

February 4, 2001

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

SUBJECT: FINAL SAFETY EVALUATION OF THE "BWR VESSEL AND INTERNALS  
PROJECT, BWR JET PUMP ASSEMBLY INSPECTION AND FLAW  
EVALUATION GUIDELINES (BWRVIP-41)," (TAC NO. M99870)

Dear Mr. Terry:

The NRC staff has completed its review of the Electric Power Research Institute (EPRI) proprietary report TR-108728, "BWR Vessel and Internals Project, BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines (BWRVIP-41)". This report was submitted by letter dated October 15, 1997, and was supplemented by letter dated August 4, 1999, in response to a staff's request for information dated February 12, 1999, and by letter dated November 17, 2000, which was in response to the open items in the staff's initial safety evaluation (SE), dated June 20, 2000.

The BWRVIP-41 report, as supplemented, provides generic guidelines intended to present the appropriate inspection and flaw evaluation recommendations to assure safety function integrity of the subject safety-related reactor pressure vessel (RPV) internal components. These guidelines considered degradation susceptibility, degradation mechanisms, loads, and inspection strategies for jet pump assemblies.

The NRC staff has reviewed the proposed revisions to the BWRVIP-41 report and finds, in the enclosed SE, that the revised guidance of the BWRVIP-41 report, with the modifications as described in the enclosed SE, is acceptable for inspection of the subject safety-related RPV internal components. This finding is based on information submitted by the above cited letters. The staff has concluded that licensee implementation of the guidelines in the BWRVIP-41 report, as modified, will provide an acceptable level of quality for inspection and flaw evaluation of the safety-related components addressed.

Carl Terry

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The staff requests that you incorporate the staff's recommendations, as well as your responses to other issues raised in the staff's initial SE, into a revised, final BWRVIP-41 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.

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

Sincerely,

Jack R. Strosnider, Director */ra/*  
Division of Engineering  
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: See next page

Carl Terry

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Joe Hagan, BWRVIP Vice Chairman  
Exelon Corp.  
200 Exelon Way (M/S KSA 3-N)  
Kennett Square, PA 19348

George Vanderheyden, Executive Chair  
Assessment Committee  
Exelon Corp.  
Suite 400  
1400 Opus Place  
Downers Grove, IL 60515-1198

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

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

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

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

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

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

Carl Larsen, Technical Chairman  
BWRVIP Inspection Task  
Vermont Yankee Nuclear Power Corp.  
P.O. Box 157  
Vernon, VT 05354

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

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

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

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
SAFETY EVALUATION OF EPRI PROPRIETARY TOPICAL REPORT TR-108728  
BWR VESSEL AND INTERNALS PROJECT, BWR JET PUMP ASSEMBLY  
INSPECTION AND FLAW EVALUATION GUIDELINES (BWRVIP-41)

## 1.0 INTRODUCTION

### 1.1 Background

By letter dated October 15, 1997, as supplemented by letters dated August 4, 1999, and November 17, 2000, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted both proprietary and non-proprietary versions of the Electric Power Research Institute (EPRI) proprietary report TR-108728, "BWR Vessel and Internals Project, BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines (BWRVIP-41)".

The staff requested additional information (RAI) in a letter dated February 15, 1999, and the BWRVIP responded to the RAI in a submittal dated August 4, 1999. By letter dated June 20, 2000, the staff provided an initial safety evaluation (SE) with several open items to the BWRVIP. By letter dated November 17, 2000, the BWRVIP provided its response to the open items in the staff's initial SE.

### 1.2 Purpose

The staff reviewed the BWRVIP-41 report, as supplemented, to determine whether its revised guidance addressed the open items in the staff's initial SE, and if it would provide acceptable levels of quality for inspection and flaw evaluation (I&E) of the subject safety-related RPV internal components. The review considered the consequences of component failures, potential degradation mechanisms and past service experience, and the ability of the proposed inspections to detect degradation in a timely manner.

### 1.3 Organization of the Report

Because the BWRVIP-41 report is proprietary, this safety evaluation (SE) was written so as not to repeat information contained in the report. This SE gives a brief summary of the general contents of the report in Section 2.0 and the detailed evaluation in Section 3.0 below. The SE does not discuss in any detail the provisions of the guidelines nor the parts of the guidelines that the staff finds acceptable.

ENCLOSURE

## 2.0 SUMMARY OF BWRVIP-41 REPORT

The BWRVIP-41 report addresses the following topics in the following order:

- Jet Pump Assembly Analysis - The jet pump assemblies are described in detail by a series of illustrations and differences among the various models of BWRs (BWR/3 through BWR/6). The various types of jet pump susceptibility factors and material degradation mechanisms, e.g., intergranular stress corrosion cracking (IGSCC), which has factors that include environment, materials and stress state; fatigue by flow induced vibration and/or thermal cycling; and, thermal embrittlement (aging), that could impact the jet pump assemblies are described in general terms. Potential failure locations are addressed from the standpoint of inspection priority, susceptibility to degradation, and consequences of failures in terms of component functions and plant safety.
- Inspection Strategy - The BWRVIP-41 report recommends the specific locations, NDE methods, and inspection frequencies for examinations of the jet pump assemblies. The report also describes the inspection basis and methods, the recommended baseline inspection scope, the reinspection frequency, scope expansion, and reporting of inspection results.
- Loads and Load Combinations - The various types of loads (e.g., pressure, seismic, etc.) of concern and the load combinations are listed and load combinations are described. Consideration for degraded assemblies are also detailed.
- Structural Evaluation Methodologies - This section presents methods which can be used to determine allowable flaw size determinations for different parts of the assemblies, set screw gap evaluation, and the ability of the riser brace to prevent jet pump disassembly.

The BWRVIP-41 report also contains an Appendix A on Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule, (10 CFR 54.21). Appendix A to the BWRVIP-41 report is not evaluated in this SE report, but will be evaluated under a separate license renewal review.

## 3.0 STAFF EVALUATION

The staff's June 20, 2000, initial SE provided three open items. The BWRVIP, in its letter of November 17, 2000, addressed these items, which are discussed below.

### Issue 1: Un-inspectable Thermal Sleeve Welds

The staff's June 20, 2000, initial SE stated:

With the exception of the issue described below, as requested in Question 6 of the staff's February 12, 1999, RAI, and stated in BWRVIP's August 4, 1999, response, this review finds that the inspection guidance provided in the subject report to be acceptable:

1. If analysis cannot be provided to alleviate the weld inspections, what type of recommended inspections are being considered for the thermal sleeve welds? Will the

inspections be performed over two inspection cycles with at least 50% of the inspections being performed in the first cycle?

**BWRVIP Response:**

It is currently anticipated that, if the analyses are not successful, the inspections recommended for the thermal sleeve welds would have to be capable of detecting IGSCC: EVT-1 or UT exams. Since the thermal sleeve is identified as a Medium/Low Priority location, the inspections would be performed over two cycles with at least 50% inspected during the first cycle.

At present, inspection techniques are not available to inspect the inaccessible thermal sleeve welds. These welds are in an extremely difficult position to reach with inspection equipment. The Inspection Committee is investigating the feasibility of developing inspection tooling to reach these welds. An engineering feasibility study will be completed by the BWRVIP. Inspection requirements will be recommended once a technique becomes available.

This issue is unresolved pending BWRVIP's submittal of the above inspection methodology for the thermal sleeve welds.

**BWRVIP's November 17, 2000, response stated:**

The BWRVIP will be re-evaluating the need to inspect the hidden welds in the jet pump, core spray and LPCI systems in 2001. This re-evaluation will review the bases for requiring the welds to be examined and determine if a technical basis exists to exclude them from the scope of inspections. However, the issue of hidden welds in the jet pump thermal sleeve is identical to the issue of LPCI hidden welds which was previously resolved between the NRC and BWRVIP. In response to the NRC question on hidden LPCI welds, the BWRVIP responded:

*The I&E guidelines contain numerous recommendations that require extensive technological development for their implementation such as inspection of the subject LPCI locations. It is possible that, after adequate attempts, the industry may determine that a recommendation (such as the inspection of the hidden LPCI welds), as written, cannot be implemented as set forth in the I&E guideline. Rather than track this inaccessible location issue separately through the Staff's SE, we propose that the BWRVIP provide a report to the NRC which describes our progress on the development of inspection tooling for inaccessible locations. In addition, to address future situations where a BWRVIP recommendation cannot be implemented, the BWRVIP proposes a programmatic control that includes NRC notification. BWRVIP-42 will be revised to include the below paragraph.*

*"If, during the course of implementing these recommendations, it is determined that implementation cannot be achieved as described in the I&E guideline, or that meaningful results are not obtained, the user shall notify the BWRVIP with sufficient details to support development of alternative actions. These notifications, as well as planned actions by the BWRVIP, will be summarized and reported to the NRC ."*

*It is also proposed that, when the other I&E guidelines are revised for final issuance, the paragraph above be included. These actions allow BWRVIP members to identify recommendations that cannot be implemented and provides for appropriate notification and coordination with the NRC.*

The BWRVIP intends to revise the Jet Pump I&E Guideline (BWRVIP-41) to contain this same language as discussed in the BWRVIP-42 SE response. Consequently, the issue of hidden thermal sleeve welds should not be considered an open issue. Rather, it should be considered closed by the additional commitment of the BWRVIP to report to the NRC any instances where inspections, as written, cannot be performed.

#### Staff's Evaluation:

The staff finds that these actions adequately addresses this open item.

#### Issue 2: Thermal Sleeve Inspection Requirements

The staff's June 20, 2000, initial SE stated:

The staff requested a description of the plant-specific analysis that could be done to alleviate or reduce the inspection requirements of the thermal sleeve welds, TS-1 through TS-4, the riser pipe welds, RS-1, RS-2, and RS-4 through RS-7, the diffuser and tailpipe welds, DF-1 through DF-3, and the adaptor/lower ring welds, AD-1 through AD-3a,b. With respect to the safety consequences, BWRVIP stated that a plant-specific analysis could be done to show that the failure location would not compromise the jet pump's ability to maintain the water level at 2/3 core height. A plant-specific analysis could also show that the failure does not allow the jet pump to disassemble. For other locations, the plant-specific analysis could focus on the redundancies of the core cooling system. Since some of these welds are classified as high priority inspection welds, the staff believes that the description of the plant-specific analyses of the safety consequences should be included in the appropriate sections of the BWRVIP-41 report.

BWRVIP's November 17, 2000, response stated:

The BWRVIP agrees that a description of the plant-specific analyses should be included in the Guideline. The BWRVIP proposes to add the following paragraph to Section 3:

#### 3.2.x Plant-specific Analyses to Modify/Eliminate Inspection Requirements

For a number of jet pump locations, the inspection requirements in Table 3-1 indicate that "*Analysis (either generic or plant-specific) may alleviate inspection requirements.*" These analyses should clearly demonstrate that a location failure would not compromise the jet pump's ability to maintain two-thirds core height water coverage following a LOCA. For some locations, such as the thermal sleeve welds, the analysis may show that a failure does not allow jet pump disassembly. For other locations, the analyses may focus on the core cooling systems' redundancies and associated ability to maintain fuel limits despite complete failure of particular jet pump locations. For this last category of analysis, the results may depend on some cycle-specific characteristics such as fuel type and core design. Assumptions



associated with calculation of fuel limits might need to be modified to be consistent with the leakage scenarios being postulated.

Results of these plant-specific analyses should be submitted to the NRC for review and approval.

Staff's Evaluation:

The staff finds that this proposed addition to the BWRVIP-41 report adequately addresses this open item.

Issue 3: Structural Evaluation Methodologies

The staff's June 20, 2000, initial SE stated:

The staff finds the methodology provided for determination of allowable flaw size for the riser, inlet-mixer and diffuser and the set screw evaluation method to be acceptable. Methodology is not provided for the jet pump beam, the riser brace or for an evaluation of the ability of the riser brace to prevent jet pump disassembly. Plant-specific analyses will be needed for evaluation of degradation that is identified for all of the jet pump components.

BWRVIP's November 17, 2000, response stated:

As noted by the staff, the Guideline does not include flaw evaluation methods for all jet pump components. BWRVIP members would expect to submit to the NRC any flaw evaluations which are not in accordance with methods presented in the Guideline. The BWRVIP proposes to clarify this by revising Section 5 of the guideline to include the following paragraph that comes from Section 4.3 of BWRVIP-76 and provides additional clarification. Furthermore, all future revisions to BWRVIP reports will contain these generic reporting requirements.

Analytical Evaluations of Inspection Results

Analytical evaluations performed to the guidance of this report for the acceptance of inspection results do not require a specific NRC review prior to restart of the plant following a refueling outage. However, results of such analyses shall be provided by the licensee to the NRC. Analytical evaluations that deviate from the guidance of this report (e. g., assumptions, methods, acceptance criteria, etc.), or evaluations of components not described in this report, shall be communicated to the NRC prior to plant restart.

Staff's Evaluation:

The staff finds that this response adequately addresses this open item.

It should be noted that, with regards to the potential degradation mechanism of thermal embrittlement caused by high fluence levels, the BWRVIP-41 report does not recommend specific inspections of CASS jet pump assembly components to inspect for embrittlement-

related degradation beyond that recommended for IGSCC concerns. The staff notes that irradiation embrittlement of CASS components becomes a concern only if cracks are present in the components, and that significant cracking has not been observed in CASS jet pump assembly components. To verify this, the BWRVIP and the NRC's Office of Nuclear Regulatory Research (RES) is engaged in a joint confirmatory research program to determine the effects of high levels of neutron fluence on BWR internals. The results of this program should be used by the BWRVIP to evaluate the need for additional inspections of the CASS jet pump assemblies in the renewal period, and to modify the inspection scope and/or frequency, as needed.

#### 4.0 CONCLUSION

The staff has reviewed the BWRVIP-41 report, as revised, and finds that the guidance of the BWRVIP-41 report is acceptable for inspection of the subject safety-related internal components. The staff has concluded that licensee implementation of the guidelines in the BWRVIP-41 report will provide an acceptable level of quality for examination of the safety-related components addressed in the BWRVIP-41 report.

#### 5.0 REFERENCES

1. Terry, C., BWRVIP, to USNRC, "BWR Vessel and Internals Project: BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines (BWRVIP-41)," EPRI TR-108728, October 15, 1997.
2. Carpenter, C.E., USNRC, to C. Terry, BWRVIP, "Proprietary Request for Additional Information - Review of "BWR Vessel and Internals Project, Jet Pump Assembly Inspection and Flaw Evaluation Guidelines (BWRVIP-41)" (TAC No. M99870)," February 12, 1999.
3. Wagoner, V., BWRVIP, to USNRC, "BWRVIP Response to NRC Request for Additional Information on BWRVIP-41 (Reference Project 704)," August 4, 1999.