CHAPTER 2 RAIs

RAI 2-7-S: 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").

Several explicit and implicit assumptions were made in the analysis and discussion provided in response to RAI 2-7. At a minimum, the bases for the following assumptions should be provided:

1) Only pipeline incidents of New Mexico are considered in assessing the potential hazard of the proposed CISF.

   Clarify whether specific characteristics of the natural gas pipelines in New Mexico make them unique for assessing the pipeline explosion hazards to the proposed CISF. The rationale for not using the nationwide statistics, consistent with Regulatory Guide 1.91, should be clearly articulated.

2) Different failure mechanisms of the pipeline ultimately leading to a release are treated as separate initiating events given that 24 hours would be needed to take necessary mitigative actions after detecting the release.

   Provide the rationale for treating different failure mechanisms of the pipeline, such as pipeline ruptures, pipeline leaks, pipeline punctures, and equipment-related failure as separate initiating events. Provide the basis for excluding the possibility of crack/hole enlargement in a high-pressure pipeline in 24 hours after leak detection leading to a complete rupture of the pipeline and associated release of natural gas.

3) Probability of sufficient gas released to form a flammable cloud is assumed to be 0.005 or 0.5%.

   During the assumed 24 hour time period before any intervening action could stop the release of natural gas, a significant amount of natural gas from a 20 inch diameter pipeline pressurized at 680 psi can be released, even if it is buried under 30 inches of rock/soil cover. Provide appropriate bases for the assumption that the potential release of natural gas in a 24-hour period is such that the probability of sufficient gas being released to form a flammable cloud is 0.005.

4) The assumption that a flammable cloud has to travel a minimum of a mile without dispersing in the atmosphere before a vapor cloud explosion can occur.

   A vapor cloud will start dispersing in the atmosphere soon after the release and the dispersion process continues as it travels by the prevailing atmospheric conditions; however, consider whether 24 hours would release enough natural gas for a significant portion to remain within the flammable range even as the cloud travels away from the release point. The cloud within the flammable range may be the source of explosion. Provide the rationale for the assumption that a flammable cloud has to travel a minimum of a mile without dispersion before a vapor cloud explosion can occur.

5) The probability that the flammable cloud does not encounter an ignition source as it travels to the CISF is estimated to be 0.01 or 1%.

   Justify this probability given that the nearest pipelines are 0.16 of a mile east of the proposed facility. Ignition sources can be sparks from electrical apparatus; hot surfaces, such as hot steam lines; friction between moving parts of a machinery or pipe fragments or rock pieces in a rupture of a pipeline; presence of open flame or open fire in, for example, furnaces, and heaters, etc. Provide the basis for assuming 1% probability that a vapor cloud would not encounter an ignition source (and create the potential for fire or explosion) before reaching the proposed facility boundary.

6) The probability that the flammable cloud is of sufficient size and concentration to cause an explosion at the proposed CISF was assumed to be 0.01.

   Clarify whether this is a conservative assumption, in light of the assumed 24 hours of continuous release. The event sequence already assumes that the quantity of released gas would be small and the released gas would disperse before reaching the facility, such that only a small portion of the gas cloud would be within the flammable range. Using another small probability value in the event sequence will reduce the estimated frequency of explosion significantly. Provide the basis for the assumption of the probability of cloud size and concentration.

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:

1) Per Regulatory Guide 1.91, when an applicant is showing that the risk is acceptably low on the basis of low probability of explosions impacting the facility, "due consideration should be given to the comparability of the conditions on the route to those of the accident database".

   Since pipeline failures are often associated with operating environment conditions including soil content, water levels, inspection requirements, structures/roadways built over them, etc. which vary significantly across the US, the analysis determined that data from states with different operating environment conditions would not be directly comparable to the data for failures near the proposed CISF site. Therefore, to evaluate the potential for a pipeline incident near the proposed CISF site, using the NM events was originally selected to ensure that only comparable information from the PHMSA database was used.

   However, to ensure the pipeline explosion risk analysis was conservative and bounding, the analysis has been updated. As part of the update, the frequencies of pipeline leaks and failures for the entire United States, for the four states with similar soil and environmental characteristics as New Mexico (Arizona, Texas, Nevada, and New Mexico), and for New Mexico alone were compared, and the most conservative values were used in the updated pipeline explosion risk analysis. The updated, bounding analysis, shows that the risk from pipeline explosions is below the Regulatory Guide 1.91 thresholds.

2) The possibility of a crack/hole enlargement in a high-pressure pipeline occurring that leads to a complete rupture of the pipeline and associated release of natural gas after leak detection has

occurred is not excluded. The original pipeline explosion risk analysis included the evaluation of the potential impact radius (PIR) for an explosion due to the gas line pipe rupture. This includes the impact radius for immediate ruptures as well as crack/hole enlargement ruptures that result in an explosion due to the force and energy of the rupture itself. The PIR showed that, regardless of the timing of the release or the quantity of gas released from the pipeline near the proposed CISF, an explosion at the rupture site associated with the size and maximum allowable operating pressure (MAOP) of the pipelines near the proposed CISF does not have the potential to impact critical structures or operations at the proposed CISF due to the physical distance between the pipelines and the proposed CISF. Therefore, rupture hazards resulting in explosions can be screened from consideration as a threat to the critical facilities and operations at the proposed CISF.

To evaluate the potential for a Vapor Cloud Explosion (VCE) occurring further away from the leak/rupture location and closer to the proposed CISF, the various types of pipeline failures were identified and evaluated. The rationale for treating different failure mechanisms of the pipeline, such as pipeline ruptures, pipeline leaks, pipeline punctures, and equipment-related failure as separate initiating events is based on the characteristics of the various initiating events and the response timing and ignition source potential. Since the pipeline failure mechanisms impact the quantify of gas released as well as the presence of ignition sources near the leak/break location, the original analysis attempted to differentiate the failures to more realistically address the impact on the other factors that influence the potential for an VCE to occur.

The statement that 24 hours would be needed to take necessary mitigative actions after detecting the release is taken out of context. The Pipeline and Hazardous Materials Safety Administration (PHMSA) Control Room Management (CRM) regulations specify the control room requirements associated with the safety regulations for gas pipeline operators. Within the regulations is a section associated with alarm management. Based on alarm management requirements and operator training, the operators are expected to prioritize their response to the leak based on the size and severity of the leak with action being taken for all leaks within the 24-hour time frame. This means that the longest a leak would knowingly exist without the Operator intervening is 24 hours. The discussion in the analysis has been expanded to make this clearer.

In the analysis, the time to isolate the break is based on the size and severity of the break. For very large breaks/ruptures that do not immediately result in an explosion occurring, high priority alarms would be expected in the control room, and for pipelines with SCADA the break would be automatically isolated. For pipelines without SCADA, operators are trained to recognize the severity of the situation based on the alarms coming in and to respond accordingly. For this analysis, automatic isolations and/or Operator actions to isolate the break are assumed to occur within 10 minutes due to the operator response to the alarms being generated that show the potential severity and consequences of the release and the value of the commodity being lost through the rupture/leak location. These size breaks/ruptures alarm in the remote monitoring facilities and are expected to be responded to immediately.

Since medium size leaks (pipeline punctures), are typically caused by heavy equipment impacting the pipeline and causing the puncture, personnel are present when the accident

occurs, as is a readily available ignition source (the hot engine of the equipment that caused the puncture). For these leaks, it is assumed that the personnel causing the puncture will notify the remote monitoring station of the issue and depending on the size and severity of the puncture, the line will be immediately isolated for inspection and repair. Because the personnel may not immediately notify the monitoring station, and smaller punctures may not be readily noticeable at the monitoring station, on average, these punctures are assumed to be isolated in an hour or less.

It is only for the very small to small leaks that up to 24 hours may be taken before the leak location is isolated. This is based on the need to identify the leak location since it is not readily noticeable at the monitoring station, the need to prioritize response actions based on other on-going activities, and the potential severity and consequences of the release and the value of the commodity being lost is small. Based on the information provided on the PHMSA website associated with leak detection activities, a large portion of these size leaks are identified by regularly scheduled leak detection efforts.

An updated analysis has been performed that does not separate the initiating events based on these characteristics but separates them based on their severity as defined by the PHMSA: Serious Incidents, Significant Incidents, and All Other On-Shore Incidents. The updated, bounding analysis performed using the PHMSA severity classifications, shows that the risk from pipeline explosions is below the Regulatory Guide 1.91 thresholds.

3) In the original gas pipeline explosion risk analysis, the probability of sufficient gas released to form a flammable cloud was based on the size of the leak. The 0.005 assumption was associated with very small/small leaks from pipes that are buried 36 inches underground. For these leaks, the pressure of the leak was assumed to be sufficient to disperse some ground cover in immediate vicinity of the leak site but would not be expected to cause a direct path from the pipeline to the ground level atmosphere. For the pipeline leak scenario, based on pipeline failure data available on the PHMSA website, most pipeline leaks are small to very small sized and, so very little gas is released. Even with an extended time period for the leak to exist, based on the size of the leak (very small), the location of the leak (36 inches underground) and the properties of natural gas (natural gas easily disperses – especially when propagating through tortuous pathways - and will not recombine), the potential for the very small/small leak to generate an explosive mixture of sufficient size is extremely small and 0.5% was assumed.

In the updated analysis, the release rate and total quantity of gas released is determined by the size of the leak/rupture explicitly using the ALOHA program and assuming a 1-hour release for 1-inch, 2-inch, and 5-inch break sizes, and a minimum 30-minute release for 10-inch and 20-inch breaks. Also, to simplify the analysis and ensure that all the elements of a VCE were considered simultaneously, the quantity of the natural gas released and the potential for a VCE cloud to form were combined into a single probability based on the results of the ALOHA program and its calculation for an overpressure (blast force) VCE cloud to develop. Based on the results of the ALOHA calculations, a Blast Threat Zone did not exist since the Level of Concern (LOC) thresholds for overpressure for "Destruction of Building", "Serious Injury", and "Shatters Glass" were not exceeded for any of the pipeline break sizes.. Even though the ALOHA program showed no potential for a VCE to occur, the analysis conservatively assumes a 0.5 percent probability that a

VCE will develop and travel to the proposed CISF. With this conservative assumption, the bounding analysis shows that the risk from pipeline explosions is below the Regulatory Guide 1.91 thresholds.

4) As noted in the responses above, the 24-hour release time is the maximum amount of time a release is expected to continue once it is identified as existing. This 24-hour time is for very small/small leaks that are perceived to not be an immediate threat and are not losing a large quantity of natural gas. Larger leaks/breaks are expected to be isolated much sooner than the 24-hours because of the potential consequences and value associated with the volume of commodity being lost through the leak/break site.

   While it is agreed that a continuous release may result in a cloud with potentially explosive properties to travel further due to the continual addition of natural gas at the release site, the natural characteristics of gas combined with the prevailing winds would cause the vapor cloud to disperse quickly. For this analysis, the travel distance of 1 mile is based on the location of the pipelines near the proposed CISF and the physical distance between them and the locations of critical facilities or operations at the proposed CISF.

   Although the pipelines are located 0.16 miles East of the site boundary, the nearest critical facility or operation at the proposed CISF is further away from the pipeline locations. The original analysis was based on the consideration that, if the vapor cloud travels a portion of the way to a critical location or operation and ignites, the explosion or fire will propagate "backwards" through the vapor cloud to the release point, not forwards through a non-flammable/explosive atmosphere towards the location of the critical facility or operation site. Therefore, the vapor cloud must travel to a location close to a critical facility or operation (within 474 feet based on PIR calculations) and then explode in order to impact the critical facility or operation at the proposed CISF.

   For the updated analysis, the 1 mile travel distance is not included in the evaluation. The evaluation is based solely on the potential for a pipeline leak/break to occur, for the leak/break to result in a VCE being formed, for the wind to be blowing in the required direction to direct the vapor cloud towards the proposed CISF critical facilities or operation locations, and then to ignite causing a VCE without taking credit for the additional distance that must be traveled prior to reaching the critical locations at the proposed CISF. Based on the results of the ALOHA calculations, a Blast Threat Zone did not exist since the Level of Concern (LOC) thresholds for overpressure for "Destruction of Building", "Serious Injury", and "Shatters Glass" were not exceeded for any of the pipeline break sizes. Even though the ALOHA program showed no potential for a VCE to occur, the analysis conservatively assumes a 0.5 percent probability that a VCE will develop and travel to the proposed HI-STORE CIS. With this conservative assumption, the bounding analysis shows that the risk from pipeline explosions is below the Regulatory Guide 1.91 thresholds.

5) As stated in the question, there are multiple types of ignition sources that can cause a vapor cloud to ignite. Some of these are expected to be between the location of the release and the location of the proposed CISF critical facilities or operations. However, as noted above, if the vapor cloud travels a portion of the way to a critical location or operation and ignites, the

explosion or fire will propagate “backwards” through the vapor cloud to the release point, not forwards through a non-flammable/explosive atmosphere towards the location of the critical facility or operation site. Therefore, the vapor cloud must travel to a location close to a critical facility or operation (within 474 feet based on PIR calculations) and then explode in order to impact the critical facility or operation at the proposed CISF.

For the updated analysis, once a vapor cloud of sufficient size and quantity to cause a VCE is generated, it is assumed to travel to the critical facility or operation location at the proposed CISF and then it is assumed to ignite and cause an explosion. No credit is given for the potential of the cloud to ignite between the release point and the critical locations such that the propagation of the vapor cloud is essentially terminated.

The evaluation is based solely on the potential for a pipeline leak/break to occur, for the leak/break to result in a VCE being formed, for the wind to be blowing in the required direction to direct the vapor cloud towards the proposed CISF critical facilities or operation locations, and then to ignite causing a VCE without taking credit for the potential for an early ignition of the vapor cloud prior to reaching the critical locations at the proposed CISF.

6) Based on FM Global Property Loss Prevention Data Sheet 7-42 (referenced by RG 1.91), there are two important factors that must be present for an ignited vapor cloud to produce overpressure. These are outdoor confinement and turbulence generation. It also states that a plant with mostly open space and minimal or small process structures or partially covered process areas tend not to produce the right conditions for VCE enhancement. Such plants have a high ratio of open area or enclosed buildings to congested process areas. Even though suitable amounts and types of flammable materials may be present and a vapor cloud release could occur, the plant layout would likely not generate the turbulence that contributes to overpressure. A review of the proposed CISF site shows that is mostly open space with few structures, and the critical operations are performed primarily at outside pad locations, so the potential for an overpressure event to occur was deemed very low.

   Additionally, Data Sheet 7-42 states that Liquified Naturel Gas and Natural Gas (NG) (methane), when ethane component is less than 15% by volume, does not present a significant or credible outdoor VCE exposure. This conclusion is based on many factors such as heats of combustion, fundamental burning velocities, research testing, ease of dispersal, other experts’ opinions and loss history.

   Since it is not the duration of the release, but the characteristics of the gas being released and the vapor cloud travel path that determine if a vapor cloud has the potential to cause overpressure, the 0.01 assumption for having the required size and concentration for explosion causing an overpressure event to occur was considered conservative.

   In the original analysis, the potential for a vapor cloud to be formed, then travel to the critical locations of the site, then encounter an ignition source, then have the ignition source be sufficient to cause an explosion were all evaluated as separate conditions. Since this was confusing, an updated analysis has been performed that simplifies the parameters that are

> evaluated, and that relies on the ALOHA program to evaluate the dispersion of the released commodity and determine the potential for a VCE to occur.
>
> The ALOHA computer model was used to determine the blast force zone associated with leaks that ranged in size from 1 inch to 20 inches under both Atmospheric Stability Class D and F conditions. These Atmospheric stability classes were used since, consistent with the site Environmental Impact Report, they represent the most likely atmospheric stability classes present at the proposed CISF site. Based on the results of the ALOHA calculations, a Blast Threat Zone did not exist since the Level of Concern (LOC) thresholds for overpressure for "Destruction of Building", "Serious Injury", and "Shatters Glass" were not exceeded for any of the pipeline break sizes.

RAI 2-8-S: Provide the basis for the statement in the response to RAI 2-8 that, *"[n]o new oil and gas wells will be constructed within the Facility boundaries because new drill islands will not be permitted on the privately owned land."*

The response to RAI 2-8 does not provide a discussion or justification for why new drill islands would not be permitted within the privately owned land where the facility will be constructed.

This information is necessary to determine compliance with 10 CFR 72.24, 72.90(a) through (d), 72.94, and 72.98.

Holtec Response:

The Secretary of the Interior (SOI) Order 3324 [1] and the State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (EMNRD OCC) Order No. R-111-P [2] define the requirements to prevent waste, protect correlative rights, and assure maximum conservation of the oil, gas, and potash resources of New Mexico, and to permit the economic recovery of oil, gas, and potash minerals. The orders are applicable only in the Potash Area (PA) as defined by SOI Order 3324, Figure 1. Order 3324 is administered by the Department of Interior, Bureau of Land Management (BLM), and Order No. R-111-P is administered by the EMNRD OCC. SOI Order 3324 governs Federal Lands while EMNRD OCC Order R-111-P governs State Lands.

The HI-STORE facility is proposed to be built on Section 13 of Township 20 South, Range 32 East, N.M.P.M. which is State Land within the SOI PA. Section 13 is part of Development Area (DA) "West Egg Roll" as defined by Titus Oil and Gas LLC (Titus) [3], Figure 2. Under SOI Order 3324, a Development Area is:

> An area established by the BLM within the Designated Potash Area in consideration of appropriate oil and gas technology such that wells can be drilled from a Drilling Island capable of effectively extracting oil and gas resources while managing the impact on potash resources. Each Development Area will typically have only one Drilling Island, subject to narrow exceptions based on specific facts and circumstances. All new oil and gas wells that penetrate the potash formations within a Development Area will be drilled from the Drilling Island(s) associated with that Development Area. SOI 3324 § 4.f.

DAs "may include Federal oil and gas leases and other Federal and non-Federal lands." SOI 3324 § 6.e(2)(a). Subsequent to the creation of a DA, the BLM informs lessees that "future drilling on lands under an oil and gas lease within that DA will: (i) occur, under most circumstances, from a Barren Area or a Drilling Island within the DA; and (ii) be managed under a unit or communitization agreement, generally by a single operator, consistent with BLM regulations and this Order. Unit and communitization agreements will be negotiated among lessees..." SOI 3324 § 6.e(2)(b). In this case, the creation of the West Egg Roll DA was initiated by the non-federal oil and gas lessee (Titus) [3] directly beneath the Holtec site to access those oil and gas reserves.

The Tetris Anise Drill Island (DI) is designated for the Pakse West and West Egg Roll DAs. The Tetris Anise Drilling Island (DI) is defined in the Pakse West DA approval letter [4]. The six drilling areas within this DI are designated for vertical and horizontal drilling to the south into Pakse West and north into West Egg Roll. The Tetris Anise DI allows access to the entire oil and gas reserve under Section 13. Titus' letter [3] shows the proposed access to Section 13. A new DI on Section 13 would need to be coordinated with all oil, gas, and potash lease holders in the area (interested parties). The new DI would likely interfere with the Tetris Anise DI already defined and would provide no new access since the Tetris Anise DI already provides access to all the oil and gas of Section 13. A new DI would only make more of the Designated Potash Area unavailable due to the buffers between oil and gas vertical wells and potash mining required by both SOI Order 3324 and EMNRD OCC Order R-111-P.

As one final matter, oil and gas drilling at the proposed Holtec facility could result in monetary damages for a mineral lessee that attempts to take that approach. The New Mexico Supreme Court has previously explained that mineral lessees in New Mexico are "entitled to use as much of the surface area as is reasonably necessary for its drilling and production operations." *Amoco Production Co. v. Carter Farms Co.*, 703 P. 2d 894, 896 (NM 1985) (*citing Warren Petroleum Corp. v. Monzingo*, 157 Tex. 479, 304 S.W.2d 362 (1957); H.R. Williams & C.J. Meyers, *Oil and Gas Law* § 218.7 (1984)), abrogated on other grounds by *McNeill v. Burlington Resources Oil & Gas Co.*, 143 N.M. 740, 182 P.3d (2008). The mineral lessee's "surface rights and the servitude it holds, however, must be exercised with due regard for the rights of the surface owner." *Id.* (*citing Hunt Oil Co. v. Kerbaugh*, 283 N.W.2d 131 (N.D. 1979); *Getty Oil Co. v. Jones*, 470 S.W.2d 618 (Tex. 1971) (explaining that "where there is an existing use by the surface owner which would otherwise be precluded or impaired, and where under the established practices in the industry there are alternatives available to the lessee whereby the minerals can be recovered, the rules of reasonable usage of the surface may require the adoption of an alternative by the lessee"). "Unreasonable or excessive use" of surface lands has given rise to litigation under the theory of negligence and can generate subsequent damages for the mineral lessee (*id.* at 897), including damages either for diminution of the property value as a whole or the cost of repair. *See McNeill v. Burlington Resources Oil & Gas Co.*, 143 N.M. 740, 182 P.3d (2008).

In the case of the proposed Holtec facility, the oil and gas beneath Section 13 is already available for access through the Tetris Anise DI immediately south of Section 13. Indeed, that DI was located there specifically for the purpose of accessing the minerals beneath Section 13 [4]. Thus, with access to those resources already secured and available, it appears that additional drilling directly on Section 13 would likely amount to unreasonable or excessive use of the surface lands, potentially allowing for litigation from the surface owner with potential damages for the oil and gas lessee.

Figure 1 Designated Potash Area [5]

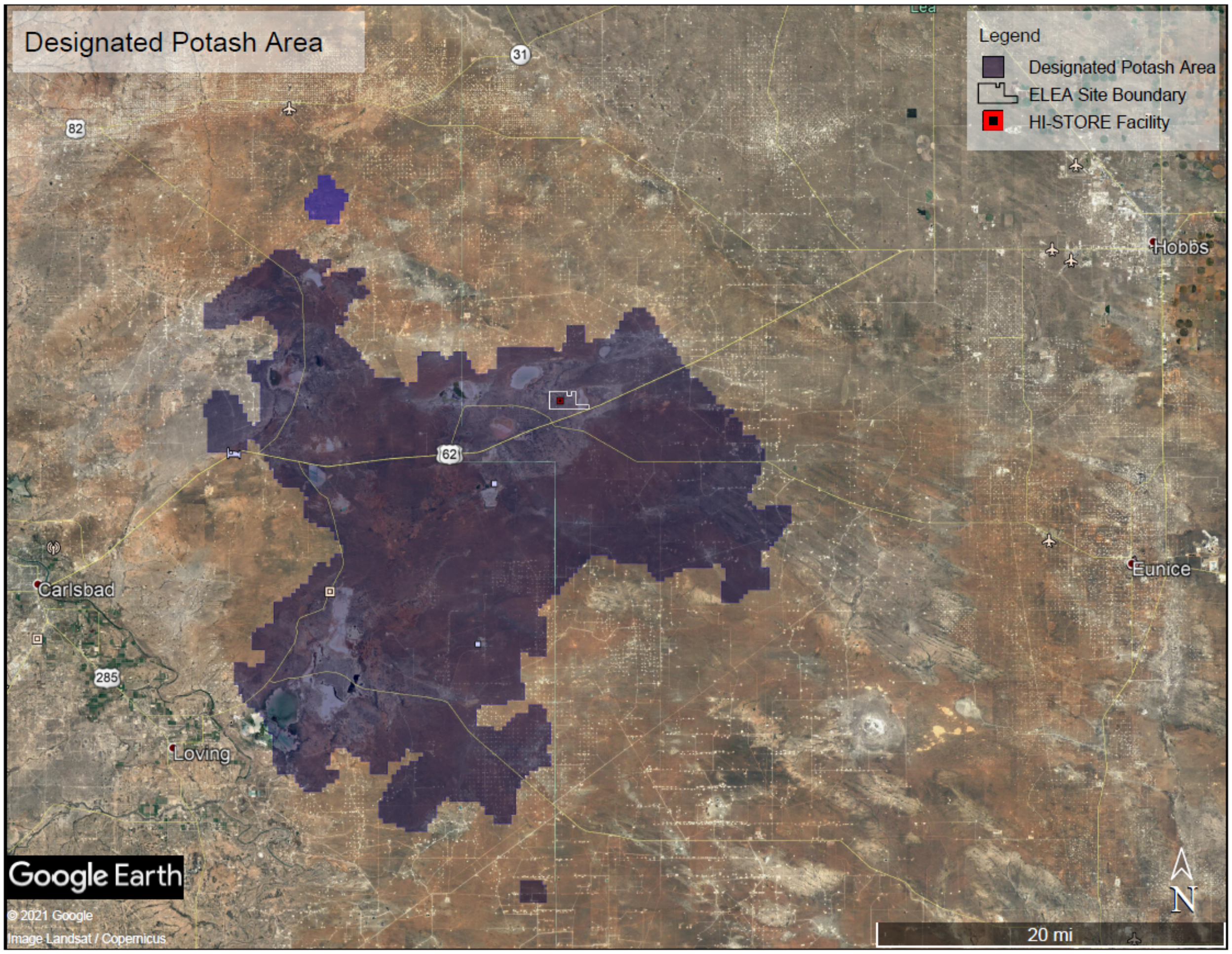
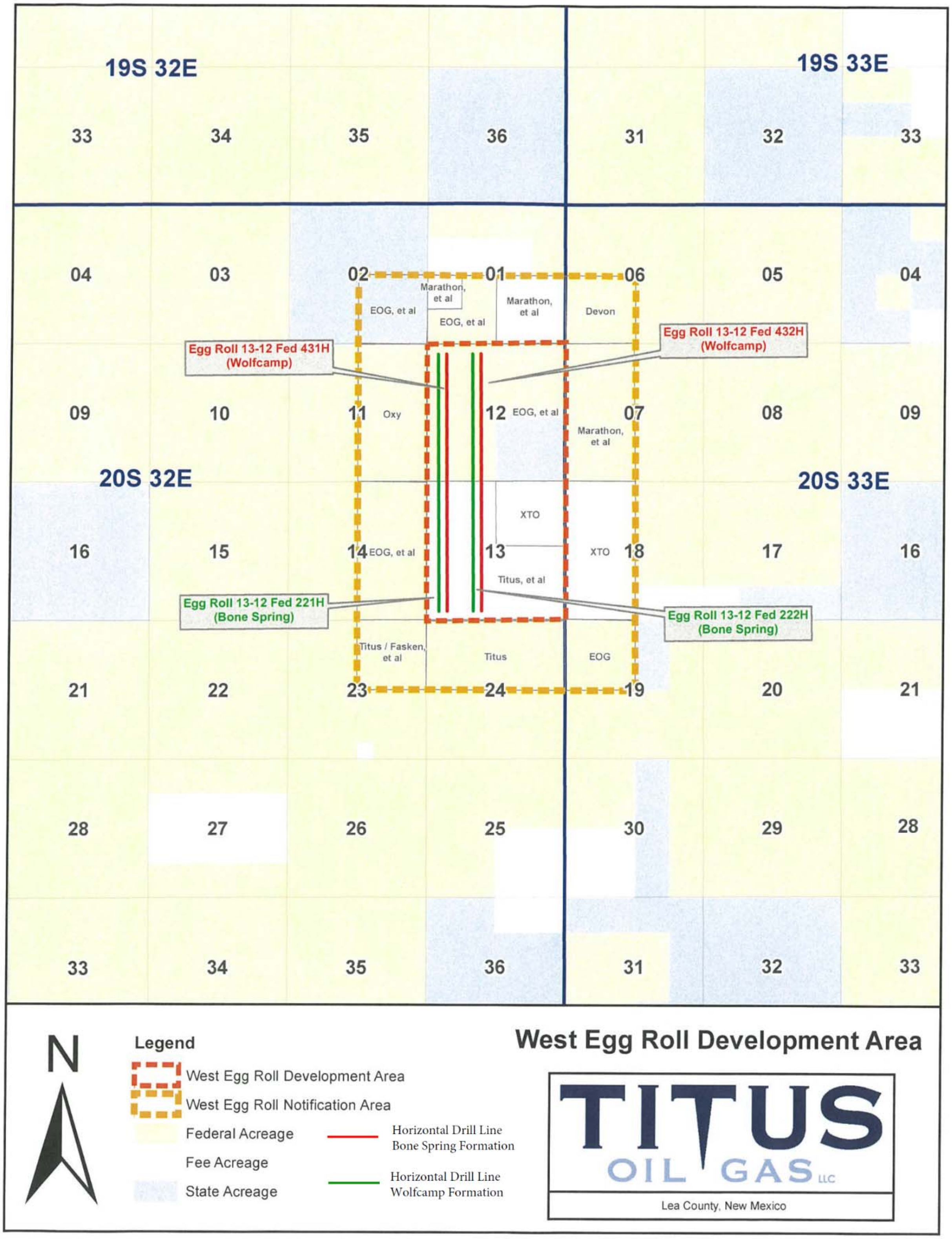


Figure 2 West Egg Roll Development Area [3]



References for RAI 2-8:

1. State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (EMNRD OCC), "Order R-111-P", 1988
2. Secretary of the Interior, "Order No. 3324 – Oil, Gas, And Potash Leasing and Development within the Designated Potash Area of Eddy and Lea Counties, New Mexico." 2012.
3. Titus Oil & Gas Production, "Designation of Development Area, Egg Roll Development Area" Letter, December 4, 2020
4. Bureau of Land Management, "Designation of the Pakse West Development Area" Letter, August 2, 2021
5. Bureau of Land Management, Carlsbad Office Spacial Data, https://www.nm.blm.gov/shapeFiles/cfo/carlsbad_spatial_data.html, Accessed 8/6/2021.

RAI 2-12-S: Provide a legend for Figure 1 to the response to RAI 2-12 (Figure 2.1.24 in HISTORE SAR, Rev. M) for each color and size of circles and squares depicted. Also, provide a detailed discussion as to why mining of potash would not be feasible beneath or around the proposed CISF site for the proposed duration of the license.

Both SAR Figure 2.1.24 and Figure 1 of the RAI response do not have any description of the colors and symbols used to depict features. Additionally, explain in detail the basis for the conclusion that mining of potash from underneath the proposed CISF site would not be feasible for the proposed duration of the license. For example, explain the extent to which this position relies on the State of New Mexico, Oil Conservation Commission's Order No. R-111-P, or the U.S. Secretary of the Interior Order No. 3324.

This information is necessary to determine compliance with 10 CFR 72.24(a), 72.90(a) through (d), 72.94, and 72.98.

Holtec Response:

Updated Figure 1 (Adapted SAR Figure 2.1.24) below shows:

1. Proposed HI-STORE Facility on Section 13 of Township 20 South, Range 32 East, N.M.P.M.
2. Potash rights by lessee. Specifically, Intrepid Mining and the Mosaic Company [1,2].
3. Existing oil and gas wells and drill islands [1,2].
4. Potash mining buffer zones around existing oil and gas wells and drill islands as determined from the Secretary of the Interior (SOI) Order 3324 [3] and the State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (EMNRD OCC) Order No. R-111-P [4], on page 12 (¼ mile buffer for oil wells and drill islands and ½ mile buffer for gas wells and drill islands).
5. Current potash mine workings around the proposed facility [1].

Potash mining around and under the proposed facility for the duration of the license is not expected due to three contributing factors: the complexity of mining potash in the vicinity of the proposed facility due to significant oil and gas operations, the distance from current potash mine shafts, and the economic viability of such operations in Section 13.

In the implementation of SOI Orders 3324 and EMNRD OCC R-111-P, the Bureau of Land Management and EMNRD OCC coordinate potash, oil, and gas harvesting with local lease holders. Figure 1 shows the complexity of ongoing operations in the vicinity of the proposed facility based on the mining buffer zones required by the orders. Mining around and under the proposed facility can only be done by extending current mine workings or creating a new mineshaft.

Intrepid has the only available approach from existing mine workings (Figure 1). Mining would be required to proceed north from the existing mine workings, between the buffer zones for the “Snoddy Federal #021H” (API 30-025-40838) well and the “Felmont Federal Com #002” (API 30-025-26302) well. This pathway is less than 1000 ft wide. Once clear of these wells, the new mine workings would have to continue north, passing under Laguna Gatuna and into the Intrepid owned mineral rights in Section 13. The total extension of the existing mine workings would be over 3 miles.

Alternatively, Intrepid could develop an entirely new mining facility to access the mineral rights they own in and adjacent to Section 13. This strategy would require surface support facilities, equipment, and the construction of a new mine shaft.

Mosaic does not own mineral rights close enough to the proposed HI-STORE Facility to present a concern. Mosaic would be required to procure the mineral rights for Section 13 and then develop an entirely new mining facility as discussed above. This strategy would also require surface support facilities, equipment, and the construction of a new mine shaft.

In summary, there is reasonable assurance that potash mining will not occur around or under the proposed facility during its license period due to the complexity of mining in oil and gas fields, the distance from existing mine workings, and the economic viability of such operations in Section 13.

Additional information will be submitted under separate letter concerning the economic viability of mining potash in Section 13.

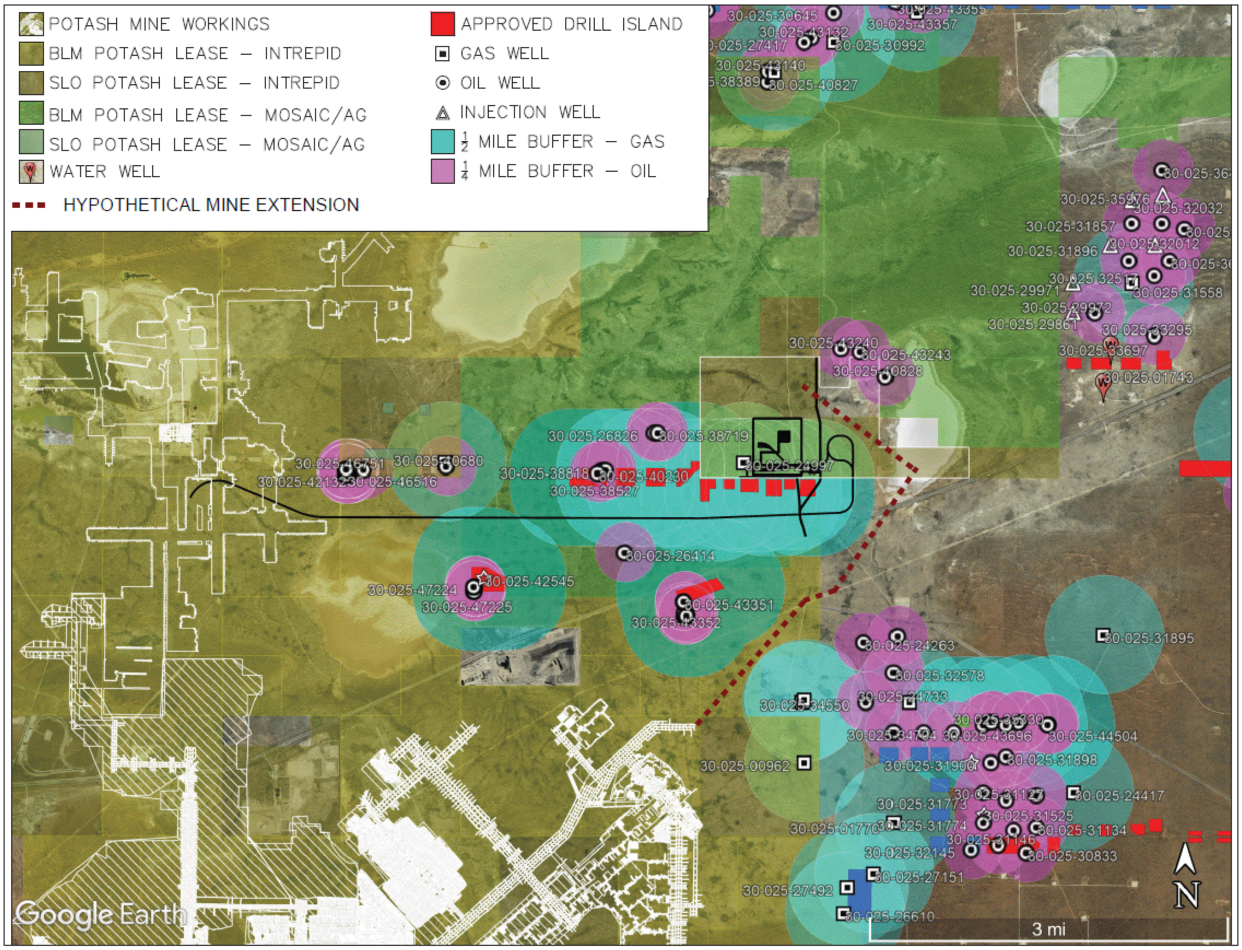


Figure 2 Potash Rights, Oil and Gas Buffers, and Mine Workings

<u>References for RAI 2-12:</u>

1. Bureau of Land Management, Carlsbad Office Spatial Data, https://www.nm.blm.gov/shapeFiles/cfo/carlsbad_spatial_data.html, Accessed August 2021.
2. New Mexico State Land Office, GIS Data, https://www.nmstatelands.org/maps-gis/gis-data-download/ , Accessed August 2021.
3. Secretary of the Interior, "Order No. 3324 – Oil, Gas, And Potash Leasing and Development within the Designated Potash Area of Eddy and Lea Counties, New Mexico." 2012.
4. State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (EMNRD OCC), "Order R-111-P", 1988

RAI 2-14-S: Explain whether a release of hazardous chemicals while being transported through U.S. Highway 62/180 or by rail cars near the proposed facility would pose any credible hazard to the proposed CISF.

The responses to the RAIs 2-14 and 2-15 account for potential explosions. Explain whether there is a credible hazard from release of other hazardous chemicals, such as a chlorine spill.

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 report HI-2210619 [1] evaluates the potential of a hazardous material release due to a railway incident impacting the critical operations at the proposed HI-STAR CIS Facility. The conclusion of the analysis is that the potential for a release of hazardous material due to a railway incident to impact critical operations at the proposed HI-STORE CIS Facility is less than 1x10-6 per year. Therefore, the risk from railcar accidents is considered to be acceptably low and HI-STORE CIS does not need to be designed to specifically withstand the hazardous material releases due to railcar accidents.

Holtec report HI-2210620 [2] evaluates the potential of a hazardous material release due to a highway transportation incident impacting the critical operations at the proposed HI-STAR CIS Facility. The conclusion of the analysis is that the potential for a release of hazardous material due to a highway incident to impact critical operations at the proposed HI-STORE CIS Facility is less than 1x10-6 per year. Therefore, the risk from highway transportation accidents is considered to be acceptably low and HI-STORE CIS does not need to be designed to specifically withstand the hazardous material releases due to highway transportation accidents.

HI-STORE SAR Section 2.2.4 has been updated to include these conclusions and to reference HI-2210619 [1] and HI-2210620 [2].

<u>References for RAI 2-14:</u>

1) Holtec International Report HI-2210619, “HI-STORE Railway Hazardous Chemicals Risk Evaluation”, Revision 0.
2) Holtec International Report HI-2210620, “HI-STORE Highway 62/180 Hazardous Chemicals Risk Evaluation”, Revision 0.

RAI 2-16-S-1: Provide a technical basis to justify the use of a point estimate instead of an areal estimate of precipitation for the 100-year storm.

In its RAI response and updated SAR, the applicant maintains that point-estimation of the 100-year storm precipitation can be used to estimate flood level at the proposed CISF site. Provide the technical basis for the use of the point-estimation approach versus a comparable areal-estimation approach. Explain how, in selecting representative storm events for flood analysis, the applicant considered the size of the watersheds surrounding the proposed CISF so that temporal and accumulated impacts to the CISF from storms moving through the entire watershed can be accounted for.

This information is necessary to demonstrate 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:
The 7.5" – 100 year storm has been removed from the SAR. The design storm is the Probable Maximum Precipitation (PMP) which is now reflected in the SAR. See GEI Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF" for details of the Probable Maximum Flood (PMF) and PMP storm event [1].

Updates have been made to Section 2.4 of the SAR.

References for RAI 2-16-1:

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 2, July 2021

RAI 2-16-S-2: Provide a technical basis to justify the use of the probable maximum precipitation from the Colorado-New Mexico Extreme Precipitation Study.

In the updated SAR, the applicant uses the probable maximum precipitation (PMP) of 6-hour and 24-hour duration to calculate the flood level at the proposed CISF site. PMPs are almost identical for both the 6-hour and 24-hour events. Provide the technical basis for following the Colorado – New Mexico (CO-NM) Extreme Precipitation Study, instead of the National Weather Service's (NWS) Hydrometeorological Reports 51/52. Describe how the PMP was obtained and clarify how the precipitation was distributed over the storm duration, namely how the hyetograph was determined. Given the size of the watersheds surrounding the proposed CISF site, justify why 6-hour and 24-hour events were selected, but 48-hour and 72-hour events were not considered.

This information is necessary to demonstrate 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:
Additional technical basis for both the Colorado-New Mexico Extreme Precipitation Study and HMR 51/52 reports has been included in the revised PMP/PMF report [1]. The CO-NM Regional Extreme Precipitation Study was created to provide updated and more accurate PMP storm determinations than

the NOAA Hydrometeorological Reports, for use in dam safety projects in the Colorado/Mew Mexico Region.

The revised report uses both methods (CO-NM and HMR) to determine PMP values for 6hr, 24hr, 48hr, and 72hr storm events. The governing method was identified for each storm duration for each watershed. As the same PMP event will be applied across all watersheds, the governing method was selected for each duration, weighted by watershed area.

Once the governing PMP (72-hr HMR) was determined a sensitivity study was performed to determine the effects of a front vs middle vs end loaded storm. The Middle loaded "base case" resulted in the most conservative PMF. Front loading the storm reduced the peak outflow and volume by approximately 0.1% and end loading the storm decreased peak outflow by about 3% and volume by 0.5%. Thus, the results are not very sensitive to hyetograph loading. The PMP/PMF report [1] provides additional discussion regarding the determination of the hyetograph.

Updates have been made to Section 2.4 of the SAR.

References for RAI 2-16-2:

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 2, July 2021

RAI 2-17-S-1: Provide the rationale for using two differing modeling approaches to calculate flood water level at the proposed CISF site.

In the updated SAR, the applicant retains the mass balance approach for the 7.5-inch storm event but uses the hydrological and surface flow routing approach for probable maximum flood (PMF) calculation in the GEI report (GEI, 2019). Justify why, for the mass balance approach, a one-half depth to restrictive layer for subsurface storage of storm water infiltration is conservative. The water levels at Laguna Gatuna and Laguna Plata were initially assumed at 5 feet, but the approach used in hydrological modeling done by GEI Consultants assumes full pool condition. Additionally, Laguna Plata was included in the 100-year mass balance analysis but was used as a receiving water body in the GEI report. In the latter case, clarify whether the PMF water level in and surrounding the laguna was hydrologically modeled or estimated with unstated assumptions. If it was estimated or calculated offline, clarify the boundary condition used to calculate the water level in the laguna. Justify the exclusion of Laguna Plata from the GEI hydrological calculations of surface water elevation due to the selected PMP events and identify the boundary condition for Laguna Plata for the HEC-RAS hydraulic analysis. Justify the use of different modeling approaches in the updated SAR.

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

Reference:

GEI, 2019. Attachment 6 to the Holtec Letter 5025038, Probable Maximum Flood Analysis, HISTORE CISF, Lea Country, New Mexico. ML20260H147 (proprietary).

Holtec Response:

The 7.5" – 100 year storm has been removed from the SAR; therefore, there are no longer differing modeling approaches. The Probable Maximum Flood (PMF) determined in the GEI Report [1] is the

Design Flood. The revised GEI report [1] includes Laguna Plata and its watersheds in both the hydrologic and hydraulic models. Laguna Plata, along with Laguna Gatuna and Laguna Tonto, was modeled at full pool condition at the start of the PMP event. These initial water surface elevation assumptions are in general accordance with NUREG/CR-7046, which states "The water-surface elevation in a reservoir prior to the arrival of a PMF is assumed to be at the full pool level."

The flow area in the HEC-RAS model includes Laguna Plata and considered four (4) up-stream boundary conditions corresponding to the four (4) adjacent sub basins and their associated hydrographs developed in the HEC-HMS Model (Laguna Tonto watershed flows into Laguna Gatuna watershed). The flow area has one down-stream boundary condition set as the normal depth estimated based on the approximate average channel slope downstream of Laguna Plata. See Appendices F and G of GEI PMP/PMF [1] report for additional detail.

SAR Chapter 2 Section 2.4 has been revised to reflect the revised GEI Report [1].

References for RAI 2-17-1:

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 2, July 2021

RAI-2-17-S-2: Provide a technical basis to justify the curve numbers (CNs) used for flood analysis.

In the RAI response and updated SAR, the applicant claims to follow the Hierarchical Hazard Analysis (HHA) methodology, which starts from the most conservative assumptions, then follows up with more site-specific data to reduce conservatism. The CNs used are in the range of 40 – 70, indicating fair amount of precipitation loss assumed for the basins and the proposed CISF site. Discuss the iteration from generic, conservative assumptions (e.g., CNs in the high 90s and/or wet antecedent soil water retention) to more site specific, less conservative ones (i.e., supplementing the generic data such as the NRC soil map to more site specific data such as the onsite measurements of infiltration capacity and evapotranspiration). Justify, with technical basis, that an acceptable level of conservatism is being considered in the flood analysis if only generic, rather than site-specific, information is used.

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

Holtec Response:
GEI performed an initial gauging evaluation for the hydrologic model of the 72-hr storm assuming no loses (initial and constant loss = 0). The total volume of water on all study watersheds including the Plata North and South was then applied to only the "HI-STORE" watershed (i.e. all precipitation falling on all of the watersheds in the study was placed on the "HI-STORE" watershed). This overly conservative initial evaluation indicated a total depth of water on the "HI-STORE" watershed of approximately 13 ft. a similar, overly conservative evaluation was done assuming plausible losses and resulted in approximately 7.5 ft of flood water across the "HI-STORE" watershed. The next and final iteration was the detailed PMP/PMF evaluation as presented in the GEI Report [1] and is discussed below. Due to their over conservatism, the initial iterations are not discussed in the GEI Report [1].

As stated in the RAI above, the intent of moving to site-specific data is to reduce conservatism. The conservatively determined PMF water surface elevation [1] does not exceed critical elevations of SSCs at the site. As the safety of the facility is not impacted, Holtec has chosen not to reduce the conservatism any further.

The GEI Report [1] utilized Soil Conservation Service (SCS) guidelines to determine Curve Numbers (CN) based on hydrologic soil groups from the Web Soil Survey, and data from the National Land Cover Database. GEI utilized GIS software to plot the land cover and soil groups across each of the project watersheds. A CN reference table developed from the TR-55 tables 2-2 a, b, c, and d highlights the corresponding CNs for the identified land cover and soil groups. Weighted CNs for each watershed were computed from area outputs from the GIS software and a spreadsheet look-up function using the CN reference table.

The vast majority of the project study is shrub/scrub arid and semiarid rangeland land cover with varying hydrologic soil groups. The CN reference table and TR-55 tables are included in Appendix A of the GEI Report [1].

The Curve Numbers were used to determine initial loss and constant infiltration rate was determined in part based on the hydrologic soil groups. These values were adjusted as part of the sensitivity study performed for the models which indicated that the model performed as expected and appropriately conservative parameters were selected. Further discussion of the sensitivity analysis is provided in the GEI Report [1] as well as the response to RAI 2-18-S.

Updates have been made to Section 2.4 of the SAR.

<u>References for RAI 2-17-2:</u>

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, “Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico,” Revision 2, July 2021

RAI 2-18-S: Provide a technical basis to justify the representativeness of parameters used for flood analysis.

In response to RAI 2-18, the applicant provided an updated SAR and supporting analyses that use the United States Department of Agriculture Natural Resources Conservation Service (NRCS) data to parameterize its surface water flow model. The NRCS data particularly of interest here—the infiltration rate and soil water capacity—are generic. Using non-site-specific data will incur uncertainty of unknown quantity for the calculated flood water level. If only generic, non site-specific data is available for forward prediction of flood water level, quantify the model prediction uncertainty and prediction sensitivity to model parameters.

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

Holtec Response:
It is standard engineering practice to estimate design-basis floods using one of two analytical approaches: deterministic analysis or probabilistic analysis. Deterministic analysis is the current

approach used to develop design-basis floods for nuclear power plant sites in the United States [4]. The deterministic approach relies on predicting the PMP and PMF rather than the probabilistic approach, which estimates floods based on probability of exceedance of past observations. With prediction of the PMP and PMF comes a degree of uncertainty. It is very difficult, if not impossible to fully quantify uncertainty in the estimation of extreme floods [2]. The literature indicates that sensitivity analysis is the primary practice to understand uncertainty of the PMP and PMF derived using the deterministic approach [2] [3] [4].

The NRC has adopted the concept of a “probable maximum event,” which is determined by accounting for the physical limits of the natural phenomenon [4]. This event is considered to be the most severe reasonably possible event at the location of interest and is thought to exceed historically observed events. The main assumption for PMP calculations using the deterministic approach is that there is the optimum combination of available moisture in the atmosphere and storm efficiency that will cause maximum precipitation. NRC also accepts that the PMF is the hypothetical flood generated in a watershed from a PMP event.

Deterministic analysis relies on a particular set of inputs whereby the prediction is always the same and therefore uncertainty in inputs and model parameters are in general not considered explicitly [4]. This differs from probabilistic analysis, which relies on historical data for extreme events. It is noted that those observed extreme events can be limited by the period of the observed records and potentially subject to significant uncertainty in estimates.

Estimation of design-basis floods requires two simulations: hydrologic model and hydraulic model. The hydrologic model requires input of parameters to define the rainfall, loss rates, and rainfall-to-runoff transformation processes. The hydraulic model, in addition to input of physical characteristics such as terrain, depends on selection of the roughness coefficient (Manning’s n-value), which is typically based on referenced literature. In addition to potential uncertainty of input parameters, the models themselves contain uncertainty due to simplification of governing equations which scientists have developed to approximate reality.

Confidence in model predictions using the deterministic approach can be gained with calibration using data from large historical precipitation and flood events. In the absence of available records, not to mention events of similar magnitude to the PMP/PMF as was the case with the HI-STORE site, confidence can be gained by performing sensitivity analysis to understand the influence of key parameters on the results. To address uncertainty, NUREG/CR 7046 [4] confirms that the design-basis flood analysis can “describe and quantify the source of uncertainty by appropriately selected sensitivity analyses.”

Section 6.2 of the revised GEI Report [1] discusses the hydrologic model (HEC-HMS) sensitivity analyses which, in summary, included:

- Hyetograph front, middle (base case), and end loading.
- Loss Methods.
- Initial coefficient varied by +20% (more runoff) and -20% (less runoff).

- Constant coefficient varied by taking the high loss (low runoff) and low loss (high runoff) values from the recommended range ([5] [6]) for comparison with the base case represented by mid-range values.
- Percent Impervious was varied by +20% (high runoff) and -20% (low runoff).

Section 6.2 of the revised GEI Report [1] also discusses the hydraulic model (HEC-RAS) sensitivity analyses which in summary included:

- Manning's n-value varied by +20%.
- 2-D mesh cell size varied as 25 ft cells, 50 ft cells (base case) and 100 ft cells.
- Equation set full momentum (base case), and diffusion wave.

Individual parameter variations of ±20% did not have linear impact on the results and in fact at most resulted in 10% difference from the base case (for several parameters the effect was much less). Even when stacking the parameter variations from hydrologic model and hydraulic model (Max runoff Max Manning's N), the max water surface elevation changed less than one foot. The sensitivity analysis confirms that the hydraulic model responds as expected and confirms that the input parameters are appropriately conservative.

Updates have been made to Section 2.4 of the SAR.

<u>References for RAI 2-18:</u>

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico," Revision 2, July 2021

[2] Micovic, Z., Schaefer, M.G., Taylor, G.H. (2015). Uncertainty analysis for Probable Maximum Precipitation estimates. Journal of Hydrology.

[3] Singh, A., Singh, V., AR, B., (2018). Computation of probable maximum precipitation and its uncertainty. International Journal of Hydrology

[4] 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.

[5] U.S. Bureau of Reclamation (USBR), "Flood Hydrology Manual. A Water Resources Technical Publication," 1989

[6] New Mexico Office of the State Engineer Dam Safety Bureau (NMOSE), "Hydrologic Analysis for Dams," August 15, 2008

RAI 2-19-S: Provide additional information to justify that on-site flooding due to PMP storm events will not cause damage to important to safety (ITS) structures, systems, and components (SSCs) at the HI-STORE CISF site.

In its response to the RAI and updated SAR, the applicant's analyses suggest flooding can occur at the site, particularly in areas inside the CISF boundary where later phases of the proposed CISF will be constructed. Discuss whether any flood protection is needed for ITS SSCs, according to the NUREG/CR-7046 HHA methodology. If the applicant seeks to claim credit from the HI-STORM UMAX System's

flooding analysis, which demonstrates that a canister would not leak in evaluated flooding conditions, the SAR should discuss what effects, if any, the onsite flood water depth would have on the UMAX pad system, including the backfill, cementitious material between casks and around casks. This should include water depth from surface water ponding and a column of saturated subsurface soil with groundwater, including the loading from the saturated backfill material. Furthermore, based on hydraulic modeling results, the applicant should provide a map of the CISF clarifying where soil erosion may occur and its impact, if any, on ITS SSCs or physical security structures. The applicant should describe mitigation actions it plans to take in the event soil erosion does happen.

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

Holtec Response:

The License as currently written is for phase 1 only. If Holtec choses to pursue additional phases or expansion, then the effects of the PMF would be revisited.

As shown in the revised GEI report [1], flood waters would permeate the site, however the PMF elevation does not exceed the critical depth for any SSCs at the facility. According to the HI-STORM UMAX FSAR [4] the UMAX System is capable of being submerged up to 125 ft of water. See Section 2.4.7 and 12.2.4 of the UMAX FSAR [4] for additional discussion of the effects of the flood on the system. These sections of the UMAX FSAR [4] have been incorporated by reference into the HI-STORE SAR [5] as noted in HI-STORE SAR Table 4.3.1 [5] and HI-STORE SAR Section 15.3.4 [5], respectively. Following the flood, each CEC would be required to be inspected for debris accumulation in accordance with HI-STORE SAR Section 15.3.4.

According to the GEI PMP/PMF report [1], the flood waters do not reach the Cask Transfer Building elevation.

The Security Building would see a maximum of 1.5 ft during the Probable Maximum Flood. The site security functions of the building are designed to withstand emergency as detailed in the Physical Security Plan [6] and Safeguards Contingency Plan [7]. The flood waters would not reduce the facility's ability to meet security requirements.

No additional flood protection is required for the site.

Regarding potential soil erosion at the facility during the PMP/PMF event, the Figure 2-19-1 below maps the peak PMF velocities across the facility and provides specific information for key locations on site. In addition to the peak velocity at the key locations, the figure provides the corresponding flood depth and a threshold/permissible velocity above which erosion would be expected.

The velocity threshold is a function of the soil particle size distribution and varies based on the water depth. The median particle size D_{50} values for native soils, as determined in the GEI Geotechnical report [2], were considered for this evaluation. Table 2-19-1 below provides the native sediment information.

Table 2-19-1. Sediment Information

Boring/Test Pit No.	Sample No.	Depth of Sample (ft)	USCS	Description	D_{50} (mm)
B106	S5	10 to 12	GW-GM	Widely-graded GRAVEL with silt and sand	4.5
B106	S7	15 to 17	SC	Clayey SAND	0.2
B107	S7	15 to 17	SC	Clayey SAND	0.1

Notes:

1) Boring, soil classification and D_{50} information from GEI Geotechnical Data Report for HI-STORE CISF Phase 1 dated February 2018.
2) Boring locations and depths were selected for this analysis to represent the most shallow samples collected at the HI-STORE site.

The NRCS National Engineering Handbook 654 Chapter 8 “Threshold Channel Design” Figure 8-3 provides allowable water velocities as function of bed material grain size. Table 2-19-2 below summarizes the peak velocity and corresponding flow depth for the key locations and provides the allowable velocity threshold for both[2] D_{50} values.

Table 2-19-2. Allowable Velocity for all Points

HEC-RAS Data Point	Peak Velocity (ft/s)	Depth of Flow at Peak Velocity (ft)	D_{50} (mm)	Allowable Velocity (ft)
Phase 1 ISFSI Area	2.5	0.2	0.15	1.9
			4.5	3.3
South Side of Security Building	0.3	1.5	0.15	1.9
			4.5	3.3
South Side of Cask Transfer Building	0.0	0.0	0.15	1.9
			4.5	3.3
Northeast Corner of VBS	3.7	7.1	0.15	2.4
			4.5	4.1
Haul Path Section 2	0.8	0.1	0.15	1.9
			4.5	3.3
Haul Path Section 1	0.0	0.0	0.15	1.9
			4.5	3.3
Haul Path Section 3	1.4	0.2	0.15	1.9
			4.5	3.3
Wash to the West	0.6	3.3	0.15	1.9
			4.5	3.3
Wash to the North	7.7	19.4	0.15	3.0
			4.5	4.8
South Side of ISFSI Area	2.0	0.3	0.15	1.9
			4.5	3.3

Notes:

1) The samples collected and analyzed under the 2018 Geotechnical Data Report [2] were collected below ground surface at specific boring locations.
2) The D_{50} for samples B106 (S7) and B107 (S7) were averaged to 0.15 mm.
3) Velocity and depths reported for the 72-hr storm and proposed condition and are based on a 10-minute mapping output interval. For some locations, the instantaneous maximum velocity may be up to 0.3 ft/s higher than values shown in the table.
4) Allowable velocity information is based on thresholds published by the NRCS (2007) [3] and varies based on depth of flow.

Following construction of the facility, the land surface surrounding all site components will be appropriately landscaped. The native soil will be replaced with gravel or other large graded stone. Due to this, the threshold velocity for the D_{50} value of 4.5 mm is conservatively taken as the allowable velocity to prevent erosion adjacent to key areas on the facility. The washes and other areas of the site that will maintain native soils likely have a combination of the two soil types so a combination of both thresholds may apply as the allowable.

As can be seen in Figure 2-19-1, the peak PMF velocity at all of the onsite facility components (Security Building, Cask Transfer Building, Haul Path, ISFSI, or Fences) does not exceed the allowable velocity. Therefore, the potential for erosion adjacent to these features is very low, and any erosion that may occur would be minimal and have no effect on the structures.

As noted above the land immediately adjacent to and paved structure or building will be landscaped with appropriately graded stone to further prevent erosion. Any areas within the facility boundary that

do experience erosion during a storm event would not have an impact on the operation of the facility. That being said, where any erosion does develop on site, it will be handled as typical maintenance and site upkeep.

The Wash to the north is the only area that is likely to experience significant erosion during extreme storm events. However, given the nature of this natural feature, that is to be expected. It is understood that this feature formed naturally over time due to slow erosion. Continued erosion in the wash is natural and will not affect the facility.

Updates have been made to Section 2.4 of the SAR.

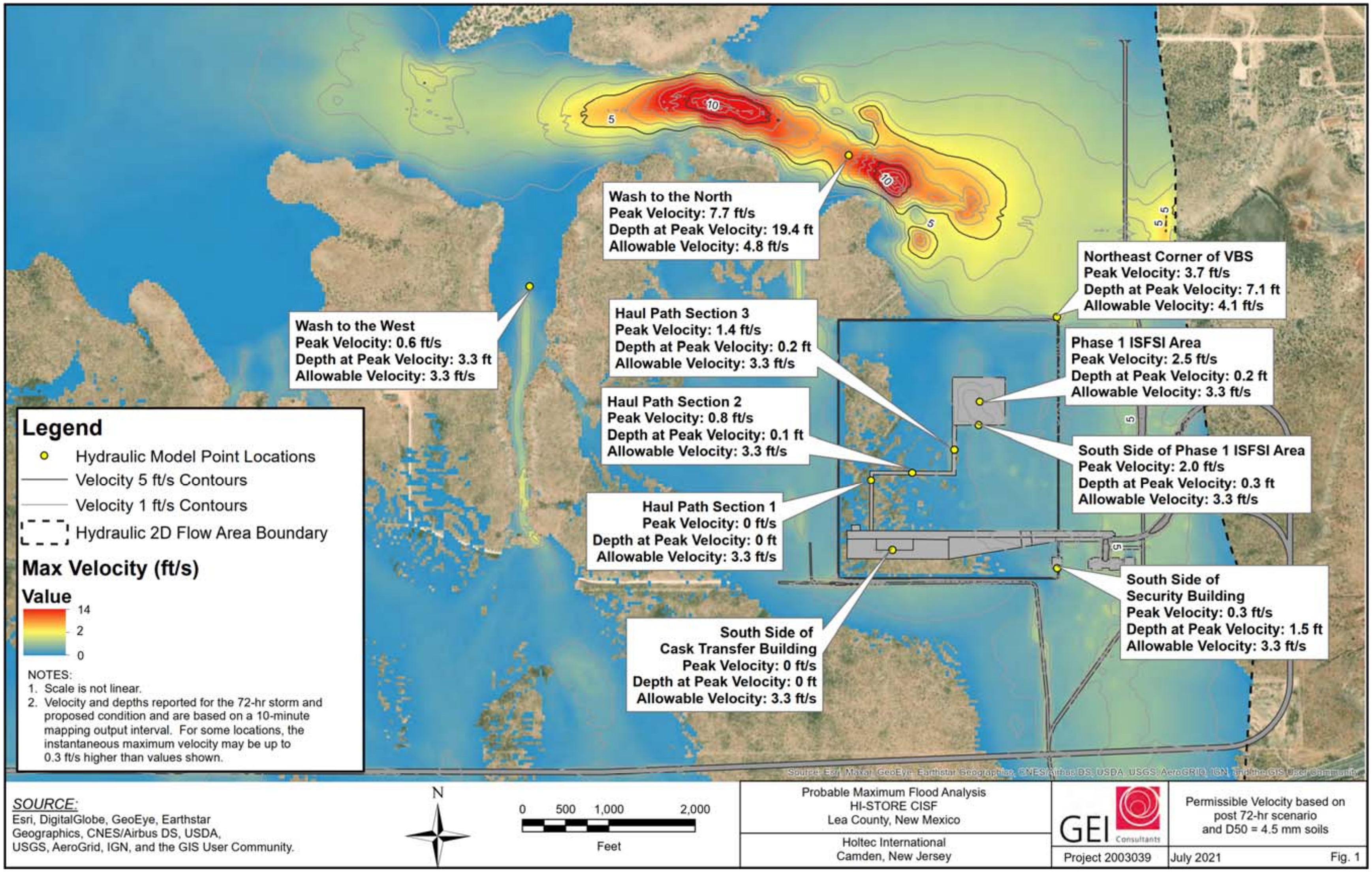


Figure 2-19_1: Maximum vs Allowable Velocity

<u>References for RAI 2-19:</u>

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico", Revision 2, July 2021

[2] GEI Consultants, Inc., Report CIS – RP 001 – 01, "Geotechnical Data Report. HI-STORE CISF Phase 1, Site Characterization, Lea County, New Mexico", Revision 1, February 2018

[3] Natural Resources Conservation Service (NRCS), National Engineering Handbook Part 654 "Stream Restoration Design", Chapter 8 "Threshold Channel Design", August 2007

[4] USNRC Docket 72-1040, "Final Safety Analysis Report on The HI-STORM UMAX Canister Storage System", Holtec Report No. HI-2115090, Revision 3. Submitted with Holtec Letter 5021032 (ML16193A336), dated June 30, 23016

[5] USNRC Docket 72-1051, "Licensing Report on The HI-STORE CIS Facility", Holtec Report No. HI-2167374, Revision 0O.

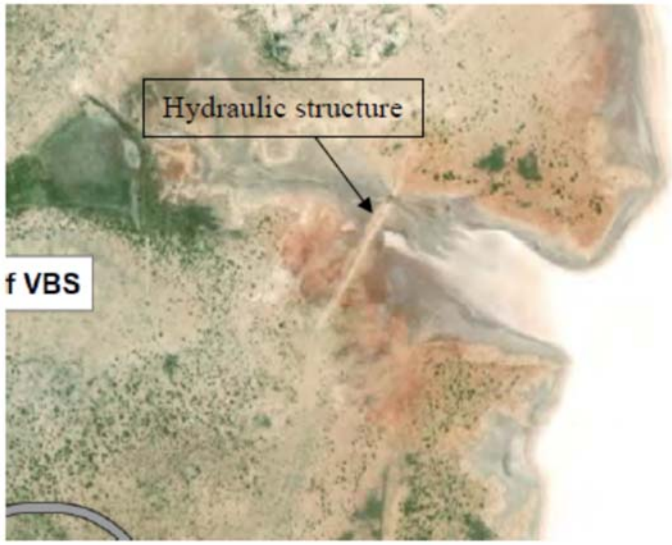
[6] Holtec Report No. HI-2177559, "Holtec International & Eddy Lea Energy Alliance (ELEA) Underground Consolidated Interim Storage Facility - Physical Security Plan," Revision 3

[7] Holtec Report No. HI-2177560, "Holtec International & Eddy Lea Energy Alliance (ELEA) Underground Consolidated Interim Storage Facility - Safeguards Contingency Plan," Revision 3

RAI 2-20-S: Provide an estimate of the likelihood that flooding may occur from a 100-year storm event as a result of damage to the hydraulic structure near Laguna Gatuna.

In its response to RAI 2-20, the applicant provided a PMP/PMF study (GEI, 2019), which assumes Laguna Gatuna in 'extreme full' condition, with water inundating the hydraulic structure. The effect of the hydraulic structure on flooding is thus accounted for. However, in the 100-yr storm event, where the Laguna was assumed to be filled with 5 feet deep of water, runoff into the wash and the hydraulic structure (looking like an earthen dam with an area that has been broken – see picture taken from the GEI report, Fig. 6) may create back water effect, which in turn may cause flooding around the northeastern corner of the proposed CISF. Provide calculations to estimate the likelihood that flooding may occur and, if so, at what depth under this scenario.

Alternatively, most of the water in Laguna Gatuna will be stored east of this structure in a sub- PMP storm event. Provide additional analyses to determine the potential impact of the structure's partial or complete collapse (e.g., the potential for flooding to the wash northeast of the proposed CISF), particularly under sub-PMP weather conditions.



This information is necessary to demonstrate compliance with 10 CFR 72.90(a), and 72.122(b) (2)(i) (A) and (B).

Holtec Response:
The 7.5”- 100 year storm has been removed from the SAR. The Probable Maximum Flood (PMF) as determined in the GEI Report [1] is the design basis flood for the HI-STORE Facility. As noted, in the PMP/PMF study, the Laguna Gatuna full pool initial condition water elevation is higher than the hydraulic structure. It was assumed that under these conditions this earthen feature would wash away and therefore the berm was not included in the hydrologic or hydraulic models.

In a sub PMP event, the opening in the hydraulic structure would allow water to equilibrate on either side of the structure as water level rises in Laguna Gatuna. The opening prevents the “earthen dam” from retaining water and will likely continue to erode/degrade with each passing rainfall event.

Furthermore, the surface elevation at the top of the “earthen dam” remains significantly below the surface elevation of the CISF facility. Therefore, even if the sub PMP/PMF water surface elevation rose above the “earthen dam” top elevation, the sub PMP/PMF water surface elevation would remain well below the facility elevation.

Updates have been made to Section 2.4 of the SAR.

<u>References for RAI 2-20</u>

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, “Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico”, Revision 2, July 2021

RAI 2-22-S: Clarify if the impacts from failure of the proposed rail embankment during a flooding event were assessed in the hydraulic modeling exercise.

In its RAI response, the applicant provided a drawing of a standard embankment for the proposed rail line into the CISF site. The embankment appears to be included in the HEC-RAS model (see Appendix F of the GEI report); clarify whether the impact of its failure, with a potential rush of flood water north of the embankment into the proposed CISF, was assessed in the hydraulic modeling exercise (per Figs. 11 and 12 of the GEI report).

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

Holtec Response:
The GEI PMP/PMF report [1] included the proposed rail line and modeled it as flush to existing grade with a Manning's n-value of 0.017 similar to new concrete and asphalt construction. The rail line would generally follow the natural terrain of the area and is expected to be BNSFs standard industry track design. The land traversed by the rail spur is generally flat and the majority of the embankment would be the minimum ~20" (6" sub-ballast + 6" ballast + tie) above the grade immediately adjacent to the track. Periodic drainage pathways will be included in the embankment design. The volume of water that could be retained on the upland side of the embankment would be limited, assuming blockage of drainage pathways, and would be insignificant compared to the overall analysis area/runoff volumes. i.e. there would not be a significant "rush of flood water" if there was an embankment failure. Furthermore, modeling the rail as a raised structure would divert flow around the site. it is conservative to assume that flow is conveyed to the site.

<u>References for RAI 2-22:</u>

[1] GEI Consultants, Inc., Report CIS – RP 003 – 02, "Probable Maximum Flood Analysis HI-STORE CISF Lea County, New Mexico", Revision 2, July 2021

RAI 2-29-S: Provide the revised version of the geotechnical report.

HI-STORE SAR, Rev. 0J cites the following reference:

> *[2.1.24] GEI Consultants (GEI). "Geotechnical Data Report: HI-STORE CISF Phase 1 Site Characterization." February 2018.*

However, the version of this report on docket is dated December 2017. Describe whether changes have taken place in the revised version that may affect the geotechnical analyses.

This information is necessary to determine compliance with 10 CFR 72.103(f)(2)(ii).

Holtec Response:

The revised version of the geotechnical report dated February 2018 is provided as part of this RAI submittal. The geotechnical analysis performed in Holtec Report No. HI-2188143, as well as the geotechnical data and evaluations in Chapter 2 of the HI-STORE SAR, have been updated to reflect the latest information.

RAI-2-32-S: Provide the document with detailed analysis showing that the site is not susceptible to liquefaction.

The response to RAI 2-32 refers to the following document:

GEI Document No. CIS-CS-001-00, "Liquefaction Resistance of Soils for HI-STORE CISF."

This document has also been referenced in the revised Report No. HI-2188143, "HI-STORE Bearing Capacity and Settlement Calculations." This report provides the details of analysis why the site is not susceptible to liquefaction. However, this report has not been submitted as a part of the application.

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

Holtec Response:

GEI Document No. CIS-CS-001-00, "Liquefaction Resistance of Soils for HI-STORE CISF" is provided as part of this RAI submittal.

CHAPTER 3 RAIs

RAI-3-2-S: Clarify what actions the site personnel will take if contamination levels on the canisters of incoming shipments exceed site requirements.

In its response to RAI 3-2, the applicant added TS 3.2.1 to include contamination limits for accessible portions of the canister. The TS also includes a requirement that if the contamination limit is found to be exceeded for a canister, it must be restored within limits in 7 days. However, Section 3.1.4.6 of the SAR states, in part, that *"HP personnel ensure that contamination levels on the canisters of incoming shipments meet site requirements. Canisters exceeding the limits will be returned to the originating power plant for dispositioning."* Clarify whether this second sentence of this statement is consistent with the TS 3.2.1 requirement to decontaminate a canister exceeding site contamination limits.

This information is needed to determine compliance with 10 CFR 72.126.

Holtec Response:

In Section 3.1.4.6 of the SAR, the sentence stating that "canisters exceeding the limits will be returned to the original power plant for dispositioning" is deleted and replaced with the following text:

> "Prior to shipment to the HI-STORE Facility, canisters must meet contamination survey limits set forth in 10 CFR 71.87(i). If canisters are subject to normal transportation conditions in route to the HI-STORE CIS Facility, it is highly unlikely that upon arrival a contamination survey would exceed canister contamination limits. Nevertheless, if any canisters upon arrival at the HI-STORE CIS Facility are found to exceed the contamination limits, notifications will be made in accordance with 10 CFR 20.1906(d)(1) ~~the following two parties will be notified immediately: the final delivery carrier and the NRC Headquarters Operations Center by telephone at the phone number(s) specified in 10 CFR 73 Appendix A~~.
>
> Accessible surfaces of the MPC will be wiped down thoroughly using a spray bottle and rag to decontaminate accessible canister surfaces. All contamination survey wipes or absorbent material, and any rags used for decontamination shall be disposed of in a secure, low specific activity (LSA) Class A waste container. Periodically, the HI-STORE CIS Facility Class A waste containers, with Class A waste contained therein, will be transported to an appropriate Class A waste disposal facility for disposal. ~~Most likely the Class A waste will be disposed of at the Waste Control Specialists (WCS) LLC disposal facility located near Andrews, Texas. This WCS disposal facility accepts Class A, B, and C radioactive waste.~~
>
> Following completion of decontamination of a canister that arrives on site exceeding the contamination limits, the contamination survey will be reperformed. If the canister is brought into compliance with contamination limits, processing of the canister can proceed. If the canister still does not meet the contamination limits, accessible surfaces of the MPC will be wiped down thoroughly with a spray bottle and rag a second time and the contamination survey will be performed for a third time. If the canister passes after the third contamination survey, processing of the canister can proceed. In the highly unlikely event that the canister, after the third contamination survey remains above the limit, ~~the NRC Headquarters Operations Center~~

> ~~will be notified a second time for guidance on whether to 1.)~~ appropriate licensing actions will be taken to proceed with processing the canister at the HI-STORE CIS Facility ~~despite not meeting contamination limits~~ or reinstall the lid of the transportation cask and ship the canister back to the originating facility or another ~~predetermined~~ facility that ~~has the willingness, ability, and credentials to process and decontaminate spent fuel canisters~~meets the necessary requirements."

RAI-3-3-S: Justify the use of canister lid contamination surveys to determine the total amount of canister surface contamination.

In its response to RAI 3-3, the applicant revised SAR Section 3.1.4.2 and 3.1.4.3 to state that the empty transportation cask will be surveyed to confirm that it is free of removable contamination and that decontamination will be performed if any contamination is found. However, the SAR also states that "*With the canister lid exposed, a contamination survey is taken on the accessible areas of the canister lid to verify that the canister is free of removable contamination*." (Emphasis added.) This is also discussed in SAR Sections 3.1.4.2 and 10.3.3.2, Step 3.

Justify how the canister lid would be representative as a survey for the level of contamination for other accessible areas of the canister, considering that the TS Bases in Chapter 16 of the SAR, Section B 3.2.1, requires the location and number of surface swipes be based on standard industry practices for objects of this size. Additionally, in the event the contamination is higher than the contamination level in TS 3.2.1 and cannot be removed in the period of 7 days, describe what actions site personnel will take. The SAR should be updated, and any additional TS 3.2.1 actions should be provided as necessary depending on the proposed actions.

This information is needed to determine compliance with 10 CFR 72.24(e) and 72.126(a)(4).

Holtec Response:

The referenced "quoted" sentence in RAI 3-3 (Clarification, above) in Chapter 3 is changed to:

> "With the lid of the transportation cask removed, contamination surveys are taken on accessible areas of the ~~MPC~~ canister to verify that the arriving loaded ~~MPC~~ canister meets the contamination limits set forth in the Technical Specifications LCO 3.2.1."

More information is provided on the precautions taken at originating nuclear power plants to minimize contamination on the surface of the MPC in HI-STORE FSAR Subsection 3.1.1, where it is mentioned that:

> "The canister exterior is prevented from direct contact with potentially contaminated spent fuel pool water by means of a slightly-pressurized clean water annulus with an inflatable top seal."

The following text as added to Section 3.1.1 as additional explanation and justification:

> "It should be noted that, when loaded in the transfer cask or transport cask, the accessible top surface of the canister is considered to be representative of the canister's worst-case potential surface contamination levels, as the top surface of the canister is not protected from exposure to spent fuel pool water during the loading process. "

Holtec's response to RAI 3-2 provides the actions Holtec will take in the unlikely event that the contamination level of the arriving canister is above the removable contamination level limits in the Technical Specifications LCO 3.2.1.

CHAPTER 5 RAIs

RAI-5-3-S: Confirm the anchor rod details as they pertain to the seismic calculations for the HITRAC CS (Concrete Shielded) and update the drawings/calculations as necessary.

In its response to RAI 5-3, the applicant stated that the lowest natural frequency of the HI-TRAC CS when subjected to lateral excitation (seismic loads) is 18.979 Hz for 2 resisting anchor bolts. The RAI response calculation appears to assume an anchor rod diameter of 3 inches, while anchor rod (part 4), per Sheet 2 of drawing 10895, indicates a diameter of 3 ¼”. An implicit assumption appears to be that the anchor rods secures the HI-TRAC CS.
However, the anchor rods pass through several parts as shown on Sheet 1, drawing 10868, where the opening for the anchor rods is actually wider than the diameter of the anchor rod itself: 3 ¾” for the shield gate bottom flange (Part 13) and 5” through the shield gate top flange (Part 9). Clarify how the anchor rods as shown secure the HI-TRAC CS given that hardware such as anchor rod nuts are not depicted or specified and clarify how Part 4 on Sheet 1 of drawing 10895 engages Part 21 on Sheet 1 of drawing 10868.

Explain why the HI-TRAC CS, as depicted, would remain secure in response to seismic loads (e.g., would not experience increased loading as an inverted pendulum).

Revise the seismic analysis of HI-TRAC CS for both lateral and vertical loads on the anchor rods (which resist combined bending/shear and tension) and connecting components (Part 10 and 11 on Sheet 2 of Drawing 10895), and their depiction on the licensing drawings as necessary.

This information is necessary to determine compliance with 10 CFR 72.92 and 72.122(b)(2)(i).

Holtec Response:

The tie-down stud’s stress area of 7.032 in^2 (i.e., the minimum tensile area of the stud’s threaded section calculated in Supplement 5, Appendix A, Page A3 of HI-2177585R1) was used to calculate natural frequencies of the anchored HI-TRAC CS transfer cask secured by four 3.25” diameter tie-down studs at the canister transfer facility. Thus, the correct stud diameter was considered in the frequency calculation presented in the initial response to RAI 5-3. The tensile stress area of the 3.25” tie-down stud is almost identical to the cross-sectional area of a 3” diameter solid bar, which may have caused the confusion that the frequency calculation incorrectly used 3” as the diameter of tie-down studs.

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] In response to RAI 5-15, the HI-TRAC CS seismic analysis, which is applicable for both the canister transfer facility and the HI-STORM UMAX ISFSI pad locations, is revised and documented in Supplement 5 of Report HI-2177585R2. The tensile, shear and bending loads obtained from the revised seismic analysis for the tie-down stud are used to perform the structural evaluation of the tie-down stud in Supplement 5. This revised supplement also demonstrates that all structural members and weld joints of the HI-TRAC CS transfer cask are structurally sufficient under the seismic condition.

The tie-down stud (Part 21 in Holtec drawing 10868) is also identified as Part 4 in Holtec drawing 10895R0. However, in the revised Holtec drawing 10895R1, Part 4 is deleted, and the tie-down studs are only shown as Part 21 in Holtec drawing 10868 to avoid any confusion. The Section 2E-2E of the revised Holtec drawing of HI-TRAC CS transfer cask (i.e. 10868R1) clearly depict how the HI-TRAC CS transfer cask is secured using the tie-down studs at the canister transfer facility.

RAI-5-4-S: Provide additional information on cask handling operations.

In its response to RAI 5-4, the applicant stated that a work shift is 8 hours long. In SAR Section 4.3.6, the applicant states that it follows the “universally practiced ‘lift and set’ rule,” which excludes certain operations from seismic qualification. The applicant further stated, “For clarity of application, any activity that spans less than a work shift is deemed to be seismic-exempt.” However, the ‘lift and set’ rule” is not defined nor recognized by the NRC. Additionally, the HI-STORE CISF may potentially handle thousands of canisters, which cumulatively would far exceed 8 hours to handle. Even if a strong technical basis were provided for any seismic exemption, additional operational procedures or administrative controls would have to be provided. The cask is susceptible to seismic loads as shown in Figure 3.1.1f of the SAR, where the cask lid is completely unbolted, the canister is on its side, and susceptible to having fuel/canister slide out and drop onto the cask transfer building floor. The staff requests the following:

1. Provide seismic qualification supporting calculations for cask upending, attaching of slings, or installation of fasteners, and;

2. Describe the condition of the canister when subjected to seismic loads when performing cask handling operations.

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

Holtec Response:

In response to Staff’s concerns, the HI-STORE SAR Section 4.3.6 has been reworded to remove the statements regarding work shift and lift-and-set rule, i.e., no seismic exception is used for handling evolutions. Detailed seismic analyses have been performed for all the cask handling evolutions at the HI-

STORE CISF. These include loaded HI-STAR 190 cask in horizontal orientation lifted off the rail car and placed on the tilt frame/saddle assembly using horizontal lift beam, loaded HI-STAR 190 cask upended and placed in the CTF pit using HI-STAR lift yoke, loaded HI-TRAC CS lifted from CTF location to be placed on HI-PORT using HI-TRAC lift yoke, and VCT (HI-TRAN 225) lifting loaded HI-TRAC CS from HI-PORT using lift links to move cask to UMAX storage location. The seismic analyses of HI-PORT carrying HI-TRAC CS, VCT carrying HI-TRAC CS, and stack-up for MPC transfer at CTF and UMAX are also performed. All of these seismic analyses are documented in Structural Calculation Package, HI-2177585, Revision 2. The seismic accelerations at CTB crane and slab elevations are obtained from the detailed building seismic analysis in calculation package, HI-2210576, Revision 0.

Holtec regrets the confusion with regards to Figure 3.1.1f of the HI-STORE SAR. The transport cask lid will not be unbolted with the cask in the horizontal orientation. The transport cask lid is only removed when it is placed inside the CTF cavity in vertical orientation. Therefore, there is no potential for the canister to slide out of the HI-STAR 190 transport cask. Figure 3.1.1 of the HI-STORE SAR has been revised to clearly show the bolt removal occurring after the transport cask is placed in the CTF. The seismic analyses performed in HI-2177585 demonstrate that the loaded casks remain stable and the canister will remain inside HI-STAR 190 cask or HI-TRAC CS cask during all handling (or short-term) operations at HI-STORE site, and there would be no breach of confinement boundary as the seismic accelerations experienced by the canister at HI-STORE site are significantly lower than those the canister (MPC) is qualified to in HI-STORM FW FSAR.

RAI-5-8-S: Provide calculations/analyses of the vertical cask transporter (VCT) when transporting a loaded HI-TRAC CS.

The response to RAI 5-8 does not address the staff's request. The SAR does not provide sufficient information or design details to support the assumptions for treating the VCT as a rigid body or the use of the PGA (Peak Ground Acceleration) alone with an uncharacterized/designed tensioned restraint strap.

In its response, the applicant stated in part:

> *"The HI-TRAC CS is physically secured against the chassis of the VCT using a tensioned restraint strap while it is in transit. This prevents the HI-TRAC CS from swaying with respect to the VCT. Also, by bracing the HI-TRAC CS against the VCT, the flexible beam modes associated with the VCT lift towers are diminished since the massive HI-TRAC CS is restrained against lateral motion (relative to VCT). The VCT chassis is a large welded steel structure with a substantial cross-section, which behaves like a rigid body under seismic loading."*

Provide calculations supporting these assertions. The analysis of the system should incorporate the response spectrum of the site, actual dynamic behavior of the system (VCT & load which do not necessarily act in unison) subjected to a 3-dimensional seismic time history analysis to support tipping and sliding calculations. Note that lateral portion of seismic loads can be applied at any direction. The analysis should include:

1. Details for the tensioned restrained strap, such as material properties, dimensions, configuration relative to the cask, acceptable tensioning procedures, and depiction in the licensing drawings and in the SAR, if not provided already. The dynamic analysis (time history) should

consider the tension strap's potential to go "slack" or "stretch" when subjected to seismic loads when attempting to restrain a fully loaded cask, as it is expected to potentially sustain very large alternating loads. This information should be noted in the licensing drawings and/or SAR.

2. Materials, dimensions, configurations, and specifications of the VCT while carrying a fully or partially loaded canister. The SAR describes the VCT as a very "open-ended" device that has the "ability to raise or lower a cask", and can have several suspensions (wheeled, tracked, etc.). The dynamic analysis of such an "open ended" vehicle would have to cover a multitude of parameters pertinent to a time history analysis. The VCT carrying a fully loaded canister will have at least two significant modes of vibration, where the VCT displaces laterally due to its suspension and tall nature, and the carried load is free to oscillate relative to the VCT in any direction.

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

Holtec Response:

In response to Staff's concerns, the details of the tracked Vertical Cask Transporter (VCT) or HI-TRAN 225 are provided in Licensing Drawing 12432 along with supporting analyses in Supplements 6, 15 and 17 of structural calculation package, HI-2177585. The report makes reference to the in-depth structural/seismic evaluation of the HI-TRAN 225 (rated for 450 kips) slated to be used at the HI-STORE facility in HI-2210216. The governing configurations and multiple loading conditions are considered for completeness.

Supplement 17 of HI-2177585 evaluates the newly added screw jack restraints which are specially designed supports for the HI-TRAC CS used instead of the traditional belly bands (slings/straps). The restraining straps are eliminated from the updated VCT design to address the concerns related to their behavior and the potential impact on VCT's dynamic response. The screw jack restraints secure the HI-TRAC to the VCT, are much stiffer than the traditional restraints and are active in both tension and compression. The screw jack and hydraulic restraints (hereafter referred to as seismic restraints) are strategically located to align with the CG of the HI-TRAC CS such that the seismic load path of the cask passes directly through the robust seismic restraints and into the VCT chassis. The screw jacks are sized to ensure a minimum stiffness based on the calculations performed in Supplement 17 using the representative model. The loads transmitted to the VCT chassis top and bottom plates are bounded by the hydraulic cylinder loads considered in HI-2210216 for the following reasons.

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The seismic stability of the loaded VCT is performed in Supplement 6 of HI-2177585 using 0.25g ZPA Regulatory Guide 1.60 earthquake in all directions, for conservatism, to demonstrate that the VCT will not tip or excessively slide at the HI-STORE site in the event of an earthquake. The dynamic analysis of the VCT in HI-2210216 along with the screw jack restraints evaluated in Supplement 17 of HI-2177585 substantiate the analysis in Supplement 6 of HI-2177585.

The fatigue evaluation of the VCT at HI-STORE site is presented in Supplement 15 of HI-2177585.

Based on the performed detailed evaluations, it is concluded that the HI-TRAN 225 is structurally adequate to carry and support the HI-TRAC CS under all loading conditions at the HI-STORE facility.

RAI-5-9-S: Provide calculations and drawings to support the design of the CTB.

In RAI 5-9, staff requested additional information regarding the collapse scenarios for the CTB on the HI-TRAC CS. In its response, the applicant stated that the CTB is now classified as ITS-C. However, no building design was provided to justify the CTB's structural integrity in response to natural phenomena, blast, etc., which would preclude the need to analyze the effects of a collapse on the HI-TRAC CS.

The response should provide site specific licensing drawings and design calculations for the CTB that include structurally pertinent information, such as dimensions, members sizes, materials, connection details, welding/bolting, foundation details, crane detail designs, geotechnical calculations including soil-structure interaction, etc. Since the CTB is now classified as ITS-C, the applicant should incorporate applicable structural design codes (ACI, ANSI and AISC).

This information is necessary to determine compliance with 10 CFR 72.24(d) and 72.122(b)

Holtec Response:

Per the staff's request, Drawing 10912 has been significantly revised and expanded to include more detailed design information for the CTB, including building dimensions, member sizes, foundation details, construction materials, connection details, etc. In addition, a new site-specific licensing drawing (Drawing 12404) has been introduced to capture the design information for the CTB overhead crane. As indicated on Drawings 10912 and 12404, the crane design has been changed from the previous floor mounted, double gantry crane to the current wall mounted, overhead bridge crane. This change, which became possible when the CTB was upgraded to ITS-C, increases the range of travel of the crane and allows for more effective use of the CTB floor space. It also eliminates a former concern expressed by the staff that a suspended load could possibly impact the gantry crane legs during a seismic event.

With regard to the structural integrity of the CTB, Holtec has performed a detailed finite element analysis of the CTB using ANSYS to evaluate the internal forces and moments in the structure due to normal and accident condition loadings, including dead, live, wind and seismic loads, as specified in SAR Section 4.6.2. The ANSYS model of the CTB is plotted below in Figure 5-9.1.

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After the individual load cases are solved, the results are combined in ANSYS to form the governing load combinations per SAR Section 4.6.2, which are derived from Table 4-3 of NUREG-2215 and Section 9.2 of ACI 318. The reinforced concrete portions of the CTB are designed to meet the strength requirements per ACI 318, and the steel portions of the building are designed to meet the applicable capacity limits per AISC 360. All calculated safety factors for the CTB shall be demonstrated to be greater than 1 thereby confirming that structural integrity is maintained, and a building collapse is not credible under the design basis normal and accident condition loads. The complete details of the structural integrity evaluation for the CTB will be documented in Holtec Report HI-2210576, and also summarized in SAR Subsection 5.3.2.4.

RAI-5-10-S: Clarify the number of “canister deployments” that can be made with the HI-TRAC CS, VCT, and associated lifting equipment, which incorporates low cycle fatigue and a dynamic load factor.

For discussion purposes, canister deployment can be defined as the movement of a canister upon initial receipt from rail car to its final ventilated vertical module (VVM) location, or from the VVM back to the rail car. The fatigue calculations provided in the response to RAI 5-10 do not show how low stress, high

cycle fatigue combined with low cycle, high-stress fatigue corresponds to a canister deployment. Potentially hundreds, if not thousands, of low cycles may be experienced by the VCT. The distance of each canister deployment should also be noted, as long distances while in transit will accrue many more cycles. Operating experience shows that hundreds of fatigue cycles will occur for even relatively short distances for just one canister. Clarify the number of "canister deployments" that can be made with the HI-TRAC CS, VCT, and associated lifting equipment.

In addition, justify the use of dynamic load factor increase of 15%. The 15% increase in "live load" should be applied as a 1.15 factor to maximize (worsen) alternating stresses and not behave as a stress reduction factor, per Section 10.5 of Supplement 10 in Holtec Report No. HI- 2177585R1 for those components loaded in tension. Confirm that the dynamic load factor is applied appropriately and update the calculations and SAR as necessary.

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

Holtec Response:

Lifting Ancillaries, Pedestal and Tilt Frame/Saddle Assembly:

In order to address Staff's concerns related to fatigue analysis, Supplement 10 of HI-2177585 is revised to consider low stress high cyclic fatigue in combination with high stress low cyclic fatigue (using Miner's rule) for all important-to-safety ancillaries at HI-STORE facility (inside and outside Cask Transfer Building). The list includes HI-TRAC CS cask including trunnions, HI-STAR and HI-TRAC lift yokes, HI-TRAC lift links, MPC lift attachments, horizontal lift beam, pedestal and tilt frame/saddle assembly. For each load cycle (each load cycle is defined as one lift and set down operation of the cask/canister), low stress high cyclic fatigue would occur due to the shifting of equilibrium force with already suspended load. The exact number depends on operator maneuvers, crane control system, and mechanical damping characteristics. The kZ-method, as described in KTA-3902, is applied to obtain the number of associated low stress cycles as 30 per each lifting cycle. For low stress high cyclic fatigue, the magnitude of alternating stress is considered to be 15% of the peak stress under the maximum lifted load to account for stress fluctuations which occur during handling and movement. This is consistent with the inertial/dynamic load factor of 1.15 per CMAA-70. The maximum number of canister deployments for each of the SSC's is then established using S/N curves of ASME B&PV Code, Appendix I in Supplement 10 of HI-2177585 and also presented in Chapter 5 of the HI-STORE SAR.

VCT:

An in-depth structural evaluation of the HI-TRAN 225 VCT (rated for 225 US tons; shown in Licensing Drawing 12432) is performed in HI-2210216 for the governing operating modes of the machine. Appendix D of the report considers the impact of high stress low cycle fatigue on the various components in the direct load path and presents the maximum number of allowable cycles for each. Supplement 15 of HI-2177585 builds on the methodology used in Appendix D of HI-2210216 and incorporates low stress high cycle fatigue contribution using a similar approach to the one described above. The combination of both types of fatigue cycles determines the maximum number of allowable canister deployments, where a deployment is defined as 3 high stress cycles and 1000 low stress cycles. The usage of 1000 cycles as a bounding low stress high cyclic value is based on engineering judgement, swayed by three primary factors, namely:

1. The total travel distance of the VCT is limited mainly to the concrete pads (approach apron and ISFSI pad) by utilizing the HI-PORT (trailer-style transporter) to bridge the gap between the CTB and the pads.
2. Steel plates will be laid out over a large portion of the pads to ensure the VCT travels over a smooth level surface.
3. The VCT is operated at low speeds.

In combination, the measures listed above will reduce drive related vibrations and inertial loads, thereby limiting the magnitude of the low cycle alternating stress and the total number of low stress cycles. Nevertheless, a dynamic load factor (DLF) of 25% (associated with fast lifting and mobile hoist cranes) is conservatively applied to maximize stresses for the lifting case. An inertial load factor of 15% associated with drive conditions is considered to account for stress fluctuations in the low stress high cycle fatigue evaluation. The maximum number of canister deployments for the various components in the VCT is then established using S/N curves of ASME B&PV Code, Appendix I in Supplement 15 of HI-2177585.

<u>HI-PORT:</u>
A HI-PORT (trailer-style transporter shown on licensing drawing 12481) will be used to transport the loaded HI-TRAC CS from CTB to ISFSI pad. Since the HI-PORT is a vendor supplied equipment, the following requirement will be imposed using Holtec's Purchase Specification to ensure required service life: The HI-PORT unit shall have a design/service life of 15 years or shall be capable of driving 500 miles with the rated load of 400 kips for at least 500 loading/unloading cycles.

The loaded HI-PORT is evaluated using seismic acceleration time histories obtained from CTB analysis (HI-2210576) in Supplement 18 of HI-2177585.

As an additional measure of safety, all primary load bearing parts in the structural ancillaries (including VCT and HI-PORT) will be subjected to a visual examination at 14-month intervals which emulates the specification for the special lifting devices in ANSI N14.6.

RAI-5-11-S: Provide clarification on groove weld options on drawings and groove weld design.

In Note 2 on Sheet 1 of 5, Drawing 10868, the applicant indicated that the fabricator can replace all fillet welds with grove welds of equal or greater strength, as indicated in other licensing drawings.

Specifically, the revised drawing states:

> *"FILLET WELDS MAY BE REPLACED WITH GROOVE WELDS OF EQUIVALENT OR GREATER EFFECTIVE THROAT THICKNESS AS DEFINED BY NF-3324.5."*

This response does not provide a groove weld design, only a code to design to, rather than a weld option for the actual design that demonstrates equivalent weld strength. Clarify how the fabricator will be able to replace fillet welds with groove welds of equal or greater strength.

This information is necessary to determine compliance with 10 CFR 72.24(c)

Holtec Response:

Holtec regrets the note that empowers the Fabricator to substitute fillet welds with groove welds. The Fabricator does not have any design change authority and every note purporting to give the Fabricator any design substitution authority has been deleted in the revised drawings. Any design change must follow the change process pursuant to the CFR provisions implemented in Holtec's nuclear program, which limit such authority to the licensee (under 10CFR72.48), and even that under a very restricted set of conditions.

With regard to Note 2 on Drawing 10868 (Sheet 1 of 5), the original wording in Note 2, as referred to above, has been deleted in its entirety.

RAI-5-13-S: Justify the basis for the assertion that the welds are 'not safety-significant'. Specify and size all the welds used for the components depicted on Sheets 3 and 4 of Drawing 10895.

In its response to RAI 5-13, the applicant stated that:

> *"Note 3 on Sheet 1 of Drawing 10895 is modified as follows, to clarify that the note is applicable to the CTF Shell:*
>
> *SHELL (ITEM 1) MAY BE FABRICATED FROM MULTIPLE PIECES WITH NONSTRUCTURAL WELDS SUCH AS INDICATED BY WELDS 3-1, 3-2 AND 3-3 SHOWN ON SHEET 3. TYPE OF WELD, NUMBER, AND LOCATION OF WELDS TO BE DETERMINED BY FABRICATOR.*
>
> *The CTF shell and shell welds are non-structural, as the structural loads on the CTF are imparted on the CTB slab at the top and the CTF foundation slab at the base. Number, type and locations of welds are therefore not specified on licensing drawing 10895 as they are not safety-significant."*

However, these welds are safety related since they transfer load and have stresses, which are tabulated in Table 5.4.1, when subjected to seismic loads during cask transfer operations. The latest revision of SAR Section 5.4 further discusses this. Thus, all components shown on Sheets 3 and 4 of Drawing 10895 need to be welded to a specified code, such as ASME NF, and have appropriate weld sizes supporting their structural integrity, including any supporting calculations as it is not clear how these welds that are not specified are sized. This includes the adapter plate, schedule 40 pipes used for heat rejection when a cask is in the pit, the shell of the pit itself, and all connecting components since all are subjected to seismic demands. The adapter plate (BOM 10) is currently classified as NITS, but should be ITS, as it must still be designed to prevent block shear around the anchor rods for instance, and the plate "tabs" used to inset the adaptor into the CTF shell to prevent lateral movement of the HI-TRAC CS during seismic events.

Specify and size all the welds used for the components depicted on Sheets 3 and 4 of Drawing 10895 and classify them accordingly as ITS or NITS for use in the CTF. The applicant should also consider the prestressing nature of the wet Controlled Low-Strength Material (CLSM) cast against the CTF shell. This information is necessary to determine compliance with 10 CFR 72.24(c).

Holtec Response:

In response to the Staff's request, all welds on Drawing 10895 have been designated as "NF" welds, which means that they must comply with the applicable welding requirements per Subsection NF of the ASME Code. There are no longer any welds on Drawing 10895 that are designated as "non-structural". In addition, sizes have been specified for all welds shown on the drawing.

The most heavily loaded welds in the CTF weldment are the weld between the anchor block (BOM 9) and the gusset plate (BOM 11), and the weld between the gusset plate (BOM 11) and the CTF shell (BOM 1). These welds are evaluated for seismic loading in Supplement 5 of HI-2177585, which provides the basis for their sizing.

With regard to the adapter plate (BOM 10), it has been re-classified as ITS on the drawing, and the adapter plate has been evaluated for shear tear-out at the anchor block locations in Supplement 5 of HI-2177585, which shows substantial safety margin. [

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The stresses induced in the CTF shell during placement of the wet Controlled Low-Strength Material (CLSM) are not a significant concern since the CLSM will be cast in place via multiple pours to achieve the full height. [

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] Once the CLSM cures, the CTF vent pipes are not vulnerable to seismic loading since they are encased in CLSM.

Lastly, it remains permissible to fabricate the CTF shell (BOM 1) from multiple pieces per Note 3 on Sheet 1 of Drawing 10895, but the note has been revised to remove the fabricator's authority to determine the type of weld. The joint type and weld size must comply with the weld specifications on Sheet 3 of the drawing.

RAI-5-14-S: Provide structural calculations and drawing details for the HI-STAR 190 SL pedestal.

In its response to RAI 5-14, the applicant provided some details regarding the construction of a pedestal that is to be used in conjunction with the HI-STAR 190SL in the CTF cavity (Sheet 10895, Drawing 4). Provide structural calculations to justify the heat dissipation properties of the HI-STAR 190SL cask

pedestal, including updating the drawings with connection details, such as weld locations, weld sizes, and other appropriate weld information.

This information is necessary to determine compliance with 10 CFR 72.24(c) and 10 CFR 72.122(b).

Holtec Response:
The HI-STAR 190SL pedestal ("Pedestal"), as shown in the Licensing Drawing 10895, is a simple cylindrical weldment consisting of a cylindrical shell equipped with reinforcements at its extremities bracketed by circular plate members. The Pedestal carries the weight of the loaded HI-STAR cask during normal conditions and an amplified weight during an earthquake event. The small radial gap between the Pedestal and the CTF shell permits the Pedestal to expand (or contract) without experiencing thermal constraint-induced stresses. The Pedestal is designed to meet ASME Section III Subsection NF ("Code") stress limits. Supplement 16 of the HI-STORE SAR supporting structural calculation package, HI-2177585, provides the supporting calculations and computed safety margins against the Level A (normal condition) and the Level D (seismic condition) loads. The seismic condition analysis conservatively imposes all of the downward vertical load (live load plus DBE load) onto one-quadrant of the Pedestal. The structural safety margins under all conditions are demonstrated to be large.

The Pedestal is classified as an ITS Category C structure. The material acquisition, fabrication, welding, NDE and factory acceptance tests will be informed by the requirements of the Code and the quality commitments pursuant to ITS Category C. The top of the Pedestal will be in contact with the bottom of the HI-STAR 190 cask whose normal surface temperature will be well below 300 Deg. F. Nevertheless, the metal temperature of the Pedestal is assumed to be 300 Deg. F to obtain the material properties for conservatism.

RAI-5-15-S: Revise finite element models (FEM) to address possible excessive hour glassing energy.

In response to RAI 5-15, the applicant stated that the excessive amount of hour glassing energy was not of concern due to the kinetic energy of the system. The staff notes excessive hour glassing can be an indicator of the FEM possibly exhibiting unrealistic behavior. Additionally, the staff notes that the kinetic energy generated by a stationary structure during a seismic event is not of interest for this analysis. The area of interest is the performance of the HI-TRAC CS and the strains and stresses within itself.

Revise the model and any output results for the stack-up and the "Safe Shutdown Earthquake" (SSE) scenarios such that the ratio of hour glassing energy to internal energy is less than 10% as per LS-DYNA recommendations or otherwise further justify why the hour glassing energy would not adversely affect the structural integrity of the HI-TRAC CS.

This information is necessary to determine compliance with 10 CFR 72.24(c) and 72.122(b)

Holtec Response:

The LS-DYNA seismic model is revised to use fully integrated elements for the HI-TRAC CS model to eliminate hourglass energy in the stack-up analysis as shown in Figure 5-15-1 below. The seismic loadings

obtained from the revised LS-DYNA seismic analysis are used update the structural calculations documented in Appendices B to D to Supplement 5 of the calculation package HI-2177585. All safety factors remain above 1.0. Therefore, the HI-TRAC CS design is not affected by the revised analysis.

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PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390

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RAI-5-18-S-1: Provide additional information on the suitability of the CLSM.

Section 2.6.6 of the UMAX FSAR indicates that the CLSM material in Space A shown in Figure 4.3.1 of the HI-STORE SAR will have a compressive strength of 1,000 psi and a density of 120 pcf. However, the response to RAI 5-18 indicates that the material will have a compressive strength of 1200 psi. CLSM material is intended to be used as backfill material but Licensing Drawing 10895 shows that it is used as primary load bearing material. CLSM material can have a compressive strength as low as 50 psi, yet no compressive strength has been specified on the licensing drawings. ACI 229R-13 (ACI 229R-99, referenced by the applicant, has been superseded) indicates that this material cannot be treated as low strength concrete, since it is unreinforced, and only suitable as backfill. Given the wide range of material properties and densities of CLSM**,** the staff requests the following:

1. Indicate the compressive strength and density of the CLSM on Licensing Drawing 10895;

2. Justify how CLSM is suitable as a primary load bearing material as currently indicated in the drawings.

This information is necessary to determine compliance with 10 CFR 72.24(c) and 72.122(b)

Holtec Response:
Holtec regrets the confusion regarding the compressive strength for CLSM. It is specified to be 1000 psi (minimum) on the Licensing Drawing 10912, which has been significantly revised to include more detailed information on the Cask Transfer Building (CTB) design. The existing Licensing Drawing 10895 makes reference to Drawing 10912 for CTB slab, CLSM and CTF foundation slab details. In addition, the minimum density of CLSM is specified as 120 pcf on Drawing 10912. The applicable code for the CLSM is also updated to ACI 229R-13. The information provided in Figure 4.3.1 and Table 4.3.2 of the HI-STORE SAR are specific to the UMAX ISFSI location and the CLSM requirements for CTB are captured in Drawing 10912.

The CLSM serves as the underlay below the CTB reinforced concrete slabs as indicated on Drawing 10912, i.e., it is not subject to a direct loading from the SSCs that may traverse the CTB slab or those that are placed on CTF foundation slab.

RAI-5-18-S-2: Provide floor slab design details and calculations for the CTF.

The geometry and footprint of the VCT have a large influence on the floor's capacity to resist loads and must be accounted for when designing the CTB floor slab, CTF pit, and its influence on the CTB. Therefore, the floor slab should be designated as ITS.

Explain whether live loads generated by the building itself and overhead crane transiting with a load nearby could influence the CTF pit design by imparting additional loads via their foundations. In addition to the CTB, seismic loads using time history analysis should also be considered for the CTB, its foundation, and the CTF pit, and input/output files provided accordingly.

The CLSM material is depicted in Licensing Drawing 10895 as a floor slab that is directly loaded around the canister transfer pit shell by the crawler, which weighs more than the indicated 180,000 lbs., given the cask weight it carries when transiting and downloading in the cask transfer pit. Given that the CLSM is unreinforced and will be used as a floor slab per licensing drawing 10895, the staff requests the following:

1. Justify how the CLSM will support shear loads;

2. Justify how the CLSM will maintain structural integrity under loads when the CTB is used by the VCT.

This information is necessary to determine compliance with 10 CFR 72.24(c) and 72.122(b)

Holtec Response:

All reinforced concrete structures in the Cask Transfer Building (CTB) including the slab and the walls are designated as ITS. The CTF pit and the steel weldments are also designated as ITS. The CLSM serves as the underlay below the CTB reinforced concrete slabs as indicated on Drawing 10912, i.e., it is not subject to a direct loading from the SSCs that may traverse the CTB slab or those that are placed on the CTF foundation slab. In addition, the CLSM is upgraded to ITS for conservatism notwithstanding the fact that there is no credible failure mode of the CLSM that can possibly cause fuel failure or release of radioactivity. The details of the CTB are captured on Licensing Drawing 10912.

VCT (Vertical Cask Transporter) will no longer be used inside the CTB, instead, a HI-PORT (trailer-style transporter shown on Licensing Drawing 12481) will be used to transport the loaded HI-TRAC CS from CTB to ISFSI pad where the HI-TRAN 225 VCT (shown on Licensing Drawing 12432) will pick up the cask and travel to the UMAX storage locations for MPC transfer operations. Therefore, the loads from loaded VCT on the CTB slab and the CTF pit are no longer applicable. Without the presence of such a heavy load on or in the vicinity of the CTF shell, the lateral stress on the shell, as would be expected from the Boussinesq effect, is quite low and localized. The updated operations are shown in Chapters 3 and 10 of the HI-STORE SAR.

The detailed CTB analysis considering the overhead crane and all- other live loads inside the building is performed in calculation package, HI-2210576. The details of the analysis are discussed in response to RAI 5-9, and they are also summarized in Subsection 5.3.2.4 of the SAR. The CTB slab qualification is also presented in HI-2210576 with additional calculations in Supplement 11 of HI-2177585 for loads from loaded HI-TRAC CS, loaded HI-TRAC CS on HI-PORT, loaded HI-STAR 190 on rail car and loaded HI-STAR 190 on tilt frame and saddle under normal and seismic conditions. The applicable seismic accelerations are obtained from the detailed CTB analysis in HI-2210576. The CTF foundation slab is also evaluated in Supplement 11 of HI-2177585 for normal and seismic conditions with the seismic accelerations obtained from HI-2210576.

RAI-5-21-S: Provide stress-strain curves based on material testing for SA-516 Gr. 70 at 400 degrees F.

In its response to RAI 5-21, the applicant did not fully address the staff's request. Supplement 5 to Holtec Report No. HI-2177585 provides stress-strain curves with estimated material properties (n and k coefficients) for SA-516 Gr. 70 at 400 deg. F, which is used in seismic simulations of the HI-TRAC CS. Material properties used in ITS equipment should be well defined and based on physical testing to support the seismic evaluations. The staff notes that the letter (ML21110A671) transmitting responses to NRC staff RAIs for the Model No. ATB-1T package used a methodology to construct stress-strain curves for SA-516 Gr. 70 at 400 degrees F that could be incorporated or referenced in this application.

This information is necessary to determine compliance with 10 CFR 72.24(c)(3) and 72.122(b)(2)(i)

Holtec Response:

The stress strain curve for material SA-516 Gr. 70 at 400°F provided in Supplement 5 to Holtec Report No. HI-2177585 is a power law true stress-strain curve established based on the calculated n and K coefficients, which corresponds to the minimum strength properties of the material required by the ASME Code. As the staff correctly notes, the methodology used to calculate n and K coefficients is identical to the method employed in the HI-STAR ATB-1T SAR and further described in Holtec's RAI

response letter (ML21110A671). This numerical method of constructing a true stress-strain curve for input to LS-DYNA has been thoroughly benchmarked against physical measurements for 15 different test specimens involving 3 different metals. The complete results of this benchmark study are documented in Holtec Report No. HI-2210251, “Benchmarking of Material Stress-Strain Curves in LS-DYNA”, which was previously submitted to the staff for review under Docket No. 71-9375. The benchmark study concludes that there is good agreement between the physical test measurements and the results of the LS-DYNA numerical simulations for all test specimens, and therefore the material representation in LS-DYNA, which is based on the power law true stress-strain curve, is acceptable for analyzing dynamic impact events pursuant to 10CFR71 and 10CFR72 applications. Lastly, it is conservative to use the ASME minimum strength properties for material SA-516 Gr. 70 at 400°F, as opposed to higher strength values of the actual material used in HI-TRAC CS fabrication, to construct the true tress-strain curve from the perspective of HI-TRAC CS structural analysis.

Subsection 5.4.1.4 of the HI-STORE SAR has been updated to include a brief description of the LS-DYNA material model along with a reference to Holtec Report No. HI-2210251.

RAI-5-23-S: Provide supporting buckling calculations for the transport cask horizontal lift beam, sling specifications, crane details, CTB details and floor slab safety classification.

In its RAI response, the applicant provided an incomplete buckling analysis. It indicated that it would provide slenderness ratio values to support a buckling analysis of the transport cask horizontal lift beam (BOM 1-3, Sheet 1 of Drawing 10894) in a future revision of Supplement 9 to Holtec Report No. HI-2177585. The applicant should examine all code provisions, and not just ASME NF-3322.1 (slenderness ratio criteria). Confirm that all provisions (and design criteria) stipulated in section NF of the ASME code have been met and update the SAR accordingly. In addition, all slings (lifting equipment) appear to have only been designated as commercial items on the licensing drawings. Clarify whether the slings’ capacity accounted for the seismic loading. Thus, material specifications for the slings and their dimensions should be placed on the drawings and the SAR updated appropriately.

In general, with respect to seismic loads, the applicant has relied upon a lifting analysis to support the dynamic analyses for the tilt frame and saddle. Explain how this essentially static scenario appropriately accounts for the dynamic behavior of the components in a seismic event such as when a cask begins to oscillate during the event. Such a scenario will depend on the interaction of the crane that supports the cask, since it is free to move independently from the carried cask itself. Thus, provide greater detail regarding the crane design (materials, member sizes, layout, connection details, etc.).

This information is necessary to determine compliance with 10 CFR 72.24(c)(3) and 72.122(b)(2)(i).

Holtec Response:

Supplement 9 of HI-2177585R2 and drawing 10894R1 have been updated to address this RAI. Design details of the crane and the CTB (including slab) are provided in drawings 12404R0 and 10912R0, respectively. The drawings also include safety classifications. The crane and the reinforced concrete structures in the Cask Transfer Building (CTB) including the slab and the walls are designated as ITS.

A quantitative buckling analysis has been presented in subsection 9.7.8 of Supplement 9 of HI-2177585. The analysis follows the provisions of NF-3322 with due consideration to slenderness ratio and width ratio criteria. Other relevant stress criteria in subsection NF have also been considered. They are shown to be bounded by the NUREG 0612/ANSI N14.6 stress criteria (subsection 9.3 of Supplement 9).

Required sizing details for the slings (items 13-15 of drawing 10894R1) are now presented in subsection 9.7.10 of Supplement 9. They are sized to meet a 10:1 design factor between the ultimate load and the lifted load. This is also shown to exceed the maximum possible seismic load. The capacity ratings, sling widths, and commercial slings that satisfy the requirements are now shown in the BOM of drawing 10894R1.

To address seismic loads, Supplement 9 refers to HI-2210576R0, the seismic and structural analysis of the CTB. The seismic model of the CTB is built with sufficient detail to accurately capture the dynamic response of the crane, trolley, hanging load and their connections during the SSE event. Response spectra generated from the trolley acceleration time histories are then used in subsection 9.7.9 of Supplement 9 of HI-2177585R2 to evaluate the maximum seismic loads on the Horizontal Lift Beam and the potential for impacts due to cask oscillations. The results from the seismic evaluation demonstrate that there are large margins of safety for the lift beam and against any cask impacts.

RAI-5-24-S: Provide justification for the seismic loads on the tilt frame, saddle, transport cask horizontal lift beam, slings, and other lifting equipment used to lift a transportation cask.

In its response to RAI 5-24, the applicant stated that, in essence, the combination of existing analysis along with certain assumptions of the seismic loading, ensure that safety factors for the tilt frame, saddle, transport cask horizontal lift beam, slings, and other lifting equipment used to lift a transportation cask are greater than one.

The applicant's response considered that the components are rigid for the dynamic aspect of the analysis. This approach further assumes that the use of the peak seismic response based on a response spectrum is sufficient without further performing an actual dynamic time history of the components for all situations depicted in Figures 3.1.1. However, seismic loads that would occur in Figure 3.1.1, are three dimensional in nature, and should be applied at any orientation.

Accordingly, in all scenarios depicted in Figure 3.1.1, the interaction of the building and/or crane with the loaded cask should be addressed. The following scenarios should be considered:

a. Based on the "representative drawings" of the crane in Appendix A of Holtec Report No. HI-2177585R0, the cask could have a large degree of freedom when subjected to seismic loads. Accordingly, analyze whether the loaded cask's movement under seismic loads would result in collision with other components (e.g., the crane, CTB, saddle, tilt frame, etc.). Justify whether the slings arranged as depicted in Figure 3.1.1b provide sufficient torsional or lateral resistance to three (3) seismic components.". As indicated previously, the crane design needs to be considered in a time history analysis when carrying a cask.

b. In Figure 3.1.1d, the cask as depicted will impart lateral shearing forces at the trunnion bearing portion of the tilt frame. Analyze whether failure of this location during a seismic event could cause

the unsupported cask to potentially rotate and strike the CTB floor. In addition, explain whether the cask may bear on only one side of the tilt frame, causing that side of the tilt frame to flex, potentially causing the cask to lose contact at the other trunnion (slip off the tilt frame). The applicant should evaluate the tilt frame, saddle, and slab connections (anchor bolts) to resist static and dynamic loads.

c. A similar scenario to that referenced in (b) above is also present in Figure 3.1.1g. Here, with lifting equipment still attached when upending a cask, any lateral movement of the crane could "pull" the lifting equipment out. Explain whether, depending on the angle of the cask while being lifted, the cask may strike the floor when the tilt frame is sheared at the trunnion bearing location. The applicant should evaluate this scenario for dynamic stability of the cask lifting.

d. Figure 3.1.1f depicts the "canister" with its bolts removed. Analyze the loss of the lid and the sliding out of the fuel/canister within the over pack while still on the tilt frame and saddle due to seismic loading. Analyze whether this scenario during operation could cause an unshielded canister to slide out relative to the shielded overpack (and any associated effects for dose or canister integrity from dropping on the building floor).

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

Holtec Response:

In response to Staff's concerns, detailed seismic evaluations have been performed for the crane carrying the suspended mass of transportation cask in HI-2210576, horizontal lift beam carrying the transportation cask in Supplement 9 of HI-2177585 and tilt frame/saddle assembly with the transportation cask resting on it in Supplement 13 of HI-2177585.

a. In HI-2210576, a detailed seismic analysis is performed for the Cask Transfer Building (CTB) including the overhead crane (depicted in Licensing Drawing 12404) with the suspended mass of fully loaded HI-STAR 190 cask with impact limiters (maximum). The seismic accelerations and displacements at the crane trolley level from the analysis are then used to predict the seismic loads in all directions on horizontal lift beam and slings, and the lateral displacements of the suspended cask in Supplement 9 of HI-2177585. It is demonstrated in Supplement 9 that the maximum loads are within the capacities of lift beam and slings, and the cask displacements are less than the available clearances in the CTB. Note that the crane design is no longer a gantry-type as depicted in the illustrative Figures 3.1.1 of the HI-STAR SAR; therefore, impacts with gantry-crane legs are not credible. Also, the cask will only be carried above tilt frame/saddle assembly before setting it down on or after lifting it from the tilt frame/saddle assembly, i.e., the cask will not be in the same horizontal plane as the tilt frame/saddle assembly leading to impacts in the event of a site-specific earthquake.

b. In Supplement 13 (Attachment 13A) of HI-2177585, a detailed stress analysis of the tilt frame/saddle assembly is performed using seismic loads that envelope those obtained from the CTB seismic analysis in HI-2210576. The analysis demonstrates that the lateral forces on tilt frame (depicted in Licensing Drawing 10899) do not cause any overstress in the frame resulting in a drop of the cask. A representative design of the tilt frame and saddle anchors is also included in Supplement 13 of HI-2177585. The available cask trunnion landing length on the tilt frame (per Licensing Drawings 9841 and 10899) and the clearance between the two sides of the tilt frame will not result in the cask

losing contact at one trunnion when the cask bears up against the other side in the event of a site-specific earthquake. The deflection/flexure in tilt frame is negligible under seismic loads per Supplement 13 of HI-2177585.

c. This specific scenario is now shown in Figure 3.1.1f of the HI-STORE SAR. As discussed in “b” above, failure of tilt frame is not credible in the event of a site-specific earthquake. In addition, one cask trunnion cannot slip off when the cask bears up against the other end of tilt frame or HI-STAR 190 lift yoke arms (Licensing Drawing 10902). Therefore, the dis-engagement of cask from tilt frame or lift yoke leading to free rotation or drop of cask is not credible.

d. Holtec regrets the confusion with regards to Figure 3.1.1f of the HI-STORE SAR. The transport cask lid will not be unbolted with the cask in the horizontal orientation. The transport cask lid is only removed when it is placed inside the CTF cavity in vertical orientation. Therefore, there is no potential for the canister to slide out of the HI-STAR 190 transport cask. Figure 3.1.1 of the HI-STORE SAR has been revised to clearly show the bolt removal occurring after the transport cask is placed in the CTF. The seismic analysis performed in Supplement 13 of HI-2177585 demonstrates that the loaded cask remains stable and the canister will remain inside HI-STAR 190 cask during all handling (or short-term) operations on tilt frame/saddle assembly, and there would be no breach of confinement boundary as the seismic accelerations experienced by the canister at HI-STORE site are significantly lower than those the canister (MPC) is qualified to in HI-STORM FW FSAR.

CHAPTER 6 RAIs

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PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390

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RAI-6-2-S: Provide justification for the statement in Section 9.2.1, “Storage Systems,” of the HI-STORE SAR that the pressure and temperature induced stresses a loaded canister will experience at the HI-STORE CISF, due to the ambient temperature at the site, will be bounded by those for which the canisters have been analyzed by thermal models in the HI-STORM UMAX FSAR (Docket No. 72-1040).

The HI-STORE SAR describes the design basis heat load for all canisters eligible for storage at HI-STORE (see Tables 4.1.1, “Maximum Decay Heat Load for MPC-37 (PWR Fuel Assembly),” and 4.1.2, “Maximum Decay Heat Load MPC-89 (BWR Fuel Assembly),”) as lower than that of the canisters certified under Docket No. 72-1040 (see Tables 2.1.8, “HI-STORM UMAX MPC-37 Permissible Heat Loads,” and 2.1.9, “HI-STORM UMAX MPC-89 Permissible Heat Loads,” in the HI-STORM UMAX FSAR). The application states that it follows that the pressure in the canisters and hence any pressure-induced stresses will be

lower in HI-STORE canisters than their certification-basis in the HI-STORM UMAX FSAR; however, this statement has not been justified. The canisters in the HI-STORM UMAX FSAR were analyzed with the assumed 26.67 °C (80 °F) ambient temperature boundary condition applied to the thermal model; however, according to the FLUENT model provided in the HI-STORE CISF SAR, the inlet boundary temperature for the normal conditions model was 16.67 °C (62 °F), which was reported as the annual average temperature. As mentioned in staff's RAI 6-2, this temperature does not consider that during three months of the year at the proposed site, the average monthly maximum temperature ranges from 33.65 °C (92.57 °F) to 34.23 °C (93.62 °F), as reported in Table 2.3.1 of the HI-STORE SAR. The average monthly maximum temperature ranges are consistent with how NUREG-1567 defines, "Normal," which is:

> *The maximum level of an event or condition expected to routinely occur. The ISFSI is expected [to] remain fully functional and to experience no temporary or permanent degradation from normal operations, events, and conditions. Compares to "Design Event I" of ANSI/ANS 57.9. Events and conditions that exceed the levels associated with "normal" are considered to be, and to have the response allowed for, "off-normal" or "accident-level" events and conditions.*

Therefore, for normal conditions, defined as the maximum level of an event or condition expected to routinely occur, it has not been justified that the maximum ambient condition expected to routinely occur has been used as input to the stresses that that the canister will experience at the HI-STORE CISF, especially considering the high ambient temperatures that are present for up to three months out of a year. Nor has it been justified that the temperature-induced and pressure-induced stresses that the canister will experience at the HI-STORE CISF, which should consider the maximum ambient temperature, are, therefore, bounded by those for which the canisters are analyzed by thermal models in the HI-STORM UMAX docket, where a lower ambient temperature was used. This information is needed to demonstrate that the confinement boundary can withstand the stresses and pressures experienced during normal, off-normal, and accident conditions and remain below allowable limits.

The demonstration and justification in the HI-STORE SAR that the CISF can meet the abovementioned items can consider new analyses or relevant analyses (e.g., higher ambient temperature) in the HI-STORE SAR and the cited UMAX FSAR.

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

Holtec Response:
The previous statement in Section 9.2.1 of the HI-STORE SAR was not well justified, and the section has been revised in the latest SAR to more accurately reflect the certification basis for the HI-STORE canisters. Also, thermal analysis of the UMAX System has been performed to consider the increased ambient temperature conditions at the HI-STORE CISF site. Additional information and technical justification are provided below.

As discussed in Section 3.0 and Paragraph 3.1.3.2 of the HI-STORM UMAX FSAR, the certification basis for the structural qualification of the Multi-Purpose Canister (MPC) is adopted from Revision 6 of the HI-STORM FW FSAR. In other words, the HI-STORM UMAX FSAR refers to Chapter 3 of the HI-STORM FW FSAR for the stress qualification of the MPC, including the calculation of the pressure and temperature induced stresses in the MPC. The HI-STORE SAR, in turn, leverages the generic certificate for the HI-

STORM UMAX as the basis for the application. In particular, Section 5.0 of the HI-STORE SAR states the following:

> "The HI-STORE CIS facility utilizes the subterranean canister storage system referred to as HI-STORM UMAX certified in NRC Docket #72-1040 [1.0.6]. As the safety determination in this chapter shows, from the structural standpoint, the HI-STORM UMAX design can be adopted in its entirety from its native docket for the HI-STORE CIS facility without the need for any modification. The basis for this adoption, as elaborated in this chapter, is supported by the existing structural qualifications of the HI-STORM UMAX system that have been previously reviewed by the NRC and which uniformly bound all HI-STORE CIS site-specific loadings."

Thus, the structural qualification of the MPC at the HI-STORE CISF site also incorporates by reference the analysis results from the HI-STORM FW FSAR. This is clear from Table 5.0.3 of the HI-STORE SAR, which refers directly to Section 3.4 of the HI-STORM FW FSAR for the structural qualification of the MPC-37 and MPC-89.

Per subparagraph 3.4.4.1.5 of the HI-STORM FW FSAR, the stress analysis of the MPC Enclosure Vessel is based on a bounding normal internal pressure of 120 psig and conservatively applied temperature contours, which envelope the thermal evaluations for short-term normal and off-normal conditions in Sections 4.5 and 4.6 of the HI-STORM FW FSAR, respectively. The stress allowables for the MPC components are also obtained at conservatively bounding temperatures. Due to the higher heat load limits for the MPC-37 and MPC-89 associated with HI-STORM FW CoC, the MPC internal pressure and the metal temperatures of the MPC Enclosure Vessel are much greater for the generic HI-STORM FW System than they are for the HI-STORE CISF site application, even when the higher ambient temperature conditions are considered.

Per Table 2.3.1 of the HI-STORE FSAR, the highest average monthly maximum temperature at the HI-STORE CISF site is 93.62^{o}F. Steady state thermal evaluation of the HI-STORM UMAX is performed at a bounding ambient temperature of 94^{o}F using the thermal model in Holtec report HI-2177591. The results from this evaluation are documented in Holtec report HI-2177591 and adopted in the structural evaluations discussed above.

RAI-6-5-S: Clarify that the generic Operational Limit described in HI-STORE CIS SAR Section 10.3.3.1 will state that an approved methodology will be used if there is a need to evaluate a time limit during the operation.

The response to RAI 6-5 states that the Operational Limit in HI-STORE CIS SAR Section 10.3.3.1 is a generic requirement; this recognizes that the bounding MPC-37 and MPC-89 canisters in the HI-STAR 190, which is the content and transportation package requested to be licensed in this submittal, do not have a time limit. The "generic" language in the Operational Limit should be clarified to reflect that approved methodology should be used in an evaluation (e.g., as discussed in SAR Section 6.4.2.4).

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

Holtec Response:
The response to RAI 6-5 was stating, correctly, that there was no time limit for the MPC-37 under certain conditions (i.e., with helium in the annulus). An evaluation is still necessary of the annulus does not contain helium (e.g., nitrogen or air). Text is added to the Operational Limit on Subsection 10.3.1.1 specifying that such evaluations must be performed using NRC-accepted methodologies.

RAI-6-7-S: Clarify whether there is a need for removal of the outlet vents during use of the HI-TRAC (per HI-STORE SAR Section 10.3.3.5) and, if so, the measures that will take place to ensure debris will not enter the annulus.

The response to RAI 6-7 states that the 15 feet, 6 inches pitch was incorporated in the Technical Specifications and that the incorrect pitch in HI-STORE SAR Table 1.1.1 was corrected. If removal of outlet vents is still needed with the revised pitch, the SAR should be updated to mention the measures necessary to ensure debris does not enter the annulus while the outlet vents are removed.

This information is needed to determine compliance with 10 CFR 72.26 and 72.122(b).

Holtec Response:
The reviewer is correct that the outlet vent assembly may need to be removed under some circumstances. The cask-to-cask pitch does not affect the need to remove the outlet vent assemblies. The vent assemblies need to be removed to permit the Vertical Cask Transporter to traverse over loaded storage modules. But when the vent assembly is removed the resultant opening is covered by a low-profile Temporary Cover Screen assembly that prevents debris from entering the outlet without blocking airflow. The Operations Note in Subsection 10.3.3.5 is modified to reflect this.

RAI-6-8-S: Clarify in the HI-STORE SAR and Technical Specifications that operations will be taken in an appropriate timeframe to ensure that large blockages of inlet and outlet vents will not result in temperatures above allowable values.

Depending on when the issue is corrected, Technical Specification LCO 3.1.1 and SR 3.1.2 can allow a vent to be blocked for up to 62 hours. However, there is no way to know, *a priori*, whether the vents have been blocked 51% or 85% or 100% (for example) between the surveillances that take place every 24 hours. Recognizing that the information from the UMAX FSAR Section 4.6.2.3 indicates that 100% inlet vent blockage could result in cladding temperatures of 518 °C after 32 hours, language in the HI-STORE CIS SAR and Technical Specification should clarify that surveillances that discover large blockages must quickly act within a time period shorter than the allowed 62 hours.

This information is needed to determine compliance with 10 CFR 72.26 and 72.122(b).

Holtec Response:
As was stated in the response to RAI 6-8, consistent with prior NRC approvals the duration of the event begins at the time of discovery. This is true for every generic storage system Certificate of Compliance and every site-specific storage license issued for a Holtec-designed system including:
HI-STAR 100, Docket 72-1008
HI-STORM 100, Docket 72-1014
HI-STORM FW, Docket 72-1032

HI-STORM UMAX, Docket 72-1040
Diablo Canyon ISFSI, Docket 72-26, License SNM-2511
Humboldt Bay ISFSI, Docket 72-27, License SNM-2514

For each of these certificates and licenses, the corresponding Technical Specification presents the Completion Time convention in the Discussion portion of Section 1.3 of Appendix A, wherein it is stated that the Completion Time "… is referenced to the time of discovery of a situation (e.g., equipment or variable not within limits) that requires entering an ACTIONS Condition …". The established precedent, therefore, is that there is no requirement to assume a blockage (either partial or full) exists prior to its discovery during the periodic surveillance.

It is noted that the HI-STORE Technical Specification Basis B 3.1.1 ACTION C.2.1 and the HI-STORM UMAX Technical Specification Basis B 3.1.2 ACTION C.2.1 contain essentially identical language to this effect, as follows:

> From the HI-STORE Technical Specification Bases: "The Completion Time reflects the 8 hours to complete Required Action B.1 and the appropriate balance of time consistent with the applicable analysis results. The event is assumed to begin at the time the SFSC heat removal system is declared inoperable. This is reasonable considering the low probability of all inlet and outlet ducts becoming simultaneously blocked."
>
> From the HI-STORM UMAX Technical Specification Bases: "The Completion Time reflects the 8 hours to complete Required Action B.1 and the appropriate balance of time consistent with the applicable analysis results. The event is assumed to begin at the time the SFSC heat removal system is declared inoperable. This is reasonable considering the low probability of all inlet ducts becoming simultaneously blocked."

As the current implementation of the LCO is already consistent with both the definition of Completion Time and with prior license precedent, no change is necessary.

RAI-6-9-S: Clarify in the HI-STORE SAR that temperature monitors and associated temperature monitoring instrumentation used as the sole means of surveillance are designated as ITS.

As a result of RAI 6-9, HI-STORE SAR Section 3.4.1 was updated to mention that temperature monitors and associated temperature monitoring instrumentation used as the sole means of surveillance are designated as ITS. However, other relevant portions of the SAR were not similarly revised. For example, the current HI-STORE SAR Section 3.1.5.4 informs the reader that temperature monitors are not classified as ITS.

This information is needed to determine compliance with 10 CFR 72.128(a)(1).

Holtec Response:
Subsection 3.1.5.4 is modified to refer to Subsection 3.4.1 for the safety classification of the temperature monitors and associated instrumentation. Because Subsection 3.1.5.4 was missed previously the entire SAR was searched for any other locations that may have been missed. No other missed locations were found.

RAI-6-11-S: Revise the headings and descriptions within the HI-STORE SAR and the Technical Specifications that pertain to vent blockage so that they reflect the analyses that demonstrate thermal performance.

There are several instances in the HI-STORE SAR and Technical Specifications whereby the headings and discussions associated with vent blockage do not reflect the conditions of the referenced analyses.

According to HI-STORE SAR Chapter 15.2.4, the off-normal event is titled “Partial Blockage of the Air Inlet and Outlet Ducts.” It states that SAR Section 6.5.1 is bounded by the evaluations reported in Section 4.6.1 of the HI-STORM UMAX FSAR (incorporated by reference). However, the HI-STORM UMAX off-normal event is titled “Partial Blockage of Air Inlet Plenum”, in which it is assumed that only the UMAX air inlet vents are 50% blocked. If the application refers to the UMAX FSAR analysis that assumes 50% inlet vents blocked and 100% outlet vents unblocked, then the heading and description of HI-STORE CIS SAR Chapter 15.2.4 should indicate it is based on assuming 50% inlet vent blockage and 100% outlet vent unblocked.

In addition, the heading for the proposed HI-STORE Technical Specification LCO 3.1.1 states that the heat removal system is operable when 50% or more of the inlet vent duct areas and 50% or more of the outlet vent area are unblocked and available for flow. However, the time periods associated with the LCO are based on the analysis in UMAX FSAR Section 4.6.1, in which only the air inlet vents are blocked by 50%, which is not as severe a condition as stated in Technical Specification LCO 3.1.1. The time periods in the Technical Specification should be based on a representative thermal analysis. If the application relies on the UMAX FSAR analysis that assumes 50% inlet vents blocked and 100% outlet vents unblocked, then the heading for Technical Specification LCO 3.1.1 should indicate it is based on assuming 50% inlet vent blockage and 100% outlet vent unblocked.

The headings and descriptions in the HI-STORE SAR and the Technical Specifications should reflect what has been analyzed so that the person inspecting the vents recognizes when an operating condition is an analyzed condition or not.

This information is needed to determine compliance with 10 CFR 72.26 and 72.122(b).

Holtec Response:
Evaluations performed for vent blockages on another of Holtec’s ventilated storage casks (HI-STORM FW, Docket 72-1032) indicate that blocking 50% of the outlet vents coincident with the 50% off-normal and 100% accident inlet vent blockages does not result in peak cask temperatures significantly higher than those with completely unblocked outlet vents. In response to this RAI, HI-STORE-specific vent blockage analyses are performed.

The HI-STORE-specific 50% vent blockage is a simultaneous blockage of 50% of the inlet area and 50% of the outlet area. This is evaluated as a steady-state condition. Results indicate that all normal condition and off-normal condition temperature and pressure limits are met. The vent blockage discussions in HI-STORM SAR Subsections 6.5.1, 15.2, 15.2.4 and Table 6.0.1 and Appendix 16.A (Technical Specification Bases B 3.1.1) are modified to reflect the consideration for outlet vents to be simultaneously blocked up to the same level as the inlet vents during this blockage scenario.

The HI-STORE-specific 100% vent blockage is a simultaneous blockage of 100% on the inlet area and 100% of the outlet area. This is evaluated as a transient condition with a duration of 32 hours (to match the time for actions in the LCO). Results indicate that all accident condition temperature and pressure limits are met. The vent blockage discussions in HI-STORM SAR Subsections 6.5.2.5, 15.3, 15.3.10 and Table 6.0.1 and Appendix 16.A (Technical Specification Bases B 3.1.1) are modified to reflect the consideration for outlet vents to be simultaneously blocked up to the same level as the inlet vents during this blockage scenario.

RAI-6-12-S: Provide the maximum ambient temperature for conducting operations in the proposed HI-STORE Technical Specifications.

Currently, proposed HI-STORE Technical Specification 4.2.4 provides a minimum ambient temperature for performing short term operations; provide a corresponding maximum temperature limit for operations (e.g., transfer). Although the response to RAI 6-12 stated that including a maximum ambient temperature is unnecessary, the Technical Specifications should indicate the maximum ambient temperature for conducting operations and the basis for that value should be provided, recognizing that ambient temperatures could reach 108 °F at the site and that, depending on site operations, temperatures inside a building can be greater than ambient conditions.

This information is needed to determine compliance with 10 CFR 72.26 and 72.122(b).

Holtec Response:

The instantaneous temperature (i.e., the temperature reading from a thermometer) need not be limited due to the large thermal inertia of the HI-TRAC, as explained in the Holtec response to RAI 6-12. It is agreed, however, that the three-day average ambient temperature of 91°F is an appropriate upper temperature limit for short-term operations. Technical Specification 4.2.4 is modified to include this upper limit on temperature for performing short term operations.

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RAI-6-19-S: Provide updated heat transfer boundary condition assumptions associated with the potential collapse of a reinforced concrete structure for a canister placed within the HI-TRAC CS and HI-STAR 190 package while inside the CTF and CTB.

Certain assumptions discussed in the response to RAI 6-19 are based on the effect of corrugated metal collapsing over the HI-TRAC CS and HI-STAR 190 package in the CTB and CTF. However, the design of the CTB has been revised to a reinforced concrete frame structure rather than a corrugated structure. A reinforced concrete frame structure, if it collapsed, would include different types of debris around the HI-TRAC CS, HI-STAR 190, and CTF, which could result in different thermal-related assumptions (including those listed in items (a) through (f) in the original RAI 6-19) than those originally considered for a corrugated structure. This issue was not addressed in the RAI response.

This information is needed to determine compliance with 10 CFR 72.24(d) and 72.128(a).

Holtec Response:

The NRC staff is correct that the CTB design is now revised to a reinforced concrete structure. The structural evaluation of this CTB building design is now documented in Holtec Report HI-2210576, Revision 0. As demonstrated therein, the collapse of CTB structure is a non-credible event. Therefore, a thermal evaluation of this accident scenario is not required for the revised CTB design. All calculations related to thermal evaluation of CTB collapse have therefore been removed from Holtec Reports HI-2177553 and HI-2177597.

RAI-6-21-S: Provide a technical justification for the value of the reduced concrete density that is used in the shielding analysis for transfer cask concrete that exceeds the accident temperature limit.

The response to RAI 6-21 states that the concrete in the HI-TRAC CS transfer cask that exceeds the accident temperature limit is accounted for by using a reduced density in the shielding analysis to reflect potential degradation (as documented in HI-STORE SAR Table 7.3.1). Clarify how the reduced concrete density value was determined and how it conservatively accounted for all credible degradation effects, including any bulk effects (e.g., reduced water content) and those that may result in localized reduction of shielding capability (e.g., spalling, cracking).

This information is needed to determine compliance with 10 CFR 72.24(d), 72.106(b), and 72.128(a).

Holtec Response:

The design basis HI-TRAC CS accident case is modified to not only consider a reduction in concrete density [PROPRIETARY INFORMTION WITHHELD PER 10CFR2.390] but to also conservatively consider a total loss of hydrogen from the concrete material. The resultant areal density (g/cc) of the concrete

shielding assumed for accident conditions is conservatively lower than the areal density of the concrete shielding remaining post-thermal accident, taking into account degradation due to elevated temperatures, as described in Reference [6.5.4]. There are no localized “streaming paths” for radiation, following the thermal accident, meaning that the bulk of the HI-TRAC CS concrete shielding remains below temperatures that would cause the concrete to degrade. Additional text providing details on the accident conditions considered is added to Paragraph 7.4.2.2, and Table 7.4.4 is updated with the accident conditions dose at 100 meters from the accident for a 30-day period.

The concrete of the HI-TRAC CS is encapsulated between an inner and outer steel shell. The encapsulation of concrete minimizes any spalling, scaling, cracking, or loss of strength that could occur with unencapsulated rebar reinforced concrete. Any areas of concrete degradation during an accident with elevated concrete temperatures would remain encapsulated between the inner and outer steel shells of the HI-TRAC CS. From a shielding perspective, any degradation from high accident temperatures would be bounded by the more than [PROPRIETARY INFORMTION WITHHELD PER 10CFR2.390] density and total loss of hydrogen in the concrete considered in the shielding accident conditions model.

RAI-6-25-S: Justify the appropriateness of the “Unconditionally Safe Threshold” (UST) concept as defined in the HI-STORE SAR (e.g. Glossary, Section 1.0.1, Chapter 6).

It appears that the application is using the concept of UST for the first time. Clarify the descriptions in the Glossary, HI-STORE SAR Section 1.0.1, and Chapter 6 to provide a more detailed discussion of the UST, including how and when it is used for analyses and operations. In particular, explain how the use of the UST is compatible with the requirements of 10 CFR 72.48. Section 1.0.1 of the HI-STORE CIS SAR states that the UST defines the boundary that does not require the use of a 10 CFR 72.48 change process. However, the assessment required to be performed per the 10 CFR 72.48I(1) process for changes to the facility or spent fuel storage cask design as described in the FSAR or in the procedures as described in the FSAR is required for all applicable changes, including changes in evaluations that demonstrates the intended functions will be accomplished, and should be documented in accordance with 10 CFR 72.48(d)(1).

This information is needed to determine compliance with 10 CFR 72.48, 72.24(d), and 72.128(a).

Holtec Response:

Upon further review, the implementation of the UST concept as currently included in the SAR does appear to conflict with the requirements of 10 CFR 72.48. The UST concept is removed from the SAR.

RAI-6-26: Clarify whether the HI-STAR 190 transportation package remains leaktight in the event of a building collapse scenario that could occur before a receipt inspection leakage rate test is performed.

Explain whether the response to RAI 6-26, which describes that the sealing function of the HI-STAR 190 is not relied upon in a building collapse scenario, is consistent with the response to RAI LA-1 (ADAMS Accession No. ML19016A481), which describes that the integrity of the containment boundary of the HI-STAR 190 transportation package is maintained to be leaktight under conditions analyzed at the HI-STORE CISF without any time based restrictions.

The applicant states that the temperature of the HI-STAR 190 O-ring under that building collapse accident is 243 °C (469.4 °F). This temperature exceeds the 210 °C (410 °F) maximum temperature limit of the HI-STAR 190 O-ring that is provided in Table 4.4.4, "HI-STAR 190 Materials Temperature Limits," of the HI-STORE SAR, which could impact the ability for the HI-STAR 190 to remain leaktight. The ability of the HI-STAR 190 to remain leaktight would be important if there is a building collapse before a receipt inspection leakage rate test is performed that demonstrates that the MPC-37 or MPC-89 (i.e., the storage confinement boundary) is leaktight.

This information is needed to demonstrate compliance with 10 CFR 72.24(d), and 72.128(a).

Holtec Response:
As indicated in Holtec Response to RAI 6-19S and as demonstrated by structural analyses in Holtec Report HI-2210576, Revision 0, the collapse of the CTB is a non-credible event for the reinforced concrete structure. Therefore, the results of burial events resulting from CTB collapse are removed from Chapter 6 of the HI-STORE SAR and the revised Thermal Report HI-2177597. Therefore, consistent with the response to RAI LA-1, the HI-STAR 190 cask remains leak tight under all credible scenarios.

RAI-6-28-S: Clarify in the Caution box of Step 9 in Section 10.3.3.5 of the HI-STORE SAR that the time limit to open the shield gate is found in SAR Section 6.4.3.8 and that, if blockage of air flow cannot be removed within the SAR Section 6.4.3.8 time limit, then corrective actions must be taken within the timeframe of the relevantly defined accident condition scenario.

The text should clearly state that the relevant initial time limit (and calculation for determining the time limit) before ITS components reach normal allowable temperature limits is found in HI-STORE SAR Section 6.4.3.8.

In addition, clarify why SAR Section 10.3.3.5 (i.e., Caution box) does not mention that an accident condition is considered when the MPC experiences blockage of air flow within the HI-TRAC for periods greater than 6 hours. The user should be made aware that there is a limited amount of time before conditions may be reached when cladding (and other ITS components) are above their accident allowable temperature limits. To that end, the RAI response states that the analysis for the malfunction described in SAR Section 10.3.3.5 was bounded by the burial under debris event in the HI-STORM UMAX FSAR, which is found in Section 4.6.2.4 of the HI-STORM UMAX FSAR. The Caution box should reference that discussion, which indicates a specific time limit to reach allowable temperatures.

Finally, as stated in the RAI response, the burial under debris event appears to be relevant to the shield gate malfunction, considering that both inlet and outlet vents are unavailable to transfer heat. This is different from the Section 4.6.2.3, "100% blockage of air inlets" scenario in the HI-STORM UMAX FSAR, which allows for some heat removal via outlet ducts, currently stated in the Caution box. Therefore, the Caution box should refer to the analysis associated with the burial under debris event mentioned in the RAI response.

This information is needed to determine compliance with 10 CFR 72.24(d) and 72.128(a).

Holtec Response:
The reviewer is correct that the reference to Chapter 6 is not very specific, which could lead to confusion, and that extended blockage of airflow through the HI-TRAC is an accident condition. The text in the Caution box is modified to more precisely identify the subsection in Chapter 6 where the closed HI-TRAC shield gate time limit is located and to clearly state that a closed shield gate duration exceeding the limit therein is considered an accident condition bounded by the burial event. The mention of the blocked duct accident was inadvertently left in the last revision. It is replaced with reference to the burial event.

RAI-6-32-S: Demonstrate that there are no structural implications of thermal stresses at off-normal conditions (and any relevant accident condition) while the loaded MPC is placed within the HI-TRAC CS, CTF, and the UMAX module/VVM.

The effect of thermal stresses was considered in Holtec Report No. HI-2177553 “Thermal Analysis of HI-TRAC CS Transfer Cask” for normal conditions within the HI-TRAC CS, in Report No. HI-2177597, “HI-STORE CTF Thermal Evaluation” for “hot operation” conditions within the HI-STAR 190, and in Report No. HI-2177591 “Thermal Evaluations of HI-STORM UMAX at HI-STORE CIS Facility” for long term storage of the MPC within UMAX. These documents did not consider the impact of thermal stresses associated with off-normal conditions (and relevant accident conditions, e.g., extreme ambient temperatures) for the new design aspects of the HI-STORE system (e.g., HI-TRAC CS, CTF, and new design aspects of the VVM). Calculations should ensure the designs have adequately addressed (e.g., through sufficient clearance between components) the effects of potential thermal stresses from the varying temperatures and corresponding thermal expansions/contractions during normal and off-normal operations (and relevant accident conditions, e.g., extreme ambient temperatures).

Finally, although the RAI response appears to indicate that thermal stresses do not have to be analyzed due to language in ASME Code Section III, Subsection NF for Class 3 supports (mentioned in the response to RAI 6-32), the ASME Code does not assume that a system design will withstand thermal stresses, and, therefore, the effect of the thermal stresses should be addressed in the SAR.

This information is needed to determine compliance with 10 CFR 72.24(d) and 72.128(a).

Holtec Response:

As noted by the reviewer, differential thermal expansion calculations between SSC components under various normal condition scenarios were presented in Holtec reports HI-2177553, HI-2177597 and HI-2177591. In addition to those already presented, differential thermal expansion under the following additional off-normal and accident conditions have been performed and included in the above-mentioned reports:

1. HI-TRAC CS Fire Accident
2. HI-STORE UMAX Off-normal Ambient
3. HI-STORE UMAX Extreme Ambient
4. HI-STORE UMAX Partial Duct Blockage
5. HI-STORE UMAX All Duct Blockage
6. HI-STORE UMAX Fire Accident

Restraint-free expansion is demonstrated under all of the above scenarios.
RAI-6-34: Demonstrate how the increased amount of pressure due to rupture of rods would increase heat transfer through the UMAX system.

Although the footnote in HI-STORE SAR Section 6.4.3.2 indicated there would be improved thermal performance as a result of rod rupture, there were no supporting analyses which demonstrated that effect. Note that Interim Staff Guidance-7, "Potential Generic Issue Concerning Cask Heat Transfer in a Transportation Accident" has indicated the potential for higher component temperatures due to rod rupture.

This information is needed to determine compliance with 10 CFR 72.24(d) and 72.128(a).

Holtec Response:

A hypothetical rupture of rods results in release of fill gas and fission gases from the fuel rods into the MPC cavity. Consistent with NUREG-1536, 100% release of rod fill gas and 30% release of fission gases from a fuel rod rupture is assumed. Table 6-34.1 below summarizes the quantities of these gases for design basis fuel.
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The resultant mixture of gases in the MPC cavity has a much higher molecular weight than helium (in case there were no rods rupture) and is summarized below:

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Therefore, for the same cavity temperature and pressure, the gas mixture resulting from rod rupture will have significantly higher density than that with no rod rupture. This will enhance helium convection within the MPC resulting in a lower cavity temperature and therefore a reduced cavity pressure.

In previous approved applications such as HI-STORM FW FSAR (Docket No. 1032) and UMAX FSAR (Docket No. 1040), credit for this increased molecular weight of gases was included in the calculations of MPC cavity pressure under a 100% fuel rod rupture event. In HI-STORE FSAR, no such credit was taken thereby resulting in conservative computed results.

CHAPTER 7 RAIs

RAI-7-13: Revise Section 2.1 "Approved Contents, Fuel Specifications and Loading Conditions" of the Technical Specifications (TSs) for the HI-STORE CISF to add explicit specifications for the allowable contents for the MPC-37 and MPC-89 canisters that are qualified to be transported to the facility by the HI-STAR 190 package design that is approved based on the HI-STAR 190 SAR, Revision 3 (ML18306A916).

10 CFR 72.24(a) requires, *"[a] description and safety assessment of the site on which the ISFSI or MRS is to be located, with appropriate attention to the design bases for external events. Such assessment must contain an analysis and evaluation of the major structures, systems, and components of the ISFSI or MRS that bear on the suitability of the site when the ISFSI or MRS is operated at its design capacity."* (Emphasis added.)

In its response to the staff's RAIs, the applicant submitted revised shielding calculations (ML21004A242). In the revised shielding calculations, the source terms are developed based on the allowable contents for the MPC-37 and MPC-89 canisters as defined in Tables 7.C.8 and 7.C.10 of the HI-STAR 190 package SAR (ML17031A369). The applicant needs to add Tables 7.C.8 and 7.C.10 of the SAR for the HI-STAR 190 package, which includes specifications for the allowable combinations of burnup, enrichment, and cooling times for the authorized contents, into the Technical Specifications for the HI-STORE CISF.

This information is necessary to determine compliance with 10 CFR 72.24(a) and 72.26.

Holtec Response:
The explicit specifications for allowable combinations of burnup, enrichment, and cooling times for authorized contents from the HI-STAR 190 SAR HI-2146214, Revision 3, Appendix 7.C, Tables 7.C.8 and 7.C.10 are added in Section 2.1 of the HI-STORE CISF Technical Specifications.

RAI-7-14: Clarify if the HI-STORE CISF closure lid for the storage module VVM will address design changes previously implemented by Holtec to improve the shielding effectiveness of the UMAX Closure lid (ML16341B080). Specifically, clarify in the HI-STORE SAR the dose rate measurement locations and dose rate acceptance criterion for this new closure lid design. If the design has not been approved by the time of this application, the applicant needs to explicitly state that this design is part of the application for review and approval.

The HI-STORE CISF design uses a new closure lid for the storage module VVM and the applicant provided the drawings for the new lid. However, the applicant stated in the SAR that the closure lid design for the HI-STORE CISF is identical to that of the UMAX system. In its response to RAI 7-7, the applicant states that the HI-STORE CISF uses Version C of the HI-STORM UMAX closure lid design. However, Version C is not part of the certified design of Amendment 2 of CoC 1040 (ML16341B080), which is referenced in the HI-STORE SAR. Currently, Amendment 4 to the UMAX system resolved some of the issues with the previously approved amendments and Holtec has committed to taking corrective action(s) on them (ML17286A702). Therefore, the committed corrective actions, which include, but are not limited to, revised dose rates and locations, should be incorporated into the HI-STORE SAR.

This information is necessary to determine compliance with 10 CFR 72.104 and 72.106(a) and (b).

Holtec Response:
In the UMAX FSAR Chapter 5 Revision 4 the “Version B” lid is considered. The HI-STORE Facility uses HI-STORM UMAX Version C as shown in Drawing 10875. The Version C and Version B are geometrically identical. The only difference between UMAX Versions B and C is that some stainless steel materials in the Version B lid are changed to carbon steel in the Version C lid, which has an insignificant impact on the shielding design. The Version C MCNP models are available for NRC review in the submitted shielding calculation packages HI-2177599 and HI-2177600.

Table 7.4.2, which provides dose rates adjacent and 1 meter from the UMAX Module at five dose locations, references Figure 7.4.2 for the dose point locations. The UMAX ISFSI dose versus distance results are provided in Table 7.4.3, Table 7.4.7, Table 7.4.8, and Figures 7.4.3 and 7.4.4.

The UMAX Version C does not use the “standoff pins” mentioned in ML17286A702. Standoff pins are no longer part of the MPC basket design, and the HI-STORM UMAX Version C MCNP shielding models do not include “standoff pins” in the MPC fuel basket.

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RAI-7-16: Provide the Calculation Package titled: “Source Terms and Loading Patterns using SCALE 6.2," Holtec International, HI-2167524, Revision 5 and the base version from which Revision 5 was developed.

The applicant referenced the calculation package “Source Terms and Loading Patterns using SCALE 6.2," Holtec International, HI-2167524, Revision 5 in Holtec Report HI-2201004, “Bounding Source Terms for the HI-STORE CIS Facility” submitted on January 5, 2021 (ML21004A249). However, the referenced report was not submitted in the application materials, nor the actual calculation.

This information is necessary to determine compliance with 10 CFR 72.104 and 72.106(a) and (b).

Holtec Response:
The source terms used for the HI-STORE shielding calculations were generated in HI-2167524 Revision 2, which was submitted for the HI-STAR 190 SAR package and is available at ML18030A804. HI-2167524 Revision 5 is the most recent revision; the HI-STORE CISF SAR references the most recent revision. There were no changes to the source terms generated back in October 2018 for HI-2167524 Revision 2 (no calculational source term updates between Revisions 2 and 5), so HI-2167524 Revision 2 (already

submitted to and reviewed by the NRC) contains the relevant information and source term calculations pertaining to HI-2201004 Revision 0.

RAI-7-18: Provide a detailed description of the method used to calculate the production rate of Carbon-14 in the air. Additionally, provide the properties of the air (including the density, composition, and flow rate) used in the C-14 production calculation.

Carbon-14 production resulting from neutron irradiation of the isotopes of 14N(n, p)14C, 17O(n, α)14C, and 16O(n, α)13C/13C(n, γ)14C is a two-step reaction in which an O-16 atom absorbs a neutron to produce a C-13 atom by 16O(n, α)13C reaction and the C-13 atom further absorbs a neutron to produce C-14 by 13C(n, γ)14C reaction. As such, the air activation calculation involves three major parameters: the neutron flux, the air flow rate, and concentrations of the isotopes of 14N, 17O, and 16O in the air. The applicant states in the calculation package titled "HI-STORM UMAX C-14 Dose Rate versus Distance" (ML21004A248):

> *"MCNP calculations are performed to determine air activation within and surrounding the UMAX system."*

However, the staff's understanding of the MCNP code is that it can only calculate the neutron reaction rates with the isotopes/elements of interest in a static system. Therefore, provide an explanation on how the air flow rate was handled in the model, to clarify how the air flow rate was factored into the C-14 production analysis.

In addition, Table 5-1 of the C-14 dose rate calculation package (ML21004A248) includes the density of the air but does not provide information for the air composition. Because the composition for the air is critical for the air activation calculation, provide the composition of the air and a justification for the applicability of the air density and air composition data for the calculation of C-14 production at the HI-STORE CISF.

This information is necessary to determine compliance with 10 CFR 72.104(b) and 72.104(c).

Holtec Response:
The evaluation of the two-step reaction $^{16}O(n,\alpha)^{13}C$ / $^{13}C(n,\gamma)^{14}C$ is included in Appendix G of HI-2200954 R1. It is shown that this reaction has a very low probability to occur.

The composition and density of air in air activation calculation are provided in Table 3-1 and Table A-2 of HI-2200954 R1, based on calculation provided in Appendix A of HI-2200954 R1. These composition and density values are included in FM card as part of tallying.

The volumetric air flow rate is provided in Table 5-1 of HI-2200954 R1. The air flow rate is discussed further in response to RAI 7-19.

RAI-7-19: Clarify the definition of "proximity of dose location" and justify why the selected air activation is conservative or recalculate the C-14 production as necessary.

The applicant submitted revised shielding calculations on January 4, 2021 (ML21004A242) and a supporting technical report titled: "HI-STORM UMAX C-14 Dose Rate versus Distance." In the technical report, the applicant states:

> *"There are two sources of C-14 radiation dose rates at any location, which are:*
> *- Activated air generated at proximity of dose location,*
> *- Activated air generated at further distances."*

Clarify where the "proximity of dose location" is and why this selected location for calculation of the air activation is conservative.

This information is necessary to determine compliance with 10 CFR 72.104(b) and 72.104(c).

Holtec Response:

Regarding the air flow rate, the following approach is used in HI-2200954 R1. The details are provided in Section 3.2 of HI-2200954 R1.

[

PROPRIETARY INFORMATION WITHHELD IN ACCORDANCE WITH 10CFR2.390

]

The word "proximity" is replaced by "within 100 m of dose location."

Several conservative assumptions used in this report are re-stated (including why the selected location for calculation of the air activation is conservative) in Section 10.0.

CHAPTER 9 RAIs

RAI 9-3: Clarify the content in Section 9.2.2, "Operational Activities," (Page 9-7) of the HI-STORE SAR.

In the response to RAI 9-3, Section 9.2.2 of the HI-STORE SAR was revised to state that "no credible normal, off-normal or accident conditions" could challenge the integrity of the canister confinement integrity and result in a release of any radioactivity. However, Section 9.2.2 should consistently address normal, off-normal and accident conditions while on-site prior to, or during receipt inspection. Clarify how this was addressed in the following sentence from Section 9.2.2 (the text below is underlined for added emphasis).

"Hence once the canisters have passed the receipt inspection, also discussed in Subsection 9.2.1, there is no credible normal, off-normal, or accident conditions that could challenge the integrity of the canister confinement system and result in a release of any radioactivity"

If there is/are (a) normal, off-normal, or accident condition(s) that could challenge the canister confinement system while on-site prior to, or during, receipt inspection, those should be described in the SAR. Explain how the statement in Section 9.2.2 is consistent with Section 9.2.1, "Storage Systems," (Page 9-4) which states:

"*All normal, off-normal and accident conditions relevant to confinement integrity for which the canister is certified in the HI-STORM UMAX docket are equal to or less severe at the HI-STORE facility. Therefore, there are no new conditions for the HI-STORE CIS facility that would require additional confinement analyses."*

This information is needed to determine compliance with 10 CFR 72.104(a) and 72.106(b).

Holtec Response:
Prior to and during the receipt inspection, the canisters at the HI-STORE facility are kept inside the transportation cask in which they arrived. The transportation cask is certified for the specific canister and contents, therefore, temperatures, pressures, and stresses remain within their analyzed limits so there are no normal or off-normal conditions that would challenge the confinement integrity of the canister. Additionally, the transportation cask is designed to the hypothetical accident conditions specified in 10 CFR Part 71. These accident conditions are more severe than any of the credible events at the HI-STORE facility.

Language clarifying the condition of the canister before and during the acceptance test has been included in the updated Chapter 9.

RAI-9-6-S: Provide an update to Appendix A of the proposed Materials License to address RAI 9-6 (ADAMS Accession No. ML19016A481).

Although the RAI response to RAI 9-6 indicated that Appendix A of the proposed Materials License has been updated, no changes were provided (ADAMS Accession No. ML18345A138).

This information is needed to determine compliance with 10 CFR 72.24(g) and 72.44(c)(5).

Holtec Response:
The updated Technical Specifications are included as an attachment to the letter that forwards these RAI responses. Note that the requested information has been added to the Canister Acceptance Program, since the referenced sections 5.4 in Appendix A refer to procedures that must be written and not specific acceptance criteria.

EDITORIAL RAIs

Editorial Observations:

- RAI 3-1: The response to RAI 3-1 states that HI-STAR 190 references were removed from the HI-STORE SAR Section 1.2.7.c. However, a reference to HI-STAR 190 remains.

- **Appendix A of the Proposed Materials License, Technical Specification 3.2.1:**
    - In Condition A., CANISTER is spelled incorrectly
    - Removable is spelled incorrectly throughout

- CANISTER is also spelled incorrectly in Chapter 16 of the SAR in the bases section for SR 3.2.1.1.

- LA-2, within Section 5.5.1, “Radioactive Effluent Control Program,” of Appendix A of the proposed Materials License, “Section 5.5.6.b” should be revised to “Section 5.5.5.b”.

- LA-3, within Section 5.5.6.c, “Technical Specifications (TS) Bases Control Program” of Appendix A of the proposed Materials License, “5.1.1.b” should be revised to “5.5.6.b“.

- 10-2, within Section 5.5.5.b.2 of Appendix A, “Table 5.1,” should be revised to, “Table 5-1”.

- Appendix A of the proposed Materials License (ADAMS Accession No. ML20326A009) appears to inadvertently exclude information that was provided in an earlier version (ADAMS Accession No. ML18345A138).

Holtec Response:
Each bullet has been addressed as follows:

- This has been deleted
- Tech Spec spellings have been corrected
- Chapter 16 spelling has been corrected
- Reference has been corrected
- Reference has been corrected
- Table reference has been corrected
- The information has been re-inserted into the Technical Specifications