

May 7, 2002

Carl Terry, BWRVIP Chairman  
Niagara Mohawk Power Company  
Post Office Box 63  
Lycoming, NY 13093

SUBJECT: SAFETY EVALUATION OF THE "BWRVIP VESSEL AND INTERNALS PROJECT, INSTRUMENT PENETRATION REPAIR DESIGN CRITERIA (BWRVIP-57)," EPRI REPORT TR-108721 (TAC NO. MA4464)

Dear Mr. Terry:

The NRC staff has completed its review of the Electric Power Research Institute (EPRI) proprietary report TR-108721, "BWR Vessel and Internals Project, Instrument Penetration Repair Design Criteria (BWRVIP-57)," dated December 1998. Both proprietary and non-proprietary versions of the BWRVIP-57 report were submitted to the U. S. Nuclear Regulatory Commission for staff review by letter dated December 16, 1998. The BWRVIP-57 report provides general design acceptance criteria for the temporary and permanent repair of BWR instrument penetrations. These guidelines are intended to maintain the structural integrity of the instrument penetrations during normal operation and under postulated transient and design basis accident conditions. The BWRVIP provided the BWRVIP-57 report to support generic regulatory efforts related to the repair of BWR instrument penetrations.

The NRC staff has reviewed the BWRVIP-57 report, and has found in the enclosed safety evaluation (SE) that the BWRVIP-57 report is acceptable for providing guidance for permanent or temporary repair of BWR instrument penetrations. With the exception of the noted items, the staff has concluded that licensee implementation of the BWRVIP-57 report is acceptable for providing an adequate repair design criteria of the safety-related components, except where the staff's conclusion differs from the BWRVIP's, as discussed in the enclosed SE.

The BWRVIP-57 report is considered by the staff to be applicable for licensee usage, as modified and approved by the staff, at any time during either the current operating term or the extended license period.

The staff requests that the BWRVIP review and resolve the issues raised in the enclosed SE, and incorporate the staff's conclusions into a revised BWRVIP-57 report. Please inform the staff within 90 days of the date of this letter as to your proposed actions and schedule for such a revision.

Carl Terry

-2-

Please contact C. E. (Gene) Carpenter, Jr., of my staff at (301) 415-2169 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

Carl Terry

-2-

Please contact C. E. (Gene) Carpenter, Jr., of my staff at (301) 415-2169 if you have any further questions regarding this subject.

Sincerely

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	GHolahan	MEMayfield	WLanning, R1
SDuraiswamy	JRajan	EHackett	CCasto, R2
JLarkins		TYChang	JGrobe, R3
			AHowell, R4

DOCUMENT NAME: C:\ORPCheckout\FileNET\ML021270433.wpd

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

EMCB:DE	E	EMCB:DE	E	EMEB:DE	E	EMCB:DE	E
CECarpenter:cec		BJElliott:bje		KAManoly:kam		WHBateman:whb	
12/12/2001		02/04/2002		02/11/2002		05/07/2002	

OFFICIAL RECORD COPY

cc:

George Vanderheyden, Executive Chair  
BWRVIP Assessment Committee  
Exelon Corp.  
200 Exelon Way (KSA 3-N)  
Kennett Square, PA 19348

Bill Eaton, Executive Chair,  
BWRVIP Inspection Focus Group  
Grand Gulf Gen. Mgr., Plant Operations  
Entergy Operations, Inc.  
PO BOX 756, Waterloo Rd  
Port Gibson, MS 39150-0756

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

George T. Jones, Executive Chair  
BWRVIP Repair Focus Group  
Vice President, Nuclear Engrg. & Support  
PP&L, Inc.  
M/S GENA61  
2 N 9th St  
Allentown, PA 18101-1139

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

Robin Dyle, Technical Chairman  
BWRVIP Assessment Committee  
Southern Nuclear Operating Co.  
40 Inverness Center Parkway  
Birmingham, AL 35242

Gary Park, Chairman  
BWRVIP Inspection Focus Group  
Nuclear Management Co.  
3313 DAEC Road  
Palo, IA 52324-9646

John Wilson, Technical Chair  
BWRVIP Mitigation Committee  
AmerGen Energy Co.  
Clinton Power Station, M/C T-31C  
P.O. Box 678  
Clinton, IL 61727

Vaughn Wagoner, Technical Chair  
BWRVIP Integration Committee  
Carolina Power & Light Company  
One Hannover Square 9C1  
P.O. Box 1551  
Raleigh, NC 27612

Bruce McLeod, Technical Chair  
BWRVIP Repair Focus Group  
Southern Nuclear Operating Co.  
Post Office Box 1295  
40 Inverness Center Parkway  
Birmingham, AL 35201

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

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
SAFETY EVALUATION OF THE "BWRVIP VESSEL AND INTERNALS PROJECT,  
INSTRUMENT PENETRATIONS REPAIR DESIGN CRITERIA  
BWRVIP-57, EPRI REPORT TR-108721

1.0 INTRODUCTION

1.1 Background

By letter dated December 16, 1998, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) proprietary Report TR-108721, "BWR Vessel and Internals Project, Instrument Penetrations Repair Design Criteria (BWRVIP-57)," dated December 1998, for NRC staff review. The BWRVIP-57 report provides general repair criteria for the temporary and permanent repair of boiling water reactor (BWR) instrument penetrations. These guidelines are intended to maintain the structural integrity of the instrument penetrations during normal operation and under postulated transient and design-basis accident conditions. The BWRVIP provided the BWRVIP-57 report to support generic regulatory efforts related to the repair of BWR instrument penetrations.

1.2. Purpose

The staff reviewed the BWRVIP-57 report to determine whether 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-57 report is proprietary, this SE was written not to repeat proprietary 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 subject 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-57 report.

ENCLOSURE

## 2.0 SUMMARY OF BWRVIP-57 REPORT

The BWRVIP-57 report addresses the following topics in the following order:

- Component Configurations and Safety Functions - The functions and various configurations of BWR vessel instrument penetrations (or nozzles) and attached piping are described by a series of illustrations and a table that identifies plant-specific information by materials used. Existing loads for startup, shutdown, power operation, anticipated operational occurrences, design basis accidents and load combinations are considered. Water level signals are identified as important for several safety functions and are categorized in table format. The identified repairs are not allowed to interfere with any safety function.
- Scope of Repairs - The repair criteria, applicable to General Electric BWR/2-6 plants which plan to implement repairs to reactor vessel water level instrument penetrations, addresses cracking and/or leaking in penetration nozzles, nozzle-to-vessel shell welds, nozzle safe ends, and, where applicable, the coupling which was manufactured as part of the reactor vessel.
- Design Objectives - Structural integrity for all loading conditions is discussed for the design of the repair. The repair criteria considers the existing flaw, postulated growth of the crack, appropriate alignment across the flawed area, and loose parts for the current operating term and during the extended license period.
- Design Criteria - This section addresses code requirements for instrument penetrations (or nozzles) and their welds. In addition to individual plant safety analysis reports (SARs) and other RPV piping design requirements, Sections III and XI of the ASME Code are identified as having specific requirements to be considered in the repair design.
- Structural and Design Evaluation - Plant specific penetration structural requirements are identified from the original RPV ASME Code Design Specification and Stress Report (ASME CDSSR). This typically addresses the load definitions - applied loads, service load conditions, and load combinations. If an applicable ASME CDSSR is not available or does not contain adequate information, this section summarizes the alternative loads and load combinations which may be used for analyzing a repair design (e.g., allowable stresses, radiation effects on repair design, thermal cycles, and analysis codes and corrosion allowances to be utilized).
- System Evaluation - This section evaluates the effects of power uprate for both proposed and prior instrument penetration repairs.
- Materials, Fabrication and Installation - This section discusses material uses that meet the ASTM and ASME Code requirements, and the use of alternatives for austenitic stainless steels, Ni-based alloys, and weld repairs that are appropriate to each, welding and fabrication tolerances that the repair will accommodate, installation cleanliness, ALARA considerations, and the use of appropriate mockups for design parameter qualifications.
- Inspection and Testing - Inspection access, and pre- and post-installation inspection and system pressure tests are discussed for the instrument penetration repairs.

### 3.0 STAFF EVALUATION

Instrument penetrations (or nozzles) are located in the BWR RPV cylindrical shell at various elevations (Figure 1) and are welded to the reactor vessel, and are used to determine RPV water level in the liquid region of the core shroud annulus. The configurations of instrument penetrations vary with BWR type and RPV vendor with, in most designs, the penetration connected to the vessel wall with a partial penetration weld made on the inside of the vessel. In a few cases, the instrument lines connect to vessel nozzles which are in turn connected to the vessel with full penetration welds. The BWRVIP-57 report provides several figures showing the typical configurations for the instrument penetrations (or nozzles), and a table giving plant-specific cross-references to these figures and information on the materials used in the instrument penetrations.

The instrument penetration repairs primarily address cracking and or leaking in IGSCC susceptible stainless steel and nickel-chrome-iron alloy components. The BWRVIP-57 repair criteria applies to the instrument penetration (or low alloy nozzle forging) to vessel shell weld, the penetration (or nozzle) safe end and the socket weld fittings used to attach to drywell piping. The design life of the repair will normally be for the remaining life of the plant plus life extension beyond the current operating license. Alternatively, the repair may be temporary, that is designed for one or several operating cycles until a permanent repair or replacement can be implemented.

The staff has reviewed the guidance provided in the BWRVIP-57 report and finds it consistent with other existing guidance on the evaluation and repair of potential leakage sources. With the exception of the below noted items, the staff has concluded that licensee implementation of the BWRVIP-57 report is acceptable for providing an adequate repair design criteria of the safety-related components, except where the staff's conclusion differs from the BWRVIP's, as discussed below.

The BWRVIP-57 report is considered by the staff to be applicable for licensee usage, as modified and approved by the staff, anytime during either the current operating term or during the extended license period.

#### 3.1 Structural and Design Evaluation

A structural evaluation was performed to determine the acceptability of the BWRVIP-57 repair methodology for the instrument penetrations. Accordingly, various events and operational conditions were considered to ensure that the proposed repairs do not inhibit the ability of the instrument penetrations to perform their basic safety functions. Further, the loads existing during periods of reactor startup, shutdown, normal power operation, and upset/emergency conditions, were considered in the staff's evaluation. These loads included dead weight, differential pressure, reaction loads from the attached piping, loads due to anticipated operational occurrences which have the potential to increase instrument penetration loads above those experienced in normal operation (e.g., recirculation flow control failure, loss of feedwater with feedwater restart without feedwater heating, inadvertent activation of a safety relief valve), and loads associated with a design basis earthquake (DBE) in conjunction with a loss-of-coolant accident (LOCA).

The loads and load combinations, including seismic and LOCA events, used in analyzing a repair design are to be consistent with the current plant-specific licensing basis. The load definitions and loading combinations are similar to those described in the staff's safety evaluation related to the BWRVIP-55 report, "Lower Plenum Repair Design Criteria," dated September 21, 2001, and that evaluation is applicable for this topical report as well.

The BWRVIP-57 report requires that the repair hardware mechanical components be designed to minimize the potential for loose parts inside the vessel, with all repair parts captured and held in place for the design life of the repair by a suitable method. The plant-specific evaluation of the repair shall show by analysis and/or inspections that the components will not become loose parts or, if necessary, demonstrate the acceptability of these potential loose parts.

On the basis of its review as discussed above, the staff finds that all applicable loads and load combinations for the structural evaluation of the instrument penetration repair have been adequately considered. In addition, the general design criteria recommended for the instrument penetration repair are reasonable and acceptable.

### 3.2 General Comments:

1. In order to be consistent with other BWRVIP repair procedures, such as the BWRVIP-16 and BWRVIP-19 reports, the following requirements should be added or changed in Section 9.1.2, Materials, of the BWRVIP-57 report: "Repair and replacement designs for plants which were not designed and constructed in accordance with ASME Section III (and components not subject to 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 Cases, ASME Section II specifications, ASTM specifications, or other material specifications that have been previously approved by the regulatory authorities. This would include material specifications/criteria submitted by BWRVIP and approved by NRC. Otherwise, it is recognized that a repair or replacement design that uses a material not meeting these criteria must be submitted to the regulatory authorities for approval on a plant specific basis."
2. The staff finds Section 5.6 to be generally acceptable; however, the staff requires 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 BWRVIP could just eliminate all welding on fasteners in this document.

### 4.0 CONCLUSION

The NRC staff has reviewed the BWRVIP-57 report and found that the BWRVIP-57 report, as modified and clarified to incorporate the staff's comments above, is acceptable for providing guidance for permanent or temporary repair of cracked or leaking instrument penetrations. Therefore, the staff has concluded that licensee implementation of the guidelines in BWRVIP-57, as modified, will provide an acceptable repair design criteria of the safety-related components addressed in the BWRVIP-57 document. The modifications addressed above should be incorporated in Revision 1 of the BWRVIP-57 report.

The BWRVIP-57 report is considered by the staff to be acceptable for licensee usage, as modified and approved by the staff, anytime during either the current operating term or during the extended license period. If it is determined during the course of implementing these repair guidelines that implementation cannot be achieved as described in the guideline or that meaningful results are not obtained, then the staff requests that the user notify BWRVIP with sufficient details to support development of alternative actions. These notifications, as well as planned actions by the BWRVIP, should be summarized and reported to the NRC. It should be noted that an Owner is responsible for reviewing regulatory requirements for the system. If the repair is an alternative repair to that specified in the regulations, i.e., 10 CFR 50.55a, the Owner will need to pursue the appropriate regulatory action.

## 5.0 REFERENCES

1. Carl Terry, BWRVIP, to USNRC, "BWR Vessel and Internals Project, Instrument Penetrations Repair Design Criteria (BWRVIP-57)," EPRI Report TR-108721, dated December 16, 1998.
2. Carl Terry, BWRVIP, to USNRC, "BWRVIP Response to NRC Safety Evaluation on BWRVIP-16 and BWRVIP-19," December 6, 1999.