Mr. Robert E. Brown
Senior Vice President, Regulatory Affairs
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P. O. Box 780, M/C A-30
Wilmington, NC 28401

July 6, 2007

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RE: GE-HITACHI NUCLEAR ENERGY AMERICAS LLC (GHNE) LICENSING TOPICAL REPORT (LTR) NEDE-33284P, REVISION 0, "MARATHON-5S CONTROL ROD ASSEMBLY," (TAC NO. MD3119)

Dear Mr. Brown:

By letter dated September 27, 2006 (Agencywide Documents Access and Management System Package Accession No. ML062760215), GHNE submitted for U.S. Nuclear Regulatory Commission (NRC) staff review LTR NEDE-33284P, Revision 0, "Marathon-5S Control Rod Assembly." Upon review of the information provided, the NRC staff has determined that additional information is needed to complete the review. Jim Harrison, Project Manager Fuel Licensing, and I agreed that the NRC staff will receive your response to the enclosed Request for Additional Information (RAI) questions by July 18, 2007.

Enclosure 1 provides a non-proprietary version of the RAI questions. Enclosure 2 provides a proprietary version of the RAI questions. If you have any questions regarding the enclosed RAI questions, please contact me at 301-415-1774.

Sincerely,

/RA/

Michelle C. Honcharik, Project Manager
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 710

Enclosures: As stated

cc w/encl 1 only: See next page

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REQUEST FOR ADDITIONAL INFORMATION (RAI)

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

LICENSING TOPICAL REPORT (LTR) NEDE-33284P, REVISION 0

"MARATHON-5S CONTROL ROD ASSEMBLY"

GE-HITACHI NUCLEAR ENERGY AMERICAS LLC LICENSING (GHNE)

PROJECT NO. 710

All section, table, paragraph, figure, and reference numbers refer to LTR NEDE-33284P, Revision 0, unless specified otherwise.

1. Section 2.2 states: [

]

   a. Provide data to justify that the dimensions selected for the minimum and actual tube-capsule gap increase are adequate.

   b Provide radial expansion data and calculation methods. Justify results.

   c. Provide axial expansion data and calculation methods. Justify results.

   d. Explain the volumetric expansion interactions, axial effects on radial expansion, and vice versa. Justify results.

   e. Justify the finite element analyses (FEA), or any other techniques employed for expansion calculations. Explain if corrosion in the FEA was considered or not, and if it was modeled as a removal of material or as an addition of an insulating material layer.

2. In Table 2-1, explain the absorber tube dimensions for inner diameter (ID), outer diameter (OD), and thickness. In the table, for each lattice, there are no OD and ID differences between the Marathon and Marathon-5S designs, yet the Marathon-5S designs all have thicker absorber tubes. Is there a typographical error?

3. Section 3.1, Paragraph 1 states: "Corrosion, wear, and crud deposition are accounted for when appropriate."

   a. Provide data calculations of non-corroded, unworn, and without crud deposits, and provide data for appropriate inclusions of corrosion, wear, and crud deposition in analyses.

b. How are the differences accounted for?

c. Do the analyses show that corrosion and wear exceeding 0.005" deep can be present on the surface, without affecting the design basis allowable pressure of the tube, and that this amount of wear is considered sufficiently conservative?

1. What is the limit to which 0.005" can be exceeded?

2. Identify the analysis technique and verify that it is a method accepted by the NRC, American Society for Testing and Materials (ASTM), or other recognized scientific body.

3. Present calculations and results.

4. Justify any statement of conservatism.

5. Identify peak stress concentrations in magnitude, direction, and point of application.

6. For peak stress concentrations which are identified as being on the flat portions of the tube, explain the stress and strain differences between differently oriented or located flat portions, regarding their proximity to welded joints.

7. Explain and show calculations and results for the effects of welds on the material's microstructure in relation to applied stresses.

8. Are combined corrosion and wear modeled as a removal of material? If so, explain how corrosion is a removal of material, and not an addition of surface material.

9. Identify the model mentioned in RAI question 3.c.8 (above) and verify that it is a method accepted by the NRC, ASTM, or other recognized scientific body.

10. Justify the FEA thermal calculations, in regard to RAI question 3.c.9 (above) and explain if corrosion in FEA was considered or not.

11. In the FEA, was corrosion used as a removal of material or as an addition of an insulating material layer? Justify the answer.

12. In the FEA in Section 3.6, crud is mentioned. Is an additional corrosion layer used in the analysis? Justify the reasoning.

13. Present the FEA results for radial and axial directions, and explain directional interactions.

4. Section 3.1, Paragraph 2 states: "As in Reference 1, effective stresses and strains are determined using the distortion energy theory (Von Mises)...."

   a. For in-reactor temperature and pressure conditions, provide data to map the dominant deformation mode. Demonstrate that Von Mises analyses are adequate if the failure mode may be via either ductile, fatigue, or crack propagation.

   b. A conservatism of 0.5 ultimate tensile strength (UTS) may still be low, if failure is by fatigue or another mechanism. Provide data supporting why 0.5 UTS is conservative.

   c. Provide data to show why UTS is employed, rather than yield strength as a design criterion. Demonstrate that continued operation with plastic strain (up to UTS) is achievable with no channel/blade interference.

   d. Provide mechanical test data to support the FEA results.

   e. Provide data to demonstrate that radiation effects do not induce a ductile-to-brittle transition, which may invalidate the FEA for higher burnup materials.

   f. Provide surveillance data from Reference 1, pertaining to GHNE's un-irradiated stainless steel properties which were presented at the time (said properties which are not for the same material of which neither the Marathon nor the Marathon-5S blades are constructed). Justify that this data supports past and present calculations for Marathon (since the 5S design references the original Marathon topical report) and Marathon-5S designs.

   g. Provide data, including mechanical test results, to verify that radiation embrittlement is not a safety issue.

   h. Provide data, including mechanical test results, to verify that radiation induced changes in the ductile-to-brittle transition temperature are not a safety issue.

5. Table 3-1 lists the Marathon-5S material properties. Tensile strength may not be uniaxially equal after forging, rolling, extrusion, pilgering, or other mechanical and thermal processing. Provide mechanical test results demonstrating axial and radial tensile strength, especially across welded interfaces.

6. Section 3.2, Paragraph 1 states: "The limiting unirradiated material strengths are first identified for the control rod structural materials, and shown in Table 3.1."

   a. Provide mechanical test data showing that these unirradiated property limits hold for irradiated materials.

   b. Address the embrittlement RAI questions in 4.g and 4.h (above).

7. Section 3.8, Paragraph 1, provides the assumed lifetime on which the fatigue analysis is based. Explain the numbers of fatigue cycles. Are the fatigue cycle numbers based only upon insertion into the core (e.g., 1 scram = 1 cycle, or 1 seismic event = 1 cycle)? Or are fatigue cycle numbers based upon turbulent flow vibrations or other cyclic stresses? For example, 1 scram may be equivalent to 1 rod insertion for 72 hours duration, during which time the blade tips may deflect in an oscillating motion for thousands of cycles.

8. Section 3.6, Paragraph 4 states: [

]

   a. Provide data for the calculations showing that 100 percent burnup B_4C capsules will not swell to the point of contact with the absorber tube.

   b. Provide mechanical test data to support the analysis. Identify the tests and verify that the data is acceptable.

   c. Identify examination methods and verify that they are accepted standards.

   d. Provide radial and axial data.

   e. What are the volumetric expansion interactions of stresses and strains?

9. Section 3.6, Paragraph 5 refers to: "…the largest allowable surface defects (see Figure 3-5)."

   a. What are the criteria for quantifying the largest allowable defect?

   b. Define the term "manufacturing capability."

   c. What calculations and methods are used to determine the maximum allowable depth of a surface defect?

   d. Besides depth, what are the other dimensional maximum allowable defect sizes (i.e., length, width, radius, area)?

   e. What are the other inputs into the FEA for surface defects? How are these determined?

   f. What are the FEA results? Provide justification for the acceptability of the results.

10. Section 3.2, Paragraph 6 states: "For welded connections, a weld quality factor, q, is used...."

a. Since Marathon-5S channel thicknesses have changed from the previous design, provide data to support why laser welding parameters were changed, or why they were not changed.

b. Provide statistically adequate amount of mechanical test data (i.e., tensile tests or other generally accepted method) to show that laser welding techniques and annealing are adequate, regarding the base metal, weld, heat affected zones, and stress relaxation.

c. Provide a statistically adequate amount of micrographs used for the examination of a statistically adequate sampling of weld cross-sections.

d. Characterization the micrographs.

e. Identify the micrograph magnifications.

f. Present supporting information that the magnification is sufficient and conforms to accepted standards.

g. Present data to support that microstructural composition did not adversely change with temperature during welding or other fabrication techniques.

h. Verify that microstructural changes, such as grain boundary segregation of precipitates and precipitate free zones (i.e., strength and toughness degradation due to welding) will not affect performance and safety.

i. Present microstructural and mechanical test data to demonstrate that stress corrosion cracking will not degrade the materials.

11. Figure 2.2 illustrates Marathon-5S absorber wing weld locations. In the previous design, Marathon blades had gaps between each of the channels, which are welded to form a wing. If expansion occurred, the gaps could accommodate some expansion. Marathon-5S blades do not have gaps.

a. Provide test data to show that expansion in a blade will not exceed tolerances.

b. Present mechanical test data and calculations for both radial and axial expansion.

c. Explain the interaction of expansion in each direction upon expansion in the other direction.

d. Present data to show that crud build-up in any portion of the control rod blade (CRB) (such as at any spaces between adjoining surfaces, or against any protruding or flow resistant areas where excess crud may deposit) does not result in additional heat build-up and thermal expansion in localized areas.

12. Section 5.1 states: "The width of the absorber tube and the width of the control rod wing of the M[arathon]-5S CRB are identical to the Marathon CRB (see Table 2-1). Plus, all other envelope dimensions, including tie rod, handle, and velocity limiter are identical. Therefore, the fit and clearance of the M[arathon]-5S CRB in the fuel cell is identical to the Marathon CRB." Provide data to account for dimensional stability and integrity during longer refueling times.

13. Section 2.2 states: "The Marathon-5S CRB uses a capsule body tube geometry with [ ]"

    a. Provide test data to show that the new surface topography of the blades does not adversely affect thermal hydraulics.

        1. Present data for displaced volume differences.

        2. Present data for topographic changes.

14. Section 3.2, Paragraph 5 states: "Resulting allowable stresses for primary loads are shown in Table 3-2 for both the ASME [American Society of Mechanical Engineers boiler and pressure vessel] code method, and the ½ ultimate tensile strength criteria from Reference 1."

    a. Provide examples of maximum and allowable stress calculations from different locations on a CRB.

        1. Include all the highest ASME code and alternate design ratio results for all locations on a blade, especially for the S lattice.

    b. Justify why the alternate design ratio criteria from Reference 1 is a valid methodology.

15. In Section A-1.4, a "conservatively estimated" maximum added friction force of 5 pounds is stated.

    a) Provide calculations of how this number was determined.

    b) Why it is conservative as a percentage of maximum?

    c) What is the maximum allowable amount?

d) Across which area is this force applied?

e) Provide mechanical test data to verify that the estimate is conservative.

16. For the paragraph titled "Flow Induced Vibrational Effects" in Section A-3, on Page A-5, provide data to demonstrate no adverse change in CRB vibration.

17. The last sentence on Page A-7 states: "GE has supplied over 100 roller-less handle control rod blades to European BWRs [boiling water reactors], with no reported issues."

a. Expand the definition of "issue" to include any change which has occurred, which may be considered by the NRC to become a safety problem. "Issues" should include both operational and non-operational issues, such as cracking, neutronics problems, corrosion, excessive crud formation, or any other unanticipated or anticipated problems or degradation at any location.

b. Provide surveillance test data showing that this design has worked well in operation.

c. Include all surveillance data, foreign and domestic. Particularly, provide all information pertaining to any Marathon or Marathon-5S, control blade problems experienced in Taiwan.

d. Have there been unreported issues or other problems?

e. "Over 100" means exactly what number?

f. What is the total number of control blades supplied to all customers worldwide?

g. What problems have been encountered worldwide and what is the number of these problems?

h. Were any warrantied blades replaced? If so, why?

i. For the data, indicate the dates put into service and the dates of the examinations.

j. For the data, provide reactor power and burn-up, as well as outage times included in the overall time periods.

k. For the data, present information regarding time and position in the reactor. Also state how far into the core the blades were inserted and the duration of insertion.

l. Identify the types of inspections.

m. Present information to support that the inspection techniques are adequate and adhere to acceptable standards.

n. Present data from a statistically significant amount of reactors at different locations.

o. Identify the reactor locations, and verify if the inspection procedures at each location adhere to NRC guidelines.

18. During manufacturing, how do you ensure that metal shavings are not accumulating in pockets within CRB assemblies, as occurred in the services component operation (SCO) shop in Wilmington, NC, prior to August 10, 2006, as referenced in a letter from Thomas Carter, GE Manager RPM&D, to Tim Raush, NGS Site VP, Oyster Creek?

19. What is the operational experience of the Marathon-5S predecessor regarding any nuclear lifetime failures? If earlier than predicted failures did occur, how has the analysis process for Marathon-5S been improved to eliminate the possibility of similar shortcomings in the analysis process?

20. Section 4.2 discusses the methodology used to calculate the boron 10 (B-10) depletions.

a. Is B-10 drift accounted for in the Monte Carlo N-Particle Radiation Transport Code (MCNP) calculations of boron depletion?

b. Please state the Name/Version of the GE-MCNP that was used.

c. List any/all codes (and versions) coupled with the GE-MCNP code (e.g., ORIGEN, TGBLA, etc.).

d. Discuss any programs for the operator to monitor neutron flux/fluence over the lifetime of the CRB.

e. Discuss any inspection programs planned to validate lifetime predictions.

21. In Section 2.2 there is a discussion which indicates that due to the new capsule dimensions, there is slightly less B_4C powder mass in each capsule (a trade-off to increase mechanical lifetime). In Tables 4-5, 4-6, and 4-7 there is an increase in initial reactivity worths listed (except for cold conditions in the S lattice).

a. Please discuss how the initial reactivity worth was increased while decreasing the amount of B_4C contained in each capsule.

b. Please provide either a brief description of the original equipment (OE) and/or reference to further clarify the nuclear calculations, which compares OE and Marathon-5S initial reactivity worths. This is needed to verify that the MCNP

input deck geometries are correct. In particular, dimensions for the sheath, the stainless steel block in the middle of the CRB wing, and the absorber rods as modeled in MCNP should be provided.

22. Throughout the LTR, it states that the more restrictive ASME code limits were met for all stress analyses. In Table 3-7, the handle-to-absorber section weld was analyzed versus a 1/2 ultimate strength stress criterion.

    a. Is that statement still accurate?

    b. Please update the table to analyze this with the ASME code limits to match the text.

23. The calculation of the pressure in the absorber tube due to helium release includes worst-case variables. What is the helium release faction used and what was the basis for this value?

24. Section A-1.1 indicates that the nuclear effect of the CRB leaning slightly closer to one bundle and away from another had been reviewed. Please provide the documentation for this review.

25. Section III of the ASME code does not account for the effects of coolant and all stressing modes.

    a. Please justify why these effects are not relevant in your analyses, and explain why both or either the ASME code stress ratio and the alternate ½ UTS design ratio calculations are still valid.

    b. Cite the applicability of the ASME code calculations to comparatively thin CRB materials relative to actual pressure vessel thicknesses.

    c. It is acceptable that thick pressure vessel materials can accommodate crack propagation up to certain lengths. Verify that this does not occur in GHNE control blade materials.

    d. Present mechanical tests to support the reasoning and calculations.

26. There appears to be extensive elongation and variability in absorber tube lengths during and after welding.

    a. Please provide measurement data of the maximum changes in elongation due to welding.

    b. Present microstructural and mechanical characterization verifying that dimensional changes, due to welding or any other manufacturing process, do not

degrade mechanical properties and that the mechanical properties will remain sufficient throughout use and irradiation.

1. Include radiation embrittlement factors.

27. Section 3.6 states "The in-service performance, and inspection history of the Marathon CRB has proven the crack-resistant properties of [Rad Resist 304S]."

a. Please provide the supporting data of the inspection history, in accordance with the criteria detailed in RAI question 17.

b. Discuss all relevant forms of stress corrosion cracking, and verify that it is not and will not become a significant problem.

cc:

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