RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.01-4	To address COL License Information Item 9.7, the applicant stated in FSAR Section 9.1.6.7 that a confirmatory structural evaluation of the racks will be provided in an FSAR amendment in accordance with 10 CFR 50.71(e) prior to receipt of fuel. Since structural integrity of the racks must be demonstrated under all postulated loading conditions for providing protection to the spent fuel from mechanical damage, the applicant is requested to provide details of analysis and design of the spent fuel racks using the guidance in SRP 3.8.4, Appendix D, in order for the staff to assess structural adequacy of the spent fuel racks.	Yes	Design of the racks is described in Chapter 2. Details of analyses are provided in Chapters 4 - 7.
09.01.02-1 (1)	Provide details of the structural materials for the fabrication of the fuel storage including materials for interlocking panels that form the fuel element storage matrix.	Yes	Details of structural materials used for fabrication of the racks are provided in Section 3.2. The Holtec spent fuel racks do not utilize an interlocking panel design.
09.01.02-1 (2)	If Boraflex is used, provide a detail description of the program for monitoring neutron poison material.	Yes	Boraflex is not used in this rack design. However, Holtec racks utilize Metamic as the neutron absorber, and the coupon surveillance details are provided in Chapter 3.
09.01.02-2 a	Sketches to show all the major structural features with sufficient information to describe the racks, including the cover plate, baseplate, support screws, support plate, pool liner, weights of racks with various sizes, all welds connecting these parts, any other elements in the load path of the racks, water height in the pool, and plans and sections showing the spent fuel pool in relation to other plant structures. These sketches should indicate related information, including the north arrow, cutouts, dimensions, material thicknesses, and weld size/thickness.	Yes	Figures 2.1 - 2.17 (Chapter 2) are provided to show all the major structural features of the rack design. Geometric and physical data for the racks is also provided in Tables 2.1.1 and 2.5.1. Additionally, rack design details have been provided in the design drawing (Drawing 8946).
09.01.02-2 b	Provide information about gaps: a) Gaps in both horizontal directions and between racks, rack to wall, and rack to equipment area boundary should be provided in pool plan and cross section views; b) Clarify whether there is any gap between the four racks in the new fuel pit; c) Identify the gap tolerances for each of the gaps between the fuel to cell wall, rack to rack, rack to equipment area, and rack to wall; d) Explain whether any studies were done for different initial gap conditions considering the potential tolerances, and if not, explain why; and e) Explain whether there are any requirements to ensure that the assumed gaps (considering tolerances) will be maintained throughout the licensing period, in particular following a seismic event.	Yes	a) Gaps between racks, rack to wall, and rack to equipment area boundary are provided in Figure 1.1.1 (Chapter 1). b) Not applicable. c) Rack to rack gap tolerances are provided in Figure 1.1.1. d) Yes, studies were done for different gap conditions. Run 16 considers the maximum allowable rack to rack gap at all locations. All other runs are based on the minimum allowable rack to rack gap. e) Following a seismic event the rack to rack gaps must be measured to determine if the post-seismic rack configuration is acceptable. If the gaps are outside of the tolerance limits, then the racks must be re-positioned or a reconciliation analysis must be performed.
09.01.02-2 c	In appropriate sections of the Technical Reports, provide ASTM designations, material types and properties for all major components such as support plate, support block, baseplate, cover plate and weld metal material.	Yes	All structural materials are identified in Section 3.2 (Chapter 3) and their strength properties are provided in Table 6.5.1 (Chapter 6).
09.01.02-2 d	Are all fuel racks required to be permanently installed in the pool or pit? If not, provide technical justification or additional studies.	Yes	Yes, all spent fuel racks are required to be permanently installed in the pool unless an alternate layout is approved via LAR.
09.01.02-2 e	Figure 3-2 of the new fuel rack Technical Report shows that there is no connection between adjacent cell walls. Confirm this is true, or correct the figure. In the same figure, the enlarged detail at the upper right corner should show wrapper plate. Same questions also apply to Figure 3-3 of the spent fuel rack Technical Report.	No	These details do not apply to the Holtec rack design.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-2 f	Section 3 of the new fuel rack Technical Report states that the new fuel racks are anchored to the floor of the new fuel vault at each support foot location. However, Item 2 of Subsection 9.1.1.3.2 of STP 3 & 4 FSAR Rev. 04 states that the new fuel storage racks are supported vertically from a base that is not anchored to the bottom of the fuel vault. Explain the inconsistency. If the Section 3 statement referenced above is true, provide a sketch and description of how the new fuel racks will be anchored down to the pit floor.	No	Holtec racks are freestanding.
09.01.02-2 g	For the spent fuel racks, clarify and show on related figures the number/locations of support feet of various racks.	Yes	Holtec rack design includes five (5) support pedestals as indicated in Table 2.5.1. There is support pedestal at each corner of the rack and one pedestal near the center of the rack (see Figure 2.7). Further details are provided in the design drawing (Drawing 8946).
09.01.02-2 h	Figures of rack geometry and isometric view show that some exterior cells of fuel racks are covered by the neutron absorbing material for three sides only. Explain why.	No	Holtec design includes neutron absorber (Metamic) on all four sides of every storage cell.
09.01.02-2 i	Provide types of welds for all weld connections.	Yes	Various welds are shown in Figures 2.8, 2.9, 2.11, and 2.12 (Chapter 2). Complete weld details are provided in the design drawing (Drawing 8946).
09.01.02-3 a	Provide a breakdown of forces and stresses for each individual load in each load combination, so that the staff can determine whether all applicable load combinations have been appropriately evaluated.	Yes	Load combinations used in the structural analysis are listed in Table 6.1.1. The non-linear time history analysis performed by Holtec simultaneously considers the effects of gravity (dead load) and seismic loading. A breakdown of forces and stresses for each individual load in each load combination has not been performed by Holtec. Typically only the total combined forces and stresses acting simultaneously are reported.
09.01.02-3 b	Provide values for To and Ta. According to Appendix D to SRP 3.8.4, for the load combination with SSE, the temperature Ta, which is defined as the highest temperature associated with the postulated abnormal design conditions, should be assumed. Explain why material properties at 140 °F were used for the spent fuel rack design evaluation for the load combination with SSE.	No	Holtec has evaluated the material properties at 200 degrees Fahrenheit (as shown in Table 6.5.1), which bounds To and Ta.
09.01.02-3 c	Table 1 of Appendix D to SRP 3.8.4 identifies that a stuck fuel assembly load case be checked. However, the Technical Reports (Rev. 1) state that a stuck fuel assembly load case does not need to be considered, and reference the COLA Part 2, Tier 2, Section 9.1, (Rev. 4) statement that "the loads experienced under a stuck fuel assembly condition are typically less than those calculated for the seismic conditions." The statement does not provide sufficient technical basis for not considering the stuck fuel assembly load case. Provide analysis detail for the stuck fuel assembly load case and the technical basis for the maximum stuck fuel load that will be used in the analysis.	Yes	The stuck fuel assembly load calculations are contained in the structural calculation package and are not detailed in the licensing report. A conservative value (17.9 kN; provided in the DCD) was used to calculate the vertical pull up force.
09.01.02-4 a	For the fuel drop load case, provide details of design checks on baseplate, support plate, as specified in Section I.4 of SRP 3.8.4, Appendix D. Explain whether drop cases producing maximum bending stresses and/or maximum shear stresses in baseplate were considered, and describe the impact locations assumed in the drop cases.	Yes	Results of the fuel drop evaluations are described in Chapter 7. The complete details of the analysis are provided in the calc package.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-4 b	(For the fuel drop load case), Describe the material stress-strain curves used, and identify whether they are "engineering stress-strain" curves or "true stress-strain" curves. Also describe how the curves were adjusted for the ambient temperature. Provide references for the curves used.	No	Stress-strain curves were not used by Holtec for the fuel drop evaluations. Only the yield and ultimate strength properties of the rack material were used to estimate the damage to the rack.
09.01.02-4 c	(For the fuel drop load case), Explain whether sensitivity studies were performed to confirm the adequacy of the mesh in the finite element model. If no sensitivity studies were performed, provide the technical basis for concluding that the analyzed mesh is sufficiently refined to obtain an accurate solution.	No	Fuel drop analyses were performed using strength of materials method (Mathcad) instead of finite element analysis.
09.01.02-4 d	(For the fuel drop load case), Describe how the dropped fuel assembly was modeled. Is it assumed to be infinitely rigid, absorbing no energy by deformation, or is it assumed to be an elastic-plastic member, capable of absorbing energy by deformation? If the latter is assumed, provide figures showing the fuel assembly deformation for both the shallow and deep drop cases, and specify the percent of the initial potential energy that is absorbed by deformation of the fuel assembly.	Yes	Fuel drop analysis details are provided in Section 7.2. The dropped fuel assembly is assumed to be infinitely rigid.
09.01.02-4 e	(For the fuel drop load case), Provide figures showing the deformation shape of cell wall for the controlling shallow drop case and the deformation shape of the baseplate for the controlling deep drop case. Discuss whether baseplate deformation leads to loss of boral shielding of the active fuel zone, and whether this needs to be considered in criticality analysis.	No	The maximum depth of damage to the cell wall for the controlling shallow drop is given in Section 7.2.1. The base plate deformation does not lead to an uncovering of active fuel zone below the neutron absorber panels.
09.01.02-5 a	Section 4.2.2 of the new fuel rack Technical Report states that the bottom of the fuel is also coupled vertically to the baseplate. However, Figure 4-2 (entitled Fuel-to-Cell Connection) of the report does not show the coupling connection between the bottom of the fuel and the baseplate. Provide the physical details of the coupling and explain how this connection was modeled.	No	Each fuel assembly mass is prescribed two horizontal degrees of freedom. There is one degree of freedom in the vertical direction that tracks the vertical motion of the rack base plate and the stored fuel assemblies.
09.01.02-5 b	Explain the darker horizontal line patterns shown in the ANSYS Fuel Rack Model Isometric View of Figure 4-1 of the new fuel Technical Report and Figure 4-6 of the spent fuel Technical Report. Clarify whether they denote a finer element mesh and if so, explain the need for a finer element mesh at those locations.	No	This RAI is not applicable to the Holtec rack design.
09.01.02-5 c	Section 4.2 of the spent fuel rack Technical Report describes the contact elements. Explain whether the contact elements incorporate any impact stiffness. If yes, provide the impact stiffness values for the fuel-to-cell wall contact and the rack-to-floor contact, and explain how those values were determined. Was any sensitivity analysis for impact stiffness performed?	Yes	The impact stiffness values are documented in the structural calc package. Sensitivity analyses for impact stiffness have been performed consistent with the AP1000 licensing submittal. See run numbers 18 and 19 discussed in Section 6.6.
09.01.02-5 d	Figure 4-7 of the spent fuel rack Technical Report shows that pipe elements were used in the modeling of fuel-to-cell connections. Explain the purpose of those pipe elements. Are they rigid or flexible?	No	This RAI is not applicable to the Holtec rack design.

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09.01.02-5 e	Section 4.2 of the spent fuel rack Technical Report describes the modeling of fluidstructure interaction. Explain whether water above and below the racks was also considered in the model. Describe the differences in the hydrodynamic coupling for fuel assembly to cell wall, rack to rack, and rack to pool wall. Describe and justify the assumptions made in the modeling of fluid-structural interaction.	Yes	Simulation of fluid coupling has been described in Section 6.4.
09.01.02-5 f	Section 4.2 of the spent fuel rack Technical Report indicates that nonlinear time history SSE analysis was performed. Explain what sensitivity studies (e.g., double precision vs. single precision; varying the solution time step; etc.) were conducted to ensure solution convergence and the adequacy of the predicted results.	Yes	As described in Section 6.6, the time step size was reduced by a factor of 2 in run number 20 to ensure solution convergence.
09.01.02-5 g	For the modeling of fuel assemblies for both the new and spent fuel rack analyses, explain how the stiffness and damping of the fuel assemblies were determined and provide the corresponding values used.	Yes	Fuel assembly modeling is discussed in Section 6.4.2. Stored fuel mass is modeled as five lumped masses equally spaced over the height of the cell structure. The five fuel masses are disconnected from each other as if the fuel assemblies are infinitely flexible. There is zero damping associated with the fuel assembly model.
09.01.02-5 h	For both the new and spent fuel rack analyses, provide information on the modeling of support legs; for example, the vertical stiffness of the level screw in a support leg and the element type used for the level screw.	Yes	Modeling of support pedestals is described in Section 6.4.2.
09.01.02-5 i	Section 3 of the spent fuel rack Technical Report states that each spent fuel rack is attached to the neighboring spent fuel rack with tie-bars at the top of the racks, and each side of a rack has a tie-bar. Provide information on the modeling of side-bars. Since Figure 4-9 seems to show more tie-bars at each side of a rack, explain the apparent inconsistency between the statement in Section 3 and Figure 4-9. In addition, since the racks will only be tied together at the top of racks, explain whether any impact between racks at the baseplate level was considered in the modeling and analysis. If not, explain why not.	No	Holtec rack design does not include tie bars to attach racks to neighboring spent fuel racks.
09.01.02-5 j	The friction coefficient between the support plate and the pool liner is an important factor affecting the seismic response of the spent fuel racks. Based on its review of prior fuel rack analyses, the staff has concluded that the worst stress condition for all structural elements may not necessarily be associated with one of the bounding values. Provide the technical basis for only considering the two bounding values (0.2 and 0.8) and not other intermediate values.	Yes	The analysis performed by Holtec considers three different COF values (0.2, 0.5, and 0.8).

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-5 k	The staff requires clarification of apparent inconsistencies between the technical reports and the FSAR. Section 4.2.3 of both Technical Reports indicates that all three directions of motion are applied simultaneously to the fuel rack models for both the new and spent fuel rack seismic analyses. FSAR Subsections 9.1.1.1.3 and 9.1.2.1.3 indicate that the loads in the three orthogonal directions are combined using the square root of the sum of the squares (SRSS) method. The staff notes that in equivalent static seismic analysis, the method used for new fuel racks, the three directions of motion normally are applied separately so that the response due to each direction of motion can be obtained, and then combined with the responses due to other directions of motions by a combination rule such as SRSS. In time history seismic analysis, the method used for spent fuel racks, the three directions of motion normally are applied simultaneously in a single analysis and the combination of the responses due to the three directions of loading is automatically algebraic. Therefore, clearly describe for both the new fuel racks and for the spent fuel racks, how the three directions of motion are applied, and how the responses due to the three directions of motions are combined.	Yes	As discussed in Section 6.4, a non-linear time history analysis is performed in which all three directions of motion are applied simultaneously.
09.01.02-5 l	The fabrication of fuel racks relies heavily on the use of intermittent welds, primarily fillet welds. Load transfer between members relies on the adequacy of the welds to transmit the loads. Accurate stress evaluation of the welds is critical in establishing the seismic adequacy of the fuel rack design. There is no information on modeling of welds in the Technical Reports. Provide details on the modeling of welds at all critical locations, in both the new fuel rack and spent fuel rack Technical Reports.	Yes	Weld stress results are provided in Section 6.7.9. Complete details are provided in the calc package.
09.01.02-5 m	Section 4.2.1 of spent fuel rack Technical Report describes detailed rack models and simplified rack models. Describe the benchmarking of simplified rack models using the detailed rack models. For example, compare the major structural frequencies between two models. Explain whether the locations of detailed vs. simplified rack models were varied, and a series of Whole Pool Model (WPM) analyses were performed. If not, provide the technical basis for determining the location representing the worst case scenarios.	No	This RAI is not applicable to the Holtec rack analysis. Only one type of model, namely Whole Pool Multi-Rack (WPMR) model, is used to perform the analysis.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-5 n	For both new and spent fuel rack analyses, discuss whether various fuel loading pattern scenarios are considered; i.e., different fill ratios, from partially full to full within a given rack; varying fuel locations within the partially filled rack; varying fill and locations in adjacent racks. Would it ever be possible to have less than all fuel racks in the pool?	Yes	Consideration of fuel loading patterns is addressed in Section 6.6.
09.01.02-5 o	Section 6 of both the new and spent fuel rack Technical Reports describes computer codes used in the analyses. Explain whether the validation documents for these computer codes are in compliance with SRP 3.8.1, Subsection II.4.F.	Yes	Computer code validation documents are in compliance with SRP 3.8.1, Subsection II.4.F.
09.01.02-6 a	In Section 8.2.2 of the new fuel rack Technical Report, a factor of 0.707 is considered in the calculations for allowable weld stresses. The 0.707 factor is not considered in similar calculations presented in Section 8.2.3 of the spent fuel rack Technical Report. In addition, expand the information in the technical reports to include the code evaluation for all welds.	No	This RAI is specific to the previous analysis.
09.01.02-6 b	Section 8 of the spent fuel rack Technical Report provides selected results of the seismic analyses. Provide additional seismic analysis results for the spent fuel racks, to include maximum acceleration, maximum rocking angle of a rack, maximum uplift height of a rack support plate, maximum impact force between racks (if any), and maximum impact force on the concrete floor.	Yes	Maximum impact force between racks and maximum impact force on the concrete floor are provided in Section 6.7.6 and Table 6.6.1, respectively. The maximum acceleration, the maximum rocking angle, and the maximum uplift height are currently not provided.
09.01.02-6 c	Section 8.2.1 and 8.2.5 of the spent fuel rack Technical Report indicate that, for the fuel rack cell wall and support plate, respectively, the membrane plus bending stresses exceed the corresponding ASME Code stress limits. The applicant’s basis for the acceptability of these exceedances is provided in Note 1 of Table 8-1, Section 8.2.5, and repeated in Notes 1 and 2 of Table 9-1, and identifies that (1) the exceedances are local; (2) structural integrity of the cell wall will be maintained; and (3) the local peak stress in the support plate would redistribute. This is insufficient justification. Provide the ASME Code technical basis for the acceptance of the stress ratios of 1.8 and 1.04 shown in Table 8-1 and Table 9-1, with reference to specific applicable Code paragraphs.	No	This RAI does not apply to the Holtec analysis. All applicable ASME stress limits are met.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-6 d	Section 8.2.1 of the spent fuel rack Technical Report indicates that the critical buckling stress is 18.9 ksi in the fuel rack cell wall, for level A load combinations. Provide a description of the methodology for the calculation of the critical buckling stress. Was buckling analysis performed for fuel rack cell wall subject to level D load combinations, including seismic analysis and fuel drop analysis? If not, explain why not. If yes, provide a comparison of the calculated compressive stress vs. the allowable compressive stress based on buckling, and the basis (e.g., code limit) for the allowable value.	Yes	Cell wall buckling evaulation is provided in Section 6.7.10.
09.01.02-6 e	Explain whether punching shear analysis was performed for the part of the baseplate above a support leg, subjected to maximum vertical load under seismic or fuel drop impact loads.	Yes	The base plate has been evaluated for a deep fuel assembly drop onto the base plate. The base plate is deformed, but a punching shear failure does not occur. Note that the base plate is 1.5 inches thick. Punching shear analysis has not been performed for the part of the base plate above a support leg.
09.01.02-6 f	Section 8.1.1 “Fuel-to-Cell Wall Impact Loads” of the new fuel rack Technical Report states: “The most significant load on the fuel assembly arises from rattling during the seismic event. The magnitude of the fuel impact force is calculated by pinning both ends of the fuel beam model in the x, y, and z degrees of freedom.” Explain the technical basis for pinning both ends of the fuel beam model. Are there lateral constraints at top and bottom?	No	This question is specific to the previous analysis.
09.01.02-9 a	Confirm that the 3 synthetic time histories have been checked against each other to ensure statistical independence. Compare the calculated correlation coefficients to the acceptance criterion of ≤ 0.16. Include this information in the spent fuel racks technical report.	Yes	Holtec does not use synthetic time histories. Holtec analysis is based on five sets of modified real recorded time histories. The correlation coefficients are ≤ 0.16.
09.01.02-9 b	Provide figures comparing the 5% damped spectra (2 horizontal, vertical) generated from the synthetic time histories to the 5% damped target spectra (horizontal, vertical) at node 100. Identify the criteria used to verify the adequacy of the match. Include this information in the spent fuel racks technical report.	No	Holtec has used 4% damping in accordance with the target spectra at node 100.
09.01.02-9 c	Describe how target PSDs were developed for the Node 100 target spectra, and provide figures comparing the PSDs for the synthetic time histories to the PSDs for the target spectra. Identify the criteria used to verify the adequacy of the PSDs for the synthetic time histories.	No	This question is specific to the previous analysis. Computed response spectra are within 30% of the target spectra as specified in SRP 3.7.1. Therefore, PSD enveloping is not required.
09.01.02-10 a	Describe how the seismic demand on the spent fuel assemblies was determined, including considering maximum impact force due to both in phase and out of phase movement of fuel assemblies during a seismic event.	Yes	Fuel rattling loads are considered in Section 6.7.1. Additional details are provided in the calculation package.
09.01.02-10 b	Describe the methodology used to determine the maximum allowable impact force that spent fuel assemblies are capable of withstanding.	Yes	Maximum allowable fuel impact load are determined based on the strain energy limit of the fuel rods. See Section 6.7.1.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-10 c	Define the acceptance criteria used for functional capability, structural integrity, and no fuel damage.	Yes	The induced strain in the fuel assembly due to the maximum fuel-to-cell impact load is compared against the strain energy limit of the fuel rod. Also, the maximum fuel-to-cell impact load is compared against the load limit of the fuel grid spacer. See Section 6.7.1.
09.01.02-10 d	Describe how the effects of irradiation embrittlement of the fuel rods, at initial storage and long term, are considered in the evaluation.	Yes	The fuel rod integrity is evaluated based on the strain energy limit (1.35 J) specified in the DCD.
09.01.02-10 e	Compare the calculated capacity to the calculated demand, to demonstrate that the spent fuel assemblies will maintain their integrity under seismic loading.	Yes	The demand-to-capacity checks for the fuel assemblies are described in Section 6.7.1.
09.01.02-10 d	The plots of the horizontal synthetic time histories presented in Figures 4-2 and 4-3 of the Technical Report exhibit the characteristic that there are many acceleration peaks up to the target spectrum ZPA. It appears that these time histories are derived from traces that had higher acceleration peaks, and all the higher peaks were reduced to the ZPA. Consequently, the synthetic time histories do not look like earthquake time traces. Please explain the process used to develop the horizontal synthetic time histories, and provide the technical basis for their adequacy.	No	Holtec does not use synthetic time histories. Instead, Holtec analysis is based on five sets of modified real recorded time histories.
09.01.02-10 e	The second paragraph quoted above states: “Baseline corrected displacement time histories are developed using these accelerations.” Explain the term “baseline corrected” and explain why it is necessary to make this correction in the ANSYS analysis. It is the staff’s understanding that ANSYS would automatically remove any drift from the solution. Describe the process used to calculate the baseline correction.	No	Time history details can be located in Section 6.5.2.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-10 f	The plots of the baseline corrected displacement time histories (x, y, z) presented in Figure 4-5 of the Technical Report exhibit several characteristics that require clarification and explanation: (1) All 3 displacement time histories exhibit a dominant sinusoidal response with a period which is same as the duration of the acceleration time history (2) All 3 displacements are zero at three specific time steps. (3) Although there is only 1 horizontal target spectrum, the peak x displacement is approximately ½ of the peak y displacement. (4) The 2 horizontal displacement histories are completely out-of-phase with each other; the vertical displacement history is perfectly in-phase with y and completely out-of-phase with x. Describe how the displacement time histories are developed from the synthetic acceleration time histories, and provide the technical basis for the adequacy of the generated displacement time histories.	No	This question is specific to the previous analysis.
09.01.02-19	On 12/14/2011, the staff discussed with STP the height of the rack cells versus the height of the fuel assemblies. STP confirmed that the fuel assemblies are longer than the cells, and protrude above the cells. STP stated that assuming the struck cell is empty maximizes damage to the cell and poses a more severe threat to the neutron absorbing material. The staff expressed concern that assumption of empty cell for shallow drop analysis may not necessarily bound the structural and radiological consequences of shallow drop on cells with fuel assemblies. During the discussion STP stated that the drop scenario over the reactor core in the DCD addressed this issue. The staff was not convinced that reference to the drop scenario in the reactor core adequately addresses all issues related to shallow drop over fuel assemblies in the spent fuel pool. Therefore, the staff requests the applicant to provide its detailed technical basis for concluding that it has adequately addressed the worst-case structural and radiological consequences, without including fuel assemblies in the cells for the shallow drop analyses.	No	Fuel drop scenarios have been covered in Chapter 7. Fuel-to-fuel impacts are addressed in Chapter 15 of DCD.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-20	Figure 3-2 of the Technical Report, Rev. 2, shows wall boundaries and gaps between racks and walls. The values of the gaps are consistent with those provided in Table 4-3 of the report. Figure 4-1 of the report shows different perimeter boundaries for the pool walls. There appears to be partitions and equipment storage inside the pool wall boundaries. The staff discussed this with STP on 12/07/11. STP acknowledged that storage areas will be added to the spent fuel pool, and will change the gaps. However, they have not been designed yet. The gaps assumed for the seismic analysis are the full gaps to the SFP wall. The staff noted that the addition of the storage areas may invalidate the current seismic analysis, which indicates NO wall impact. Reducing the gaps at a later time will be an unanalyzed condition with plant safety implications. The staff also notes that the fluid coupling calculation between the racks and the pool wall will have to be updated to reflect the final gaps, even if there is adequate remaining gap to preclude impact. At a minimum, the hydrodynamic mass will need to be corrected and the analyses rerun. The staff requests the applicant to clarify that no such commodities are assumed to be present in the gaps, and to describe how any changes to the gaps will be controlled, evaluated, and documented, to ensure that the design-basis seismic analysis of the racks and the pool walls reflects the actual as-built gap conditions.	No	See response to 09.01.02-2 b.
09.01.02-21	Figures 4-2 through 4-5 of the Technical Report are unchanged between Revision 1 and Revision 2. No new information about the time history input has been included in Revision 2. RAI 09.01.02-9, parts (a) and (b), had been Confirmatory, pending inclusion of additional information about the time history input. The staff discussed this with STP on 12/07/11. The applicant indicated that it had decided NOT to include the promised information in Revision 2. Accordingly, the staff requests the applicant to revise its response to RAI 09.01.02-9, to delete the commitment to include additional information in the Technical Report, and also to provide its justification for withdrawing this commitment.	No	This RAI is specific to the previous submittal.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-22	In the Technical Report, Revision 2, Section 4.2, MODELING METHODOLOGY, the applicant describes its approach for incorporating the effects of fluid-structure interaction as follows: “The nonlinear time history SSE analysis includes the effects due to fluid-structure interaction. Fluid-structure interaction is modeled for the fuel assembly-to-cell wall interface, the rack-to-rack interface, and the rack-to-pool wall interface. The general approach used is to represent the fluid-structure interaction using a mass matrix. The procedure to determine the appropriate hydrodynamic mass matrix is to perform a fluid-structure interaction analysis using the ANSYS finite element software. The calculated hydrodynamic mass matrix is directly input to the rack structural model using ANSYS MATRIX27 elements. In the Technical Report, Revision 2, Section 4.2.3.1 “Calculation of Hydrodynamic Mass”, the applicant provides a more detailed description of the hydrodynamic mass calculations for fuelto- rack, rack-to-rack, and rack-to-pool wall. The staff is not familiar with the method applied. Explain how these analyses generate the MATRIX27 hydrodynamic mass input. If known, discuss how the overall technical approach to fluid coupling compares to methods that are currently being used by other applicants. Is there prior regulatory precedence for the approach being used? If so, please identify.	No	Holtec does not use this methodology.
09.01.02-23	In the Technical Report, Revision 2, Section 4.2.2, the applicant states: “For the validation and WPM rack finite element models, some specific details of the rack construction differ from the design specified in Section 3 and Appendix A. The detailed stress analyses of all rack components are consistent with the design specified in Section 3 and Appendix A. Changes to the design were implemented after the completion of the WPM analyses to address design issues. These changes to the design affect local regions of the rack and will not have a significant impact on dynamic characteristics of the rack. Therefore, the results from the WPM analyses are valid. Specific details on the differences between the rack finite element model and the design are discussed throughout the model discussion.” To assist the staff in reaching a conclusion that the differences are collectively insignificant, the staff requests the applicant to provide a summary description of each difference, an assessment of the individual effect of each difference on the dynamic characteristics of the racks, and an assessment of collective effect of all differences on the dynamic characteristics of the racks.	No	This RAI is specific to the previous rack design and analysis.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.01-24	In a nonlinear time history analysis with sliding, lift-off, and gap closures, it is essential to check the changes in the maximum responses at all key locations, not just the change in impact load, when studying the effects of this difficult-to-define parameter. Prior nonlinear spent fuel analyses have demonstrated this. The greater the uncertainty, the more comprehensive the sensitivity analyses should be. In this case, the values selected are not based on the “DCD fuel assembly”, and have a wide range of variation. Therefore the staff requests the applicant to conduct additional sensitivity analyses using the lower TGSIS value, with ± 20% variation. The staff notes that all key responses, for all six (6) impact stiffness sensitivity cases, including the additional cases requested above, need to be considered in the design calculations and tabulated in the technical report. In lieu of this, the staff will need to audit the detailed results of all cases analyzed, in order to confirm that the maximum response at all key locations has been used in the design-basis calculations.	No	This question is specific to the previous analysis. Holtec has performed sensitivity analyses considering a +/- 20% variation in the input stiffness values.
09.01.02-25 (a)	The applicant’s response to RAI 09.01.02-10 (briefly summarized in Technical Report, Revision 2, Section 8.1.2) addresses the evaluation of the fuel assemblies to withstand impact loads resulting from seismic excitation of the spent fuel racks. In RAI 09.01.02-10, the staff posed five (5) questions (a through e). After review of the applicant’s responses, the staff requests the applicant to address the following: From the response to Question (a), the staff cannot get a clear understanding of the methods used and the implementation of the methods, in order to estimate the maximum impact loading demand on the fuel assemblies. Using figures show the location of the 2,724 lb impact load; show the nodes on the fuel assembly model; show the locations of and the geometry of the “spacer grids”. Explain why the 2,724 lb load in not directly applied to a spacer grid. Provide details of the kinetic energy calculation, in accordance with SRP 3.8.4 App. D, and the strain energy calculation for the fuel assembly. How is a fuel impact load of 1,488 lb derived from this energy balance? What is the basis for the assumption concerning how many spacer grids carry the load? In addition, the Technical Report, Revision 1, Section 8.1.1 states that the maximum fuel impact load is 4,689 lbs. Explain the large difference between the previously reported maximum impact load and the current reported value of 2,724 lbs.	Yes	The modeling of the fuel-to-cell impacts is discussed in Section 6.4.2.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-25 (b)	The response to Question (b) discusses the "channel", and information "provided in Table 19H-10 of the SSAR (which is incorporated by reference in the DCD)" that apparently is being used to indirectly estimate a design-basis capacity for the channel in terms of maximum acceleration. The estimated capacity appears to be 4.8g. In the response to Question (a), the demand on the channel, in terms of maximum acceleration, is not specifically discussed. Provide this information and the technical basis for the calculated value. In the response to Question (a), a maximum demand on the "spacer grid" is calculated. In the response to Question (b), test results are referenced for the estimated capacity. Clarify whether the tests conducted were on the DCD fuel assembly. If not, provide a detailed technical basis for using these test results to estimate the capacity of the DCD fuel assembly "spacer grid". The response to Question (d) states: "The effects of irradiation embrittlement are ignored, as recommended in SRP 4.2, Appendix A, Section III.I (NUREG 0800): 'unirradiated production grids at (or corrected to) operating temperature.' The SRP continues with 'While [the allowable crushing load] P(crit) will increase with irradiation, ductility will be reduced. The extra margin in P(crit) for irradiated grids is thus assumed to offset the unknown deformation behavior of irradiated grids beyond P(crit).'" The staff notes that the quoted SRP section does not address irradiation embrittlement due to long-term storage in the spent fuel pool. The statement applies to the evaluation when the fuel is in the reactor core. The staff requests the applicant to answer the staff's original question about the long-term effects.	Yes	The modeling of the fuel-to-cell impacts is discussed in Section 6.4.2.
09.01.02-26	RAI 09.01.02-2 Response, Revision 1, page 3, states: "Refer to WCAP-17331-P, Revision 2, Sketch A-2. The size and weight of the fuel contained within the rack have not changed." However, the size and weight of the fuel is not in the referenced figure. To assist the staff in its review, a description and sketch of the analyzed fuel assembly, including size and weight is needed. The staff also needs clarification whether the exact same fuel assembly (referred to as the DCD fuel assembly) has been assumed for all calculations and analyses (i.e., seismic analysis; accidental drop analysis; impact stiffness calculations; impact load capacity vs. demand). The staff discussed this with STP on 12/14/11. The applicant indicated that it has no information about the "DCD fuel assembly" other than the information in the ABWR DCD, and any other publicly available sources. It is not clear to the staff what actual information and what assumed information was used to calculate the axial and bending stiffness of the "DCD fuel assembly" model for the seismic analysis. The staff requests the applicant to describe in detail its method to calculate the axial and bending stiffness for the fuel assembly, and to clearly identify the actual and assumed geometry and material properties used in the calculations. For assumed values, provide a technical basis for their selection.	No	This question is specific to the previous analysis. However, Holtec has obtained the fuel assembly information from the DCD and publicly available documents.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-27	The footnote to Technical Report, Revision 2, Table 3-3, “STP 3&4 Spent Fuel Storage Rack Material Data”, states that “Materials are dual certified to TP304/304L”. This footnote applies to most of the components that make up the rack. The staff notes that the stainless steel properties given in Technical Report, Revision 2,Table 5-1, have been revised to include the properties of Type 304 stainless steel, and that the TP304 properties are used in design calculations for the components identified as “dual certified” in Table 3-3. Code-specified stress limits are typically based on either the specified material tensile strength or the specified material yield stress, from the applicable ASTM specification (in this case A240 for plate material). The code stress limits for Type 304L stainless steel are generally lower than those for Type 304. Provide specific information about ultimate strength and yield stress for the dual certified TP304/TP304L material that justifies the use of TP304 code stress limits.	Yes	Dual certified TP304/304L material meets the chemical composition and strength requirements of both material types.
09.01.02-28	In RAI 09.01.02-12, the staff noted that, for the design check of the spent fuel storage rack for the stuck fuel assembly load case, the applicant did not develop an allowable maximum weld stress based on the base metal; the staff requested that the applicant provide this information. WCAP-17331-P, Revision 2, Section 8.4.3, page 8-24, now includes a weld design check for base metal shear. During a conference call on 12/21/2011, the applicant indicated that the allowable stress limit for base metal shear used in the calculation is shown in the Technical Report Revision 2, Section 8.4.1; i.e., Fv = 0.3Su. The staff requests the applicant to explain whether the allowable stress limit used complies with ASME Section III Division 1 Section NF-3324.5, which refers to Table NF-3324.5(a)-1 for the allowable stress limits for fillet welds. If not, explain why not, and provide the technical basis for the allowable stress limit used. If yes, explain whether the stress limit of 0.40 x yield stress of base metal for shear stress on base metal was taken into account in the calculation, as required by ASME Section III Division 1 Section NF-3324.5.	Yes	This question is specific to the previous analysis. However, the stress allowables are provided in Section 6.2.3.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-29	Technical Report, Rev. 2, Section 8.5, page 8-25, (and the response to RAI 09.01.02-8) discusses the thermal stress effects of an isolated hot cell. The assessment assumes that the hot cell temperature is 160.8oF and the uniform temperature is 150.8oF, representing a ΔT = 10oF. The staff notes that recent DCD applicants have assumed a ΔT of 50oF or greater for this same calculation. The ABWR DCD Rev 04, Section 9.1.2.1.5, states that the normal pool water operating temperatures are 16oC to 66oC (60.8oF to 150.8oF). What is the technical basis for assuming the uniform temperature is 150.8oF, and not 60.8oF? Have detailed thermal hydraulic analyses of the pool been performed for a range of operating scenarios? Is ΔT = 10oF the worst case of all scenarios?	No	The Holtec analysis considers a ΔT = 50oF which bounds the difference between the local SFP water temperature inside a loaded storage cell and the bulk SFP water temperature.
09.01.02-30	(1)Provide additional information about the directions and locations of the SRSS sliding displacements, conclusively demonstrating there is no rack-to-pool wall impact for all cases analyzed. (2)The results reported in Table 8-2 of the Technical Report, for cases 2, 3, and 4, indicate the SRSS Sliding displacements are 12.7”, 17.0”, and 17.3”, respectively. This trend shows increasing sliding displacements with increasing coefficients of friction, which appears to be opposite of what would be expected. Higher coefficients of friction should reduce the sliding displacement. Provide a detailed technical explanation for these unexpected results. (3)Provide a detailed technical justification for not considering additional partial loading cases, in order to ensure that upper bound responses of the racks have been identified for use in the design qualification calculations. (4)The magnitude of the SRSS sliding displacements (12.7” to 20.9”) reported in Table 8-2 of the Technical Report are significantly higher than have been reported in previous analyses of spent fuel racks under similar loading. Confirm that the reported displacements are the rack movements relative to the floor of the spent fuel pool.	No	This RAI is specific to previous analysis.
09.01.02-31	Due to the absence of rotational compatibility about an axis along the weld, it would appear that welds are modeled as pinned connections. The overall rack stiffness for seismic analysis, and the stress evaluation of the welds depend on the modeling of welds. The staff requests the applicant to provide the technical basis for release of rotational compatibility.	No	This RAI is specific to previous analysis.

RAI NUMBER	RAI CONTENT	APPLICABLE TO HOLTEC?	RAI RESOLUTION
09.01.02-32	1. Provide the technical basis for the postulated impact load application area, which from the text and Figure 4-34 appears to be about 100 in2. 2. Explain the meaning of the sentence “[Second sentence of proprietary text]” 3. Provide the technical basis for the selection of the elevations and the horizontal locations shown in Figure 4-34, for the application of the fuel impact load. Are these worstcase locations based on WPM analysis results? What are the numerical values of the fuel impact loads at the 2 selected locations? 4. Provide the technical basis for the specification of [Sixth sentence of proprietary text] constraints at the leveling screws. 5. Discuss whether any sensitivity studies were performed, considering (1) alternative boundary conditions at the leveling screws; (2) alternative vertical and horizontal locations for the fuel impact load; and (3) alternative definitions of the impact load area on the cell wall. If so, describe the results. If not, provide the technical basis why this was not necessary.	No	This RAI is specific to previous analysis.