



BWRVIP / NRC Technical Update

Dissimilar Metal Weld Update for BWRs

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IGSCC Susceptible Weld Categories and Inspection Frequencies (BWRVIP-75-A)

| Category | Weld Description | Inspection Frequency | |
|----------|--|---|--|
| | | NWC | HWC/NMCA |
| A | Resistant Materials | B-F = 25% every 10 years B-J = 25% every 10 years (Note 3(a)) | 10% every 10 years |
| B | Non-Resistant Materials Stress Improved within 1 st 2 years of Operation | 25% every 10 years (Note 4, 5) | 10% every 10 years (Note 4, 5) |
| C | Non-Resistant Materials Stress Improved after 2 years of Operation | 25% every 10 years (Note 5) | 10% every 10 years (Note 5) |
| D | Non-Resistant Materials, No Stress Improvement | 100% every 6 years | 100% every 10 years, at least 50% in 1 st 6 years |
| E | Cracked - Reinforced by Weld Overlay | 25% every 10 years, at least 12.5% in 1 st 6 years | 10% every 10 years |
| | Cracked - Mitigated by Stress Improvement | 100% every 6 years | 100% every 10 years, at least 50% in 1 st 6 years (Note 6) |
| F | Cracked - Inadequate or No Repair | Every Refueling Outage | Every Refueling Outage |
| G | Non-Resistant, Not Inspected | Next Outage | Next Outage |

BWR Operating Experience (2007-2008) for Dissimilar Metal (DM) Welds

- Ten cases of Category C and D planar flaws in DM welds containing alloy 182 have been observed at several BWRs
 - Plant A: Recirculation Inlet nozzle to safe-end - overlayed
 - Plant B: Recirculation Inlet nozzle to safe-end - acceptable
 - Plant C: Recirculation Inlet nozzle to safe-end - overlayed
 - Plant D: Recirculation Inlet nozzle to safe-end - overlayed
 - Plant E: Core Spray Nozzle to safe-end - acceptable
 - Plant F: Control Rod Drive return line cap - overlayed
 - Plant G: Recirculation Inlet nozzle to safe-end – acceptable
 - Plant H: Control Rod Drive Return line cap – acceptable
 - Plant I: Recirculation Inlet nozzle to safe-end – overlayed
 - Plant J: Recirculation Outlet nozzle to safe-end - acceptable

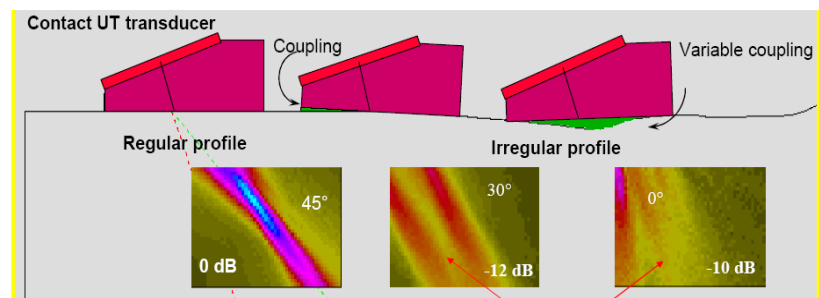
One of the Main Reasons for Newly Discovered Indications

- Surface contour of weld region appears to be the major factor affecting accurate detection and sizing



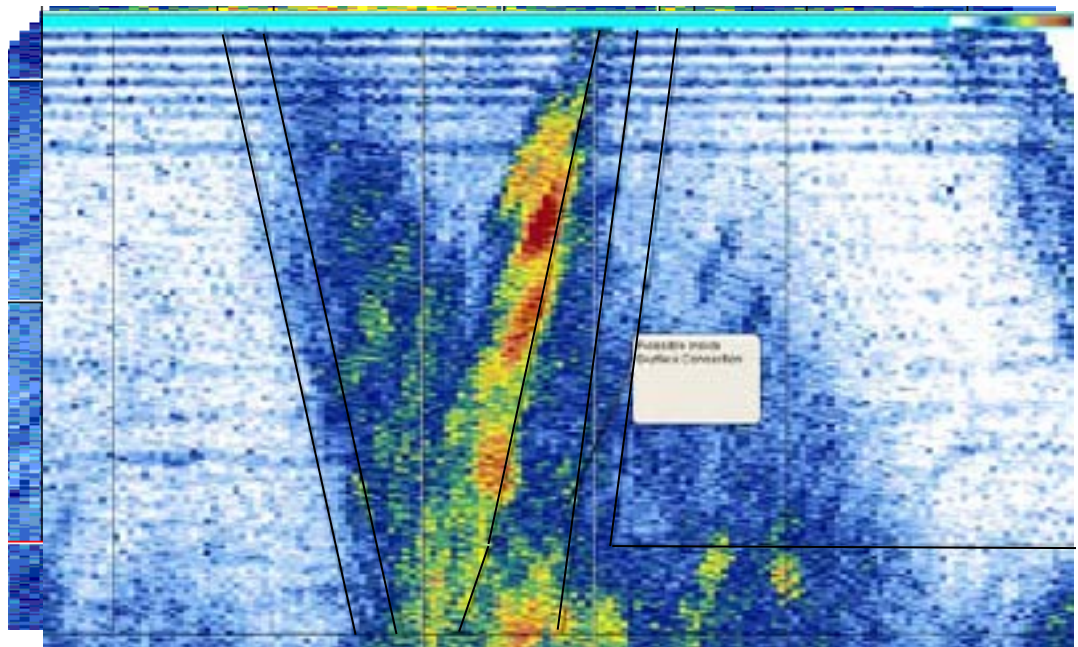
Factors affecting detection & sizing

- Irregular profile/surface condition
 - Presence of weld crowns
 - Radial shrinkage near the weld
- Inadequate probe coupling



Example of Data Loss From a UT Examination

- Incomplete probe contact resulting in loss of signal
- Following weld resurfacing, weld was re-examined
- Indication was determined to be ID connected



BWRVIP Response

- BWRVIP issued letter 2007-051 to utilities
 - Survey all the BWRs and obtain statistics on number of BWRVIP-75-A dissimilar metal welds
 - Determine the status of the application of Supplement 10 exams
 - Recommended plants with Spring 2007 reconsider their DM weld inspection scope in light of the Plant A Operating Experience
 - Survey results provided to NRC via letter 2007-173
- BWRVIP issued letter 2007-367 to utilities (and NRC)
 - Review previous examination records for all Cat D welds (regardless of material) and all Cat C welds with 82/182 metal exposed to the environment and determine welds that have not been examined in accordance with Appendix VIII Supplement 10
 - All data reviews to be completed by December 31, 2008

BWRVIP Response

- BWRVIP issued letter 2008-134 to utilities
- Required that the results of inspection data reviews be provided to the BWRVIP
 - Provide number of Cat B and C
 - Number of welds containing Alloy 182 and stainless steel
 - Number of welds treated with mechanical stress improvement (MSIP) and/or induction heating stress improvement (IHSI)
 - Number of welds inspected with Appendix VIII Supplement 10 method
- BWRVIP issued letter 2008-293 to utilities (and NRC)
 - Required identification of welds with suspect/indeterminate data and examination of those welds within 2 years
 - Provided scope expansion criteria to be used in those cases where the suspect welds were being inspected in accordance with the interim guidance only (versus Code)

Accelerated Inspection Program for Category C DM Welds

- BWRVIP developed an accelerated inspection program for Cat C welds containing alloy 182 exposed to the BWR environment that had not received an Appendix VIII Supplement 10 examination
- The accelerated inspection program incorporated the interim guidance that was issued to the BWR utilities under BWRVIP letter 2008-293
- The accelerated inspection program is detailed in “BWRVIP-222: BWR Vessel and Internals Project, Accelerated Inspection Program for BWRVIP-75-A Category C Dissimilar Metal Welds Containing Alloy 182”
 - EPRI Report 1019055, July 2009
 - Provided to the NRC via BWRVIP letter 2010-015, dated January 22, 2010

Accelerated Inspection Program for Category C DM Welds

- Approach
 - Complete all examinations within 6 years (same as Cat D inspection frequency)
 - Inspect within 2 years, welds determined to contain suspect indications based on review of previous examination records
 - Guidance provided for evaluating and dispositioning the automated and manual UT data reviews

Category B and Stainless DM Welds

- Category B and DM welds without Alloy 182 excluded from accelerated program based on:
 - Stress improvement within 2 years of operation (minimizes occurrence of IGSCC) and/or
 - Favorable operating experience (i.e., of the 102 Category B DM welds and 95 Category C DM welds without Alloy 182 material, there have been no reports of weld failures or unacceptable weld examinations)

DM Weld Inspection Status as of July 2012

- Welds that have not been examined using Appendix VIII Supplement 10 methods
 - Of the 174 Category D welds in the BWR Fleet, none
 - Of the 271 Category C welds in the BWR Fleet with 182 filler material exposed to the environment, only 4 remain to be examined with a Supplement 10 exam and they are scheduled for Spring of 2014
- Flawed welds found since 2009
 - Plant A: Recirculation Inlet nozzle safe-end to pipe 71% through-wall circ flaw and 2 small axial flaws - overlayed
 - Plant B: Low Pressure Core Injection nozzle to safe-end 34% through-wall axial flaw - overlayed

DM Weld Inspection Status as of July 2012

- To date, the accelerated inspection program has not identified any new occurrences of Stress Corrosion Cracking
 - There have been instances where unacceptable planar flaws have been identified, but in all those instances except one there was some evidence that they were pre-existing. In one recent instance, an approximately 34% through-wall axial flaw was found. The flaw is also suspected to be pre-existing because significant weld crown reduction was performed just prior to the examination, but there is no objective evidence to prove such.
 - The data reviews and accelerated exams also identified a number of welds with mid-wall planar indications that exceeded ASME XI acceptance standards and required IWB-3600 evaluations.

Implications of recent North Anna OE

- Believe that the BWRVIP's actions in response to the 2007-2008 OE events, including the accelerated campaign for examining Category C DM welds with 182 material exposed to the environment in accordance with the NEI 03-08 "needed" guidance within BWRVIP-222, means that the risk of an event similar to North Anna at a BWR is small
- Although the risk is considered to be small, the status of the BWRVIP's DM weld actions will still need to be reviewed in light of the industry's post North Anna extent of condition evaluation
 - Will look at the number of manual exams and how they were performed. The BWRVIP's DM weld database has not tracked the number of automated versus manual exams on an ongoing basis. When first surveyed in 2007, automated exams were being performed on more than 75% of the DM welds.
 - The BWRVIP's DM weld database does not currently contain any information on the number of site specific mock-up that have been performed at BWRs
 - Will review any other aspects of the DM welds exams that come out of the North Anna extent of condition evaluation

Conclusions

- Supplement 10 inspections of all the Category D welds were completed by the end of 2011
- BWRVIP developed an accelerated inspection program for Category C welds with Inconel 182 weld material in response to recent OE
 - Only 5 welds remain that have not been inspected in accordance with Supplement 10 and they will receive a Supplement 10 inspection by June 2014
 - The accelerated inspection program has not identified any evidence of IGSCC as an active degradation mechanism in DM welds with Inconel 182 material that have been stress improved
 - The status of the BWRVIP's DM weld actions will be reviewed in light of the industry's post North Anna extent of condition evaluation

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