SOUTH TEXAS PROJECT, UNITS 3 AND 4, COMBINED LICENSE APPLICATION FUEL RACK DESIGN ANALYSIS RELATED TO FINAL SAFETY ANALYSIS REPORT 9.1.2, "NEW AND SPENT FUEL STORAGE," NUCLEAR INNOVATION NORTH AMERICA, LLC, AUDIT

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1.0 SUMMARY

On April 8-9, 2014, the U.S. Nuclear Regulatory Commission (NRC) conducted an audit at the NEI NPOC and Westinghouse Twinbrook offices, located in Rockville, Maryland. 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) Letter Numbers 439, 440, and 441 related to Standard Review Plan Section 09.01.02, on November 26, 2013, December 27, 2013, and January 7, 2014, respectively, related to the spent fuel racks. The staff had identified a need to audit supporting documents for RAI responses. 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.

Next, the staff conducted a review of the calculations and documentation in support of the NINA Combined License Application following the audit plan (ML14097A358).

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.

3.0 DETAILED REVIEW, DISCUSSIONS, AND CONCLUSION

The following areas were included in the staff's review and discussions with the applicant during the audit:

1. Review of deep drop analysis results including calculation of incident velocity for deep drop over pedestal.

   During the review of the revised draft response to RAI 09.01.02-51, submitted by the applicant on March 24, 2014, describing the fuel drop analysis results using LS-DYNA discussed during the audit held on March 3, 2014, through March 7, 2014 (action items 5, 6, 7, and 18), the staff noticed that the incident velocity used by the applicant for deep drop analysis over a pedestal was substantially different from the incident velocity used for deep drop analysis away from the pedestal. The staff reviewed the calculation of the incident velocity for the two deep drop cases during the audit and found that the full frontal area of the fuel assembly was used for the case of deep drop over a pedestal instead of the conservative assumption of 40 percent of the frontal area of the fuel assembly used for the other case for calculation of drag forces. The staff discussed the subject with the applicant, and the applicant agreed to revise its response to RAI 09.01.02-51 considering 40 percent of the frontal area of the fuel assembly for both deep drop cases. Also, it was pointed out, by the staff, that Figures 7.2.1 and 7.2.2 included in the response did not reflect the drop locations assumed in the analysis. The applicant agreed to update these figures in the final response.

   During the audit, the staff reviewed the LS-DYNA input parameters and the analysis results for all fuel drop cases. The staff did not have any further questions regarding fuel drop analysis.

2. Review validation for the five lump mass fuel assembly model.

   The staff reviewed the draft response to RAI 09.01.02-60, presented by the applicant during the audit. The draft response included results of 12 DYNARACK simulation runs performed by the applicant to demonstrate adequacy of the five lumped mass model for the fuel assembly (action item 9). The simulation runs used two linear springs (one each in x and y directions) connecting the adjacent lumped masses. Thus, a total of eight springs are added, connecting the five fuel masses for each rack in the DYNARACK model. The spring stiffness value assigned for the 12 simulation runs ranged from a very low value of 10 lbf/in to a very high value of 107 lbf/in, while calculated estimate of stiffness for the fuel assembly was 340,000 lbf/in. Apart from the fuel springs, these 12 runs are identical to Run no. 19 from the Holtec Report No. HI-2135462. The staff reviewed the results and noted that the impact loadd at the intermediate nodes for the estimated spring stiffness of 340,000 lbf/in was less than what were computed using uncoupled lumped masses. However, the staff noted that the corresponding impact loads at the two end nodes were significantly higher. The staff discussed the issue with the applicant, and the applicant agreed to use the higher impact load for qualification of the fuel assembly (RAI 09.01.02-45). The staff did not have any other questions regarding the issue of modeling of fuel assemblies.

3. Review the results of sensitivity runs for rack to rack top springs.

During the audit, the applicant shared the results of the sensitivity study performed to address the issue of rack-to-rack impact captured in action item 20 for the audit held on March 3 - 7, 2014. Two sensitivity runs were performed. In the first run, the impact spring stiffness was calculated assuming that the impact load is resisted by three corner cells on each side over a depth that is equal to one-half of the rack width. The resulting spring rate was roughly 20 percent greater than the original spring rate. The impact load increased by 6.2 percent. In the second sensitivity run, the original spring rate is increased by 50 percent with a resulting impact load increase by 11.5 percent to 210,480 lbs. The results from these two runs show that the impact load is starting to plateau. The higher impact load of 210,480 lbs was used for design against rack-to-rack impact. The applicant also presented an animation of the impact analysis, and it was observed that significant buckling occurred primarily in the corner cells. The staff reviewed the draft response to RAI 09.01.02-49, Item 2, presented during the audit, and did not have any further questions.

4. Calculation for the stresses in the cell walls due to fuel assembly impact.

   During the audit, the staff reviewed Holtec calculation HI-2135615, “Structural/Seismic Analysis of Fuel Racks at South Texas Project Units 3 & 4,” Revision 3, pages D-2 through D-4, for calculation of stresses in the cell wall due to fuel assembly impact load (action item 8 from March 3 - 7, 2014, audit). The calculation demonstrated that the stresses in the cell wall remain within the yield stress of 25 ksi assuming six inch effective width of the cell wall against fuel assembly impact load with the conservative assumption of one way beam strip. The staff also reviewed the draft response to RAI 09.01.02-49, Item 1, presented during the response, and did not have any further questions regarding the issue.

5. Provide feedback and discuss the draft RAI responses received since the last audit.

   The applicant presented a complete set of revised draft responses during the audit. The staff reviewed the draft responses, and provided feedback as discussed in the items discussed above.

6. Visit the action item list from the last audit and verify closure of all items identified as requiring follow-up action including review of supporting calculations used for closing follow-up actions

   All action items identified after the audit held on March 3 - 7, 2014, were reviewed against the draft responses implementing the required actions. The staff also reviewed the supporting calculations addressing the action items contained in Holtec calculation HI-2135615, Revision 3. The staff did not identify any new issues. All action items except for the follow-up actions in Item 1 and 2 above are closed. The follow-up actions will be reviewed against the responses to the RAIs identified against each item.

7. Review of the criticality calculations and related supporting documents to address the results of the deep drop accident.

   The applicant presented the criticality analysis with the active region of one fuel assembly six inches below the neutron absorbing material and the active region of the

surrounding eight fuel assemblies three inches below the neutron absorbing material. Additionally, the applicant presented sensitivity cases of varied particles per cycle, varied initial source distribution, and to get the flux distribution. The applicant stated that the results of the analyses would be included the RAI response and subsequently in the revised technical report.

4.0 REFERENCES:

1. Drawing No. 8946, “Spent Fuel Storage Racks,” Revision No. 3.

2. Holtec Report No. HI-2135462, “Licensing Report for South Texas Project Units 3 & 4 ABWR Spent Fuel Racks,” Revision No. 1.

3. Holtec Report No. HI-2135571, “Toshiba American Nuclear Energy (TANE) Fuel Drop Accident Analysis Report for South Texas Project Units 3 & 4 ABWR Racks,” Revision No. 0.

4. Holtec Report No. HI-2135615, “Structural/Seismic Analysis of Fuel Racks at South Texas Project, Units 3 & 4,” Revision No. 2.