 of Holtec Report No. HI-2210576, Rev. 0, “Structural Analysis of HI-STORE Cask Transfer Building.”

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This information is necessary to determine compliance with 10 CFR 72.122(b).

<u>Holtec Response</u>
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RAI 5-36: Discuss how the guidance in NUREG-0800, Section 3.7.1 and 10 CFR Part 50, Appendix S are satisfied in Holtec Report No. HI-2210576, Rev. 0, “Structural Analysis of HI- STORE Cask Transfer Building.”

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This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

The seismic data used as input to the dynamic and static analyses of the HI-STORE CTB satisfies the applicable requirements from NUREG-0800, Section 3.7.1 and 10 CFR 50, Appendix S, as explained below.

Paragraph IV(a)(1) of 10 CFR 50, Appendix S requires that: “The horizontal component of the Safe Shutdown Earthquake Ground Motion in the free-field at the foundation level of the structures must be an appropriate response spectrum with a peak ground acceleration of at least 0.1g.” This requirement is fully satisfied by the analyses performed in Holtec Report No. HI-2210576, as confirmed by the seismic input data in Table 5-1 and the analysis description in Section C2.2.2 of the report. In summary, the design basis earthquake for the HI-STORE site is a Reg. Guide 1.60 response spectra with a peak ground acceleration (PGA) of 0.15g in all three directions, which is conservatively applied to the CTB dynamic model at the base of the soil column well below the CTB foundation slab.

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RAI 5-37: Discuss and justify the assumptions made in Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," regarding the analysis of seismic loads and tornado missiles on the CTB ITS SSCs.

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]. Also, describe and provide the bases for protection of the ITS (important to safety) SSCs from tornado missiles entering from large openings of the CTB building.

This information is necessary to determine compliance with 10 CFR 72.122(b).

Holtec Response

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RAI 5-38: Justify the statements in Appendix C, Section C3.2 of Holtec Report No. HI-2210576, Rev. 0, "Structural Analysis of HI-STORE Cask Transfer Building," regarding the CTB overhead crane's acceptance.

[

] Since the CTB crane is an ITS SSC, provide justification for the assumption in the SAR that controls are based on the design and procurement specifications. The staff needs this information to have reasonable assurance that the safety function of the SSC will be met, given that the complete crane design has not been submitted.

This information is necessary to determine compliance with 10 CFR 72.122(b).

<u>Holtec Response</u>

The design criteria, operational requirements, and critical characteristics of the CTB overhead crane are captured in Section 4.5.2 and Tables 4.5.1 and 4.5.2 of the SAR. In addition, the general assembly and layout of the overhead crane inside the CTB are depicted on Licensing Drawing 12404 in Section 1.5 of the SAR. The final design of the CTB overhead crane, at the time of site construction, must comply with the applicable SAR requirements and also conform with the licensing basis analysis of the CTB structure as described in SAR Section 5.3.2.

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RAI 5-39: Clarify how the HI-PORT transporter, when traveling with a loaded HI-TRAC CS, is designed to withstand the effects of tornado winds and missiles. Confirm that the HI-PORT and HI-TRAC CS are evaluated for overturning and sliding from design-basis wind, as well as tornado missile impact loads, while in this configuration and update the operations chapter and Technical Specifications, as appropriate.

This information is necessary to determine compliance with 10 CFR 72.122(b)(2)i.

<u>Holtec Response</u>

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] Lastly, paragraph 10.3.3.5 of SAR Chapter 10 has been updated to require operations personnel to check the weather conditions before transporting the HI-PORT with a loaded HI-TRAC CS out of the CTB. Therefore, a tornado missile strike on the HI-PORT or the VCT during those operations described in SAR paragraph 10.3.3.5 is considered non-credible.

RAI 5-40: Clarify how the VCT, when traveling with a loaded HI-TRAC CS, is designed to withstand the effects of tornado winds and missiles. Confirm that the VCT and HI-TRAC CS are evaluated for overturning and sliding from design-basis wind, as well as tornado missile impact loads, while in this configuration and update the operations chapter and Technical Specifications, as appropriate. In addition, specify the constraints of the VCT movement on the ISFSI pad and the approach apron.

This information is necessary to determine compliance with 10 CFR 72.122(b)(2)i.

Holtec Response

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] Lastly, paragraph 10.3.3.5 of SAR Chapter 10 has been updated to require operations personnel to check the weather conditions before transporting the HI-PORT with a loaded HI-TRAC CS out of the CTB. Therefore, a tornado missile strike on the HI-PORT or the VCT during those operations described in SAR paragraph 10.3.3.5 is considered non-credible.

RAI 5-41: Provide additional details of the cask transfer route or heavy-haul path.

Because the HI-PORT is classified as an ITS-C SSC, per Table 4.2.1 of the SAR, and will be performing frequent trips with a loaded HI-TRAC CS, the SAR should provide information on the design criteria of the haul path (as shown in Drawing 10940) to ensure that the design and/operating criteria of the HI-PORT will be met. Provide the design parameters of the haul path (e.g., bearing capacity requirements, surface type, grade, etc.).

This information is necessary to determine compliance with 10 CFR 72.122(b)(2)i.

Holtec Response

SAR Chapter 4 has been updated to include the design parameters of the haul path as requested. Specifically, the surface type, the minimum bearing capacity, and maximum grade are now specified in Section 4.5.4 of the SAR.

RAI 5-42: Provide additional details for the analysis of the HI-PORT transporter under design basis normal, off-normal, and accident conditions.

SAR Table 4.2.1 describes the HI-PORT as an ITS-C SSC. SAR Section 5.5.3.2 refers to SAR Section 4.5.4 for the design criteria of the HI-PORT. However, SAR Section 4.5.4 only specifies generic requirements for “Miscellaneous Ancillaries,” and classifies the HI-PORT as such. It further states that the “[d]esign loads and associated applicable to the ancillary under normal and accident conditions (if any) shall be defined based on its function and application,” and refers to ASME Section III, Subsection NF, Class 3, for compliance with the stress analyses on the ancillaries. The staff cannot find related analyses and/or evaluations for the HI-PORT under normal, off-normal, and accident conditions. The staff recognizes that an analysis for the seismic accident condition for the HI-PORT is provided in HI-2177585, Rev. 2. Specify and evaluate the design basis conditions and loadings associated with normal, off-normal, and accident conditions for the HI-PORT, as appropriate, and provide a table with this information (similar to Table 4.5.3). In addition, provide the purchase specification (Holtec Purchase Specification PS-5025-0001, “Purchase Specification for the HI-STORE HI-PORT,” Revision 0 or other documentation that identifies the HI-PORT materials of construction that define the mechanical properties used in the structural analysis.

This information is necessary to determine compliance with 10 CFR 72.120(a) and

72.122(b)(2)i.

Holtec Response
Section 4.5.4 has been completely revised to provide the complete design information for the HI-PORT (similar to Section 4.5.3 for the VCT). The generic requirements for "Miscellaneous Ancillaries" are now given in Section 4.5.5, which no longer includes HI-PORT. In addition, the design basis conditions and loadings for the HI-PORT are listed in Table 4.5.10 (similar to Table 4.5.3 for the VCT). The HI-PORT Purchase specification is included as an attachment to this submittal.

RAI 5-43: Clarify how off-normal loads were considered in the design of ITS components.

Some components and/or ancillary equipment do not specifically address or reference which off-normal conditions were considered, if any. Identify any off-normal loads and align with SAR Section 15.2.

This information is necessary to determine compliance with 10 CFR 72.122(b)(1).

Holtec Response
The off-normal loads applicable to the HI-STORE CISF are listed in Section 15.2 of the SAR, which are aligned with the off-normal conditions in Section 12.2 of the HI-STORM UMAX FSAR. The only exception is the FHD malfunction, which is not applicable to HI-STORE CISF since the spent fuel canisters are already dried, backfilled, and sealed prior to arrival at the facility.

There are no specific off-normal events associated with activities inside the CTB for the following reasons. When a HI-STAR 190 transport cask arrives at the CTB, its impact limiters will be installed and they will remain in place until the HI-STAR 190 package is lowered onto the tilt frame. Thus, there is no credible risk to the HI-STAR 190 cask or its contents while the impact limiters are in place, as demonstrated by the qualifying analyses in the HI-STAR 190 SAR. After the impact limiters are removed from the HI-STAR 190 cask, the loaded MPC either remains in a static resting position, inside a HI-STAR 190 or HI-TRAC CS, with support from below (i.e., tilt frame or CTB/CTF slab) or it is being actively lifted (raised or lowered) using the single-failure-proof overhead crane in combination with ANSI N14.6 compliant handling devices. Therefore, an off-normal drop event is not credible, as indicated in SAR Subsection 15.2.6.

Safety Analysis Report (SAR), Chapter 6, "Thermal Evaluation"

RAI 6-35: Confirm that the use of the HI-PORT transport vehicle is adequately bounded by the postulated HI-TRAC CS fire accident. Revise proposed Technical Specification 4.2.5 to specify a limit to the amount of combustible material I the cask transporters, and to ensure the limit is also applicable to the proposed HI-PORT transport vehicle.

SAR Section 6.5.2.1 assumes and analyzes the effects of a postulated fire that considers the Vertical Cask Transporter (VCT) related fuel, hydraulic fluid, and tires. However, the SAR does not state whether the postulated VCT related combustible material would bound a similar fire accident from the HI-PORT transport vehicle fuel combustible material (e.g., fuel, hydraulic fluid, and tires). Since the HI-PORT transport vehicle will be used to transfer a loaded HI-TRAC CS from the CTB to the UMAX ISFSI pad at the CISF, the SAR should discuss if a postulated fire from the HI-PORT transport vehicle combustible material is bounded by the VCT related combustible material fire accident scenario. In addition, proposed Technical Specification 4.2.5 should state a limit for the amount of combustible material in both the VCT and HI-PORT transport vehicle.

This information is needed to determine compliance with 10 CFR 72.122(b)(4)(c) and 72.128(a)(4).

Holtec Response

The evaluated VCT fuel tank fire in SAR Section 6.5.2.1 does not bound the fire from HI-PORT transport vehicle as the quantity of combustibles in a HI-PORT are substantially higher. Additionally, it is recognized per the operations outlined in Chapter 10 of the SAR that the VCT can be in close proximity while the HI-TRAC CS cask is still on the HI-PORT. It is for this reason that Section 6.5.2.1 of the SAR has been revised to include an evaluation of a combined fire from VCT and HI-PORT. The allowable quantities of combustibles, liquid and solid, for the HI-PORT are also specified in SAR Table 6.5.3.

The duration of the hypothetical fire due to the cumulative volumes of combustibles from both the equipment is computed following the exact same methodology adopted for the VCT fire evaluations. Utilizing the exact same ANSYS Fluent thermal model and methodology from previously reviewed evaluation in Subsection 6.5.2.1 (b), the fire and post-fire durations are simulated albeit now for a longer duration. The computed results demonstrate that the accident condition limits are satisfied for all component temperatures and MPC cavity pressures. The volume of concrete that is unavailable for shielding has marginally increased to 1.02%. Differential thermal expansion between the MPC and HI-TRAC components are computed for the combined fire accident following the same methodology as that previously adopted for the VCT only fire accident. Restraint free expansion is confirmed between all components under the combined VCT and HI-PORT fire accident also.

A new subsection 6.5.2.1 (b.2) is added to Chapter 6 of the HI-STORE FSAR to document the above evaluation. Section 4.2.5 of the technical specification has also been revised to include the maximum allowable combustible volumes from the HI-PORT. Details of the calculations are documented in the companion Holtec Report HI-2177553.

Safety Analysis Report (SAR), Chapter 7, "Shielding Evaluation"

Introductory Holtec Statement Related to Shielding RAIs 7-20 through 7-30

By now, more than 1500 of Holtec's spent fuel storage systems have been successfully loaded in the US. For all of them, dose measurements were taken, to satisfy the dose rate limits in the CoC. This provides a significant amount of data of measured and corresponding calculated dose rate values for our systems, including both above and below ground systems. Anecdotal evidence indicates that measured values are generally well below the corresponding calculations, with difference of factor 10 not unusual. Holtec is now in the process of formally reviewing these differences. The purpose is to eventually show that the actual margins to the regulatory limits are far larger than what is indicated through the calculations. So far, no single reason for these differences has been identified. It is expected that the reason is the aggregate of all the conservative assumptions applied in the calculations, such as core operating parameters of assemblies, burnup, enrichment and cooling times, material densities and compositions. No formal credit can be taken here for these investigations, since the work is still in progress, and no final conclusions have been drawn, but future work on the HI-STORE system may well incorporate insights from the studies currently being performed. However, we may point out one significant conservatism that is applied here in the dose analyses for the controlled area boundary and any permanent residents nearby: That is the assumption that all 500 storage systems are loaded instantaneously with fuel of the maximum possible characteristics from a dose perspective. This alone should provide confidence that any actual dose around the installation will be below those calculated here.

RAI 7-20: Pertaining to the shielding calculations for the HI-STORE CISF:

1. Verify and confirm that the output files for shielding calculations are the ones that Holtec intended to submit for review as the licensing basis or provide the correct files as necessary.

2. Explain with justifications how the uncertainties associated with the calculations for dose and dose rate with different regional sources are applied to the final total dose and dose rates.

In its response to RAI 7-17 (ML21124A308), the applicant provided a set of calculations for the dose rates in the near field (around the VVM storage module), dose rate as a function of distance from the ISFSI pad to the controlled area boundary, and annual dose at the controlled area boundary of the CISF. During its review of these files, the staff has observed the following:

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This information is needed to determine compliance with 10 CFR 72.104, 10 CFR 72.106, and 10 CFR 20.1201.

Holtec Response

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RAI 7-21: Justify how the uncertainties and relative errors associated with the different calculations for dose and dose rates were determined and applied to the final total dose and dose rates.

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This information is needed to determine compliance with 10 CFR 72.104, 72.106, and 20.1201.

Holtec Response

The total relative error of each tally is now approximately 5% or less. A more detailed explanation for how uncertainties and relative errors with different calculations are applied to the final total dose and dose rates is provided in the response to RAI 7-20 (2d).

RAI 7-22: Explain and justify which values have been used for the fuel assembly characteristic parameters, as shown in Table A.1: "Fuel Assembly Parameters for ORIGAMI Input", Table A.2: "Reactor Operating Parameters," of the HI-STAR 190 Source Term Calc Package.

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This information is needed to determine compliance with the regulatory requirements of 10 CFR 72.104, 72.106, and 20.1201.

Holtec Response

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RAI 7-23: Explain the calculation of the source terms for the spent fuel assembly (FA) with burnup exceeding 60 GWd/MTU and demonstrate that treatments, if any, are appropriate and adequate to assure reliable calculations of the source terms from the spent fuel.

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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This information is needed to determine compliance with 10 CFR 72.104, 72.106, and 20.1201.

Holtec Response

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RAI 7-24: Justify the C-14 release limit value used in the C-14 calculation.

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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This information is needed to determine compliance with 10 CFR 72.104, 20.1201, and 20.1301.

Holtec Response

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RAI 7-25: Justify the assumed 2000 hours per year occupancy of the real individual at the controlled area boundary.

In its response to RAI 7-17 (ML21124A308), the applicant provided its revised estimate of dose for a real individual at the controlled area boundary with 400 meters from the ISFSI pad and 1000 meters from the ISFSI pad. The applicant assumed that the occupancy of the real induvial is 2000 hours at the controlled area boundary and 8760 hours at the location that is 1000 meters from ISFSI pad. However, it is not clear what the bases are for these assumptions.

This information is needed to determine compliance with the regulatory requirements of 10 CFR 72.104 and 20.1301.

Holtec Response

Figure 7.4.5 is added, showing the HI-STORE CISF site surrounded by Bureau of Land Management Land and State Land, which precludes homes from being built on this land as long as these lands keep their current status. References to figures in Section 2.1 of the HI-STORE CISF SAR are also provided. Extraction activities will continue to take place nearby the HI-STORE CISF site, so it is possible that a "real individual" could work near the controlled area boundary full time for an entire working year of 2000 hours per year. Paragraph 7.4.2.1 now notes, "The nearest residence is approximately 1.5 miles from the controlled area boundary of the HI-STORE CIS Facility. While it is possible that a home could be built closer than 1.5 miles from the HI-STORE CIS Facility, the existing BLM and state land designations preclude homes from being built within 1 mile of the HI-STORE CIS Facility." Conservatively the dose rate calculations assume the distance to be 1000 meters from all radiation sources to the nearest residence and assumes an occupancy of 8760 hours per year.

RAI 7-26: Justify the assumption that the concrete component of the HI-TRAC CS transfer cask will only lose the hydrogen under accident conditions. If additional damage mechanisms are plausible, describe how the shielding analysis accounts for the associated decrease in concrete shielding performance and revise the shielding analysis as necessary.

In its response to RAI 6-21-S and RAI 7-17 (ML21124A308), the applicant assumed that the concrete component of the HI-TRAC CS transfer cask would lose only the hydrogen in the concrete layer under accident conditions. However, it is not clear whether this assumed condition would bound all plausible loss of concrete such as localized spallation and cracking of the concrete under fire accident. Based on studies, concrete will change both its mechanical and chemical properties. Beyond the moisture plateau, when the temperature reaches about 400 °C, the calcium hydroxide in the cement will begin to dehydrate, generating more water vapor and also bringing about a significant reduction in the physical strength of the material.

Other changes may occur in the aggregate at higher temperatures. For example, quartz-based aggregates increase in volume, due to a mineral transformation, at about 575 °C [Ref. 1]. One of the most complex and hence poorly understood behavioral characteristics in the reaction of concrete to high temperatures or fire is the phenomenon of 'explosive spalling' [2, 3]. This process is often assumed to occur only at high temperatures, yet it has also been observed in the early stages of a fire [4] and at temperatures as low as 200 °C [5]. Also, Holtec Position Paper DS-289 (2017) states that spalling can occur during rapid heating; however, neither the SAR nor the RAI response provided any information with respect to the heating rates throughout the concrete cross section in a fire.

The processes leading to cracking are generally believed to be similar to those which generate spalling. Thermal expansion and dehydration of the concrete due to heating may lead to the formation of fissures in the concrete rather than, or in addition to, explosive spalling. Based on these published papers and Holtec's position paper, spalling and cracking should also be considered and accounted for in assessing the behaviors of the concrete shield used in the HI- TRAC CS transfer cask.

This information is needed to determine compliance with 10 CFR 72.106, 20.1201, and 20.1301.

Holtec Response

The accident conditions concrete composition was changed to conservatively assume no hydrogen was present in the concrete and the density of the concrete is substantially reduced to consider concrete degradation from a high temperature accident. Spalling and cracking that may occur under accident conditions are considered to be degradation mechanisms that may cause some loss of shielding. Table 7.3.1 shows that a concrete density reduced from 3.05 g/cc to 2.40 g/cc (approximately 21%) under accident conditions is used in the accident conditions shielding analysis.

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- Reduction in concrete density under accident conditions does address any cracking, spalling or other concrete degradation that could occur under accident conditions. Any cracking or spalling of the concrete would remain contained between the inner steel shell and the outer steel shell.
- Any chemical compositional changes from the accident that could affect shielding properties of the concrete would remain bounded, from a shielding perspective by the substantial 21% reduction in HI-TRAC CS concrete density and assumed 100% loss of hydrogen from the HI-TRAC CS concrete.

- More details related to HI-TRAC CS concrete density reduction and composition under accident conditions were provided in a previous round of RAIs in the response to RAI 6-21-S.
- Table 7.4.4 shows that even with the conservative accident conditions assumptions there is substantial margin to the 10CFR72.106 dose limit (0.211 rem < 5 rem limit).

RAI 7-27: Revise the reference for the subgrade backfill material in drawings 10875 and explain why soil is used in the MCNP model for VVM shielding calculations.

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This information is needed to determine compliance with 10 CFR 72.104, 20.1201, and 20.1301.

<u>**Holtec Response**</u>

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RAI 7-28: Clarify the definition of non-fuel hardware for BWR fuel or revise the definition of the following item in the Technical Specifications (TS) for the HI-STORE CISF.

In response to RAI 7-13, the applicant provided a revised TS 2-1, item 6, that states "[f]or fuel assemblies in the MPC-89, the decay heat limits shown in Table 2-2. Note that these maximum
fuel storage location decay heat limits must account for decay heat from both the fuel assembly and any non-fuel hardware." However, the TS does not provide a specific definition for BWR non-fuel hardware. The staff's understanding is that, except for fuel channel, non-fuel hardware is not authorized to be loaded into the MPC-89 canister by design. If fuel channel is the only allowable "non-fuel hardware" to the MCNP-89 canister, revise the TS to provide explicit definition for the BWR non-fuel hardware.

This information is needed to determine compliance with 10 CFR 72.104, 72.106, 20.1201, and 20.1301.

Holtec Response

A definition of "Non-fuel Hardware (BWR)" and "Non-fuel Hardware (PWR)" are added to the glossary. It is now clarified that non-fuel hardware for BWR fuel is the BWR channel only. It is now clarified that BWR control blades are not allowed in MPC-37 or MPC-89 fuel baskets.

RAI 7-29: Explain how the gamma radiation from nonfuel hardware is treated in the shielding model or confirm that non-fuel hardware is not part of the authorized contents.

In response to RAI 7-13, the applicant provided a revised TS 2.1 "Approved Contents, Fuel Specifications and Loading Conditions" that states: "[f]or fuel assemblies in the MPC-37, the decay heat limits shown in Table 2-1. Note that these maximum fuel storage location decay heat limits must account for decay heat from both the fuel assembly and any non-fuel hardware. These fuel assemblies must also meet the restrictions on burnup, enrichment, and cooling time specified in the HI-STAR 190 SAR, Table 7.C.8 (HI-2146214, Revision 3)." Table 7.C.13 of the HI-STAR 190 SAR (HI-2146214, Revision 3) includes specifications for the required cooling times of the allowable non-fuel hardware.

In addition, TS 2-1, item 6, states that "[f]or fuel assemblies in the MPC-89, the decay heat limits shown in Table 2-2. Note that these maximum fuel storage location decay heat limits must account for decay heat from both the fuel assembly and any non-fuel hardware."

This information is needed to determine compliance with 10 CFR 72.104, 72.106, 20.1201, and 20.1301.

Holtec Response

- Gamma radiation from nonfuel hardware is added as an extra source to gamma and cobalt fuel contribution in the post-processing. In the MCNP input files this means that any material of the NFH (which would result in additional shielding) is conservatively neglected. There are no separate MCNP calculations for NFH used or needed.
- As stated in Sub-section 7.1.2 of the HI-STORE CISF SAR, a design basis BPRA is conservatively included with all PWR fuel assemblies for UMAX VVM and HI-TRAC CS calculations.
- The HI-STAR 190 SAR Table 7.C.13 (HI-2146214, Revision 3) is now included in the HI-STORE CISF SAR Technical Specifications.
- The design basis BPRA non-fuel hardware is considered bounding for the different non-fuel hardware types that may be loaded with a fuel assembly (as stated in Subsection 7.1.2), which is consistent with the HI STORM UMAX SAR (Subsection 5.2.3) and the HI-STORM FW SAR (Subsections 5.2.3 and 5.4.4). APSR and CRAs are only allowed in central basket regions as required in Section 2.1 of the HI-STORE Technical Specifications and therefore have a lesser impact on external cask dose rates than non-fuel hardware allowed in peripheral basket cell locations. The HI-STAR 190 dose vs. distance calculations considered different regionalized combinations of non-fuel hardware (including BPRAs) and presented dose rate results for the bounding case, which is explained in more detail in HI-2201053-R0. Contribution of the BPRAs to the dose rates are taken into account in the post-processing; there are no separate MCNP non-fuel hardware files within HI-2177599-R4 or HI-2177600-R3.

RAI 7-30: Provide the shielding calculations for the canister containing non-fuel hardware.

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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This information is needed to determine compliance with 10 CFR 72.104, 72.106, 20.1201, and 20.1301.

Holtec Response

The responses to RAI 7-20 (1) and 7-29 provide the information requested in this RAI 7-30.

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PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

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Safety Analysis Report (SAR), Chapter 10, "Conduct of Operations Evaluation"

RAI 10-19: Revise SAR Chapter 10 to provide detailed procedures for canister transfer operations with the HI-PORT transport vehicle.

Section 3.1.4 of the HI-STORE SAR (Revision 0O) describes the use of the HI-PORT transport vehicle during canister transfer operations at the CISF. Specifically, it describes the use of HI-PORT to transfer a loaded HI-TRAC CS transfer cask from the Canister Transfer Building to the UMAX ISFSI pad, where the HI-PORT meets the VCT, which lifts the HI-TRAC CS off the HI-PORT deck. However, SAR Sections 10.3.3.2 and 10.3.3.4 do not cite the HI-PORT vehicle nor do they provide detailed descriptions or procedures for operations with the HI-PORT. The applicant should revise SAR Chapter 3 and Chapter 10, as necessary, to ensure that operations with the HI-PORT transport vehicle are adequately described.

This information is needed to determine compliance with 10 CFR 72.24(h) and (n); and 72.122 (b)(1) and (f).

Holtec Response

Subsections 10.3.3.2 and 10.3.3.4 are revised to include descriptions for loading the HI-TRAC onto the HI-PORT and transferring the HI-TRAC from the HI-PORT to the VCT.

Safety Analysis Report (SAR), Chapter 17, "Materials Evaluation"

RAI 17-12-S-1: Revise Section 18.5 of the HI-STORE SAR to include inspection requirements for spent fuel canisters.

SAR Section 18.5, "Canister Aging Management Program," was not revised per the applicant's response to RAI 17-12-S. The RAI response stated that the SAR was revised to state that a minimum of one canister from each originating site will be inspected via remote visual methods (and, as necessary, follow-up surface or volumetric techniques). However, the actual revision to the SAR was to a table that describes *corrosion coupon testing protocols* – which is unrelated to the subject of the RAI. An independent reading of Table 18.5.1 would conclude that corrosion coupons need to be placed near the inlets of one canister from each originating site. SAR Section 18.5.1 still discusses the visual inspection of an MPC but was not revised to state "one canister from each originating site." SAR Section 18.5 should be revised to clearly state that the external surface of one canister from each originating site will be inspected via the remote visual method.

This information is needed to demonstrate compliance with 10 CFR 72.120(a).

Holtec Response

Section 18.5.1 of Chapter 18 is updated to state that a minimum of one canister from each originating site shall be inspected. Additionally, revision in Table 18.5.1 is removed as it does not belong to this Table.

RAI 17-14-S-1: Revise the description of the HI-STORE CISF aging management program in SAR Chapter 18 to reflect the response to RAI 17-14-S.

The SAR was not updated correctly to reflect the response to RAI 17-14-S; rather than revise the SAR *aging management* description, the applicant revised the SAR *maintenance* description (these are two different sets of activities with different implementation timelines). Specifically, the applicant revised the VVM Aging Management Program (effective when the VVM exceeds 20 years of service) in the Aging Assessment Report (Holtec Report No. HI-2167378) to require that the internal surfaces to be inspected for all VVMs that house an MPC that is also undergoing remote inspection (i.e., when an MPC is being remotely inspected, also look at the VVM internal cavity surrounding that MPC). However, the applicant did not make any changes to the VVM AMP description in SAR Chapter 18 to reflect the change. The applicant did make a change to the Maintenance activity description (effective immediately) description in the SAR (SAR Table 10.3.1, item 10) to state that "[a]ll VVMs that contain the MPCs used for the MPC AMP shall be inspected." An independent reading of this table would lead to a conclusion that the 5-year VVM inspection begins as soon as the VVM is placed into service.

This information is needed to demonstrate compliance with 10 CFR 72.120(a).

Holtec Response

VVM AMP description in Section 18.7 of Chapter 18 has been updated to state that all VVMs containing the MPCs used in the MPC AMP shall be inspected.

To avoid misunderstanding Table 10.3.1 is updated to remove the changes for items 8 and 10.

RAI 17-21-S-1: Revise SAR Chapter 18 to include information about inspections referenced in Holtec's response to RAI 17-21-S.

The SAR was not revised per the applicant's response to RAI 17-21-S related to inspections to verify the condition of the incoming canisters. The RAI response stated that SAR Chapter 18

was revised to reflect the: "Adoption of the HI-STAR 190 inspection checklist as a

mandatory
requirement for all MPCs, including those not containing high-burnup fuel." However, no such
changes to the SAR were made with respect to the referenced "checklist", and thus the staff cannot evaluate the adequacy of the RAI response. In addition, it is not clear why SAR Chapter 18, "Aging Management Program," would be cited for revision for this item, rather than Chapter 10, "Conduct of Operations Evaluation," where other such MPC receipt criteria are documented.

This information is needed to demonstrate compliance with 10 CFR 72.120(a).

Holtec Response

Section 10.3.3.1 of Chapter 10 is revised to include information about inspections to verify condition of incoming canisters.

Additionally, the section has been updated to include inspection of quality records from originating site and adoption of HI-STAR 190 checklist referenced in Appendix 8.A of HI-STAR 190 SAR.

Editorial Observations:

- Update SAR Table 4.2.1 per the response to RAI 17-1:
  - The response stated that “special lifting devices” will be removed, while HI-TRAC CS lift link will be added.
- Harmonize the name of the MPC AMP between the SAR and Holtec Report No. HI- 2167378, “Aging Assessment and Management Program for HI-STORE CIS”:
  - SAR Chapter 18 references “Canister AMP”, while Holtec Report No. HI-2167378 references “MPC AMP”.
- In the first sentence of Section 4.3.1.4 of the SAR, “The MPC provides for confinement of all radioactive materials for all design basis, off-normal and postulated accident conditions.,” the word, “normal,” is missing after, “design basis.”
- Section 9.5.1 (page 9-10) of the SAR should be revised to read 18.13 and 18.15 (from 18.12 and 18.14).
- SAR Reference 10.3.2 for Recommended SNT-TC-1A should be updated from December 1992 to 2006.

Holtec Response

Each of the listed editorial observations have been updated and are identified with track changes and highlighting in the attached SAR document.