

BWR Vessel and Internals Project

Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines (BWRVIP-48)

NON-PROPRIETARY INFORMATION

NOTICE: This report contains the non-proprietary information that is included in the proprietary version of this report. The proprietary version of this report contains proprietary information that is the intellectual property of BWRVIP utility members and EPRI. Accordingly, the proprietary report is available only under license from EPRI and may not be reproduced or disclosed, wholly or in part, by any Licensee to any other person or organization.

REPORT SUMMARY

The Boiling Water Reactor Vessel and Internals Project (BWRVIP), formed in June, 1994, is an association of utilities focused exclusively on BWR vessel and internals issues. This BWRVIP report provides information on potential failure locations in BWR vessel attachment welds and recommends an inspection program which will assure that the integrity of related safety functions is maintained.

Background

The core spray piping and the jet pump assemblies in BWRs are supported in part by attachments welded to the vessel wall. A safety assessment conducted by the BWRVIP ("Safety Assessment of BWR Reactor Internals (BWRVIP-06)") concluded that failure of these welds could adversely affect the integrity of the core spray and jet pump functions and that Inspection and Evaluation (I&E) procedures should be defined to assure the long term integrity of the attachments. The Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines were developed to present the appropriate inspection recommendations to assure that safety function integrity is maintained.

Objectives

To develop a generic inspection strategy to assure that degradation of attachment welds is detected before the safety function of the attached component is compromised. A secondary objective is to recommend additional inspections of nonsafety attachment welds to assess the possibility that cracks which initiate at the attachments might propagate into the vessel.

Approach

A group of utility and industry experts evaluated available information, including BWR inspection data and information on intergranular stress corrosion cracking (IGSCC), to determine which bracket attachment welds might be susceptible to cracking. This susceptibility is dependent on material type, stress level and environmental conditions. Based on these considerations, the team then made inspection recommendations intended to ensure continued plant safety.

Results

The team determined that a visual inspection of the attachment welds for the jet pump and the core spray piping was warranted. Baseline and reinspection schedules were established. In addition, inspection recommendations were made for certain of the non-safety attachments which were determined to be relatively more susceptible to cracking. For these attachments welds, inspections are to be performed on the same schedule as current ASME Code inspections. However, the optical resolution of the visual technique recommended for the inspections is higher than that required by the Code.

EPRI Perspective

When implemented, the inspection recommendations in this report will ensure that attachment weld integrity will be maintained with respect to all essential safety functions. In addition, the inspections will assess whether the potential exists for cracks to initiate at attachment welds and, subsequently, propagate into the vessel.

Project

WOB301

EPRI Project Manager: Robert G. Carter

Nuclear Power Group

Contractor: MPR Associates

For ordering information about this report, call the EPRI Program Manager at (415) 855-2340.

For membership information, call (415) 855-2514

TR-108724

Interest Categories

Piping, reactor, vessel & internals

Licensing and safety assessment

Key Words

Boiling water reactor

Flaw evaluation

Brackets

Attachments

Inspection strategy

Stress corrosion cracking

Vessel and internals

BWR Vessel and Internals Project

Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines (BWRVIP-48)

TR-108724

Research Project B301

Final Report, February, 1998

Prepared by:

MPR Associates

BWRVIP Attachment Weld Focus Group

Prepared for

**BOILING WATER REACTOR VESSEL & INTERNALS PROJECT and
EPRI**

3412 Hillview Ave.

Palo Alto, California 94304

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

This report was prepared by the organization(s) named below as an account of work sponsored or cosponsored by the BWR Vessel and Internals Project (BWRVIP) and the Electric Power Research Institute, Inc. (EPRI). Neither BWRVIP, EPRI, any member of EPRI, any cosponsor, the organization(s) named below, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, express or implied, (i) with respect to the use of any information, apparatus, method, process or similar item disclosed in this report, including merchantability and fitness for a particular purpose, or (ii) that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or (iii) that this report is suitable to any particular user's circumstance, or

(b) assumes any responsibility for any damages or other liability whatsoever (including any consequential damages, even if BWRVIP, EPRI or any EPRI representative has been advised of the possibility of such damages) resulting from your selection or use of this report or any information, apparatus, method, process or similar item disclosed in this report.

Organization(s) that prepared this report:

MPR Associates

BWRVIP Attachment Weld Focus Group

ORDERING INFORMATION

Requests for copies of this report should be directed to the BWRVIP Program Manager, 3412 Hillview Ave., Palo Alto, Ca. 94304, (415) 855-2340.

ACKNOWLEDGMENTS

The members of The BWRVIP Vessel ID Attachment Weld Focus Group, listed below, are gratefully acknowledged for their efforts which led to the successful completion of this document.

Vaughn Wagoner, Chairman	CP&L
Sri Dodeja	Centerior
Carlos Bosch	Iberdrola
Magdalena Gris	CFE
Dana Covill	GPUN
George Inch	NMPC
Tim Steingass	PP&L
Tony Oliveri	PSE&G
Rick Nademus	GPUN
John Langdon	CP&L
Bruce McLeod	SNC
Albert Piha	PECO
Har Mehta	GENE
Ken Wolfe	EPRI

MPR Associates Principal Investigator:

H. William McCurdy

Table of Contents

EXECUTIVE SUMMARY	ix
1.0 INTRODUCTION	1-1
1.1 Background	1-1
1.2 Objectives and Scope	1-1
2.0 VESSEL ID ATTACHMENT WELD DESIGN AND SUSCEPTIBILITY INFORMATION	2-1
2.1 Bracket Attachment Configurations	2-1
2.2 Susceptibility Factors	2-2
2.3 Potential Failure Locations	2-5
3.0 INSPECTION STRATEGY	3-1
3.1 Background	3-1
3.2 BWRVIP Inspection Guidelines	3-3
3.3 Inspection Acceptance Criteria	3-4
3.4 Reporting of Inspection Results	3-4
4.0 LOADING AND DEFECT EVALUATIONS	4-1
4.1 Bracket Attachment Loads	4-1
4.2 Load Combinations	4-1
4.3 Flaw Evaluation Approach	4-1
5.0 REFERENCES	5-1
APPENDIX A - LICENSE RENEWAL APPENDIX	

List of Tables

2-1. Bracket Failure Consequences	2-6
2-2. Bracket Attachment Configuration Variations	2-7
3-1. Bracket Attachment Inspection Information.....	3-5
3-2. Bracket Attachment Inspection Recommendations.....	3-7
4-1. Example Bracket Attachment Loads	4-3

List of Figures

2-1. Jet Pump Riser Brace - Primary, Single Leaf	2-10
2-2. Jet Pump Riser Brace - Primary, Double Leaf (Type 1).....	2-11
2-3. Jet Pump Riser Brace - Primary, Double Leaf (Type 2).....	2-12
2-4. Jet Pump Riser Brace - Secondary, Double Leaf	2-13
2-5. Jet Pump Riser Brace - Primary, Double Leaf (Type 3).....	2-14
2-6. Core Spray Piping Bracket - Primary (Type 1)	2-15
2-7. Core Spray Piping Bracket - Primary (Type 2)	2-16
2-8. Core Spray Piping Bracket - Supplemental	2-17

Executive Summary

This Vessel ID (inside diameter) Attachment Weld Inspection and Evaluation (I&E) Guideline is one in a series of I&E guidelines being developed by the BWR Vessel and Internals Project (BWRVIP) to assist BWR plant utilities in performing inspections of those internal structures determined by the safety assessment in BWRVIP-06 [1] to be important for safe shutdown of the plant.

This I&E guideline provides generic inspection and evaluation guidelines which are applicable to all BWR plants within the BWRVIP program. Guidelines are provided for those vessel attachments which were determined to be safety-related (the core spray piping bracket and jet pump riser brace attachments). In addition, inspection guidelines are provided for other non-safety-related bracket attachments which utilize weld material which is highly susceptible to stress corrosion cracking (SCC), such as Alloy 182 or furnace-sensitized stainless steel (E308/309 or E308L/309L). These additional inspections address the concern for bracket attachment welds serving as initiation sites for crack growth into the vessel base material.

The recommended inspections contained herein apply to the attachment welds between the support brackets and the vessel. The inspection recommendations for the brackets themselves, including the bracket-to-pad weld where applicable, are provided in the I&E guidelines for the component for which they provide support. The attachment weld guidelines are intended to assure the integrity of the vessel ID attachments to perform their safety function. The economic and normal operational consequences of cracking are not factored into the inspection recommendations.

This guideline provides the following:

- A description of the geometry of the vessel ID attachments for each of the types of BWR plants including the weld attachment materials.
- An evaluation of the susceptibility of the vessel ID attachments to in-service degradation and an identification of potential failure locations.
- A definition of the inspection strategy for the vessel ID attachments including baseline and reinspection.
- A discussion of structural evaluation approaches which could be followed to assess indications found during any inspections including loads, load combinations and defect evaluation approaches.

About the BWR Vessel and Internals Project

The BWR Vessel and Internals Project (BWRVIP) is an association of utilities owning and operating boiling water reactors. The project is focused exclusively on reactor vessel and vessel internals issues in operating plants. Objectives of the BWRVIP are to lead the BWR industry toward generic resolution of vessel and internals integrity and operability issues; to identify or develop generic, cost-effective strategies from which each operating plant will select the most appropriate alternative; to serve as the focal point for the regulatory interface with the industry on BWR vessel and internals integrity and operability issues; and to share information among members. EPRI manages the technical program on behalf of the utility members of the BWRVIP.

About EPRI

Electricity is increasingly recognized as a key to societal progress throughout the world, driving economic prosperity and improving the quality of life. The Electric Power Research Institute delivers the science and technology to make the generation, delivery, and use of electricity affordable, efficient, and environmentally sound.

EPRI manages a collaborative research and development program on behalf of the electricity industry, its customers, and society. Created in 1973, EPRI now has more than 700 members worldwide and an annual budget of \$500 million. Membership is open to qualifying organizations involved in power generation, power delivery, energy sales, or related services.

EPRI. POWERING PROGRESS.

© 1998 Electric Power Research Institute (EPRI), Inc. All rights reserved.
Electric Power Research Institute, and EPRI are service marks of the
Electric Power Research Institute, Inc.

 Printed on recycled paper in the United States of America.

TR-108724