December 9, 2002

Mr. Alexander Marion, Director - Engineering
Nuclear Energy Institute
Suite 400
1776 I Street, NW
Washington, DC 20006-3708

SUBJECT: INITIAL COMMENTS AND QUESTIONS ON MRP-75, "PWR REACTOR PRESSURE VESSEL UPPER HEAD PENETRATIONS INSPECTION PLAN," REV 1

On September 9, 2002, the Nuclear Energy Institute (NEI) submitted EPRI Report 1007337, "PWR Reactor Pressure Vessel (RPV) Upper Head Penetrations Inspection Plan"(MRP-75), Revision 1 for NRC review. The submittal describes the RPV head inspection plan and associated technical basis developed by Electric Power Research Institutes' Material Reliability Program (MRP) to address industry and NRC concerns regarding the adequacy of current inspection requirements of RPVs for vessel head penetration (VHP) cracking and vessel head degradation.

Recently, the NRC staff learned and confirmed through Kurt Cozens, during a telephone conversation on November 14, 2002, that the MRP and NEI plan to revise MRP-75 by January 2003. Also, during that telephone conversation it was stated that formal industry approval and documentation of the revisions would be completed after January 2003. Enclosed for your consideration during the planned revision to MRP-75 are the staff's initial comments and questions on the version submitted on September 9, 2002.

The staff has not completed its review of MRP-75, however you may find the staff's initial set of comments and questions helpful during your ongoing efforts to revise MRP-75. To date, the staff's review focused mainly on cracking of the VHPs rather than on the portions of the submittal addressing wastage of the head (e.g., Appendices C and D). Nonetheless, many of the generic observations in the enclosed list of comments and questions may be applicable to the evaluations performed in support of the head wastage issue.

During public meetings prior to the submittal of MRP-75, the staff provided verbal comments on draft versions of MRP-75 regarding the lack of detailed explanations in the draft reports. In response to staff questions soliciting greater detail, MRP and NEI typically provided greater technical details during subsequent public meetings (e.g., public meeting on September 17, 2002). However, it does not appear that a sufficient level of detail was included directly or by reference in the version of MRP-75 that was submitted for staff review. For example, no substantive discussion nor reference is provided regarding the basis for the stress intensity factors in Tables A-3 and A-4. In order to minimize the number of requests for additional information or staff comments associated with the staff review of future versions of MRP-75, MRP and NEI may want to consider increasing the level of technical detail about the basis for key assumptions and parameters in the planned revision to MRP-75.

Since MRP-75 is being revised by the MRP and NEI, the staff plans to suspend its ongoing review of MRP-75 until the planned revision is formally transmitted to the NRC for review. In order to minimize the need to re-review MRP-75 in its entirety, please consider identifying the portions of the revised document that have changed to address staff comments.

If you have any questions about the enclosed comments, please, contact Mr. Kenneth Karwoski at 301-415-2752.

Sincerely,

/RA/

Richard Barrett, Director
Division of Engineering
Office of Nuclear Reactor Regulation

Project No. 689

Enclosure: As stated

cc: Larry Mathews, Southern Company
Kurt Cozens, NEI
Christine King, EPRI

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Enclosure

Staff's Initial Comments on MRP-75, Rev. 1

ACCEPTANCE CRITERIA

1. For determining the inspection category for plants, the Materials Reliability Program (MRP) appears to use the following:

   Leakage:

   High Risk: 75% cumulative probability of having a leaking nozzle

   Moderate Risk: 20% cumulative probability of having a leaking nozzle

   Net Section Collapse (NSC) or circumferential failure:

   High Risk: 10^{-3}

   Moderate Risk: 10^{-4}

   Wastage

   No loss of ASME code margins due to consequential wastage

   In determining these categories (primarily the NSC categorization), the MRP uses the criteria outlined in Regulatory Guide 1.174 as the basis. These acceptance criteria are probabilistic in nature. The MRP's inspection plan proposal does not address how the inspection plan will ensure the deterministic acceptance criteria are met. That is, the inspection plan should address how the inspection plan ensures both the deterministic and probabilistic acceptance criteria are met. Deterministic acceptance criteria would include:

   Leakage:

   No RCPB leakage (consistent with Technical Specifications)

   Net Section Collapse (circumferential failure)

   Consistent with the margins of safety of the ASME Code and licensing/design basis (e.g., factor of safety of 3 against failure)

   To meet the leakage criteria, one would need to develop an inspection plan that would ensure with a high degree of reliability that flaws are found prior to them penetrating entirely through-wall.

   In addition, one of the major goals of any type of inspection is to identify not only the expected types of degradation at an early enough stage such that corrective action

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can be taken, but also to identify other conditions that may be adverse to quality which were not anticipated. In light of this consideration, one could argue that the inspection plan should be developed with the goal of finding degradation at the outage after it initiates.

2. The probabilistic acceptance criteria proposed by the MRP appears to imply a 75% probability of having a leaking nozzle is acceptable. It would seem prudent that the probability of having a leak in a nozzle should be kept low (consistent with the requirement to have no RCPB leakage). A value of 5% would seem appropriate and consistent with other regulatory positions.

3. The confidence levels at which the acceptance criteria are being evaluated was not discussed. For example, is there a 95% probability that the NSC criteria will not be violated (or are the curves plotted mean curves)?

4. Much of the analysis supporting the proposed inspection interval seems to be based on cracking in the nozzle base metal. Discuss the need to modify the model to include cracking in the J-groove weld to ensure that the requirement that there is no RCPB leakage is met. The MRP noted that a higher crack growth rate is expected for the nozzle J-groove weld material than for the nozzle base metal.

<u>ADMINISTRATIVE</u>

5. It was indicated that the inspection plan would be reviewed within 3 years from issuance. Should a protocol be established regarding how/when to notify members of non-conservative inspection findings.

6. Please discuss the status of the proposals to DOE's Nuclear Energy Plant Optimization (NEPO) program to conduct specific boric acid corrosion tests.

7. Please provide a summary of the inspection findings to date which addresses all flaws detected in the nozzle and/or J-groove weld. This information should include, but not necessarily be limited to, the number of flaws, the date of inspection, the method of the inspection, the date of any prior inspections for the affected nozzle, the size of the flaw (length, depth, flaw profile), whether there was conclusive evidence of leakage or whether any evidence of leakage was masked, and the EDY/EFPY at the time of discovery.

<u>PFM CODE</u>

8. It was indicated that the PFM algorithm is benchmarked and conservative. The basis for these statements is not clear. The algorithm was developed based primarily on operating experience. As a result it is reasonable to expect the code should predict the existing experience unless a coding error was made (i.e., the code is not

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benchmarked it just predicts what one expects it to). To consider a code benchmarked, it should be developed on one set of data and then run against another set of data to determine the acceptability. As a result, the claim that the code is benchmarked is not clear. In addition, it was claimed that the code is conservative since it was based on the most severe cracking found to date. Just because the code is based on the most conservative data to date does not ensure the code is conservative. [Could a plant with less operating time and cooler temperatures exhibit cracking? If so, it could become the most limiting plant and the code would need to be modified.]

9. Along the lines of the code being benchmarked, it would appear appropriate that the code should predict the probability of a leaking nozzle at all B&W plants is 100% at (or before) the time the leaking nozzles were discovered. If the code can predict multiple leaking nozzles it should also predict these. By predicting a probability less than 100%, it would appear the code is not conservative. In addition, the uncertainty in the time at which the nozzles started leaking should be addressed.

10. The industry uses an algorithm based primarily on time, temperature and material conditions to predict the likelihood of "failure". Similar algorithms used for predicting the lifetime of Alloy 600 steam generator tube plugs which accounted for time, temperature, and heat-to-heat structural differences were developed in response to NRC Bulletin 89-01. These algorithms were modified several times (based on more experience) and were not entirely successful in predicting the useful life of plugs. Given the experience with these plugs, provide additional justification that cracking can be modeled primarily based on time and temperature with some insights on nozzle microstructure.

11. Sensitivity studies were performed for the purpose of evaluating inspection intervals. Some of the assumptions made include the ability of a bare metal visual inspection to detect a leaking penetration. Please provide the technical basis for these detection probabilities.

12. Please describe the trends in Figure A-3 of MRP-75. Are the downward trends in the probability of net section collapse a result of inspections. Please describe the confidence levels from which these curves were derived (i.e., are these mean curves, 95^{th} percentile, etc.)?

13. Referring to Figure B-1, please describe the purpose of the double-headed line. The argument that the hole dilation will be greater for heads with "larger" R/T ratios is understood; however, it would appear that the only conclusion that could be drawn is that for a given interference fit, the likelihood that a leaking penetration would exhibit leakage is more likely for a head with a larger R/T than for a smaller R/T.

    In steam generators, there is an interference fit between the tubes and the tubesheet. Cracking has been observed in this region; however, leakage from these cracks (assuming some are through-wall) has been minimal (not measurable). Given the above, discuss whether your expected experience with head penetrations matches the experience from steam generator tubes.

Please clarify what is meant by: "based on a normal distribution of fits with the maximum and minimum specified values representing 2σ upper and lower bounds...". In the probabilistic analysis, were limits placed on the input parameters? If so, discuss the basis for the limits. At what confidence level were the data evaluated.

14. It was indicated that there is no precedent for large areas of lack-of-fusion and inspections performed to date do not show significant areas of lack-of-fusion. Were preservice inspections performed for nozzles? If so, to what extent were inspections performed and were the "assumed" lack-of-fusion areas detected? How many nozzles have exhibited lack of fusion and what was the extent?

15. For the data in Table A-1 (with the exception of the growth data and the number of nozzles), discuss the technical basis for the various values chosen. Please provide the data and fits to the data with these parameters. For example, provide the data supporting the mean and standard deviation used for the yield strength of the nozzles. Please discuss whether any of these distributions were truncated. If so, provide the basis for the truncation. Please verify the value for the interference fit provided in Table A-1. Regarding the interference fit data, how was a plant's R/T ratio accounted for in the analysis (given that plants with smaller R/T ratios are less likely to leak). Discuss the effect on the proposed inspection interval as the number of nozzles is changed.

16. Please discuss how the PFM algorithm uses the various input parameters in calculating the "probability of failure." Refer to WCAP-14277, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections" for the level of detail that the staff is interested in.

17. Discuss whether the Weibull parameters for the time-to-leakage model assessed the experience with the observed non-through-wall flaws. For example, several plants have found non-through-wall flaws. Making assumptions about the growth rate for these flaws, at some point they would be predicted to grow through-wall. Were the Weibull parameters derived using this information? If not, why not?

18. Discuss the basis for the activation energies used in the assessments. Discuss how the uncertainty/variability in these values were modeled?

VISUAL INSPECTIONS

19. Discuss in detail how licensees will evaluate boric acid deposits on the head. How will deposits that are not adjacent to the nozzle be addressed? What actions are required if the source of the deposit is not conclusive? In the event that leakage deposits are

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observed coming from sources above the head, would non-visual inspections always be performed of nozzles in the vicinity (since the deposits could be from both a leaking nozzle and from the source above the head).

20. Indications of boric acid deposits emanating from the nozzle-to-head annulus will be considered unacceptable for continued service until supplemental examinations or evaluations are complete and any identified flaws meet applicable acceptance criteria. What type of evaluations would be considered acceptable for addressing boric acid deposits emanating from the nozzle-to-head annulus. It would seem that inspections would always be warranted in this case.

21. As part of the bare metal visual examination, additional examinations of uncertain deposits will be conducted to further discriminate between the possible sources of origin. These examinations may require additional optical aids with greater resolution, magnification, etc. How will visual examinations be used to discriminate between the sources of origin of uncertain deposits? It would seem appropriate that in the case of "uncertain deposits" all surrounding nozzles should be investigated. Has testing and analysis been performed indicating that leakage emanating from a nozzle always result in deposits at the junction between the nozzle and the head. Would the flow across the head be such to disperse the deposits? Please provide the test results confirming the answer to these questions.

22. Discuss the actions to be taken when a plant notices evidence of RCPB leakage in the case where the RPV head has closely conforming rigid insulation.

23. It was stated that the inspection periods could be extended by 0.5 EFPY for scheduling purposes. Discuss the basis for this extension. Is this a one-time extension for plants currently operating beyond the recommendations of the guidelines or is it intended that plants would not need to schedule the inspection at the outage prior to exceeding the inspection periods?

24. Please clarify the statement "if leakage, or through-wall cracking is identified, the plant is reclassified as .....". Does the leakage refer to leakage from a penetration. What additional requirements are necessary when a plant notices leakage coming from sources other than the penetration (e.g., a leaking flange). Address plants with removable and "semi-permanent" insulation.

25. What is the technical basis for considering delaying the inspection of all nozzles during an outage when a leaking nozzle develops? The concern is that a nozzle with a through-wall flaw is not leaking and/or a flaw is near through-wall such that it would start leaking shortly after startup.

26. It was indicated that for part through-wall flaws (an embedded flaw) left in service that it should be reinspected the next scheduled RFO and once every ISI period thereafter. Discuss the basis for this general recommendation. Are flaw growth rates always such that with this inspection frequency the acceptance criteria would not be

violated in all cases?

27. If boric acid deposits, crumbs, and/or film is left on the RPV head, what criteria must be satisfied during subsequent outages to determine if a change has occurred? Presumably a change in the appearance/physical location of the deposits would indicate the possibility of leakage and require a non-visual inspection.

28. Discuss what would be considered an appropriate technical basis for revising the frequency of supplemental visual examinations. Presumably the "revision" would be a relaxation of the requirement rather than an increase in the frequency. Discuss whether a protocol exists for peer reviewing this technical basis.

29. Please clarify what is to be done when a penetration/nozzle is not examined with a non-visual technique because it requires physical modifications for accessibility. Please specify all conditions falling under the "physical modification" criteria. Although it probably is not the intent, one could argue that removing the head from the vessel is a physical modification needed for accessibility.

30. Please clarify what would be considered an acceptable plant-specific technical evaluation for justifying continued visual examinations (rather than non-visual examinations) until the component is removed from service.

FLAW EVALUATION and NDE UNCERTAINTY

31. It was indicated that nozzles with through-wall indications shall be evaluated for cavities and corrosion of the vessel head adjacent to the penetration. Discuss how NDE uncertainties are accounted for in determining whether an indication is through-wall. Discuss the basis for the NDE uncertainties and discuss how they are incorporated into the evaluation of the flaw.

32. A curve demonstrating the POD for non-visual examinations was provided. Provide the qualification data supporting this POD. Discuss the protocol for this testing. Discuss the representativeness of the samples used to develop the curve to the indications observed in the field. Include in this discussion, the level of noise in the samples versus that observed in the field. Discuss the need to adjust the generic POD to account for variations in noise from nozzle-to-nozzle or from plant-to-plant. Discuss whether all data has been used in the construction of the POD curve including any results that may exist from the laboratory examination of nozzles removed from the field.