June 23, 2006

Mr. William Eaton, BWRVIP Chairman
Entergy Operations, Incorporated
Echelon One
1340 Echelon Parkway
Jackson, MS 39213-8202

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION - REVIEW OF BWR VESSEL AND INTERNALS PROJECT REPORT, BWRVIP-03, REVISION 6, "REACTOR PRESSURE VESSEL AND INTERNALS EXAMINATION GUIDELINES"

Dear Mr. Eaton:

By letter dated January 6, 2004, you submitted to the Nuclear Regulatory Commission (NRC), Electric Power Research Institute (EPRI) proprietary report, BWRVIP-03, Revision 6, "Boiling Water Reactor Vessel and Internals Project (BWRVIP), Reactor Pressure Vessel and Internals Examination Guidelines." The report provided the methodology, inspection standards, and guidelines for BWRVIP mockups, for protocol of nondestructive examination (NDE) techniques on mockups, for demonstration of NDE techniques, and for determining uncertainties in NDE techniques and inspection tool positioning. The methodology, inspection standards, and guidelines pertain to visual testing, ultrasonic testing, and eddy current testing methods. The topical report is for the examination of the reactor vessel internals components that are not included in the American Society of Mechanical Engineers (ASME) Code examination requirements.

On June 8, 1998, the staff issued a safety evaluation (SE) to EPRI on the acceptability of the topical report with no revisions. Through the years, the BWRVIP made revisions to selected paragraphs of the topical report which were submitted to the staff for information only. Since the issuance of the staff's SE, advances have occurred in NDE. Therefore, the staff decided to undertake a review of BWRVIP-03, Revision 6, in order to verify that state-of-the-art NDE has been considered in the technical justifications supporting the topical report. The staff has determined that additional information is needed to complete the review. The request for additional information regarding the BWRVIP-03, Revision 6 report is enclosed. If you have any questions, please contact Meena Khanna at (301) 415-2150.

Sincerely,

/RA/

Matthew A. Mitchell, Chief
Vessels & Internals Integrity Branch
Division of Component Integrity
Office of Nuclear Reactor Regulation

Project No. 704

Enclosure:
Request for Additional Information

cc: BWRVIP Service List

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REQUEST FOR ADDITIONAL INFORMATION
REGARDINGTHE BWRVIP-03, REVISION 6 REPORT,
"REACTOR PRESSURE VESSEL AND INTERNALS EXAMINATION GUIDELINES"

It should be noted that because weld examinations required by the American Society of Mechanical Engineers (ASME) Code are performed in accordance with the ASME Code, the staff's review of the BWRVIP-03, Revision 6 topical report only applies to non-ASME Code examinations. The draft request for additional information (RAI) was revised in consideration of the information presented by the Boiling Water Reactor Vessel and Internals Project (BWRVIP) representatives during the BWRVIP Nuclear Regulatory Commission (NRC) Technical Meeting that was held at NRC Headquarters on March 14, 2006. The staff acknowledges that the BWRVIP provided responses in various levels of detail at the March 14, 2006, meeting to all of the RAIs below except for RAI No. 2.7.3. However, in order for the staff to complete its review, written documentation of the RAI responses is required.

The RAI questions listed with no specific section reference number are generic to the topical report and apply to the issues being addressed. The RAI questions provided with specific section reference numbers are pertinent to that specific section of the topical report.

1.0 Generic RAI

Because the topical report pertains to non-ASME Code examinations, the criteria for personnel qualification standards are not clear. Describe the personnel qualification standards (i.e., ASME Code, Section XI, Appendix VIII, Supplement 2, Intergranular Stress Corrosion Cracking; ASME Code, Section XI, Appendix VII, CP-189; American Society for Nondestructive Testing, SNT-TC-1A, others) recommended by the BWRVIP for the different RPV internals examinations (i.e., shroud, shroud support, core spray piping and sparger, core spray internal piping overlay inspection, top guide, core plate, LPCI coupling, jet pump assembly, standby liquid control, vessel attachments lower plenum, and instrument penetrations).

ASME Code, Section XI, Appendix VIII qualifications may have procedure specific limitations. For situations that use non-Appendix VIII procedures and Appendix VIII qualified personnel with specific limitations, discuss reconciliation of the limitations with the non-Appendix VIII procedures. Because the procedures are generic, discuss where/how records are maintained.

ASME Code, Section XI, Appendix VII and CP-189 qualifications are generic and attest to the knowledge, understanding, and application of specific nondestructive examination (NDE) methods. The proficiency of personnel with generic qualifications are often improved with training on mockups with similar configurations, flaws, and materials as the component/weld to be examined. The topical report discusses representative mockups and provides high level summaries of ultrasonic testing (UT) examinations performed on these mockups, but the report is silent on training. Discuss the training of personnel, if any, that is required for the different internals examinations. Discuss the protocol that is employed for evaluating the ability of personnel to follow written procedures and to interpret data.

ENCLOSURE

2.0 Generic RAI

Because the examinations are non-ASME Code required, procedures may be qualified using various technical justifications. For instance, UT procedure qualifications may be justified to the requirements of ASME Code, Section V, Article 4; ASME Code,
Section XI, Appendix III; or owner-specific criteria. For the different procedures in the topical report, identify the technical justifications used for procedure qualification.
In the topical report, procedure capabilities are demonstrated using non-blind examinations on mockups with flaws in known locations. The data from the demonstrations were used to determine detection capabilities and root mean square sizing error (RMSE) values. It is not clear how prior examiner knowledge of the flaws and flaw locations were factored into the detection and sizing data. For the different NDE methods, discuss the assumptions made and the process used for assigning detection and sizing variances to the procedures and examiners.

Some procedures listed the variable, “average error.” Explain the usefulness of this variable, and its purpose in procedure selection.

For different examinations, the topical report may list multiple acceptable procedures. Explain the value of having multiple procedures for the same examination, and provide guidance for selecting the best procedure for a given examination. Discuss the process for determining the effectiveness of existing procedures. Discuss the succession process for revising existing procedures and retiring obsolete procedures.

3.0 Generic RAI

Mock-ups and assemblies used for the purposes of qualifying inspection systems and personnel should be designed and fabricated in a controlled fashion. For BWRVIP mock-ups and assemblies, known or postulated degradation mechanisms, minimum flaw dimension data, and maximum allowable flaw size determined by fracture mechanics and structural integrity assessments are not provided.

The validity and representativeness of mock-ups and flaw selections are directly related to a number of factors that are not addressed in the topical report. It is not clear how flaws were selected for the mock-ups. The technical aspects of the process of selecting flaw type, dimensions, orientations, placement, morphology, etc., were not provided. Provide a discussion on the following:

a. The component base metal, butter, and weld metal used in vessel internals at operating plants that have experienced cracking.

b. Representativeness of the acoustic responses, eddy current responses and visual responses from the flaws in the mock-ups with respect to flaw type and degradation mechanisms typical for the components.

c. Representativeness of the mock-ups with respect to bounding conditions (such as welding practice, component dimensional variations, etc.) and assurances that these mock-ups provide an accurate replication of true component conditions encountered in the field.

4.0 Generic RAI

For the UT, eddy current testing (ET), and visual testing (VT) techniques described in the topical report, the goals/objectives of the inspection, the essential parameters of the components or inspection area(s), and the key elements of the inspection equipment and procedures have not been provided. Essential parameters are defined as those parameters which are significant in determining the outcome of the examination, such as the component, the flaws that the examination is intended to detect/size, and the environmental conditions. Key elements are defined as those parameters of the NDE technique and associated equipment, which can significantly affect the outcome and quality of a particular examination.

For the UT, ET, and VT demonstrations discussed in the topical report, provide the inspection goals/objectives for the different internals, the essential parameters for inspecting the different internals, and the key elements for the equipment and procedures (group of procedures) used to examine the different internals.

5.0 Generic RAI

The topical report (specifically pages 2-5 and 2-6) describes a protocol for NDE technique demonstrations. It is not clear how the topical report ties the demonstrations to the procedures, nor is it clear what process is in place for tying the demonstration selection to the actual inspection being conducted. A framework for a technical basis is not apparent, and the topical report does not provide supporting information, data, or other technical justifications to substantiate the selection process for equipment, equipment set-up, examination methods or NDE demonstrations. For each of the examination methods (UT, ET, and VT), describe the technical selection process for the equipment and demonstrations, and describe how the selection process is tied to the actual inspections being conducted.

6.0 Generic RAI

In the following sections of the topical report: 2.5.5.3.2, 2.5.5.6, 2.5.6.1.2, 2.5.6.1.4, 2.5.6.5.2, 2.5.7.1, 2.5.7.1.3, and 10.4.1, the statement, “....industry experience has shown....” is made without reference or appropriate substantiation. Provide references to the “Inspection & Evaluation” documents or data for substantiating and supporting this statement in the topical report.

7.0 Generic RAI

Throughout the topical report, phrases such as “all applicable flaws were detected”, or “most flaws were detected” are used. It is not clear what is meant by “applicable flaws” and no technical justification or processes are defined in the report that describe how a flaw is determined to be applicable or non-applicable in any given test. The use of the phrase “applicable flaws” appears 53 times in the topical report, including examples in Sections 4.4.3 UT Demonstration 1; 4.4.4, UT Demonstration 2; 4.4.5 UT Demonstration 3; and so forth.

Provide a definition of “applicable flaw” and provide the technical basis supporting the applicability versus non-applicability determination for using the flaws in the mock-ups described in the topical report.

RAI 2.3.4.2.3:

In Section 2.3.4.2.3 of the topical report, key elements for demonstrations of UT examinations are called out. The key elements of transducer sensitivity and frequency response are a function of the element type and excitation parameters. Other key elements affecting transducer sensitivity and frequency response are:

< Transducer housing dimensions
< Digital sampling frequency (rate)
< Wedge material type
< Wedge delay calculations (time)
< Excitation (square wave, tone burst, spike, etc.)
< Driving voltage of excitation
< Wedge dimensions
< Element type (monolithic, piezo-composite, etc.)

Provide a discussion for not identifying as key elements all the variables that affect the effectiveness of an UT examination.

RAI 2.4:

Section 2.4 of the topical report discusses guidelines for determining inspection tool position uncertainty and states a criteria for position RMSE to be calculated and documented. The topical report does not provide any data, calculations or procedures for incorporating these errors into the total measurement RMSE. Discuss how errors are incorporated into the total uncertainty of the measurement.

RAI 2.5.3.5:

The term “Key Element” is defined as “Any element, component, or combination of the inspection equipment that if changed, could affect the ability of the inspection equipment to detect indications or an evaluator’s ability to evaluate indications.” An important Key Element that is not included in remote VT is the speed at which the camera is scanned over the surface that is being examined. Another important variable is the surface finish of the subject. Provide a discussion on the applicability of scan speed and surface condition as key elements. Provide information as to the camera scan speed(s) and surface finishes of the objects being examined during the VT demonstrations reported in the Topical Report.

RAI 2.5.5.1:

The Sensitivity Resolution and Contrast Standard Test (SRCT) described in Section 2.5.5.1 does not meet the definition of “Enhanced VT” as presented in Section 2.5.3.6. “Enhanced VT” is described in Section 2.5.3.6 as any VT that can achieve a “½ mil resolution.” The SRCT described in Section 2.5.5.1 is not, in fact, a resolution test but instead a line detection test and cannot be used to determine if a system has ½ mil (12 μm) resolution. Additionally, simple line detection is a poor measure of visual acuity. A 12 μm (½ mil) resolution is defined by the ability of a system to discern a 12 Fm (½ mil) separation between two 12 μm (½ mil) wide lines, not the ability to detect a 12 μm (½ mil)-wide wire or line. A technique for measuring a camera system’s actual resolution uses a resolution target, such as a 1951 United States Air Force (USAF) resolution target. As an example, to achieve ½ mil (12 μm) resolution, a system needs to be able to discern 39 line pairs per millimeter, i.e., the separation in Group 5 Element 3 on a 1951 USAF resolution chart. Provide a discussion for selecting the SRCT testing criteria

described in Section 2.5.5.1. Refer to Section 5 of NUREG/CR-6860, "An Assessment of Visual Testing."

RAI 2.7.3:

The generic standards for ET inspection personnel are substantially less detailed than the generic standards for UT or VT inspection personnel. Provide a similar level of detail for ET generic standards or provide a technical justification for why ET inspection personnel do not need equally detailed generic standards of performance.

RAI 8.3:

The core plate rim hold-down bolts provide a unique challenge for effective replication of the assembly in a mock-up where the structural conditions around the head of the bolt are representative and uniform. Some of the bolts in this mock-up contain electrical discharge machined (EDM) notches in the threads, but nowhere in the topical report is there a technical justification or a discussion of the processes used to determine the notch sizes, depths, lengths, distributions, and placement of reflectors. For example, ASME Code, Section XI, Appendix VIII, Supplement 8, "Qualification Requirements for Bolts and Studs," provides a well-defined procedure for detection test acceptance criteria for bolts and studs as illustrated in Table VIII-S6-2 for a blind-testing evaluation format. It is not clear in the topical report what pass/fail criteria is used to assess the effectiveness of the demonstrations.

a. Provide a definition or pass/fail criteria for core plate rim hold-down bolt inspection methods.

b. Discuss the applicability of using ASME Code, Section XI, Appendix VIII qualified personnel and procedures for this examination.

RAI 13.3:

In some cases, entire mock-ups only contain sawcut reflectors and/or EDM notches. As an example, this is the case for the control rod drive guide tube body-to-sleeve weld (CRGT-2) and the control rod drive guide tube base-to-body weld (CRGT-3) in the lower plenum. ASME Code, Section XI, Appendix VIII uses compressed EDM notches on a limited bases for small cracks that are difficult to create in test specimens. It is not clear how accurately sawcuts and full width EDM notches represent true cracking in these components.

For each of the examination methods (UT, ET, and VT), provide a discussion of the responses of actual flaws as they compare to those responses from EDM notches and sawcuts. Also, provide a technical justification that ensures representativeness and accurate simulation of expected or possible cracking in these cases as related to the respective method of detection.