



# Alloy 82/182 Pipe Butt Weld Safety Assessment

MRP / NRC

April 16, 2004

Alloy 600 Issue Task Group (ITG)

Butt Weld Working Group

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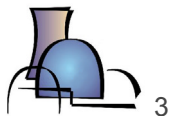
# Agenda

- Introduction
- Recent Actions
  - MRP Letter 2003-039, “Recommendation for Inspection of Alloy 600/82/182 Pressure Boundary Components,” January 20, 2004
  - MRP Letter 2004-05, “Needed Action for Visual Inspection of Alloy 82/182 Butt Welds and Good Practice Recommendations for Weld Joint Configurations”, April 2, 2004
- Preliminary Results of BW Safety Assessment
- Future Plans



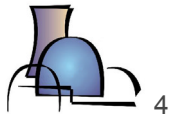
# Introduction

- Delayed transmittal of Butt Weld Safety Assessment report to allow a broader industry review and approval
- Scope of SA: Alloy 82/182 primary coolant system pipe butt welds
- Preliminary conclusions of the Alloy 82/182 Butt Weld Safety Assessment report can be summarized.
  - Preliminary deterministic crack growth analyses predict less than 10 years from crack initiation to a through wall crack for some weld locations
  - Preliminary PFM calculations show the risk from Butt Weld PWSCC is low
  - Challenges exist with inspecting the 82/182 dissimilar metal welds, and
  - Actual field weld geometries may not be bounded by the Performance Demonstration Initiative (PDI) qualification process required by Appendix VIII of the Code.



# Recent Actions

- MRP letter 2003-039, January 20, 2004, recommended insulation removal and bare metal visual inspection
  - All Alloy 600/82/182 pressure boundary components  $>350^{\circ}\text{F}$
  - Within next 2 RFOs
  - Priority to highest temperature (PZR and Hot Leg)
- MTAG/MEOG decided to categorize butt weld portion of 2003-039 as “Needed” under NEI 03-08 Materials Initiative via MRP letter 2004-05, April 2, 2004
  - “Each PWR perform a direct visual inspection of the bare metal at all Alloy 82/182 pressure boundary butt weld locations within the next 2 refueling outages.”
  - Inspection is still required within next 2 RFOs
  - This letter does not reset the clock from 2003-039



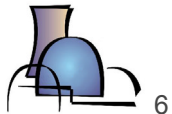
## Recent Actions (continued)

- MRP letter 2004-05 also included “Good Practice”
  - Obtain plant-specific information on weld joint configurations and available access to prepare for future volumetric examinations.
    - Review the PDI mockup library to determine if your configuration is qualified for inspection



## NEI 03-08

- The industry will ensure:
  - Its management of materials degradation and aging is forward-looking and coordinated to the maximum extent practical.
- The industry will:
  - Rapidly identify, react and effectively respond to emerging issues.
- Applies to
  - PWR and BWR reactor pressure vessel, reactor internals and primary pressure boundary components
  - PWR steam generators (SG)
  - Non Destructive Examination (NDE) and chemistry/corrosion control programs
  - Nuclear Fuels Materials issues



# Needed and Good Practice

## NEI 03-08: Guideline for the Management of Materials Issues

- Needed – will be implemented whenever possible, but alternative approaches are acceptable
- Good Practice – implementation is expected to provide significant operational and reliability benefits, but the extent of use is at the discretion of the individual plant/utility.
- MRP Letter 2004-05 invokes Materials Guidelines Implementation Protocol definitions for Needed and Good Practice



# Deviations

- Modeled after SGMP and BWRVIP programs
- The technical justification for deviations from “Needed Recommendation” shall provide:
  - Basis for determining that the proposed deviation meets the same objective and intent, or level of conservatism exhibited by the original work product
  - Shall clearly state how long the deviation will be in effect.
- Deviations from Needed requirements shall receive final concurrence from the responsible utility executive.
- Deviations will be reviewed during INPO Primary System Integrity Review visits
  - INPO lead with industry peers





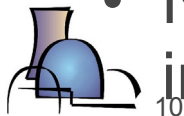
# Preliminary Results: Field Experience

- Worldwide, a very small number of partial depth axial PWSCC cracks and two small leaks have been discovered in these DM butt weld joints
- Most butt welds are inspected at approximately 10-year intervals
  - Most are done from the OD
  - Inspections performed include:
    - Volumetric examination of Class 1 piping welds 4 inches and larger in diameter
    - Surface exams
    - Visual inspections



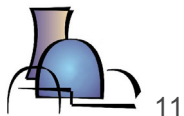
# Preliminary Results: Field Experience (cont'd)

- Recent US inspection experience
  - No leaks detected by visual methods since VC Summer
  - About 150 dissimilar metal butt welds UT inspected since 2001
    - About 140 before Appendix VIII qualification required
    - About 10 qualified to Appendix VIII
    - One weld with indications
- Butt welds locations are inspected during leakage and pressure tests (insulated) and will be inspected (bare metal) for borated water leaks.
- Butt weld PWSCC is not widespread.
- Numerous leaks from other sources have not resulted in structurally significant wastage (excluding DB).



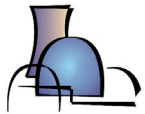
# Preliminary Results: Analyses

- Cracks that do originate should be axially oriented and limited to the width of the 82/182 weld metal.
  - Stress analysis results, hoop stresses  $>$  axial stresses suggest an axial orientation for any cracking
  - Preliminary conclusion supported by OE
    - Growth into a few adjoining Alloy 600 components possible, but at significantly slower rates, especially after growing beyond weld residual stress field



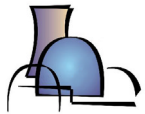
## Preliminary Results: Analyses (cont'd)

- Weld repairs can impact residual stresses and distribution of those stresses
  - Weld cracking to date has been limited to welds with repairs
    - Ringhals-3 had no documented repairs, but the welds were manufactured with double-V groove weld
- Significant structural margin exists when comparing circumferential flaw size associated with maximum TS leakage and leakage associated with critical flaw
  - B&W Pressurizer Relief Nozzle only exception
- PFM calculations show the risk from Butt Weld PWSCC is low



# Preliminary Results: Inspection Capability

- Inspection capability has improved
  - Qualification process identifies specific range of procedure applicability
  - Recent ISI experience confirms improvement
- Yet, inspection challenges remain
  - Field configuration for some welds differs from what is shown on design drawings.
  - PDI can not be fully implemented due to NDE capability limitations
- Detection capability combined with the crack growth rates may not support a 10-year interval between inspections for dissimilar butt welds



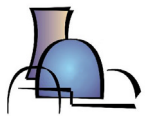
# Preliminary Results: Inspection Capability

- Performance Demonstration Initiative
  - Alloy 600 ITG Inspection WG will be folding the PDI results into I&E Guidelines
- NEI 03-08 Strategic Plan identifies the need for improved NDE capabilities as one of the industry's top materials issues
  - NDE Center workplan focusing on developing new and improved NDE technologies



# Configuration Information

- Expect to find some butt weld joint configurations that are not covered by today's qualified techniques
- Configuration information being collected to:
  - Determine the extent of configuration challenges
  - Develop future plans to appropriately address these issues
    - Inspection
    - Mitigation
    - Leak detection



## Future Work

- Draft Inspection and Examination Guidelines for butt welds will be ready by end of summer 2004
  - Augmented inspections are anticipated for some butt weld locations
- In 2004-2005, about 150 DM 82/182 butt welds are scheduled for inspection via UT
  - 47 units (736 welds total)





# Future Plans and Strategies

- Investigating mitigation options: mechanical and chemical
- Investigating possibilities for localized leak detection
- Conducting ongoing studies focused at fundamental understanding of PWSCC initiation in weld metals
- Evaluating other options for Alloy 82/182 locations such as possible component or weld replacement with more resistant materials



# Conclusion

- No immediate safety concern
- Needed Action for Visual Inspection of Alloy 82/182 Butt Welds has been issued
- Inspection and Evaluation Guideline being developed that is expected to change ISI inspection intervals for some welds
- Industry will continue to work with the staff as the requirements are developed

