March 18, 2004

Bill Eaton, BWRVIP Chairman
Entergy Operations, Inc.
Echelon One
1340 Echelon Parkway
Jackson, MS 39213-8202

SUBJECT: SUPPLEMENTARY REQUEST FOR ADDITIONAL INFORMATION - REVIEW OF BWR VESSEL AND INTERNALS PROJECT REPORT, BWRVIP-97, "GUIDELINES FOR PERFORMING WELD REPAIRS TO IRRADIATED BWR INTERNALS"

Dear Mr. Eaton:

By letter dated November 27, 2001, you submitted for NRC staff review, Electric Power Research Institute (EPRI) proprietary report, BWRVIP-97, "Guidelines for Performing Weld Repairs to Irradiated BWR Internals." BWRVIP-97 provides a methodology to determine if weld repair to irradiated components can be successfully performed, and if so, by which welding technique. The NRC staff sent a request for additional information (RAI) related to BWRVIP-97 by letter dated January 8, 2003.

The purpose of this letter is to forward to you supplementary RAIs that evolved from a review of Chapter 5.0 of BWRVIP-34, "Technical Basis for Part Circumference Weld Overlay Repair of Vessel Internal Core Spray Piping," which contains an evaluation of the effects of irradiation on the weldability of core spray piping. The staff has determined that this additional information is needed to complete the review of BWRVIP-97. Please contact Meena Khanna of my staff at 301-415-2150 if you have any further questions regarding this subject.

Sincerely,

/RA/

Stephanie M. Coffin, Chief
Vessels & Internals Integrity and Welding Section
Materials and Chemical Engineering Branch
Division of Engineering

Project No. 704
Enclosure: As stated

cc: BWRVIP Service List

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*See Previous Concurrence

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
SAFETY EVALUATION OF THE BWRVIP VESSEL AND INTERNALS PROJECT "BWR VESSEL AND INTERNALS PROJECT, GUIDELINES FOR PERFORMING WELD REPAIRS TO IRRADIATED BWR INTERNALS (BWRVIP-97)" EPRI PROPRIETARY REPORT TR-1003020

SUPPLEMENTARY REQUEST FOR ADDITIONAL INFORMATION

Note: During a conference call on January 15, 2004, it was agreed that all RAIs that relate to weldability of irradiated materials that were developed during the review of BWRVIP-34, be included as supplementary RAIs to BWRVIP-97.

Supplementary RAI 97-8

Section 4.2.1 of the BWRVIP-97 report states, "Figure 4-1 indicates that successful welds can be obtained on irradiated material at relatively high He [helium] contents if the appropriate technique is selected." Therefore, Section 4.2.1 should state that the weldability boundary developed in that section is applicable only when the gas metal arc welding (GTAW) or the yttrium-aluminum-garnet (YAG) laser technique is used for repairing irradiated stainless steel. (Note: although the data associated with the GMAW technique are presented in Figure 4-1, these data, according to Section 4.2.2 of the BWRVIP-97 report, were not considered in establishing the weldability boundary because they are associated with tritium-tricked samples and not irradiated samples. Therefore, the weldability boundary presented in Figure 4-1 is not applicable when the GMAW technique is used.)

Supplementary RAI 97-9

In response to RAI 2(a) (from the BWRVIP-34 review), the BWRVIP provided the following introductory comments: "As a preamble to this response, it should be noted that the cracking caused by entrapped helium during welding of irradiated materials does not occur in such a way as to present a safety hazard. The cracking occurs immediately after the welding is performed, and does not occur on a delayed basis. Should a utility attempt a welded repair on highly irradiated material, any cracking due to entrapped helium would be immediately obvious in post weld inspections and could be addressed appropriately at that time. As such, the issue of attempting a weld repair at a location for which the weldability cannot be accurately determined becomes only an economic concern for the utility. Should the weld crack, an alternate means of repair will be required. However, no safety concerns result."

Welding of irradiated stainless steel could degrade the mechanical properties without causing immediate cracking due to helium embrittlement. For example, in 1998, Robinson reported that when helium-charged samples of 304L stainless steel were subject to transient thermal cycles, simulating those occurring in the heat-affected zone of a gas tungsten arc weld, peak temperatures above 800°C (1472°F) caused severe ductility losses, fracture mode changes (from ductile transgranular rupture to ductile intergranular fracture), and losses in ultimate tensile strength.

The staff requests that the BWRVIP provide a comprehensive assessment of how welding of irradiated stainless steel degrades its mechanical properties. This assessment should consider the welding methods considered in the BWRVIP-34 and -97 reports (SMAW, FCAW, GTAW, GMAW and YAG)[1] and include any effect of underwater welding on mechanical properties.

Supplementary RAI 97-10

The staff's review of the BWRVIP-45 and BWRVIP-97 reports reveals that the helium threshold criterion does not adequately take into account the effect of physical constraints. The staff raised this concern earlier in its review of BWRVIP-97. In addition, the helium threshold criterion addresses only cracking due to helium embrittlement and not any degradation of mechanical properties such as loss of ductility, fracture mode shape and reduction in ultimate tensile strength.

The staff requests that the BWRVIP provide a comprehensive review of the effect of physical constraints on weldability of irradiated materials. This information, along with the information on the effects of helium concentration on cracking and material properties degradation [see Supplementary RAI 97-9], should be considered when developing the helium threshold criterion.

Supplementary RAI 97-11

Section 5 of the BWRVIP-34 report states that the boron content of the stainless steel vessel internals is not well-established and that there is a relatively large uncertainty in the thermal fluence calculations. As a result, a large uncertainty exists in the calculated helium content in the irradiated components. Therefore, some cases may require direct measurement of helium content, if the calculated values equal a certain fraction of the threshold value for welding.

The staff requests that the BWRVIP develop specific guidelines for removing a sample from a vessel internal component that is being considered for weld repair and measuring its helium content. The guidelines should address the uncertainty in determining the boron content and in estimating thermal flux. In addition, the staff requests that the BWRVIP provide the technical basis for the guidelines.

[1]SMAW = shielded metal arc welding, FCAW = flux cored arc welding, GTAW = gas metal arc welding, GMAW = gas metal arc welding, YAG = yttrium-aluminum-garnet (laser beam welding)