

Jet Pump Optimized Inspection Guidance

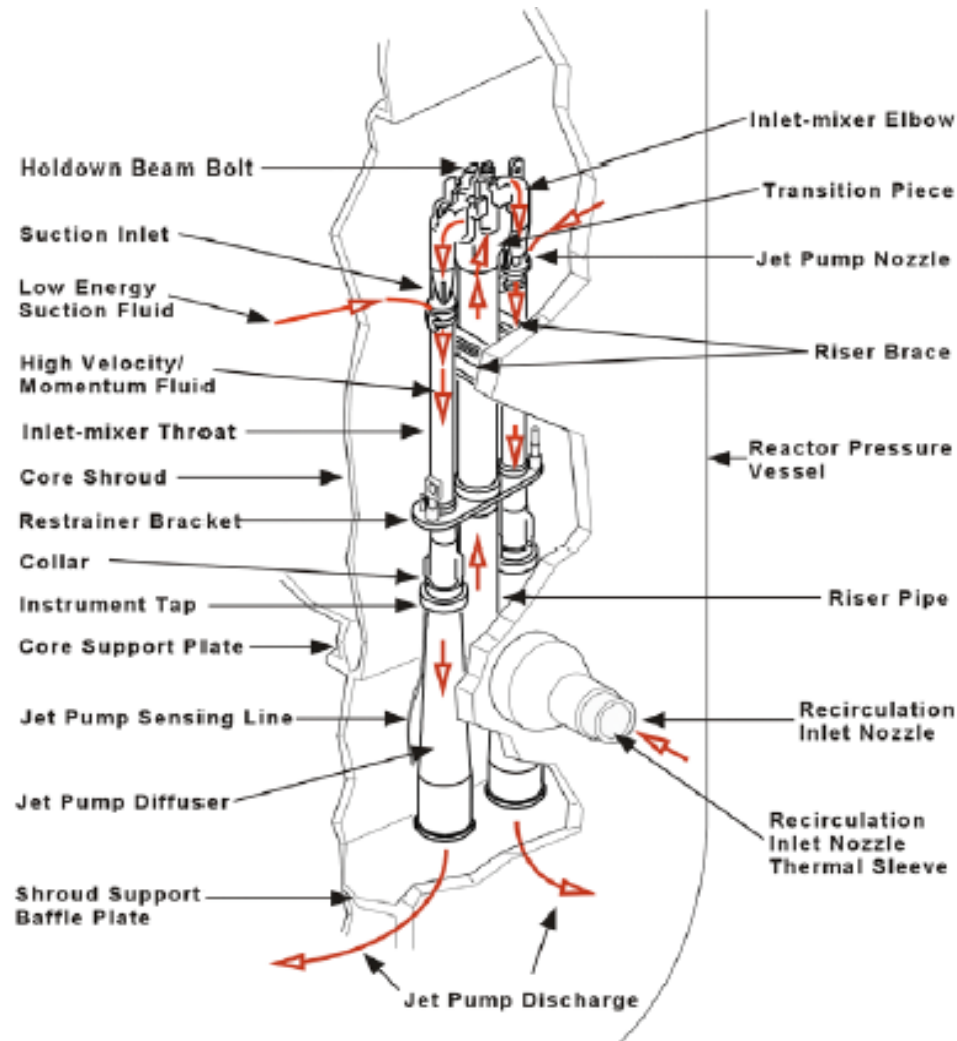
Bob Carter, EPRI

BWRVIP Assessment Committee Task
Manager

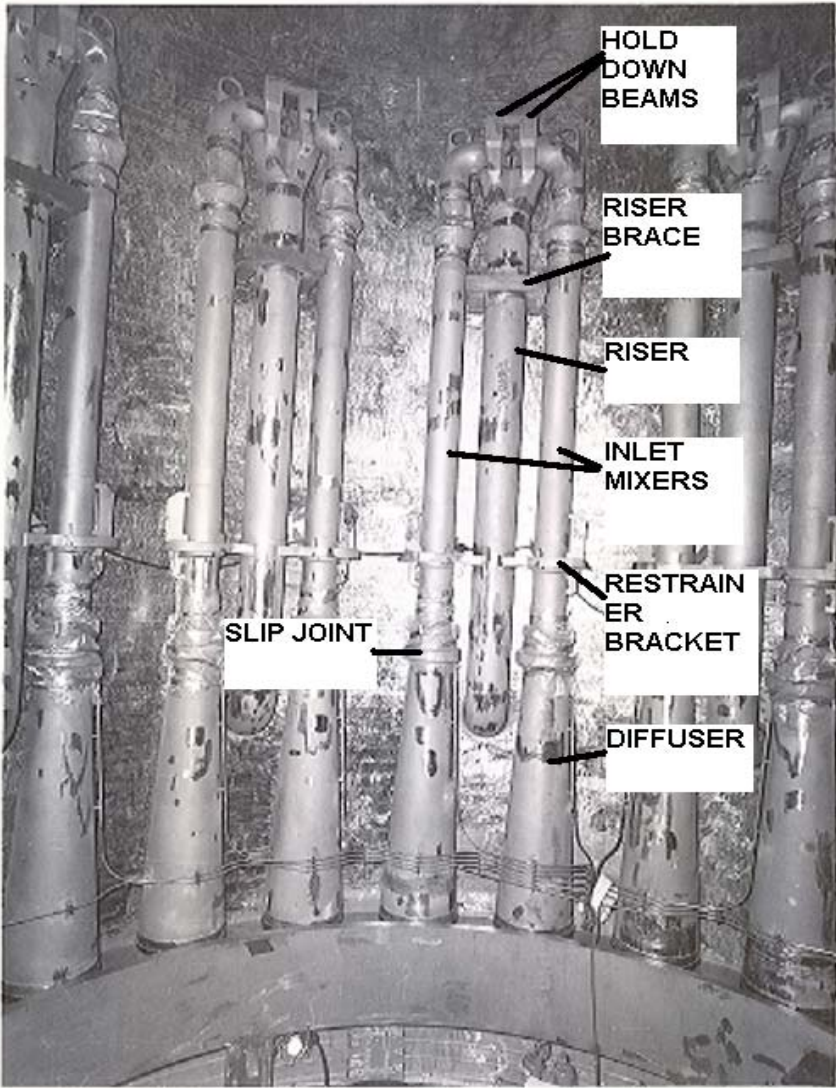
EPRI-NRC Technical Exchange
Meetings

June 2-4, 2015

BWR Jet Pump Overview



Jet Pumps as Installed





Jet Pump Assembly Inspection and Flaw Evaluation Guidance History

BWRVIP-06 Revision 1-A

BWR RPV Internals Safety Evaluation

- Developed to proactively address the continuing observations of IGSCC in BWR reactor internals
- Evaluated component function and potential failure modes and locations with the primary safety function for the jet pumps being maintenance of two-thirds core height
- Identified short and long-term actions needed for management of reactor internals
- Jet Pump Assembly evaluation concluded that the occurrence of an instantaneous recirculation line break in conjunction with undetected degradation of a jet pump, such that two-third core coverage could not be maintained, is a low probability event and thus no short-term actions were necessary to assure safety
- A long-term action was identified to evaluate the potential for cracking that might compromise a jet pump's safety function and develop appropriate generic guidelines for detection, inspection, repair or mitigation to assure the long-term function of jet pumps

BWRVIP-41, Revision 0

- BWRVIP-41, BWR Vessel and Internals Project, Jet Pump Assembly Inspection and Flaw Evaluation Guidelines
 - Published October 1997
 - Included comprehensive Visual and Ultrasonic inspection guidance
 - Final Safety Evaluation Issued by the NRC on February 4, 2001
 - Final SE did not contain any conditions or limitations

BWRVIP-41, Revision 1

- Primary reasons for revision:
 - Change all Modified VT-1 (MVT-1) exams (i.e., 1 mil wire resolution) to Enhanced VT-1 (EVT-1) exams (i.e., ½ mil wire resolution)
 - Incorporate the revised jet pump beam inspection requirements of BWRVIP-138, which were developed in response to 2002 Quad Cities Jet Pump beam failure
- Published September 2005
- BWRVIP-138 and BWRVIP-41, Rev. 1 originally submitted to the NRC in 2005, but subsequently withdrawn in order to further address jet pump beam inspection guidance

BWRVIP-41, Revision 2

- Primary reason for revision:
 - Incorporate the updated jet pump beam inspection requirements of BWRVIP-138, Rev. 1, which was more conservative than the jet pump beam guidance in the BWRVIP-41, Rev. 0
- Published July 2009
- BWRVIP-138, Rev. 1 submitted to the NRC in March 2009 and a final SE, with no conditions or limitations, was received in March 2012
- BWRVIP-41, Rev. 2 was not submitted to the NRC because plans were already in place for another revision to incorporate guidance for hidden welds

BWRVIP-41, Revision 3

- Primary reason for revision:
 - Incorporate guidance to address the inspection and evaluation requirements for hidden welds, which addressed a long standing open item for the jet pump guidelines
- Published September 2010
- BWRVIP-41, Rev. 3 was not submitted to the NRC because work was already underway BWRVIP-41, Rev. 4, the optimized version the jet pump inspection and evaluation guidelines



Optimization of BWRVIP Inspection and Flaw Evaluation Guidelines

Background

- BWRVIP I&E Guidelines were developed from 1994 to 1999 and largely based on safety considerations and potential degradation mechanisms including limited inspection results
 - Program based on normal water chemistry, thus no credit taken for or consideration of SCC mitigation via improved water chemistry (MHWC/NMCA)
- Post-implementation of I&E Guidelines
 - Significant inspection data generated which provides insight regarding component degradation trends and mitigation effectiveness
 - Widespread implementation of MHWC / NMCA and desire to obtain credit for SCC mitigation
 - EPRI/BWRVIP R&D efforts have improved knowledge of degradation mechanisms
 - NDE improvements both in UT and VT

Objective

- Optimize inspection programs based on:
 - Field inspection data and fleet operating experience
 - Evaluation of mitigation credit for benefits of HWC / NMCA
 - Current NDE capabilities
- Primary considerations:
 - Inspection results
 - Crack growth studies
 - Structural evaluations

Approach

- Phase 1: Component Prioritization
 - Prioritize order for optimizing inspection of components addressed by BWRVIP
- Phase 2: Inspection Optimization
 - Develop revised inspection recommendations for each component:
 - Technical basis report
 - Revision to inspection guidelines
 - Submit reports to NRC for approval
- Approach presented to NRC at 6/11/2011 public meeting

Phase 1 Prioritization Process

- Systematic process established for screening & prioritizing I&E Guidelines
- Prioritization approach
 - Relevant attributes identified
 - Available inspection data
 - Effectiveness of mitigation
 - Applicable NDE techniques
 - Structural margin
 - Other factors (e.g., fluence, fatigue cycling)
 - Utility value
 - Ranking and weighting of attributes
 - Final ranking by consensus

Phase 1 Results


| No. | I&E Guideline | Priority |
|-----|---------------------------------------|----------|
| 1 | Core Spray (BWRVIP-18) | High |
| 2 | Jet Pump (BWRVIP-41) | |
| 3 | Shroud (BWRVIP-76) | |
| 4 | Shroud Support (BWRVIP-38) | |
| 5 | CRD Guide Tubes (BWRVIP-47) | |
| 6 | Vessel ID Brackets (BWRVIP-48) | Medium |
| 7 | Top Guide Rims / Pins (BWRVIP-26) | |
| 8 | SLC / Core DP Piping (BWRVIP-27) | |
| 9 | LPCI Coupling (BWRVIP-42) | |
| 10 | Access Hole Cover (BWRVIP-180) | |
| 11 | Jet Pump Beam (BWRVIP-138) | |
| 12 | Top Guide Grid Beam (BWRVIP-183) | Low |
| 13 | Core Plate Bolts (BWRVIP-25) | |
| 14 | Steam Dryer (BWRVIP-139) | |
| 15 | Bottom Head Drain Piping (BWRVIP-205) | |

Resultant Changes to I&E Guidelines

- What is changed
 - Incremental changes to the inspection requirements
 - In general, inspection frequency and/or sample size requirements are relaxed, but some are increased
 - More credit for volumetric exams (incentivize its use)
- What is not changed
 - Safety bases
 - Flaw evaluation methodologies
 - Leakage analysis requirements
 - Hidden weld guidance

Status of I&E Guidelines Optimization

- Results of ranking published in BWRVIP-236: Inspection Optimization Program Roadmap
- Core Spray (BWRVIP-18, Revision 2)
 - Revision 2 submitted to the NRC for review and approval on 05/09/2012 (Basis document BWRVIP-251)
- Jet Pump Assembly (BWRVIP-41, Revision 4)
 - Revision 4 submitted to the NRC for review and approval on 09/24/2014 (Basis document, BWRVIP-266)
 - Acceptance review complete, now in technical review
- Core Shroud (BWRVIP-76, Revision 2)
 - Revision 2 is published, but not yet submitted to the NRC (Basis document, BWRVIP-278)



Optimized Version of Jet Pump Assembly Inspection and Flaw Evaluation Guidelines, BWRVIP-41, Revision 4

BWRVIP-41, Revision 4

- Technical basis report published October 2012 (BWRVIP-266)
- Inspection optimization results:
 - Relaxation of sampling requirements for riser welds and high priority diffuser welds
 - 2x longer inspection intervals for most medium priority welds
 - Elimination of inspections for low priority welds
 - Increased inspection frequency for RS-8 and RS-9 (for “susceptible” units)
 - Greater credit for UT inspections
- Overall reduction in inspections by 20-40% depending on plant vintage
- No changes to flaw evaluation and leakage guidance

BWRVIP-41, Revision 4

- Revision 4 states that optimized guidelines therein have not been approved by the NRC and thus are not to be implemented until notified by the BWRVIP that they are approved for use.
- Revision 4 submitted to the NRC for review and approval on 09/24/2014
- NRC “acceptance review” completed 04/23/2015
- Per the current review schedule, RAI expected to be issued to the BWRVIP by 09/28/2015

BWRVIP-41, Revision 4 Interim Guidance

- Currently there is a proposal to accelerate implementation of the Revision 4 supplemental requirements for inspection of the upper riser brace to riser welds (i.e., RS-9 welds)
- As stated in Revision 4, the supplemental inspection guidance applies to RS-9 welds at susceptible plants (i.e., 251 diameter BWR4/5 units with greater than 4.87M lb/hour flow per jet pump)
- The interim guidance is currently in the BWRVIP's committee review process
- This is an example of the BWRVIP implementing guidance based on operating experience in an expedited manner when it is warranted

Summary

- The BWRVIP commitment has always been to evaluate operating experience (OE) and make appropriate adjustments to the program
- As a result, the BWRVIP has made several revisions to the original issuance of jet pump Inspection and Evaluation Guidelines
- BWRVIP-41, Rev. 4 incorporates the latest understanding of operating experience and degradation mechanisms