August 3, 2006

Mr. James H. Riley, Director
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Nuclear Energy Institute
1776 I Street, NW, Suite 400
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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING MATERIALS RELIABILITY PROGRAM (MRP)-169 "TECHNICAL BASIS FOR PREEMPTIVE WELD OVERLAYS FOR ALLOY 82/182 BUTT WELDS IN PWRS" (TAC NO. MC9779)

Dear Mr. Riley:

By letter dated September 7, 2005, the Nuclear Energy Institute (NEI) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Electric Power Research Institute (EPRI) Topical Report (TR) MRP-169, "Technical Basis for Preemptive Weld Overlays for Alloy 82/182 Butt Welds in PWRs [pressurized water reactors]." In supplemental letter dated December 15, 2005, NEI clarified that NRC's review and approval is requested for only those sections of the report pertaining to design requirements, design methodology, and the examination volumes of full and optimized structural pre-emptive weld overlays, specifically, Section 4.0, Design Requirements, and Section 7.1, Requirements for Types of Examination for Weld Overlays.

The NRC staff has identified a number of items for which additional information is needed to continue its review. The NRC staff requires responses to the enclosed request for additional information (RAI) questions in order to continue the review. In our telephone conversation on July 21, 2006, it was agreed that the NRC staff will receive your response to the enclosed RAI questions by September 29, 2006. Please call me at 301-415-1774, if you have any questions on this issue.

Sincerely,

/RA/

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

Project Nos. 669 and 689

Enclosure: RAI questions

cc w/encl: See next page

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Accession No.: ML062050337 **NRR-088** ***No Substantial change from the Memorandum**

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REQUEST FOR ADDITIONAL INFORMATION

NUCLEAR ENERGY INSTITUTE (NEI)

MATERIALS RELIABILITY PROGRAM (MRP) TOPICAL REPORT (TR) MRP-169

"TECHNICAL BASIS FOR PRE-EMPTIVE WELD OVERLAYS

FOR ALLOY 82/182 BUTT WELDS IN PWRS"

PROJECT NO. 689

All section, paragraph, page, table, or figure numbers in the questions below refer to items in TR MRP-169, unless specified otherwise.

General Comments

1. NEI has requested that the U.S. Nuclear Regulatory Commission (NRC) staff review and approve only Section 4.0, Design Requirements, and Section 7.1, Requirements for Types of Examination for Weld Overlays, of MRP-169. However, the NRC staff review and potential approval of these sections has necessitated the review of the entire report. Accordingly, the NRC staff is transmitting questions on various sections beyond Sections 4.0 and 7.1 and will need responses to those questions in order to proceed with the review.

2. The treatment of preemptive full structural, design, and optimized weld overlays (WOLs) is confusing because in various sections the discussion of the design and optimized preemptive weld overlay (PWOL) is intermingled with the discussion of the full structural PWOL. The NRC staff suggests that the report be clarified to (a) provide an introductory section that defines the differences between full structural, design, and optimized WOLs and (b) more clearly separate out the differences in the design and inspection rules for each category of overlay.

3. There may be conflicts between MRP-169 and other MRP reports. Question 3 under "Inspections" illustrates one such example. Sections 4.0 and 7.1 of MRP-169 contain information that is also in MRP-139, "Primary System Piping Butt Weld Inspection and Evaluation Guideline," which the NRC staff has not been requested to review and approve. Also, MRP-169 may not be consistent with MRP-140, "Leak-Before-Break [LBB] Evaluation for PWR Alloy 82/182 Welds." The NRC staff recommends that additional reviews be performed of these documents for consistency.

4. There appears to be a number of differences between MRP-169 and the corresponding draft code case for PWOLs. For example, the draft code case does not provide a maximum residual stress value for the design. Also, the draft code case does not indicate that if a qualified examination cannot be performed immediately prior to the WOL, the WOL should be assumed to be a full structural examination. Please provide a crosswalk of the design and inspection requirements in MRP-169 and the draft code case and discuss any plans to make these two documents consistent, including a revision of MRP-169.

Inspections

1. Page 4-2 in Section 4.1 on Weld Overlay Sizing indicates that, “For an optimized structural PWOL, ...[t]he pipe will have been inspected, and found to exhibit no evidence of cracking, so there is a high level of assurance that no flaws greater than -10% of the wall thickness exist in the original weld.” This wording is not clear as to whether the inspection for an optimized structural PWOL has to be performed immediately prior to the application of the WOL. However, on Pages 7-2 and 7-3 it appears that if a qualified inspection is not performed immediately prior to application of the PWOL, the weldment must be assumed to be cracked and the WOL repair will be full structural, not optimized structural. Please verify that the above statement is correct. In other words, please clarify (if possible, in both sections of the report) that if a American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, Appendix VIII, inspection is not performed immediately prior to application of the PWOL, the WOL must be full structural, not optimized structural.

2. On Page 4-2 in Section 4.1, the ASME Code Case N-504-2 is mentioned. This ASME code case lists calculations to be completed under g(1), (2), and (3). Additionally, Page 4-3 states that a joint-specific, overlay-specific weld residual stress analysis is required for each unique PWOL configuration. It has come to the NRC staff’s attention that the ASME Code Case N-504-2 analyses are not being completed by the licensees prior to startup. Please discuss what calculations need to be completed for a PWOL prior to startup or provide a technical justification for any calculations not performed until a specified time has elapsed after startup.

3. In Section 4.4, the last sentence in the section on Fatigue Crack Growth on Page 4-6 states that, “PWOL examinations may not be eliminated or reduced as a result of Risk-Informed ISI [inservice inspection] considerations.”

   Section 7.2 on Inspection Interval and Sample Size for PWOLs indicates that if qualified examinations are performed prior to application of the PWOL and such ISI demonstrates the weld to be absent of any flaws or crack-like indications, future ISI of the welds shall be performed in accordance with the current requirements of Section XI of the ASME Code. This paragraph goes on to say that, “This requirement is consistent with MRP-139 Category B, except that it is independent of whether the PWOL is a full structural or optimized structural overlay.”

   MRP-139, Category B, inspections are the existing ASME Code examination program or approved alternative. The NRC staff understands “approved alternatives” to mean alternatives to ASME Code requirements which the NRC has previously approved. Approved alternatives may include risk-informed ISI programs. Risk-informed ISI may lead to certain dissimilar metal (DM) welds never being inspected after the post-mitigated inspection.

   Please clarify this potential conflict between MRP-169 and MRP-139.

4. In Section 4-4, the discussion of ASME intervals and “that interval” for allowable flaw sizes on Page 4-6 is confusing. Please provide a few examples for subsequent ISIs using the criteria you discuss.

5. The fourth paragraph in Section 7.1 discusses construction examination of a WOL on piping that is normally examined from the inside surface for ISI. The construction examination is the overlay volume. The criterion is silent on examination of the heat affected zone. Provide an explanation for excluding the heat affected zone from the examination of the WOL.

   The same paragraph is silent on performing examination from the inside surface prior to applying the WOL. If a crack is located on the inside surface, how effective would depth sizing be after applying the WOL. Discuss why an examination prior to applying the WOL is or is not necessary. Discuss the monitoring of an inside surface crack from the inside surface at a location with an outside surface WOL.

6. The last paragraph in Section 7.1 states that procedures, equipment, and personnel will be qualified for examinations of WOLs in accordance with Appendix VII of the ASME Code, as amended in Section 50.55a of Title 10 of the *Code of Federal Regulations*. The ASME Code, Appendix VIII, Supplement 11, qualifications apply to full structural WOL of austenitic piping (WOL thickness plus 25 percent of through-wall (T-W) base metal thickness). For the optimized WOL, the minimum percent T-W inspection volume is the WOL plus base metal necessary for structural integrity including consideration for flaw growth up to the design basis flaw depth plus a 25 percent T-W tolerance. Therefore, the minimum percent T-W inspection volume is a variable and may require inspecting 50 percent T-W of the base metal. For an optimized WOL, discuss the performance demonstration qualifications for similar configurations (same diameter pipe-to-pipe), dissimilar configurations (different diameter pipe-to-flange or nozzle), DM welds, and cast austenitic piping.

7. Section 7.2, requirement 1., states that if an ISI examination immediately prior to a PWOL that is absent of any flaws or crack-like indications, then future ISI of the WOL shall be performed in accordance with requirements of Section XI of the ASME Code. What are the specific ASME Code, Section XI non-destructive examination (NDE) methods and volume and/or surface examination requirements? Do the examination requirements of Section XI, Appendix Q of the ASME Code apply?

8. Section 7.2, requirement 2., states that if no ISI examination is performed immediately prior to a PWOL, or crack-like indications are detected, then the weld must be assumed to be cracked. Discuss the application of the requirements of Section XI, Appendix Q of the ASME Code and explain the differences between Appendix Q and the referenced, MRP-139, Category F, examination frequency, examination methods, and examination volume.

<u>Leak-Before-Break</u>

1. Section 4.5 states that, “Prior to performing the PWOL, a PDI [Performance Demonstration Initiative] qualified examination of the weld and adjacent base material must be performed to show that no cracking is present.” Not all welds previously approved for LBB by the NRC can be inspected by a qualified examination. For example, qualified procedures have not been developed for examination of DM welds between cast austenitic components and ferritic components. How does MRP-169 address the issues discussed in Section 4.5 for these types of welds?

2. The application of a PWOL would alter the piping configuration assumed in the LBB critical flaw size and leakage crack size analyses. Section 4.5 is not clear that for PWOLs these LBB analyses need to be performed and verified to satisfy the specified margins in draft Standard Review Plan 3.6.3. Please clarify in both the RAI response and a revision to MRP-169 that these analyses need to be performed for the PWOLs applied to welds in piping systems that were approved for LBB.

Fatigue

1. In Section 4.4, provide the basis for postulating the existing cumulative usage factor (CUF) of 0.2 as a threshold for not requiring a fatigue analysis per Section III NB-2300 of the ASME Code, since the existing CUF is based on the simplified rules of the ASME Code, Section III NB-3600, which are not applicable to WOL regions. The NRC staff also believes that the appropriate NB-3200 fatigue analysis should be based on the licensing basis design transients, and not on an alternate, less severe, set of design transients.

2. Relative to Section 4.4, the NRC staff notes that for those plants that have been approved for license renewal or are considering a license renewal application, the license renewal period extends plant life to 60 years. Discuss the time period considered for end of life of the PWOL as evaluated for fatigue crack growth.

Weld Overlay Effectiveness

1. Section 5.1 on Page 5-4 discusses the "MRP/EPRI PWOL Development Program for Alloy 600 PWSCC [primary water stress corrosion cracking] Mitigation." This section indicates that the program is on-going and that the analysis results are preliminary. Please provide the status of this program and the final results.

2. Section 5.2 on Analytical Programs discusses the effects of WOL without water backing. Given the rapid cooling with relatively thin water backed components, is the temper bead technique always used for WOLs?

3. A premise of the PWOL design is that the overlay will induce compressive stress in the inside diameter region of the pipe so that PWSCC flaws will not initiate or a small existing PWSCC flaw would not propagate. Discuss the potential adverse impact of a PWOL on a weld with a subsurface flaw considering that the crack tip may experience the tensile component of the T-W stress gradient.

Stress Analysis

1. Section 4.2 discusses residual stress improvement and states that, "...the resulting inside surface stresses, after application of operating pressure and loads, must be less than 10 ksi tensile. This target stress level has been selected as a conservatively safe value, below which PWSCC initiation, or growth of small initiated cracks, is very unlikely." This criterion appears to be based on the presence of only small preexisting cracks. However, if preexisting cracks extend into a tensile stress region of the original weld, crack propagation may continue to occur. Please justify the appropriateness of this criterion given that MRP-169 indicates that PWOLs may be used without performing

examinations prior to application of the WOL and given that the probability of detection even for relatively deep flaws is less than 1.

2. Section 4.2 discusses overlay specific weld residual stress analysis and states that these analyses are required for each unique PWOL configuration. This section also notes that most boiling water reactor pipe WOLs did not require weld specific residual stress analyses since the geometric configurations were fairly standard. Please provide the criteria that will be used to determine whether or not weld specific residual stress analyses will be performed.

3. Page 4-4 in Section 4-2 indicates that the resultant stresses on the inner diameter (ID), after the application of operating pressures and loads, must be less that 10 ksi tensile. Page 4-3 states that, "...to adequately demonstrate the favorable residual stress effects of a weld overlay, one must start with a highly unfavorable, pre-overlay residual stress condition...." Describe how the pre-overlay residual stress will be determined. How will the repair history (or lack of information on the repair history) be taken into account in the stress analysis used to determine the post-overlay stress profile?

4. Figures 5-11 and 5-12 show the residual hoop and axial stress distributions for the PWOL mockup. After application of the PWOL, the residual hoop and axial stresses in the WOL appear to be mostly compression. In addition, prior to the application of the PWOL, the figures indicate high tensile hoop and axial stresses that may be beyond the ultimate stresses of the materials. After application of the PWOL, the high tensile regions in the nozzles become compressive, but the compressive regions appear to remain compressive. The stresses in the WOL are also shown mostly as compressive. Figures 8-8 and 8-9 show the residual stress distribution for a pressurizer spray nozzle, which appears to be similar to the mock-up geometry. The stress distributions are different from those of the mock-up nozzle. Likewise, the T-W stresses shown in Figures 8-11, 8-13, and 8-15 tend to be tensile towards the outer surface, as expected.

    a. Provide a discussion why the stress distributions in the mock-up PWOL are different from those of the nozzle PWOLs in Section 8.0.

    b. Provide a table showing the material properties used in the finite element analyses in Section 5.0 and Section 8.0.

5. In Table 8-5, identify the acronyms HLST, HHST, CLST, and CHST.

6. Draft ASME code cases related to WOLs contain a requirement to evaluate the effects of any changes in applied loads, as a result of weld shrinkage from the entire overlay, on other items in the piping system (e.g., support loads and clearances, nozzle loads, and changes in system flexibility and weight due to the WOL). MRP-169 does not appear to address these conditions. Please address this comment.

Example Analysis

1. Page 8-5 states that, "The final spray nozzle overlay dimensions that produced these results are a WOL thickness of 0.3" and a WOL length of ~7.2", making this effectively a full structural overlay as defined in Table 8-3...." As stated in Section 4.1, PWOL

thickness is calculated based on the ASME Code maximum flaw depth considerations, IWB-3641 allowable flaw size considerations, and residual stress considerations. Clarify what aspect(s) of this analysis yielded a full structural WOL versus an optimized WOL result.

Clarifications

1. Please clarify the word "consider" in the following statement on Page 4-9: "[I]n meeting the leakage rate requirements, one must consider the potential for more flow resistance through a PWSCC crack morphology."

2. The NRC staff has identified the following typographical errors. (a) In the last paragraph in Section 8-1, it appears that Table 8-2 should have been identified as Table 8-3, (b) References to Tables 8-7 through 8-9 on Pages 8-10 and 8-11 may be incorrect.

3. The last "sentence" on Page 4-5 is not a complete sentence. Please clarify.

4. As part of the design requirements, the NRC staff requests clarifications regarding how certain parameters may be limitations or conditions, if any, to the application of the PWOL. For example, the following parameters:
    a. applicable pipe sizes
    b. applicable pipe thicknesses
    c. applicable configurations, e.g., pipe-to-pipe, pipe-to-safe end, pipe to nozzle
    d. applicable pipe degradation mechanisms
    e. maximum WOL thickness
    f. number of times a PWOL can be applied to a location