AUDIT REPORT

South Texas Project, Units 3 and 4, Combined License Application

Audit of Fuel Rack Design Analysis Related to Final Safety Analysis Report 9.1.2, "New and Spent Fuel Storage"

Nuclear Innovation North America, LLC.

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1.0 SUMMARY

On March 3 - 7, 2014, the U.S. Nuclear Regulatory Commission (NRC) conducted an audit at the Holtec Center, located in Marlton, New Jersey. The audit was held in order to continue to review detailed reports and supporting charts, spreadsheets, calculations and analysis that will aid in resolving the technical issues concerning the design of the spent fuel racks as outlined in Section 9.1.2, "New and Spent Fuel Storage," in Revision 10 of the Final Safety Analysis Report, and the proposed responses to NRC's Request for Additional Information (RAI) 09.01.02-33 through 09.01.02-66. Representatives from Nuclear Innovation North America (NINA), LLC, Holtec, Brookhaven National Laboratory (BNL), and NRC were present during the audit, including key technical personnel.

2.0 AUDIT ACTIVITIES

After introductions and a review of the agenda, THE NRC staff made introductory remarks regarding the audit background, scope, and objectives. Following these remarks, Holtec presented an overview on the DYNARACK methodology in support of the fuel rack design.

Next, the staff conducted a review of the calculations and documentation in support of the NINA Combined License Application. The following areas were included in the staff's review and discussions with the applicant during the audit:

1. Layout and detailed drawings of the racks and the fuel assemblies, including the spent fuel rack layout with the bearing pad locations and the leak chase locations.

2. Calculations providing details of the development and validation of the stick model properties used in the whole pool method.

3. Calculation for the spring constants used in the analysis.

4. Calculation for the stresses in the tie bars and tie bar welds.

5. Calculation for the punching shear evaluation of the base plate.

6. Calculation for the stresses in the rack pedestals, base plate, bearing pads, and cell walls.

7. Calculation of the various weld stresses.

8. Review of verification and validation documents for all computer programs used in the analysis.

9. Review of a sample Dynarack analysis including review of input parameters used, output results, calculation of various stress factors, etc.

10. Review of allowable stresses used for Level A and Level D loading cases.

11. Review of methodology and calculation for fuel drop analysis.

12. Review of methodology and calculation for buckling analysis.

13. Review of methodology and calculation for thermal analysis.

14. Review of methodology and calculations pertaining to modeling of fuel assembly in the Dynarack model.

15. Review of methodology and calculations for structural assessment of fuel assemblies subject to seismic loads.

16. Review of Draft RAI responses presented by the applicant during the audit, as applicable.

17. Quality issue pertaining to one calculation.

Details of the review and discussion are given in the following section below.

The audit concluded with an exit meeting which summarized the discussions and the disposition of the issues raised during the audit; follow-up and open items are identified in attachment 4.

3.0 <u>DETAILED REVIEW, DISCUSSIONS AND CONCLUSION</u>

1. Layout and detailed drawings of the racks and the fuel assemblies, including the spent fuel rack layout with the bearing pad locations and the leak chase locations.

During the audit held during February 4 - 5, 2014, in Rockville, Maryland, the NRC staff reviewed Holtec drawing no. 8946, Sheets 1 through 7, showing the layout and details of the fuel racks. The NRC staff noted that Sheet 1, Note 11, of the drawing stated that the “bearing pads may be shimmed or slotted to span liner weld seams and other floor projections as necessary to permit installation.” This appeared to contradict an earlier draft response to request for additional information (RAI) 09.01.02-49, where the applicant had stated that the racks will be positioned such that the fuel racks under all loading conditions, including safe shutdown earthquake, will not result in the rack bearing plates contacting an area of the pool liner that is backed by a leak chase channel, which is placed under the liner weld seams. Also, the applicant had not considered presence of a leak chase channel in its calculation of bearing stress in the concrete under a bearing pad. The staff verified during the audit that the applicant revised drawing no. 8946, Sheet 1, and deleted the referenced note.

The staff also had noted during the audit on February 4 - 5, 2014, that the layout drawings for the fuel racks did not include locations of the rack pedestals with respect to the bearing pads. The pedestals must maintain a minimum distance from the edge of the bearing pads in order to not slip off the bearing pads during a seismic event. The staff verified that the applicant added a layout drawing showing locations of the pedestals with respect to the bearing pads in order to maintain the minimum required edge distance. Figure 1.1.2 was also added to Holtec Report HI-2135462 (Licensing Report) to show pedestal locations with respect to the bearing pads.

No drawings for the fuel assembly were available for review. Fuel assembly dimensions used for design of racks are obtained from publicly available reports. The staff did not identify any other issues with the rack layout drawings.

2. Calculations providing details of the development and validation of the stick model properties used in the whole pool method.

During the audit held during February 4 - 5, 2014, the staff asked the applicant to provide documentation that confirms that the stick model representation of the fuel rack for seismic analysis adequately captures the modal behavior of the rack. During this audit the subject was discussed with the applicant. The applicant stated that the lowest natural frequency of the rack cellular structure, based on its mass and geometric properties, is approximately equal to the cut-off frequency of the input response spectra, and the rack structure is essentially rigid. The applicant also calculated the natural frequency of the rack structure considering both bending and shear deformation, and showed it to be in the rigid range. The NRC staff considered that since the rack structure is essentially rigid, multimode amplification of the rack structure during a seismic event is not an issue. The applicant also proposed to revise Section 6.4.4 of the Licensing Report to include the modeling basis. The issue is tracked under Action Item 11.

3. Calculation of spring constants used in the analysis.

During the audit held at the HOLTEC office in New Jersey from March 3 - 7, 2014, the staff performed reviews of methodologies for determining various spring constants used for the DYNARACK model to perform the seismic/structural analyses of the spent fuel racks, and consequently to close the RAI 09.01.02-50. The staff tabulated elements, nominal stiffness values, spring types, and sources for determining the stiffness constants used in the model. The staff performed a detail review of the sources of DYNAMO suite program PREDAYNA1 output and HOLTEC Report HI-2135615, Revision 2 as well as reviewed the technical paper titled "Seismic Response of a Free Standing Fuel Rack Construction to 3-D Floor Motion, by A. I. Soler and K. P. Singh, January, 1984":

Stiffness Values Used in Dynamic Model			
Elements	**Stiffness Value**	**Spring Type**	**Source**
Rack Bending Spring (X-Z Plane), lbf-in/rad	6.573E+10	1	PREDAYNA1
Rack Shear Spring (X-Dir.), lbf/in	5.868E+06	1	PREDAYNA1
Rack Bending Spring (Y-Z Plane), lbf-in/rad	9.017E+10	1	PREDAYNA1
Rack Shear Spring (Y-Dir.), lbf/in	6.362E+06	1	PREDAYNA1
Rack Extension Spring, lbf/in	6.589E+07	1	PREDAYNA1
Rack Torsional Spring, lbf-in/rad	5.251E+09	1	PREDAYNA1
Fuel-to-Cell Impact Spring, lbf/rad (fully loaded spent fuel rack-340 assemblies)	3.911E+06	3	HI-2135615, Rev. 2, Appendix A
Pedestal Compression Spring, lbf/in	1.321E+6	3	HI-2135615, Rev. 2, Appendix A
Pedestal Friction Spring, lbs/in	1.321E+9	2	HI-2135615, Rev. 2, Appendix A
Rack-to-Rack Impact Spring (@ Top of Rack), lbf/in	4.310E+05	3	HI-2135615, Rev. 2, Appendix A
Rack-to-Rack Impact Spring (@ Baseplate), lbf/in	4.580E+06	3	HI-2135615, Rev. 2, Appendix A
Rack-to-Wall Impact Spring (@ Baseplate), lbf/in	3.860E+06	3	HI-2135615, Rev. 2, Appendix A
Rack-to-Wall Impact Spring (@ Top of Rack), lbf/in	7.632E+05	3	HI-2135615, Rev. 2, Appendix A

Type 1 – Linear elastic beam-like element.
Type 2 – Bi-linear friction spring elements used to developed horizontal forces between rack pedestal and bearing pats.
Type 3 – Non-linear gap element.

The applicant also stated that the stiffness values provided in the table are the nominal values. The stiffness value fuel-to-cell impact spring is adjusted for different run-cases to reflect the number of loaded fuel assemblies in each rack.

RAI 09.01.02-50 also requested information regarding the terminology of "piecewise linear friction springs." The applicant responded that it referred to the bi-linear springs that are used to simulate friction behaviour between the support pedestals and the bearing pads. In its response, the applicant also provided a figure showing the deflection shape of the "piecewise linear friction springs," which was illustrated in a two dimensional Cartesian coordinates of force-deflection relations, where friction stiffness line is extending from x = 0, y = 0 coordinates in a steep slopping vertical line up to the μN limiting friction force; and from that level, it has a horizontal line parallel to the deflection. The staff did not have any issue with the representation of the bi-linear spring that was used to simulate friction behavior between the support pedestals and the bearing pads.

Based on the review, the staff did not have any issue with any of the spring constant used to perform the seismic/structural analyses of spent fuel racks, exception described below.

During its review of the spring constants, the staff identified that the impact spring constant for rack-to-rack impact was calculated considering compression of only the two corner cells, whereas the calculated impact load was applied across the full width of the rack with a rigid impactor. The staff believed that this assumption may have underestimated the spring constant value resulting in underestimation of the calculated impact force. The applicant agreed to perform a sensitivity study considering the cells that share most of the impact load for calculation of spring constant, and review the results with the staff. The issue is tracked under Action Item 20.

4. Calculation of stresses in the tie-bar and tie-bar welds (cell-to-cell weld).

The staff reviewed the Section titled "Cell to Cell Welds Analysis" in Holtec Report HI-2135615, "Structural/Seismic Analysis of Fuel Racks at South Texas Project, Units 3 & 4" for calculation of stresses in the tie-bar welds. The staff noted that the general methodology followed for the evaluation was adequate and conservative assumptions were used for the evaluation. However, the staff noted that the calculation did not consider presence of intermittent welds while calculating shear stresses in the weld due to flexure. However, due to other conservatism in the calculation, this is not expected to impact final results. The applicant agreed to revise the calculation considering intermittent welding of the tie-bars. The issue is tracked under Action Item 31. Further, the shear stresses in the weld was calculated using the shear stress factors which needed to be revised based on discussions in Item 6 below.

5. Calculation for the punching shear evaluation of the base plate.

   In RAI 09.01.02-65, the staff asked the applicant why four sides around a corner pedestal were considered for evaluation of punching shear for the base plate. In its response, the applicant proposed to revise the evaluation using two sides of the pedestal for punching shear calculation and update the licensing report accordingly. During the audit the staff reviewed the revised punching shear calculation and proposed update of the licensing report. The issue is considered confirmatory.

6. Calculation for the stresses in the rack pedestals, base plate, bearing pads, and cell walls.

   In RAI 09.01.02-49, Item (1), the staff had asked the applicant to provide the effective width of the cell wall that was used to determine ultimate capacity of the cell wall against fuel assembly impact load. During the audit held during February 4 - 5, 2014, the staff reviewed the supporting calculation in Appendix D of Holtec Report HI-2135615, "Structural/Seismic Analysis of Fuel Racks at South Texas Project, Units 3&4," and noted that the effective width of cell wall assumed for calculating cell wall capacity against fuel assembly impact was 10 inches. The subject was discussed with the applicant during the audit regarding assumptions used in the calculation and acceptance criteria to be used for evaluation. The applicant was asked to provide technical basis for the assumption and demonstrate that the cell wall may not have plastic deformation due to fuel assembly impact that may potentially compromise storage rack configuration. The applicant agreed to revisit the issue and provide feedback. This issue is tracked under Action Item 8.

   The staff also reviewed the calculation of various stress factors for the rack. It was noted that the stress factor for shear was calculated assuming that the entire rack cross section being effective in shear. This did not meet the requirements of American Society of Mechanical Engineers (ASME) Section III, Subsection NF-3322. The staff discussed the issue with the applicant, and the applicant agreed to revise the calculation of shear stress considering only the effective area in shear being half of the cross sectional area of the rack. This did not affect the maximum stress factors included in the licensing report, since the shear stress factors were very low. This also affects calculations of stresses in the cell wall to base plate welds (Item 7 below) and cell to cell welds (Item 4 above) which had used shear stress factors in the calculation. This issue is tracked under Action Item 34.

7. Calculation of the various weld stresses.

   During the audit held during February 4 - 5, 2014, the staff noted that stresses in the weld between the rack base plate and the pedestals were calculated assuming that the weld will not experience any stress from vertical load transmitted by the pedestals. The staff discussed the subject with the applicant during the audit and communicated that the assumption may not be conservative unless special care is taken during fabrication of the rack to ensure full contact between the base and the pedestal. The applicant agreed to ensure full contact by specifying machining at the interface of the base plate and the pedestal in the drawing and updating the licensing report accordingly. The issue is tracked under Action Item 13.

The staff noted during review of calculation of stresses in the weld between the cell walls and the base plate that shear stress in the weld was calculated from the shear stress factors which needed to be revised as discussed in Item 6 above. The applicant agreed to address the issue which is tracked under Action Item 34.

8. Review of verification and validation documents for all computer programs used in the analysis.

During the audit held at the HOLTEC office in New Jersey from March 3 - 7, 2014, the staff performed a review to validate the list of computer codes used in the design analysis, and to close RAI 09.01.02-62, requesting validations of computer codes used to perform the seismic/structural analyses of the spent fuel racks. The staff's validation criteria on the computer program used in design analysis is provided in Subsection II.4.F, Section 3.8.1 of NUREG-0800. Those validation criteria are:

(i) the computer program is recognized in the public domain and has had sufficient history of use to justify its applicability and validity without further demonstration,

(ii) the computer program's solutions to a series of test problems have been demonstrated to be substantially identical to those obtained by a similar and independently written and recognized program in the public domain, and

(iii) the computer program's solutions to a series of test problems have been demonstrated to be substantially identical to those obtained from classical solutions or from accepted experimental tests or to analytical results published in technical literature.

In its response, the applicant provided discussions regarding following computer codes: EZ-FRISK, DYNAMO suite, ANSYS, LS-DYNA, and Mathcad.

EZ-FRISK is a general purpose software package to perform site-specific earthquake analysis, which was purchased commercially. HOLTECH uses it to develop real recorded acceleration time-histories from design basis floor response spectra to be used in non-linear time-history analyses. The validation was achieved by comparing the response spectra generated from EZ-FRISK against the corresponding response spectra generated using SHAKE2000

(Version 7.7.0), and was validated under HOLTEC's quality assurance (QA) program (QAP) in HOLTECH Report HI-2135536, Revision 1, "Validation of EZ-FRISK Computer Code." The staff agreed that EZ-FRISK software package is recognized in the public domain and has sufficient history of use. Therefore, it is in compliance with the criteria of Item (i) in Subsection II.4.F, Section 3.8.1 of NUREG-0800.

The DYNAMO is the HOLTEC proprietary computer code, which is also referred as DYNARACK. DYNAMO was developed to provide dynamic stability analysis of one or more empty or loaded spent fuel storage racks subject to known acceleration time-histories representing seismic events of a given duration. DYNAMO was validated under HOLTEC's QAP in HOLTECH Report HI-2114848, "QA Validation of DYNAMO Codes for whole Pool Multi Rack Analysis." Hereafter, called "DYNARACK." During the audit, the applicant made a presentation of DYNARACK computer program that included history of use, basis for DYNARCK methodology, model, program execution and validation. DYNARACK originated in the late 1970s as a general purpose dynamic analysis code. Later, in 1979-1980, special subroutines were added to make it especially adaptable for simulation of fuel Rack structures. Since that time, HOLTEC has used in over 1000 dynamic simulations of free-standing fuel rack structures, and has provided thousands of storage racks of this design to various nuclear power plants around the world, which may set precedent for this application. The basis for DYNARACK methodology the rack cellular structures is modeled as a beam member based on the guidance in Standard Review Plan 3.8.4, of "…design, fabrication, and installation of spent fuel racks of stainless steel material may be performed based on ASME Code, Section III, Division 1, Subsection NF requirements for Class 3 component support." The solution method is based on a publication titled "The Component Element Method in Dynamics, by Levy and Wilkinson." The spring stiffnesses are based on the technical paper titled "Seismic Responses of free Standing Fuel Rack Construction to 3-D Motions, by A. I. Soler and K. P. Singh, January, 1984." The entire DYNARACK model is comprised of 22 degrees of freedom to represent the dynamic behavior of each rack module. The applicant provided a proprietary copy of HOLTECH Report HI-91700, Revision 1, "DYNARACK Validation Manual," which provides a series of problems with known solutions compared against the DYNARACK results. Based on the review of the validation manual, the NRC staff determined the validation manual basically provided capabilities of the DYNARACK program only. The applicant also referred to a letter to the NRC from FirstEnergy Nuclear Operation Corporation (FENOC), dated May 10, 2010, for a NRC RAI response related to Beaver Valley Power Station, Unit 2 Spent Fuel Pool Re-rack License Amendment Request (ML101460057) for benchmarking of DYNARACK simplified mass model against a detailed LS-DYNA finite element model (for Sizewell Nuclear Plant Rack, in England) to demonstrate the adequacy to predict the anticipated acceleration time-history seismic responses. The LS-DYNA analysis was performed on a detailed spent fuel rack model that was a freestanding in-air (rather than in-water) for simultaneously applying three orthogonal acceleration time-history input. The seismic attenuation factor (multiplier to earthquake accelerations) was applied to account for the effect of the pool water. During the audit, the applicant also provided following two tables depicting how the seismic attenuation factor was determined, and previously performed comparison of results between a 22 degree of freedom DYNARACK model and a detailed three-dimentional finite element model created from LS-DYNA. Table 1 compares the results of DYNARACK and LS-DYNA in-air with an applied seismic attenuation factor of 0.45, and provides DYNARACK results in-water with coefficient of friction (COF) for the same model subject to identical seismic inputs. Table 2 provides the methodology used to determine the attenuation factor of 0.45 by running several DYNARACK cases in-air, which would provide comparable results in-water when applied to the same rack geometry and subject to identical seismic inputs for DYNARACK models in-air.

Table 1

Results	LS-DYNA Model (In-Air)	DYNARACK Model (In-Air)	DYNARACK Model (In-Water)
Seismic Attenuation Factor	0.45	0.45	1.0
COF	0.8	0.8	0.8
Max. Horizontal Displacement at Top of Rack (in) **N-S Direction:** **E-W Direction:**	 0.761 0.999	 1.526 1.772	 0.889 0.861
Max. Horizontal Displacement at Base of Rack (in) **N-S Direction:** **E-W Direction:**	 0.216 0.228	 1.132 0.929	 0.023 0.028
Max. instantaneous Fuel-to-Cell Impact Load (per assembly average) (lbf)	624	>859	813
Max. Total Vertical Reaction Force between Support Legs and Concrete Slab	523,000	499,700	458,500

Table 2							
Summary	**Governing DYNARACK Case In- Water**	**DYNARACK Dynamic Runs In-Air (No Fluid Effect)**					
		Case 1 R=0.50	**Case 2 R=0.40**	**Case 3 R=0.42**	**Case 4 R=0.421**	**Case 5 R=0.425**	**Case 6 R=0.45**
Max. Displacement (X/Y) (in)	0.889	2.18/2.03	0.83/9.89	0.76/0.96	1.25/1.32	1.40/1.14	1.77/1.53
Max. Rack Pedestal Vertical Load (lbf)	296,000	304,000	235,000	248,000	256,000	291,000	309,000
Max. Pedastal Friction Force (lbf)	115,000	129,000	107,000	90,900	99,200	125,000	141,000
Max. Stress Factor	0.329	0.358	0.260	0.254	0.392	0.302	0.307

The staff reviewed the results with respect to the LS-DYNA and DYNARACK solutions for the same geometry and subject to identical seismic input in-air, and determined that DYNARACK results in-air compared to the LS-DYNA results in-air are more conservative. The staff concluded that DYNARACK results in-water should also produce more conservative results compared to the LS-DYNA results in-water, and therefore, it is in compliance with the criteria of Item (ii) in Subsection II.4.F, Section 3.8.1 of NUREG-0800.

ANSYS is a general purpose finite element analysis program, used to simulate interactions of physics, structural, vibration, fluid dynamics, heat transfer and electromagnetic for engineering problems. HOLTEC uses it to model pedestal-to-baseplate to evaluate weld stresses and cell wall buckling. The validation was achieved by comparison of test cases in ANSYS, Inc. verification manual, and was validated under HOLTEC's QAP HOLTEC Report HI-2012627, Revision 10, "QA Documentation Package for ANSYS (Version 11.0 and higher)." The staff agreed that the ANSYS FEA program is recognized in public domain and has sufficient history of use. Therefore, it is in compliance with the criteria of Item (i) in Subsection II.4.F, Section 3.8.1 of NUREG-0800.

LS-DYNA is a general-purpose finite element analysis program capable of simulating complex real world problems. HOLTECH uses it to evaluate rack-to-rack impact the capacity of the rack bumper bars and fuel assembly accidental drop analysis cases on structural member of the racks. The validation was achieved under HOLTEC's QAP in HOLTECH Report HI-961519, Revision 7, "LS-DYNA QA Validation." The staff agreed that LS-DYNA FEA program is recognized in public domain and has sufficient history of use. Therefore, it is in compliance with the criteria of Item (i) in Subsection II.4.F, Section 3.8.1 of NUREG-0800.

Mathcad, Version 15, is computer software primarily intended for solving, analyzing, documenting and re-using of engineering calculations. HOLTEC used it to perform energy balance method for fuel assembly drop analyses. The staff agreed that Mathcad computer software program is recognized in public domain and has sufficient history of use. Therefore, it is in compliance with the criteria of Item (i) in Subsection II.4.F, Section 3.8.1 of NUREG-0800.

The staff did not have any issue with any of the computer codes used to perform the seismic/structural analyses of spent fuel racks.

9. Review of a sample DYNARACK analysis.

During the audit, the applicant made a presentation of a sample DYNARACK run that included details of development of the input files, the analysis, and processing of the output files. The pre-processor program developed the input mass and stiffness parameters using the formulas for calculation of spring stiffness and assigned the spring stiffness and gap elements at each node of the model. The main DYNARACK routine then performed a non-linear time-history analysis of the model by performing direct integration of the equations of motion using a central difference scheme. Fluid coupling effects are simulated by appropriate inertial coupling in the system kinetic energy. A post-processor program was used for calculating the various stress factors and extracting the maximum spring forces and rack displacements.

The staff performed some sample checks of the input and output parameters used in the analysis by manual calculation and found them to agree with the values used in the analysis. The staff asked the applicant how the linear friction springs in two directions at bottom of the pedestal were adjusted to accurately represent the coefficient of friction. The applicant explained that the DYNARACK program included a routine for computing frictional forces at the base in the resultant direction at any time step, and then resolving the frictional spring forces in the two orthogonal directions to accurately capture the coefficient of friction in the analysis. The staff agreed that the analysis adequately used the frictional springs in the analysis by considering the resultant direction of the base reaction for computing the frictional resistance. The staff did not have any other issues with the general analysis methodology.

10. Review of allowable stresses used for Level A and Level D loading cases.

In RAI 09.01.02-44, the staff had asked the applicant to include the stress limits for tension and bending for the Level D condition. During the audit, the staff reviewed a draft response to the RAI and noted that the allowable stress in bending did not appear to have addressed the criteria provided in ASME Section

III, Division I, Appendix F, Section F-1334.4 and F-1334.5. The subject was discussed with the applicant and is tracked under Action Item 30.

11. Review of methodology and calculation for fuel drop analysis.

    NINA Letter, U7-C-NINA-NRC-130059, dated November 14, 2013, Attachment 5, Item 9, discusses the energy balance method used to carry out the accidental fuel drop analyses using energy balance method.

    During the audit, the staff reviewed Holtec Report HI-2135571, Toshiba America Nuclear Energy (TANE) Fuel Drop Accident Analysis report for South Texas unit 3&4 ABWR Racks." A detailed review of the derivation of energy balance method for fuel drops was performed. Some issues were found for both deep drop and shallow drop, which were discussed with the Holtec staff during the audit. After discussions, the applicant decided to use LS-DYNA to re-evaluate the fuel drop events, instead of using previously proposed energy balance method. Some preliminary results from LS-DYNA were presented during the audit. Further review will be performed in details regarding both deep drop and shallow drop analyses performed using LS-DYNA. The issues pertaining to fuel drop analysis are tracked in Action Items 5, 6, 7, and 18.

12. Review of methodology and calculation for buckling analysis.

    In RAI 09.01.02-64, the staff had asked the applicant to provide technical basis for assumed boundary conditions for buckling evaluation of cell walls. The subject was discussed with the applicant during the audit regarding potential un-conservatism in the assumed boundary conditions in the model, and the applicant agreed to revise its buckling evaluation using a more conservative ANSYS model. The issue is tracked under Action Item 10.

13. Review of methodology and calculation for thermal analysis.

    In RAI 09.01.02-39, Items (b) (10, (2), and (3), the staff had asked the applicant to provide additional details about the thermal analysis of an isolated hot cell. The staff discussed the response with the applicant during the audit regarding additional clarification regarding the thermal gradient used in the analysis, and the assumption of a continuous weld for evaluation of thermal stress in the cell to cell weld. The applicant agreed to revise the response to address the issues. This is tracked under Action Items 28 and 29.

14. Review of methodology and calculations pertaining to modeling of fuel assembly.

    In RAI 09.01.02-60, the staff had asked the applicant to provide the technical basis for concluding that assuming the fuel assembly as five lumped masses may provide a conservative estimate of fuel impact load. The subject was discussed with the applicant during the audit, and the applicant proposed to perform sensitivity runs connecting the lumped masses with representative springs to demonstrate that the assumption of five lumped masses for the assembly is conservative. The issue is tracked under Action Item 9.

15. Review of methodology and calculations for structural assessment of fuel assemblies subject to seismic loads

    The applicant provided a mark up of Section 6.7.1, of Holtec Report HI-2135462 to include details of the structural assessment of fuel assembly under seismic loads in Item 57 of Attachment 5 to letter U7-C-NINA-NRC-130059. The staff reviewed the referenced documents used in the assessment during the audit and verified the various dimensions and material properties used in the assessment. The staff did not identify any issues with this review.

16. Review of draft RAI responses presented by the applicant during the audit.

    No draft RAI responses were presented during the audit that needed to be reviewed by the staff.

Deviations from Audit Plan:

None.