

August 20, 2004

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

SUBJECT: SUPPLEMENT TO SAFETY EVALUATION OF THE "BWRVIP VESSEL AND INTERNALS PROJECT, LOWER PLENUM REPAIR DESIGN CRITERIA (BWRVIP-55)," EPRI REPORT TR-108719, SEPTEMBER 1998 (TAC NO. MC0654)

Dear Mr. Eaton:

In a letter dated July 18, 2003, the Boiling Water Reactor Vessels and Internals Project (BWRVIP) provided responses to the Nuclear Regulatory Commission (NRC) Safety Evaluation (SE) for the Electric Power Research Institute (EPRI) proprietary report TR-108719, "BWR Vessel and Internals Project, Lower Plenum Repair Design Criteria (BWRVIP-55)," dated September 1998. Both proprietary and non-proprietary versions of the BWRVIP-55 report were submitted to the U. S. NRC for staff review by letter dated September 22, 1998. This report was supplemented by a letter dated December 6, 1999, which was in response to the staff's request for additional information (RAI), dated August 13, 1999. The staff's initial SE is documented in a letter to C. Terry, BWRVIP Chairman, dated September 21, 2001.

The BWRVIP-55 report provides general design acceptance criteria for the temporary and permanent repairs of cracked or leaking internal components in the reactor vessel lower plenum area. These guidelines are intended to maintain the structural integrity of the internal components in the reactor vessel lower plenum area during normal operation and under postulated transient and design basis accident conditions. The BWRVIP provided the BWRVIP-55 report to support generic regulatory efforts related to the repair of BWR internal components in the reactor vessel lower plenum area.

The NRC staff has reviewed the BWRVIP-55 report and the BWRVIP's associated RAI responses and finds, as documented in the enclosed SE supplement, that the BWRVIP-55 report is acceptable for providing guidance for permanent or temporary repairs of the cracked or leaking internal components in the reactor vessel lower plenum area. The staff has concluded that implementation of the guidelines in the BWRVIP-55 report will provide an acceptable repair design criteria for the safety-related components addressed. The BWRVIP-55 report is considered by the staff to be applicable for licensee usage at any time during either the current operating term or during an extended license period. Licensees should note that when applying the repair design criteria to components that, according to the licensing basis of the plant, are classified as American Society for Mechanical Engineers (ASME) Code components, a submittal to the NRC, pursuant to 10 CFR 50.55a(a)(3) is required to request authorization of the repair as an acceptable alternative to the ASME Code.

B. Eaton

- 2 -

In accordance with the procedures established in NUREG-0390, "Topical Report Review Status," the staff requests that the BWRVIP publish the accepted version of the BWRVIP-55 report within 90 days after receiving this letter. In addition, the published version shall incorporate this letter and the enclosed SE supplement, between the title page and the abstract.

Please contact Meena Khanna of my staff at (301) 415-2150 if you have any further questions regarding this subject.

Sincerely,

*/RA/*

William H. Bateman, Chief  
Materials and Chemical Engineering Branch  
Division of Engineering  
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: BWRVIP Service List

B. Eaton

- 2 -

In accordance with the procedures established in NUREG-0390, "Topical Report Review Status," the staff requests that the BWRVIP publish the accepted version of the BWRVIP-55 report within 90 days after receiving this letter. In addition, the published version shall incorporate this letter and the enclosed SE supplement, between the title page and the abstract.

Please contact Meena Khanna of my staff at (301) 415-2150 if you have any further questions regarding this subject.

Sincerely,

*/RA/*

William H. Bateman, Chief  
Materials and Chemical Engineering Branch  
Division of Engineering  
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: BWRVIP Service List

DISTRIBUTION:

EMCB R/F	AHiser	RLorson, R1	CMarschall, R4
EMCB A	CEMoyer	MLesser, R2	JRajan
MWeston	WCullen	DHills, R3	Yung Liu, ANL

ADAMS Accession No.: ML042360610

INDICATE IN BOX: "C"=COPY W/O ATTACHMENT/ENCLOSURE, "E"=COPY/ENCL, "N"=NO COPY

OFFICE	EMCB:DE	EMCB:DE	EMCB:DE	EMCB:DE
NAME	BElliot	MKhanna	MMitchell	WBateman
DATE	08/05/2004	08/04/2004	08/05/2004	08/20/2004

OFFICIAL RECORD COPY

cc:

Tom Mulford, EPRI BWRVIP  
Integration Manager  
Raj Pathania, EPRI BWRVIP  
Mitigation Manager  
Ken Wolfe, EPRI BWRVIP  
Repair Manager  
Larry Steinert, EPRI BWRVIP  
Electric Power Research Institute  
P.O. Box 10412  
3412 Hillview Ave.  
Palo Alto, CA 94303

George Inch, Technical Chairman  
BWRVIP Assessment Committee  
Constellation Nuclear  
Nine Mile Point Nuclear Station (M/S ESB-1)  
348 Lake Road  
Lycoming, NY 13093

William C. Holston, Executive Chairman  
BWRVIP Integration Committee  
Constellation Generation Group  
Nine Mile Point Nuclear Station  
P. O. Box 63  
Lycoming, NY 13093

Jim Meister, BWRVIP Vice-Chairman  
Exelon Corp.  
Cornerstone II at Cantera  
4300 Winfield Rd.  
Warrenville, IL 60555-4012

Al Wrape, Executive Chairman  
BWRVIP Assessment Committee  
PPL Susquehanna, LLC  
2 N. 9<sup>th</sup> St.  
Allentown, PA 18101-1139

H. Lewis Sumner, Executive Chairman  
BWRVIP Mitigation Committee  
Vice President, Hatch Project  
Southern Nuclear Operating Co.  
M/S BIN B051, P.O. BOX 1295  
40 Inverness Center Parkway  
Birmingham, AL 35242-4809

Robin Dyle, Technical Chairman  
BWRVIP Integration Committee  
Southern Nuclear Operating Co.  
42 Inverness Center Parkway (M/S B234)  
Birmingham, AL 35242-4809

Denver Atwood, Technical Chairman  
BWRVIP Repair Focus Group  
Southern Nuclear Operating Co.  
Post Office Box 1295  
40 Inverness Center Parkway (M/S B031)  
Birmingham, AL 35242-4809

Jeff Goldstein, Technical Chairman  
BWRVIP Mitigation Committee  
Entergy Nuclear NE  
440 Hamilton Ave. (M/S K-WPO-11c)  
White Plains, NY 10601

Dale Atkinson, BWRVIP Liason to EPRI  
Nuclear Power Council  
Energy Northwest  
Columbia Generating Station (M/S PEO8)  
P. O. Box 968  
Snake River Complex  
North Power Plant Loop  
Richland, WA 99352-0968

Richard Ciemiewicz, Technical Vice Chairman  
BWRVIP Assessment Committee  
Exelon Corp.  
Peach Bottom Atomic Power Station  
M/S SMB3-6  
1848 Lay Road  
Delta, PA 17314-9032

Gary Park, Chairman  
BWRVIP Inspection Focus Group  
Nuclear Management Co.  
Monticello Nuclear Plant  
2807 W. Country Road 75  
Monticello, MN 55362-9635

Robert Carter, EPRI BWRVIP  
Assessment Manager  
Greg Selby, EPRI BWRVIP  
Inspection Manager  
EPRI NDE Center  
P.O. Box 217097  
1300 W. T. Harris Blvd.  
Charlotte, NC 28221

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
SUPPLEMENT TO SAFETY EVALUATION OF THE "BWRVIP  
VESSEL AND INTERNALS PROJECT, LOWER PLENUM REPAIR  
DESIGN CRITERIA (BWRVIP-55)." EPRI REPORT TR-108719

1.0 INTRODUCTION

1.1 Background

In a letter dated July 18, 2003, the Boiling Water Reactor Vessels and Internals Project (BWRVIP) provided responses to the Nuclear Regulatory Commission (NRC) Safety Evaluation (SE) for the Electric Power Research Institute (EPRI) proprietary report TR-108719, "BWR Vessel and Internals Project, Lower Plenum Repair Design Criteria (BWRVIP-55)," dated September 1998. Both proprietary and non-proprietary versions of the BWRVIP-55 report were submitted to the U. S. NRC for staff review by letter dated September 22, 1998. This report was supplemented by a letter dated December 6, 1999, which was in response to the staff's request for additional information (RAI), dated August 13, 1999. The staff's initial SE is documented in a letter to C. Terry, BWRVIP Chairman, dated September 21, 2001.

1.2 Purpose

The staff reviewed the BWRVIP-55 report, as supplemented, to determine whether its proposed guidance adequately addressed the open items in the staff's SE, and if it will provide an acceptable repair design criteria of the subject safety-related reactor pressure vessel (RPV) internal components. The review assessed the design objectives, structural evaluation, system evaluation, materials, fabrication and installation considerations, as well as the required inspection and testing requirements.

1.3 Organization of this Report

Because the BWRVIP report is proprietary, this SE was written not to repeat information contained in the report. The staff does not discuss, in any detail, the provisions of the guidelines, nor the parts of the guidelines it finds acceptable. A brief summary of the contents of the BWRVIP-55 report is given in Section 2 of this SE, with the evaluation presented in Section 3. The conclusions are summarized in Section 4. The presentation of the evaluation is structured according to the organization of the BWRVIP-55 report.

ENCLOSURE

## 2.0 SUMMARY OF BWRVIP-55 REPORT

The BWRVIP-55 report addresses the following topics in the following order:

- Component Configurations and Safety Functions - The internal components in the RPV lower plenum area are described, in detail, with brief descriptions of each component's function and characteristics. The safety design bases for the internal components in the RPV lower plenum area are given. An event analysis is also provided for various operational conditions to ensure that the component safety functions are maintained.
- Scope of Repairs - The scope of the proposed repairs is given, which primarily addresses cracking and/or leaking in intergranular stress-corrosion cracking (IGSCC) susceptible stainless steel and nickel-chrome-iron alloy (e.g., Alloy 82/182/600) components in the RPV lower plenum area.
- Design Objectives - The following design objectives are presented and briefly discussed: design life, safety design bases, safety analysis events, structural integrity, retained flaw(s), loose parts considerations, and physical interfaces with other reactor internals. Two features of component repair also considered in order to minimize in-vessel time for installations were vessel drain down (in order to support repair of the internal components in the RPV lower plenum area without draining the vessel) and repair accessibility.
- Design Criteria - The design criteria of the internal components in the RPV lower plenum area are presented. In summary, all repair designs shall meet the individual plant safety analysis report (SAR), as well as the NRC and American Society of Mechanical Engineers (ASME) Code established methodology for the RPV and internals mechanical design.
- Structural and Design Evaluation - Terms (e.g., hydraulic loads, fuel lift loads, etc.) associated with applied loads on the RPV and the RPV internals are briefly discussed. The various events and operational service level conditions are also considered to ensure that the repairs do not inhibit safety and operational functions of the internal components. Other structural and design topics addressed are: load combinations, functional evaluation criteria, allowable stresses, flow-induced vibration, repair impact on existing internal components, radiation effects on repair design, analysis codes, thermal cycles, and corrosion allowance.
- System Evaluation - No system evaluation should be required in support of repairs to lower plenum components. Power uprate is briefly discussed for those units currently undergoing a power uprate program.
- Materials, Fabrication and Installation - The materials specifications are given along with the regulatory requirements pertaining to austenitic stainless steel and nickel-chrome-iron (e.g., Alloy 600/82/182) alloys. The minimization of crevices and welding and fabrication guidelines are also discussed. Installation considerations include the indication of the

as-built dimensional tolerances that the repair can accommodate, as well as the minimization of the in-vessel debris generation. Reducing radiation exposure using as low as reasonably achievable (ALARA) practices and qualification of critical design parameters (e.g., preload in tensioned members, critical tolerances) were presented.

- Inspection and Testing - Inspection and testing of the RPV internal components are addressed in the following topics: inspection access, pre- and post-installation inspection, system hydrostatic test, and scram tests.

### 3.0 STAFF EVALUATION

The BWRVIP-55 report is provided to assist BWR owners in designing repairs which maintain the structural integrity of the lower plenum components during normal operation and under postulated transient and design basis accident conditions for the remaining plant life or other service life as specified by the plant owner.

This document is applicable to General Electric BWR/2 through BWR/6 plants which plan to implement repairs to lower plenum items. The following lower plenum components are addressed in this document: Control Rod Drive Housing, Control Rod Drive Stub Tube, In-core Housing, In-core Guide Tube, In-core Stabilizer and BWR/2 Flow Baffle. The aligner pin for the Control Rod Guide Tube (CRGT) and Orifice Fuel Support (OFS) and the peripheral fuel support assembly are also included in this repair criteria, even though they are located on the upper surface of the core support plate. The shroud support legs, and standby liquid control and core delta pressure nozzles and internal lines are addressed in separate repair criteria and are not included in the scope of this report.

#### 3.1 BWRVIP Response to Staff's Open Items

The staff's September 21, 2001, letter identified two open items and had three comments. The BWRVIP, in its letter of July 18, 2003, addressed these items, which are discussed below.

Item 2: The staff indicated that austenitic stainless steel or any other materials shall meet the requirements of EPRI document No. 84-MG-18 or the requirements of other materials proven through testing, performance demonstrations, and field experience to be satisfactory for the application.

BWRVIP Response to Staff Evaluation of Item 2: The discussion of material requirements will be removed from the final version of the BWRVIP-55. All material-related considerations for repair are now contained in BWRVIP-84. Item 2 is addressed in BWRVIP-84, which is currently under review by the staff. While BWRVIP-84 does not require adherence to 84-MG-18, the detailed material requirements specified in BWRVIP-84 are consistent with the staff's position that all materials should be proven through testing, performance demonstration, and field experience.



Staff Evaluation of BWRVIP Response to Item 2: The staff has reviewed the information contained in BWRVIP-84. It does not specify the testing and performance demonstration that will be performed on non-ASME Code materials. This issue will be resolved during the staff review of BWRVIP-84. The staff finds the BWRVIP's response acceptable because the material requirements will be removed from the BWRVIP-55 report and the remaining issue will be resolved in the staff's review of the BWRVIP-84 report.

Item 5: The staff indicated that only low carbon (e.g., Type 304L and Type 316L) or carbon-stabilized (e.g., Type 347 and Type 321) stainless steels, which exhibit excellent resistance to sensitization, can be subjected to re-solution annealing.

BWRVIP Response to Staff Evaluation of Item 5: The discussion of material requirements will be removed from the final version of the BWRVIP-55. All material-related considerations for repair are now contained in BWRVIP-84. Item 5 is addressed in BWRVIP-84, which is currently under review by the staff. Note that Sections A.5 (300 Series) and C.5 (XM-19) allow local solution annealing only on a case-by-case basis.

Staff Evaluation of BWRVIP Response to Item 5: Section A.4 of BWRVIP-84 indicates that the carbon content of 300 series, cast equivalent austenitic stainless steel and weld metal will not exceed 0.030% and the carbon content of XM-19 is limited to 0.045%. Therefore, the materials limitations in BWRVIP-84 satisfy the staff's concern and the BWRVIP has provided an adequate response.

Comment 1 in General Comments: On the page after the title page under the heading, "Results," the BWRVIP-55 report states, "the document provides general design acceptance criteria for the repair of SLC piping." The staff recommends this to be reworded to state, "the document provides general design acceptance criteria for the repair of lower plenum components."

BWRVIP Response to Comment 1: The text will be revised as suggested.

Staff Evaluation of BWRVIP Response to Comment 1: Since the BWRVIP will revise the text as suggested, the BWRVIP has provided an adequate response to the staff's comment.

Comment 2 in General Comments: In order to be consistent with other BWRVIP repair procedures, the following requirements in Section 9.1.2, Materials, of the BWRVIP-55 report should be modified to read: "Repair and replacement designs for plants which were not designed and constructed in accordance with ASME [Code] Section II (and components not subject to [ASME Code] Section XI) must meet the individual plant SAR and other plant commitments for RPV internals mechanical design, as stated in Section 6. In that instance, materials must meet the requirements of ASME [Code] Section II specifications, ASME Code Cases, ASTM specifications, or other material specifications that have been previously approved by the regulatory authorities. This would include material specifications/criteria

submitted by the BWRVIP and approved by the NRC. Otherwise, it is recognized that a repair or replacement design that uses a material not meeting these criteria must be submitted on a case-by-case basis to the regulatory authorities for approval, on a plant-specific basis."

BWRVIP Response to Comment 2: The discussion of material requirements will be removed from the final version of the BWRVIP-55. All material-related considerations for repair are now contained in BWRVIP-84. Comment 2 is addressed in BWRVIP-84, which is currently under review by the staff. (Note: the essential elements of the comment have been included in paragraph 3.2 of the BWRVIP-84 report).

Staff Evaluation of BWRVIP Response to Comment 2: Section 3.2 of the BWRVIP-84 report states, "materials must meet the requirements of ASME [Code] Section II specifications, ASME Code Cases, ASTM specifications, or other material specifications that have been previously accepted by the regulatory authority. Otherwise, a material that is necessary for a design must be submitted on a case-by-case basis to the governing regulatory authority for approval, either on a plant-specific basis or through a mechanism such as a BWRVIP repair design criteria topical report." The staff interprets this statement to mean that the materials will meet ASME Code Section II, ASTM specifications that have been previously accepted for use by the staff, and/or ASME Code Cases that have been previously accepted for use by the staff. This statement does indicate that materials not meeting ASME Code Section II specifications will be submitted to the governing regulatory authority for approval. Therefore, Comment 2 is resolved. The staff finds the BWRVIP's response acceptable because the material requirements will be removed from the BWRVIP-55 report and the BWRVIP-84 report contains the requested information.

Comment 3 in General Comments: The staff requests licensees to determine the weldability of all materials to be welded since some fasteners may be made of generally unweldable materials or require very special conditions to weld them, such as AISI 4140, 4340 (B7) low alloy materials or 410 (B6) type stainless steel alloys. Alternatively, the BWRVIP could eliminate all welding on fasteners in this document.

BWRVIP Response to Comment 3: All material issues, including those involving welding, will be removed from the final version of BWRVIP-55. Material considerations are now contained in BWRVIP-84. Comment 3 is addressed in BWRVIP-84, which is currently under review by the staff.

For information, the issue is currently addressed in Section 5.4 of the BWRVIP-84 report, which states, "Underwater tack welding applications shall be demonstrated with a mockup to be capable of withstanding the specified torque or load without breaking prior to use." However, for clarity, the following sentence will be added to Section 5.4 immediately preceding the quoted sentence: "If tack welds are used, fastener material shall be evaluated for weldability."

Staff Evaluation of BWRVIP Response to Comment 3: The staff finds the BWRVIP's response acceptable because the material requirements will be removed from the BWRVIP-55 report and the BWRVIP-84 report will contain the requested information.

#### 4.0 CONCLUSION

The NRC staff has reviewed the BWRVIP-55 report, the associated RAI responses and the responses to the staff's initial SE. The staff finds that the BWRVIP-55 report, as modified and clarified to incorporate the staff's comments above, is acceptable for providing guidance for permanent or temporary repairs of the cracked or leaking internal components in the reactor vessel lower plenum area. Therefore, the staff has concluded that implementation of the guidelines in the BWRVIP-55 report, as modified, will provide an acceptable repair design criteria for the safety-related components addressed. The BWRVIP-55 report is considered by the staff to be applicable for licensee usage at any time during either the current operating term or during an extended license period. The modifications stated in the RAI and addressed above should be incorporated in the A-version of the BWRVIP-55 report. Licensees should note that when applying the repair design criteria to components that, according to the licensing basis of the plant, are classified as ASME Code components, a submittal to the NRC, pursuant to 10 CFR 50.55a(a)(3) is required to request authorization of the repair as an acceptable alternative to the ASME Code.

#### 5.0 REFERENCES

1. Carl Terry, BWRVIP, to USNRC, "BWR Vessel and Internals Project, Lower Plenum Repair Design Criteria (BWRVIP-55)," EPRI Report TR-108719, dated September 1998.
2. C. E. Carpenter, USNRC, to Carl Terry, BWRVIP, "Propriety Request for Additional Information - Review of EPRI Topical Reports TR-108720, TR108719, and TR-108721," dated August 13, 1999.
3. Carl Terry, BWRVIP, to USNRC, "BWRVIP Response to NRC Request for Additional Information on BWRVIP-55," December 6, 1999.
4. Carl Terry, BWRVIP, to USNRC, "BWRVIP Response to NRC Safety Evaluation on BWRVIP-16 and BWRVIP-19," December 6, 1999.
5. Carl Terry, BWRVIP to USNRC, "Project 704 - BWRVIP Response to NRC Safety Evaluation of BWRVIP Repair Design Criteria (BWRVIP-16, -19, -50, -51, -52, -55, -56 and -57)," July 18, 2003.
6. Carl Terry, BWRVIP, to USNRC, "BWR Vessel and Internals Project, Guidelines for Selection and Use of Materials for Repairs to BWR Internals (BWRVIP-84)," EPRI Report TR-1000248, October 2000.