



ELECTRIC POWER RESEARCH INSTITUTE

BWRVIP Inspection Optimization

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Agenda

- Overview of BWRVIP Inspection Optimization Project
- Core Spray Inspection Optimization
- Summary

BWRVIP Inspection Optimization Project

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
  - No consideration of SCC mitigation via improved water chemistry (MHWC/NMCA)
- Post-implementation of I&E Guidelines
  - Significant inspection data generated which provides insight on component degradation 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

Phase 1 - Screening & Prioritization

- Systematic process established for screening & prioritizing I&E Guidelines
- Prioritization approach
  - Relevant attributes identified
  - Ranking and weighting of attributes
  - Final ranking by consensus

Phase 1 - Screening & Prioritization

- Relevant attributes:
  - Available inspection data
  - Effectiveness of mitigation
  - Applicable NDE techniques
  - Structural margin
  - Aggravating factors
  - Utility value

Final Prioritization of BWR Components

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)	

Status

- Results of ranking published in BWRVIP-236: Inspection Optimization Program Roadmap
- Core Spray optimization initiated in 2010
  - Technical basis report to be completed mid-2011
- Optimization of other components initiated in 2011

Core Spray Inspection Optimization

Objective

- Revise core spray piping, sparger and bracket inspection guidelines (BWRVIP-18) based on:
  - Inspection experience
  - NDE capabilities
  - Flaw tolerance calculations

Approach

- Survey utilities for all historical inspection data
- Perform statistical evaluations of inspection data
- Adjust inspection frequencies based on engineering judgement and implementation considerations
- Perform flaw evaluation calculations to confirm appropriateness of revised inspection frequencies

Survey Data

- Primary source of data supporting optimization
  - Inspection data received from all U.S. plants
- Inspection data
  - Locations of IGSCC
  - Estimation of crack growth rates
  - Flaw size distribution
  - Time-dependency of cracking, i.e., early or later in life
- NDE capability
  - Examination method (UT, EVT-1, VT-1, VT-3)
  - Coverage

Key Survey Results

- Overall population of cracked piping and sparger welds is extremely low
  - Piping welds
    - Cracking occurrence in non-creviced locations approximately half that in creviced locations
    - Cracking in L-grade material lower than non L-grade material
    - Flaws in creviced welds often longer than in non-creviced welds
    - Flaws in 304SS welds often longer than in L-grade welds
  - Sparger weld cracking very limited (some cracking associated with sparger brackets)
  - Quantitative details provided in Technical Basis report

Key Survey Results (cont)

- NDE
  - Method
    - Combination of UT and visual used on piping welds
    - Visual used exclusively on sparger welds
  - Coverage
    - For welds on which UT can be applied, coverage is very high
      - UT cannot be applied to all welds or to both sides of some welds
    - EVT-1 coverage varies with location
    - Quantitative details provided in Technical Basis report
  - Inspection per BWRVIP-18 are occurring every one or two refueling outages

Key Survey Results (cont)

Overall data evaluation supports:

1. Most cracking was found during initial core spray inspections performed ~1994-1998
   - Very limited new cracking found in recent years
2. Crack growth rates tend toward zero with time
   - Old cracks typically show little or no recent growth

Flaw Tolerance Evaluation

- Used to confirm the appropriateness of revised inspection intervals
- Approach
  - Assumed flaws in weld and determine time to failure
  - Based on typical loads
  - Methodology is consistent with other I&E guidelines approved by NRC
  - Conservative crack growth rate used
- Results: Typical piping or sparger cracking requires ~6 to 12 years to propagate to failure

Revised Inspection Program

- Draft adjustments made to BWRVIP-18 inspection schedule based on weld-by-weld evaluations
- Highlights of revised schedule
  - Piping welds:
    - Inspection interval increased for many welds
    - Some reduction in interval for L-grade welds
  - Sparger welds: inspection interval increased
  - Sparger brackets: inspection interval increased

Draft Revised Inspection Program

- Additional changes
  - Reinspection interval for cracked welds determined by plant-specific flaw-evaluation
  - In certain cases, use of UT inspection intervals are allowed when only 1-sided UT inspections have been performed
    - Requires specified minimum inspection coverage

Status

- Revised core spray inspection recommendations developed
  - Documented in technical basis report
  - Currently under BWRVIP review
- Draft revision to BWRVIP-18 under development
- Technical basis for inspection optimization of other components underway per BWRVIP-236

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