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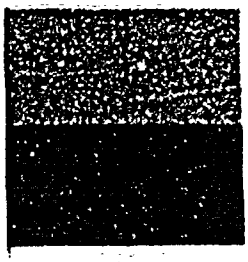

BWR Vessel and Internals Project

BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05)

Prepared by
BWR Vessel and Internals Project Beltline Team
Structural Integrity Associates
VECTRA Technologies, Inc.
GE Nuclear Energy

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REPORT SUMMARY

BWR Vessel and Internals Project

BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05)

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 report, the fifth in a continuing series, provides an evaluation of the current inspection criteria for BWR vessel welds, formulates recommendations for alternative inspection requirements, and provides a technical basis for these recommended requirements.

INTEREST CATEGORIES

Piping, reactor, vessel & internals
Licensing and safety assessment

KEYWORDS

Boiling water reactor
Reactor pressure vessel
Stress corrosion cracking
Vessel and internals
Welds

BACKGROUND Events in 1993 and 1994 confirmed that intergranular stress corrosion cracking (IGSCC) is a significant issue for BWR internals. US BWR executives formed the BWRVIP in June, 1994, to address integrity issues arising from service-related degradation of the vessel internals.

Over the past few years, the inservice inspection requirements for welds in nuclear pressure vessels have become increasingly rigorous. This significant increase in inspection criteria has raised a number of important issues concerning the inspection of reactor pressure vessels (RPVs).

OBJECTIVES To provide an evaluation of the current inspection requirements for BWR RPV shell welds, formulate recommendations for alternative inspection requirements, and provide a technically justified basis for these recommended requirements.

APPROACH The project team investigated a number of issues related to BWR reactor pressure vessel integrity. Based on the results of this investigation, they recommended alternative inspection requirements which would significantly reduce the extent of volumetric inservice inspections currently required on BWR reactor pressure vessel shell welds.

RESULTS Results of the evaluations performed in this report demonstrate the inherent safety and integrity of BWR RPVs. The report also concludes that the amount of inservice inspections currently required could be reduced while still meeting NRC safety goals by a significant margin. The report recommends inservice inspections requirements that focus inspections on the most appropriate vessel welds while eliminating those inspections which have a negligible effect on plant safety. Revised criteria for the performance of successive and additional inspections are also recommended.

EPRI PERSPECTIVE The cost benefit study performed to compare the existing vessel shell weld inspection requirements with the recommended inspection criteria verified that performing the RPV inspections recommended in this report represents a substantial savings in cost and radiation exposure at BWR facilities. The results of

the evaluations demonstrate that even with a significant reduction in the extent of inspections required, the integrity of the RPV is assured and greatly exceeds NRC safety goals.

PROJECT
RPB302-01
Project Manager: W. Bilanin
Nuclear Power Group
Contractors: BWR Vessel and Internals Project Beltline Team
Structural Integrity Associates
VECTRA Technologies, Inc.
GE Nuclear Energy

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

BWR Vessel and Internals Project

BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05)

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Research Project B302-01

Final Report, September,1995

Prepared by:

BWR VESSEL AND INTERNALS PROJECT BELTLINE TEAM

STRUCTURAL INTEGRITY ASSOCIATES
3315 Almaden Expressway, Suite 24
San Jose, Ca. 95118-1557

VECTRA TECHNOLOGIES, INC.
215 Shuman Blvd, Suite 200
Naperville, Il. 60563

GE NUCLEAR ENERGY
175 Curtner Ave.
San Jose, Ca. 95125

Prepared for

BOILING WATER REACTOR VESSEL & INTERNALS PROJECT and
ELECTRIC POWER RESEARCH INSTITUTE
3412 Hillview Ave.
Palo Alto, California 94304

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BWR VESSEL & INTERNALS PROJECT BELTLINE TEAM
STRUCTURAL INTEGRITY ASSOCIATES
VECTRA TECHNOLOGIES, INC.
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BWR REACTOR PRESSURE VESSEL SHELL WELD INSPECTION RECOMMENDATIONS

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EXECUTIVE SUMMARY

The objectives of this report were to evaluate the current inspection requirements for the reactor pressure vessel shell welds in Boiling Water Reactors (BWRs), formulate recommendations for alternative inspection requirements, and provide a technically justified basis for these recommended requirements. To accomplish this objective, a number of issues related to BWR reactor pressure vessel integrity were investigated, including fabrication practices, inservice inspection data, operational issues, degradation mechanisms, non-destructive examination capabilities and probabilistic fracture mechanics analysis results. Based on the results of this investigation, alternative inspection requirements are recommended which would significantly reduce the extent of volumetric inservice inspections currently required on BWR reactor pressure vessel shell welds.

An evaluation of vessel fabrication practices, construction examinations and preservice inspections established that reactor pressure vessels were constructed to very high standards which maximized the initial quality of the vessels. The results of inservice inspections performed to date support the conclusion that vessel seam welds are free from unacceptable fabrication defects, and that no flaws have developed during operation. In order to substantiate non-destructive examination capabilities, a detailed review of current criteria and technology verified that the industry's ability to ultrasonically locate and size flaws in vessels is highly reliable. A review of operational issues including loadings and irradiation provided evidence of the inherent integrity of BWR reactor pressure vessels. This point was further supported by an evaluation of potential degradation mechanisms which concluded that there are presently no known degradation mechanisms which challenge vessel weld integrity. Finally, a probabilistic fracture mechanics analysis was performed to quantify these observations. This analysis concluded that the probability of vessel failure was extremely low and well within NRC safety goals, even with a proposed reduction in the level of inservice inspections. In addition, this probabilistic analysis determined that the risk of either vessel leakage or failure from circumferential shell welds is orders of magnitude less than that associated with longitudinal shell welds.

Results of the evaluations performed in this report clearly demonstrate the inherent safety and integrity of BWR reactor pressure vessels. Furthermore, it was concluded that the amount of inservice inspections currently required could be reduced while still meeting NRC safety goals by a significant margin. Therefore, this report recommends inservice inspection requirements that focus inspections on the most appropriate vessel welds while eliminating those inspections which have a negligible affect on plant safety. The recommended requirements are to perform inservice inspections on 50% of the reactor pressure vessel longitudinal shell welds, and eliminate the inspection of circumferential shell welds. Revised criteria for the performance of successive and additional inspections are also recommended. Finally, a cost benefit study was performed to compare the existing vessel shell weld inspection requirements with the recommended inspection criteria. The results of this study verified that performing the reactor pressure vessel inspections recommended in this report represents a substantial savings in cost and radiation exposure at BWR facilities.