January 9, 2012

Mr. Scott Head, Manager
Regulatory Affairs
STP Units 3 & 4
Nuclear Innovation North America, LLC
P. O. Box 289
Wadsworth, TX 77483

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 415 RELATED TO SRP SECTION 9.01.02 FOR THE NUCLEAR INNOVATION NORTH AMERICA, LLC COMBINED LICENSE APPLICATION

Dear Mr. Head:

By letter dated September 20, 2007, South Texas Project (STP) submitted for approval a combined license application pursuant to 10 CFR Part 52. The U. S. Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed application.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter.

To support the review schedule, you are requested to respond within 30 days of the date of this letter. If changes are needed to the safety analysis report, the staff requests that the RAI response include the proposed wording changes.

If you have any questions or comments concerning this matter, I can be reached at 301-415-5787 or by e-mail at Rocky.Foster@nrc.gov or you may contact George Wunder at 301-415-1494 or George.Wunder@nrc.gov.

Sincerely,

/RA/

Rocky D. Foster, Project Manager
Licensing Branch 3
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 52-012, 52-013

eRAI Tracking No. 6263

Enclosure:
Request for Additional Information

cc: William Mookhoek
James Agles
Loree Elton

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DATE	12/22/2011	12/22/2011	12/27/2011	12/29/2011	01/09/2012

***Approval captured electronically in the electronic RAI system.**

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Request for Additional Information No. 6263 Revision 6

1/9/2012

South Texas Project Units 3 and 4
South Texas Project Nuclear Operating Co
Docket No. 52-012 and 52-013
SRP Section: 09.01.02 - New and Spent Fuel Storage
Application Section: FSAR 9.1.2

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

09.01.02-17

The staff's review of Westinghouse Electric Company LLC, WCAP-17331-P, Rev. 2, "Structural Analysis Report for STP Units 3 & 4 Spent Fuel Storage Rack Baseline Design" (hereafter referred to as Technical Report), identified several places where clarification and/or editorial correction is needed. The staff requests the applicant to address the following:

1. In Figure 3-5, a "leveling block assembly" and a "leveling pad assembly" are indicated. Explain the difference and provide a picture that clearly shows the difference.

2. The first paragraph of Section 4.1 "Time History Input" states "The base of the spent fuel pool is at 64.96 feet (19.8 meters), and the top of the racks is at 81.36 feet (24.8 meters)." This implies that the racks have a height of 196.8 inches. Explain the difference between this dimension and the "total module height" given in Table 3-2.

3. Figure 4-1 appears to be a plan view. If this is a plan view, then Y is vertical and Z is horizontal west. This is inconsistent with the text in Section 4.1, which defines Y as horizontal west and Z as vertical. Correct the text and figures to be consistent. Also confirm that the seismic input was properly applied in the 3 coordinate directions.

4. In Figure 4-23, it appears that "GZ4" should be "GZ3", to be consistent with Table 4-3. Also, "GZ2" appears twice; correct as necessary to be consistent with Table 4-3. Also, the Z direction is shown as horizontal west; confirm this is correct.

09.01.02-18

Westinghouse Electric Company LLC, WCAP-17331-P, Rev. 2, "Structural Analysis Report for STP Units 3 & 4 Spent Fuel Storage Rack Baseline Design" (hereafter referred to as Technical Report), was submitted by the applicant to provide updated information. Section I.4 of SRP 3.8.4, Appendix D, identifies that the applicant should demonstrate that the functional capability and/or the structural integrity of each component is maintained. Although the Technical Report presents updated analysis and design information, the staff finds that it is insufficient to conduct its review in accordance with SRP 3.8.4, Appendix D. The staff requests the applicant to address the following questions related to Section 8.2 of the Technical Report:

1. Some of the stress results tables in the Technical Report, Revision 2, Section 8.2, present weld stress evaluations. As indicated, stress limits are specified in Table 4-8

and Table 4-9 for linear type support and plate and shear type support, respectively. However, the staff noted that stress limits for weld are not provided in the two tables. Provide stress limits for welds in Tables 4-8 and 4-9. Since ASME Section III Appendix F does not clearly specify stress limits for welds in level D analysis, provide the technical basis for the weld stress limits used.

2. The Technical Report, Revision 2, Section 8.2.1, presents level screw analysis results. Table 8-3 entitled leveling screw geometric properties shows that a value of [proprietary] inch for level screw length is used for design and allowable stress calculations. Note 1 of the table states that the level screw length is the bending moment arm. This value is also shown in Figure 3-5 as the exposed height of level screw between the top surface of bearing pad and bottom surface of support plate. During a conference call, the applicant indicated that this value would vary from leg to leg, to level the rack in the pool. Since this value is used in both stress and allowable stress calculations, explain whether it is an upper bound value. If not, explain why an upper bound value is not used. Also, provide the calculations for the moment in the level screw. In addition, a requirement for maximum exposed height of level screw between the top surface of bearing pad and bottom surface of support plate should be clarified in the report.

3. The Technical Report, Revision 2, Table 4-8, presents stress limits for linear type component supports. In the last row of the table, a factor of $C_{\text{level D}}$ is used. Note 1 of the table explains that the factor is a level A to level D increase factor. Provide the value of the factor and the technical basis for the value.

4. The Technical Report, Revision 2, Section 8.2.4, presents analysis results for grid structure, cover plate, and boral wrapper. It states that the grid structure stresses are evaluated using the floor impact submodel analysis described in Section 4.2.4 and the fuel impact submodel analysis described in Section 4.2.5. Explain whether the effects from rack to rack interactions, including impact between two rack groups and loads from linkages between racks, are taken into account. Also explain whether the effects from various impacts/rack interactions are combined or considered separately for the design evaluation.

5. The Technical Report, Revision 2, Table 8-7, provides a summary of grid structure stresses. The staff noted that stresses in the cell wall and welds between cell walls are much smaller than the corresponding values given in Revision 1 of the Technical Report, and they are much smaller than those of coverplate presented in the same table. Provide explanations. Also, the first column of Table 8-7, explain what "Grid" stands for. The last row of the table, explain why strength check for wrapper other than weld check is not presented.

6. The Technical Report, Revision 2, Section 8.2.4 presents analysis results for upper and lower linkage assemblies. Table 8-9 presents a summary of lug stress ratios. Explain why for some stress checks, such as bearing, the stresses for stress ratio calculation shown in Table 8-9 are not the maximum stresses shown in Table 8-8, Summary of lug stresses. The linkage details shown in FE model figures such as Figure 4-9 are inconsistent with those shown in figures in Appendix A. Explain the difference and discuss the effect of the difference on linkage evaluation. Table 8-10 presents maximum linkage band weld stresses. If the stresses are calculated by hand calculations, provide the weld length used in the calculation and the basis.

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.

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 re-run.

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.

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.

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 fuel-to-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.

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.

09.01.02-24

In Section 4.2.2.1, the applicant states:

> “The 10 x 10 rack model was developed with two configurations: fully loaded with 100 fuel elements and empty. The DCD fuel assembly is supported laterally by the rack grid structure and vertically by the support plate. The lateral connection to the rack grid structure consists of four rigid beams at each fuel node elevation. Each of these beams connects directly to the grid cell wall. The other end of the rigid beam is connected to a unidirectional spring element. These connections are illustrated in Figure 4-7. The spring elements represent the fuel through-grid structure impact stiffness (TGSIS). Each spring element is connected to the fuel assembly. TGSIS values of [proprietary] and [proprietary] were used in the modal analysis of

the detailed rack model as a range of grid impact stiffness. The impact stiffness did not have a significant impact on the dynamic properties of the rack. The greater stiffness value of [proprietary] is used for the fuel impact stiffness because a higher stiffness will result in conservative impact loads."

The staff required clarification concerning the origin of the two TGSIS values considered, and whether either value is representative of the "DCD fuel assembly". The staff also wanted details of how the TGSIS is determined - by calculation or by test?

The staff discussed this with STP on 12/14/11. The applicant stated that values are typical for a PWR fuel assembly, and are believed to be stiffer than a BWR fuel assembly. The applicant does NOT have access to detailed geometry of the "DCD Fuel Assembly". STP stated that ± 20% variation in the higher TGSIS value did not produce a significant change in the impact load, indicating insensitivity to the impact stiffness.

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.

09.01.02-25

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.

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.

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.

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.

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 <u>0.40 x yield stress of base metal</u> 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.

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 160.8°F and the uniform temperature is 150.8°F, representing a ΔT = 10°F. The staff notes that recent DCD applicants have assumed a ΔT of 50°F 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 16°C to 66°C (60.8°F to 150.8°F). What is the technical basis for assuming the uniform temperature is 150.8°F, and not 60.8°F? Have detailed thermal hydraulic analyses of the pool been performed for a range of operating scenarios? Is ΔT = 10°F the worst case of all scenarios?

09.01.02-30

Technical Report, Rev. 2, Section 8.1.1, Tables 8-1 and 8-2, present the “Summary of Seismic Forces” and the “Summary of Seismic Displacements”, respectively, for the 6 cases analyzed. The staff notes that Section 8.1.1 has no discussion of the results presented in the tables. After review of the data in the tables, the staff requests the following clarifications and explanations:

(1) Table 8-1 shows there are no rack-to-wall impacts for the 6 cases currently analyzed. Table 8-2 shows SRSS Sliding displacements in the range of 12.7” to 20.9”. In Tables 4-3 and 4-4 of the Technical Report, there are several rack-to-pool wall gaps in this range. 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) Table 4-6 of the Technical Report describes the 6 cases analyzed. Cases 2, 3, and 4 are the “Detailed WPM”, assuming 0.2, 0.5 and 0.8 coefficients of friction, respectively. 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) Table 4-6 of the Technical Report describes cases 5 and 6 as “Partial Loaded Pool”, assuming 0.2 and 0.8 coefficients of friction, respectively. From Tables 8-1 and 8-2 of the Technical Report, case 6 produced the only rack-to-rack impact and case 5 produced the largest SRSS sliding displacement. 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, and, if so, provide a technical explanation how the sliding displacement response to a loading that is oscillatory in nature reaches the reported magnitudes.

09.01.02-31

In response to RAI 09.01.02-5 Item (I), the Technical Report Revision 2 provides information on modeling of welds. Section 4.2.2.1, on page 4-11, states that “All welds are modeled using the ANYSYS CP coupling command. All couplings are in the x, y and z translation DOF. Rotational loads are not transmitted through the coupled nodes.” In addition, a note in Figures 4-10 states that “Cell to cell weld modeled as coupled nodes in x, y, and z translation.” There are similar notes in Figures 4-11 through 4-13 for coverplate weld, cell to baseplate weld, and support to baseplate weld, respectively. 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.

09.01.02-32

The Technical Report, Revision 2, Section 4.2.5, page 4-45, discusses the fuel impact submodel. The second paragraph of this section states that “Two impact locations are investigated: at an interior cell and on a coverplate. [Six sentences – proprietary]”

The evaluation of stress in the cell walls when subjected to fuel impact load relies on the fuel impact submodel analysis. The staff requests the applicant to provide the following information concerning the fuel impact submodel:

Provide the technical basis for the postulated impact load application area, which from the text and Figure 4-34 appears to be about 100 in^2.

Explain the meaning of the sentence "[Second sentence of proprietary text]"

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 worst-case locations based on WPM analysis results? What are the numerical values of the fuel impact loads at the 2 selected locations?

Provide the technical basis for the specification of [Sixth sentence of proprietary text] constraints at the leveling screws.

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.