EPRI
Electric Power
Research Institute

EPRI TR-107286
April 1997

BWR Vessel and Internals Project

BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines (BWRVIP-27)

Prepared by
BWR Vessel and Internals Project Assessment Committee
Standby Liquid Control Inspection and Evaluation Focus Group

GE Nuclear Energy

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

BWRVIP Vessel and Internals Project

BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines (BWRVIP-27)

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 defines inspection requirements for BWR Standby Liquid Control (SLC) system piping from the vessel nozzle safe-end inward.

INTEREST CATEGORIES

Piping, reactor, vessel & internals
Licensing and safety assessment

KEYWORDS

Boiling water reactor
Inspection strategy
Standby liquid control
Stress corrosion cracking
Vessel and internals

BACKGROUND Cracking due to intergranular stress corrosion cracking (IGSCC) has been observed in a number of internal components in domestic and overseas BWRs. Utilities require a standardized methodology which is accepted by regulators for performing inspections and for evaluating the consequences of any observed cracking.

OBJECTIVE To develop a generic inspection strategy for BWR SLC piping.

APPROACH A group of utility and industry experts evaluated available data, including IGSCC experience, to develop generic Guidelines. This information was used to identify the weld locations on the SLC piping (from the vessel safe-end inward) which could be susceptible to cracking. The consequences of cracking at each of the locations was assessed and, based on those results, generic inspection recommendations were developed.

RESULTS The report concludes that the integrity of the piping internal to the vessel is not critical to safety. However, it is critical that the vessel nozzle integrity be maintained such that sodium pentaborate can always be injected into the vessel with only minor loss due to leakage. Consequently, inspection requirements concentrate on inspection of the nozzle and safe-end welds. It is recommended that for most configurations, the current ASME inspection requirements be followed. For some configurations, however, an additional ultrasonic (UT) examination is recommended.

EPRI PERSPECTIVE It is the intent that, for BWRVIP members, these Guidelines will be followed in place of prior GE Services Information Letters (SILs). It is further intended that these Guidelines will be submitted to the US NRC and, possibly, non-US regulators for their approval. Regulatory acceptance of these Guidelines will significantly reduce the utility effort required to obtain approval for plant-specific programs.

PROJECT
B310
EPRI Project Manager: Robert G. Carter
Nuclear Power Group
Contractor: General Electric

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

For membership information, call (415) 855-2514.

BWR Vessel and Internals Project

BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines (BWRVIP-27)

TR-107286
Research Project B301

Final Report, April, 1997

Prepared by:

BOILING WATER REACTOR VESSEL AND INTERNALS PROJECT
ASSESSMENT COMMITTEE STANDBY LIQUID CONTROL
INSPECTION AND EVALUATION FOCUS GROUP

GE NUCLEAR ENERGY

Principal Investigator

Tom Caine
K. R. Kotak

Prepared for

BOILING WATER REACTOR VESSEL & INTERNALS PROJECT and
ELECTRIC POWER RESEARCH INSTITUTE
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:

BWR VESSEL AND INTERNALS PROJECT ASSESSMENT COMMITTEE STANDBY LIQUID CONTROL INSPECTION AND EVALUATION FOCUS GROUP

GE NUCLEAR ENERGY

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.

Table of Contents

Executive Summary

In the BWRVIP-06 safety assessment, there are several components where extensive degradation can be tolerated because of the redundancy provided by the Standby Liquid Control (SLC) System. Therefore, the successful function of the SLC system is important to achieve reactor shutdown. A number of failures are readily detectable, but even without detection of cracking the SLC system would function adequately when initiated as long as the boron is injected into the bottom head. Therefore, the focus of the evaluations in these guidelines is on the region where the ΔP/SLC housing or nozzle penetrates the vessel bottom head.

The objective of these guidelines is to show that boron can be successfully injected into the bottom head under the worst credible cracking conditions because the line to the vessel will not fail in a way that the external pipe is ejected from the vessel. Each of the nine penetration design types in BWR/2-6 is presented and a basis is provided to support the conclusion that the ΔP/SLC housing or nozzle will not be ejected as a result of potential cracking of the penetration weld. Further, such cracking would result in pressure boundary leakage, which would be detected and allow for an orderly shutdown.

Based on the conclusion that a ΔP/SLC housing or nozzle cannot be ejected, and the detectability of significant cracking of the penetration weld, the guidelines recommend that the inspection requirements currently in ASME Section XI continue to be followed for penetration welds.

For the plants where a stainless steel safe end is welded to the ΔP/SLC low alloy steel nozzle, and the plants where a stainless steel safe end extension is welded to the Alloy 600 ΔP/SLC housing, UT is recommended for SCC-susceptible regions.

ABOUT BWRVIP

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.

Created by the nation's electric utilities in 1973, EPRI is one of America's oldest and largest research consortia, with some 700 members and an annual budget of about $500 million. Linked to a global network of technical specialists, EPRI scientists and engineers develop innovative solutions to the world's toughest energy problems while expanding opportunities for a dynamic industry.

EPRI. *Powering Progress*

Printed on recycled paper (50% recycled fiber, including 10% postconsumer waste) in the United States of America.