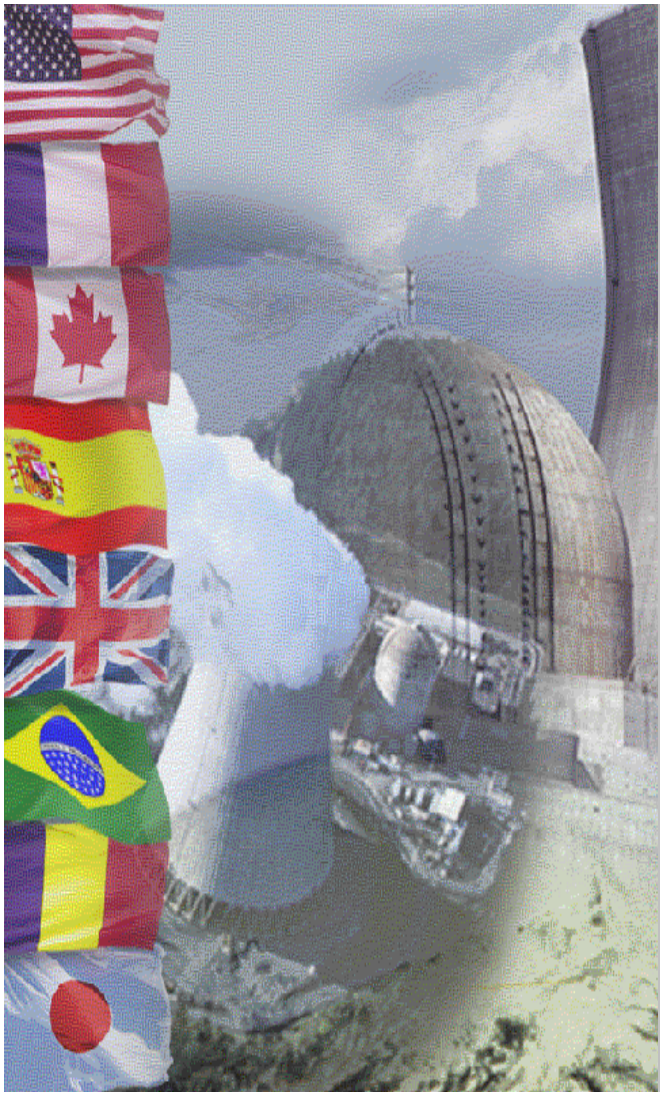

Alloy 600 Management: MRP Activities

Craig Harrington, TXU
Dana Covill, Progress Energy

Alloy 600 ITG Co-chairman
March 24, 2005

EPRI

Agenda

- Overall Objective
- Review Alloy 600 Locations
- Review Current and Pending inspection guidance
  - Schedule for current or future activities
- Review Butt Weld I&E Guidelines (MRP-139)
- Discuss LBB
- Concluding Remarks

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Alloy 600 ITG Mission and Scope

- Mission
  - Establish sound technical positions on A600 for industry
    - Understand the implications – safety and economic
  - Develop degradation management tools for A600 locations
    - Safety assessments
    - Inspection & evaluation guidance
    - Mitigation methods and strategies
  - Maintain safety and reliability of the plant
  - NRC interface on generic Alloy 600 issues
- Scope
  - All Alloy 600 base material (with the exception of SG tubing) and Alloy 82/182 weld metal locations in PWR primary systems

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Strategy

- Identify the Alloy 600 locations for the fleet
- Categorized
- Develop safety assessment evaluations
- Evaluate operating experience
- Understand Inspection Capabilities
- Develop Inspection and Evaluation Guidance
- Develop Repair/Replace/Mitigation Options as needed

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Handouts

Typical A600/82/182 Locations

Typical Locations of Alloy 600/82/182 Type Materials in PWR Plants

Location	Westinghouse	Combustion Engineering	Babcock & Wilcox	Inspection Guidance (Pending)
Large Diameter (≥4") RV Head Nozzles				
- Top Head CRDM / CEDM	Yes	Yes	Yes	Order EA 03-009 (CC N729)
- Top Head ICI	No	Yes	No	
Small Diameter Nozzles (<4.0")				
- Pressurizer Steam Space Instrument	No	Yes	Yes	(MRP-139) / MRP-126
- Pressurizer Liquid Space Instrument	No	Yes	Yes	(MRP-139) / MRP-126
- Reactor Vessel Top Head Vent	Yes	Yes	No	Order (CC N729)
- Reactor Vessel Top Head Thermocouple	No	No	Yes (Note 3)	MRP-126
- Reactor Vessel Head Leak Monitor Tubes	Yes	Yes	Yes	MRP-126
- Hot Leg Instrument	No (Note 6)	Yes	Yes	(MRP-139) / MRP-126
- Cold Leg Instrument	No	Yes	Yes	(MRP-139) / MRP-126
- Reactor Vessel Bottom Head Instrument	Yes	Yes (Note 5)	Yes	MRP Letter
- Steam Generator Bowl Drain	Yes (some S/Gs)	Yes	Yes (older S/Gs)	West Tech Bulletin / MRP-126
- Pressurizer Heater Sleeves	No	Yes	Yes (Note 2)	WOG Letter (Note 2)
Reactor Vessels				
- Inlet & Outlet Nozzle	Yes	No (Note 1)	No	(MRP-139)
- CRDM Motor Housing	No	Yes	Yes (Note 7)	MRP-126
- Core Flood Nozzle	NA		Yes	(MRP-139)

NOTES:
1. One CE design plant has Alloy 82/182 welds
2. Oconee 1 and TMI 1 only, MRP-126 applies rather than WOG Letter.
3. Applies only to TMI 1
4. B&W terminology for "safety injection" nozzle is "high pressure injection (HPI)" nozzle.
5. Palo Verde only
6. Some plants may have used Alloy 600 in plant modifications for RTD bypass elimination
7. Type A and B plants have Alloy 600, type C plants do not.
8. May be removed for replacement steam generators.
9. One Westinghouse design plant has Alloy 82/182 welds.
10. One CE design plant does not have Alloy 82/182 welds.

Westinghouse, CE, and B&W	CE and BW
Westinghouse and CE	B&W Only
Westinghouse Only	

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Handouts

Typical A600/82/182 Locations – cont'd

Typical Locations of Alloy 600/82/182 Type Materials in PWR Plants

Location	Westinghouse	Combustion Engineering	Babcock & Wilcox	Inspection Guidance (Pending)
Pressurizer Vessel Nozzles				
- Surge Line Nozzles	Yes	Yes	Yes	(MRP-139)
- Spray Nozzles	Yes	Yes	Yes	(MRP-139)
- Safety & Relief Valve Nozzles	Yes	Yes	Yes	(MRP-139)
Main Coolant Piping Loop				
- SG Inlet & Outlet Nozzles	No (Note 9)	No (Note 1)	No	(MRP-139)
- RCP Suction & Discharge Nozzles	No	Yes (Note 10)	Yes	(MRP-139)
Branch Line Connections				
- Pipe-to-Surge Nozzle Connection	No	Yes	Yes	(MRP-139)
- Charging Inlet Nozzles	No	Yes	Yes	(MRP-139)
- Safety Injection and SDC Inlet (Note 4)	No	Yes	Yes	(MRP-139)
- Shutdown Cooling Outlet Nozzle	No	Yes	Yes	(MRP-139)
- Spray Nozzles	No	Yes	Yes	(MRP-139)
- Let-Down and Drain Nozzles	No	Yes	Yes	(MRP-139)
- Core Flood Tank Nozzle	N/A		Yes	MRP-126
Miscellaneous Locations				
- Steam Generator Divider Plate/Weld	Yes	Yes	No	MRP-126
- Steam Generator Tube Sheet Cladding	Yes	Yes	Yes	MRP-126
- Core Support Blocks/Alignment Lugs	Yes	Yes	Yes	MRP-126
- Flow Element	N/A	N/A	Yes	MRP-126
- Steam Generator Nozzle Dam Ring	No	Yes (Note 8)	Yes	MRP-126
- Flow Meter	N/A	N/A	Yes	MRP-126

NOTES:
1. One CE design plant has Alloy 82/182 welds
2. Oconee 1 and TMI 1 only, MRP-126 applies rather than WOG Letter.
3. Applies only to TMI 1
4. B&W terminology for "safety injection" nozzle is "high pressure injection (HPI)" nozzle.
5. Palo Verde only
6. Some plants may have used Alloy 600 in plant modifications for RTD bypass elimination
7. Type A and B plants have Alloy 600, type C plants do not.
8. May be removed for replacement steam generators.
9. One Westinghouse design plant has Alloy 82/182 welds.
10. One CE design plant does not have Alloy 82/182 welds.

Westinghouse, CE, and B&W	CE and BW
Westinghouse and CE	B&W Only
Westinghouse Only	

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Handouts

Current Inspection Guidance Duration Overview

Industry Letter	Date Issued	Duration	Inspection Requirement for specific Alloy 600 Location	2003	2004		2005		2006		2007	
				Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
MRP 2003-017	23-Jun-03	2 RFOs	BMV of Alloy 600 Bottom Mounted Nozzles	18 month 24 month								
MRP 2003-039	20-Jan-04	2 RFOs	BMV of All Alloy 600/82/182 Pressure boundary locations >350 Deg F		18 month 24 month							
WOG -04-057	30-Jan-04	Ongoing	BMV of Pressurizer Heater Sleeves; If Leak is found - characterize flaw		18 / 24 months							
Materials Guideline Implementation Protocol Rev 0	12-May-04	Ongoing	Provides guidelines for Good Practice, Needed, or Mandatory	All plants								
MRP 2004-05	2-Apr-04	2 RFOs	Needed: BMV of 82/182 Butt Welds Good Practice: Collect Config Info		18 month 24 month							
MRP 2004-04	14-May-04	Interim guidance	Plants with 10 yr ISI, UT/ET of Alloy 600 BMNs (voluntary)			18 month 24 month						
Westinghouse TB-04-019	18-Oct-04	Ongoing	Steam Generator Bowl Drains: BMV - if leak, perform PT.		18 / 24 months							
MRP-126	22-Dec-04	Ongoing after 18 months	Mandatory: Alloy 600 Program				Develop			Maintain		
WCAP-15988, Revision 1	28-Feb-05	Ongoing after 18 months	Mandatory: BACC Program (enhancement of existing programs)				Develop			Maintain		

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Common Locations: W, CE, and B&W Designs

- Large Diameter (≥4”) Reactor Vessel Head Nozzles
  - Top Head CRDM / CEDM/ ICI
- Small Diameter Nozzles (<4”)
  - Reactor Vessel Head Leak Monitor Tubes
  - Reactor Vessel Bottom Head Instrument
  - Steam Generator Bowl Drain
- Pressurizers
  - Surge Line Nozzles
  - Spray Nozzles
  - Safety & Relief Valve Nozzles
- Non Pressure Boundary Locations
  - Steam Generator Tube Sheet Cladding
  - Core Support Blocks/Alignment Lugs

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Common Locations: CE and B&W

- Small Diameter Nozzles (<4”)
  - Pressurizer Steam Space Instrument
  - Pressurizer Liquid Space Instrument
  - Hot Leg Instrument
  - Cold Leg Instrument
- Pressurizer Heater Sleeves/Bundles
- Reactor Vessels
  - CRDM Motor Housing
- Main Coolant Piping Loop
  - RCP Suction & Discharge Nozzles
- Branch Line Connections
  - Pipe-to-Surge Nozzle Connection
  - Charging Inlet Nozzles
  - Safety Injection and SDC Inlet
  - Shutdown Cooling Outlet Nozzle
  - Spray Nozzles
  - Let-Down and Drain Nozzles
- Non Pressure Boundary
  - Steam Generator Nozzle Dam Ring

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Specific Locations

- Westinghouse and CE Designs
  - Small Diameter Nozzles (<4”)
    - Reactor Vessel Top Head Vent
    - SG Divider Plate Welds

- Westinghouse Design
  - Reactor Vessel
    - Inlet and Outlet Nozzles
  - Main Coolant Piping Loop
    - SG Inlet and Outlet Nozzles

- Babcock & Wilcox Design
  - Reactor Vessel
    - Core Flood Tank Nozzles
  - Small Diameter Nozzles (<4”)
    - Reactor Vessel Top Head Thermocouple
  - Flow Element
  - Flow Meter

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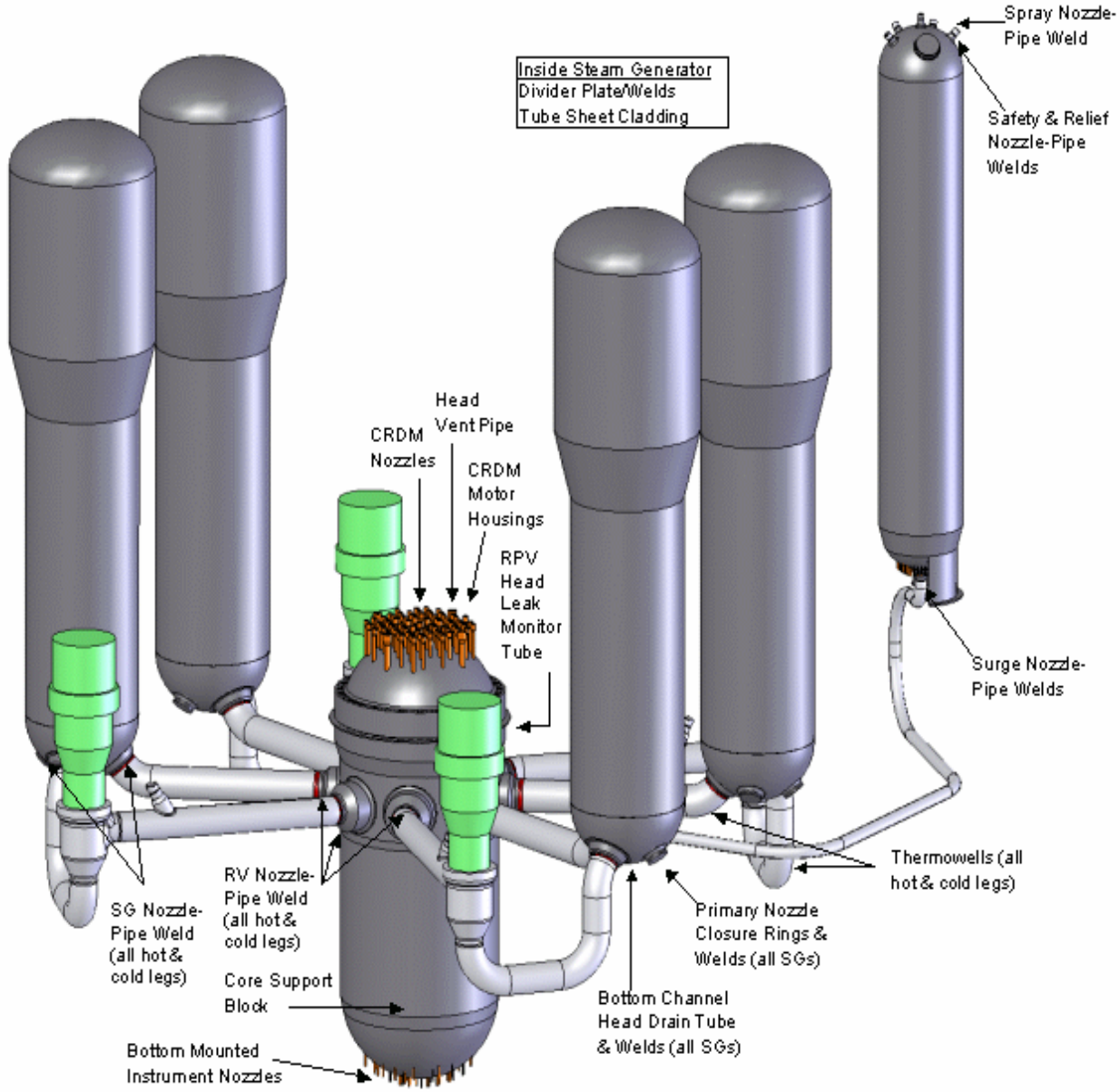
Alloy 600 Locations in Westinghouse Plants



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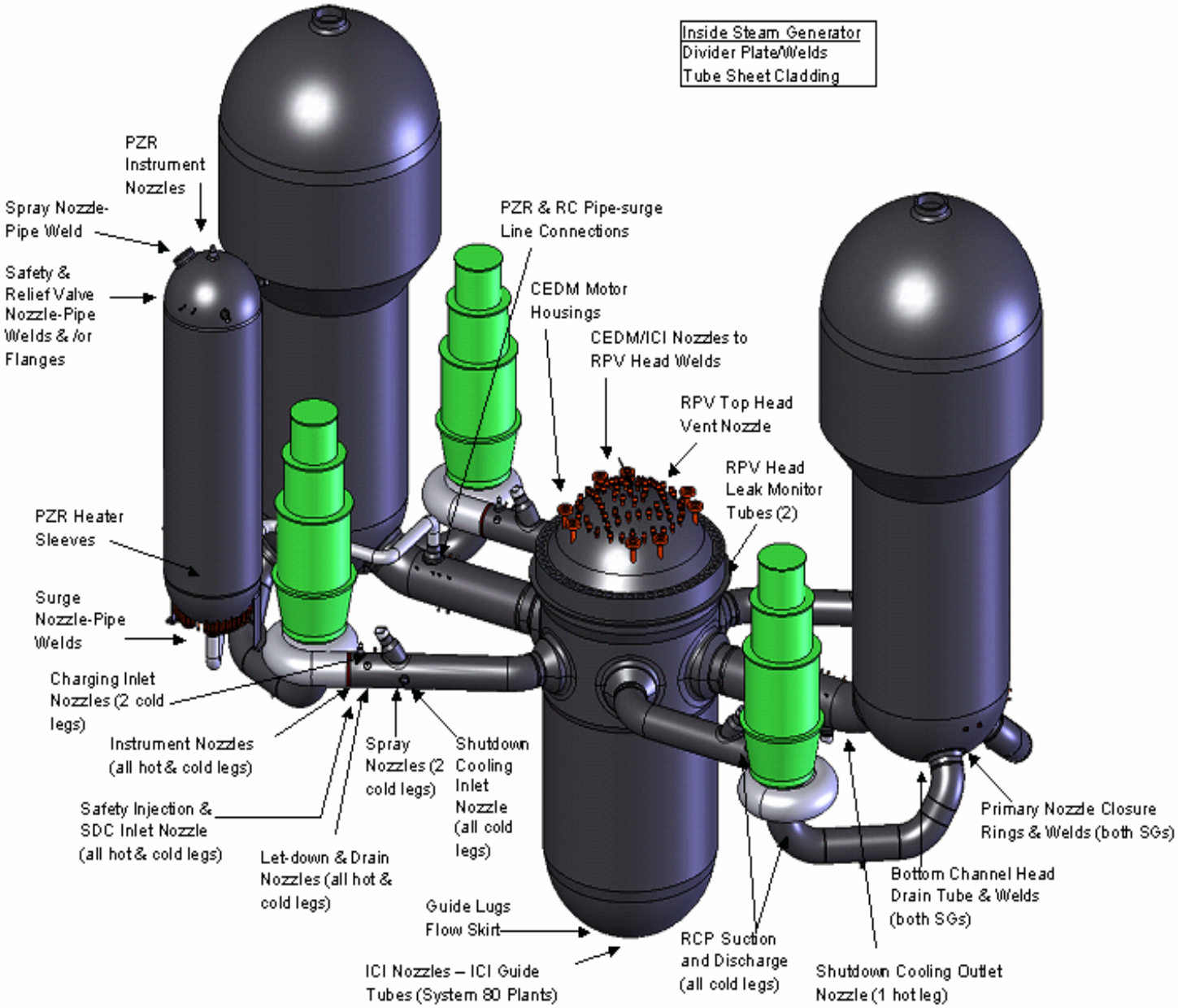
Alloy 600 Locations in Combustion Engineering Plants



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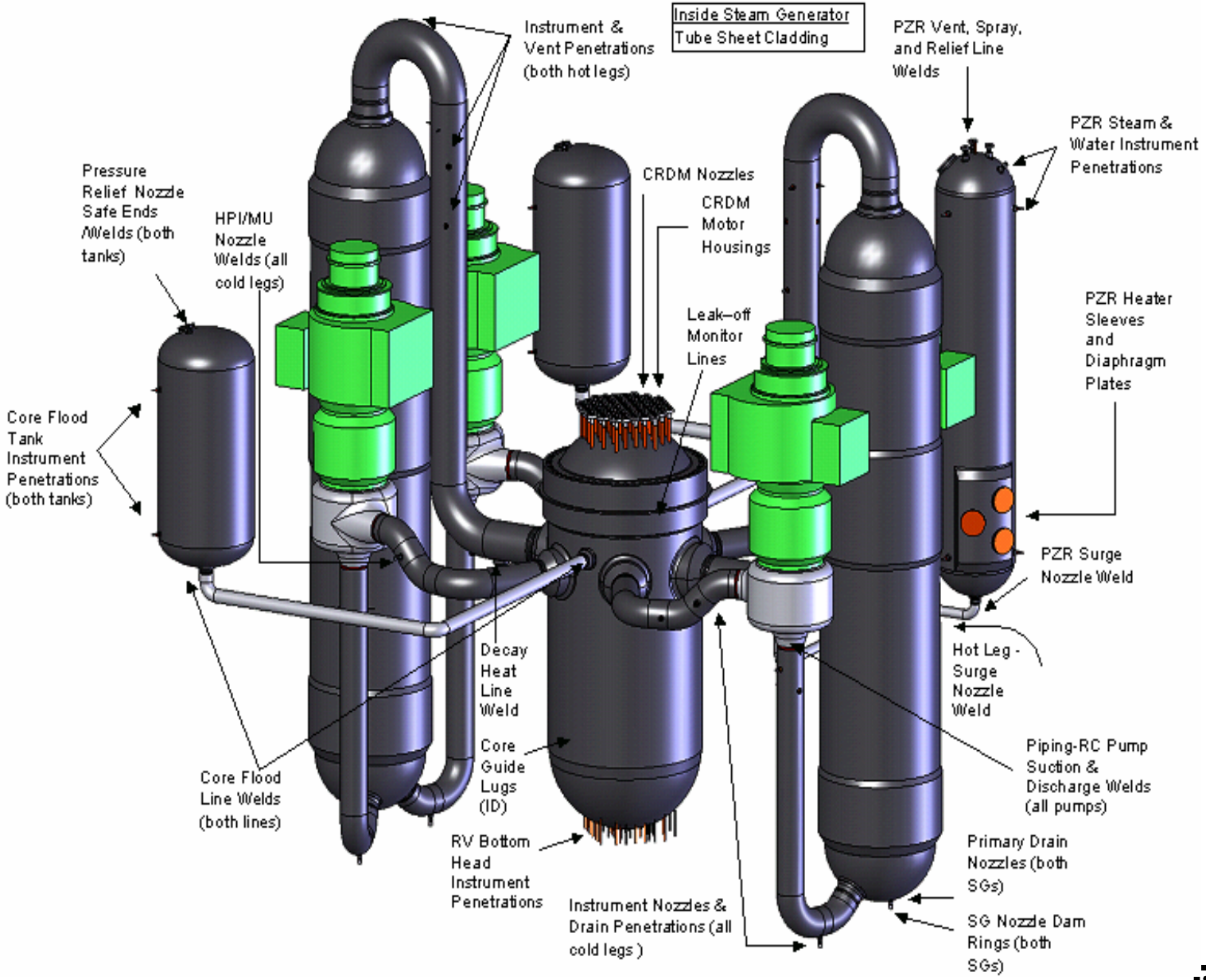
Alloy 600 Locations in B&W Plants



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Areas of Industry Guidance

- General Guidance for All Locations
- Specific Guidance for Specific Locations
  - Reactor Pressure Vessel Top Head Nozzles
  - Reactor Pressure Vessel Bottom Mounted Nozzle
  - Pressurizer Heater Sleeves
  - Steam Generator Bowl Drains
  - Other Locations
  - Alloy 82/182 Butt Welds

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General Guidance for All Locations: Alloy 600 Management Plans (MRP-126)

- A600 Management Plan
  - *Mandatory Requirement:*
    - *Each plant shall develop and document an Alloy 600 management plan, defining the processes it intends to use to maintain the integrity and operability of each Alloy 600/82/182 component for the remaining life of the plant.*
    - Must be implemented at all U.S. PWRs by June 2006.

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General Guidance for All Locations
Key Elements of a Plant Specific Alloy 600 Management Plan

	Attribute	Alloy 600 Management Plan Document Elements
1	Scope of Program	• Alloy 600/82/182 locations and inspection programs • Assigned responsibilities for Alloy 600 management (including individuals from multiple disciplines and departments) • Implementation plans (modification packages, budget, scheduling, etc.) with contingency planning
2	Preventative Actions	• Plan for implementation of Alloy 600/82/182 mitigation strategies • Plan for possible replacement of components as preventative action
3	Parameters Monitored /Inspected	• Detailed data (including location, component function, service history, temperature, operating environment, fabrication records, etc.) about components containing • Alloy 600/82/182 to be used in inspection ranking

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General Guidance for All Locations
Key Elements of a Plant Specific Alloy 600 Management Plan

	Attribute	Alloy 600 Management Plan Document Elements
4	Detection of Aging Effects	• Plant specific inspection plan for detection of PWSCC cracking • Plant specific inspection matrix listing applicable inspection techniques
5	Monitoring and Trending	• Inspection schedule that meets Code and regulatory requirements for Alloy 600/82/182 locations and incorporates results from previous inspections
6	Acceptance Criteria	• Reference to applicable Code and regulatory requirements for Alloy 600/82/182 locations (ASME and NRC requirements) for evaluation of inspection results

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General Guidance for All Locations
Key Elements of a Plant Specific Alloy 600 Management Plan

	Attribute	Alloy 600 Management Plan Document Elements
7	Corrective Actions	• Procedures for disposition of inspection findings • Plant specific repair matrix listing acceptable repair techniques for each type of Alloy 600/82/182 component/weld
8	Confirmation Process	• Reference to site quality assurance procedures and associated regulations
9	Administrative Controls	• Reference to site quality assurance procedures and associated regulations
10	Operating Experience	• References to Industry Alloy 600/82/182 experience • Schedule for periodic review of industry data

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General Guidance for All Locations
Generic Guidance for an Effective BACC Program for PWRs

- WCAP-15988, Rev 1
  - Mandatory under the NEI Materials Guidelines Implementation Protocol NEI 03-08
    - Each PWR utility shall have a Boric Acid Corrosion Control Program (BACCP).
    - The BACCP shall encompass all the key elements described in Section 4 of this WCAP document.
  - Provides Guidance for Developing Plant Specific Boric Acid Corrosion Control Programs (BACCP) For PWRs
  - Covers PWRs with Westinghouse, CE, and B&W design
  - Utilities to Update the Plant specific Programs within 18 month after WCAP-15988, Rev. 1 was issued.

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General Guidance for All Locations
WCAP 15988 Rev 1: Key Elements

1. Identification of Inspection Locations
2. Obstructions to Visual Inspections
3. Program and Inspection Procedures
4. Inspection Methods
5. Other Inspections and Parallel Programs
6. Screening, Evaluation, and Disposition
7. Data Collection and Documentation
8. Corrective and Mitigating Actions
9. Program Ownership and Responsibility
10. Personnel Qualification and Training
11. Continuous Improvement and Self-Assessment

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General Guidance for All Locations
BMVs for All Alloy 600 Locations

- MRP Letter 2003-039, January 20, 2004
  - Insulation removal and BMV inspection of all Alloy 600/82/182 pressure boundary components >350°F
  - Once within next 2 RFOs
  - Priority to highest temperature (PZR and Hot Leg)

- ASME CC N-722 (Pending approval)
  - Insulation removal and BMV inspection of all Alloy 600/82/182 pressure boundary components
  - Prioritize on temperature and operating experience
  - Inspections are split over interval (some inspections every period)

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Reactor Pressure Vessel Top Head Nozzles :
Top Head CRDM / CEDM / ICI

- Inspections currently being conducted to NRC First Revision Order EA 03-009
- Ongoing/Completed Work
  - RPV Head Penetration Safety Assessment
    - Reactor Vessel Closure Head Penetration Safety Assessment for U.S. PWR Plants (MRP-110), 1009807.
      - Failure Modes and Effects Analysis
      - RPV Head Penetration Risk Assessment
      - Supporting Reports
  - Generic Evaluation of Examination Coverage Requirements for Reactor Pressure Vessel Head Penetration Nozzles, Revision 1 (MRP-95R1), 1011225.
  - MRP-89: CRDM Demonstration Program
  - Inspection Plan for Reactor Vessel Closure Head Penetrations in U.S. PWR Plants (MRP-117), 1007830.
    - Comprehensive, unified technical basis for SA and I&E Guideline
    - ASME Code Case N-729

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RPV Bottom Mounted Nozzles

- B&WOG, MRP and WOG are completing Safety Assessment calculations
  - Similar to approach used for RPV Head Nozzles
  - Calculations are scheduled to be complete in Fall 2005
  - Final Safety Assessment Report completed in 2006

- Inspection Plan Development will start in late 2005
  - Guidance will be issued in 2006

- Inspection of RPV Bottom Head Penetrations
  - MRP 2003-17 Letter, Dominion Generation; June 23, 2003, Recommendation for PWR Owners with Alloy 600 Bottom Mounted Reactor Vessel Instrument Nozzles
  - MRP 2004-04 Letter, Dominion Generation; May 14, 2004, BMI Integrated Industry Inspection Plan

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Reactor Pressure Vessel Bottom Mounted Nozzles MRP 2003-17 Letter: BMV for BMNs

- During the current or next refueling outage, a bare metal visual examination of any Alloy 600 nozzles penetrating the bottom head of the reactor vessel be performed.

- Issued June 23, 2003 within two RFOs
  - 18 Month Cycle
    - Completed by end of Spring 2006
  - 24 Month Cycle
    - Completed by end of Spring 2007

- Greater than 90% of plants with BMNs have completed BMVs – no indications of leakage

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Reactor Pressure Vessel Bottom Mounted Nozzles
MRP 2004-04 Letter: BMN Integrated Industry Inspection Plan

- Objective is to proactively gather data from volumetric inspections at a number of plants with near term 10-year vessel ISIs.
  - Supplement the lower vessel BMV inspections with volumetric inspections
  - Inspections to consider (depending on vendor capabilities)
    - UT of the nozzle
    - Enhanced visual of the J-groove weld
    - ECT of the J-groove weld
- Letter will remain effective until Industry BMN Inspection Guidelines are complete
- 7 volumetric and in-vessel visual inspections completed to date
  - no indications identified
- 5 planned for remainder of 2005

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Pressurizer Heater Sleeves & Steam Space

- Westinghouse Owners Group (WOG) CE Fleet Pressurizer Heater Sleeve Inspection Program, January 30, 2004 (WCAP-16180-NP, Rev. 0)
  - Visual inspection every RFO
  - If a leak is found, volumetric inspection to characterize flaw
  - If the volumetric inspection identifies flaw as circumferential below the sleeve attachment weld, notify the NRC and develop an appropriate inspection plan for extent of condition.
  - Repair leaking locations

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Steam Generator Bowl Drain

- Westinghouse Electric Company Technical Bulletin, TB-04-019: Steam Generator Channel Head Bowl Drain Line Leakage, October 18, 2004
  - Each plant recommended to confirm whether or not the channel head bowl drain line configuration in their steam generators is similar to that of a plant that had a leak in this line.
  - If it is, recommends that plant perform a visual exam (with insulation removed) of each SG drain coupling and surrounding weld build-up at each outage.

- Shared with B&W fleet as operating experience with Alloy 600 degradation

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Other Locations

- Utilities have identified where all Alloy 600/82/182 locations are for the PWR plants that are not addressed within the previously discussed groupings
  - NSSS Vendor-specific
  - MRP compilation of remaining scope locations for fleet underway
- "Other" locations not covered by existing guidance will be assessed through completion and implementation of the NEI 03-08 strategic plan, gap analyses, and Issue Management Table (IMT)
- Interim inspection guidance has been and will be issued to assess current condition of fleet until final, permanent guidance can be put into practice
- Final guidance to be implemented through ASME Code Cases, NEI 03-08 Implementation Protocol, or other methods

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Summary

- Industry has a plan to address all Alloy 600 / 82 / 182 locations
  - RV closure heads
    - ASME Code Case in progress
  - RV bottom heads
    - SA and I&E Guidance - 2006
  - Pressurizer Heater Sleeves
    - WOG guidance issued 2004
  - NiCrFe DM buttwelds
    - I&E Guidance mid 2005
  - Other locations
    - IMT assessment – late 2005

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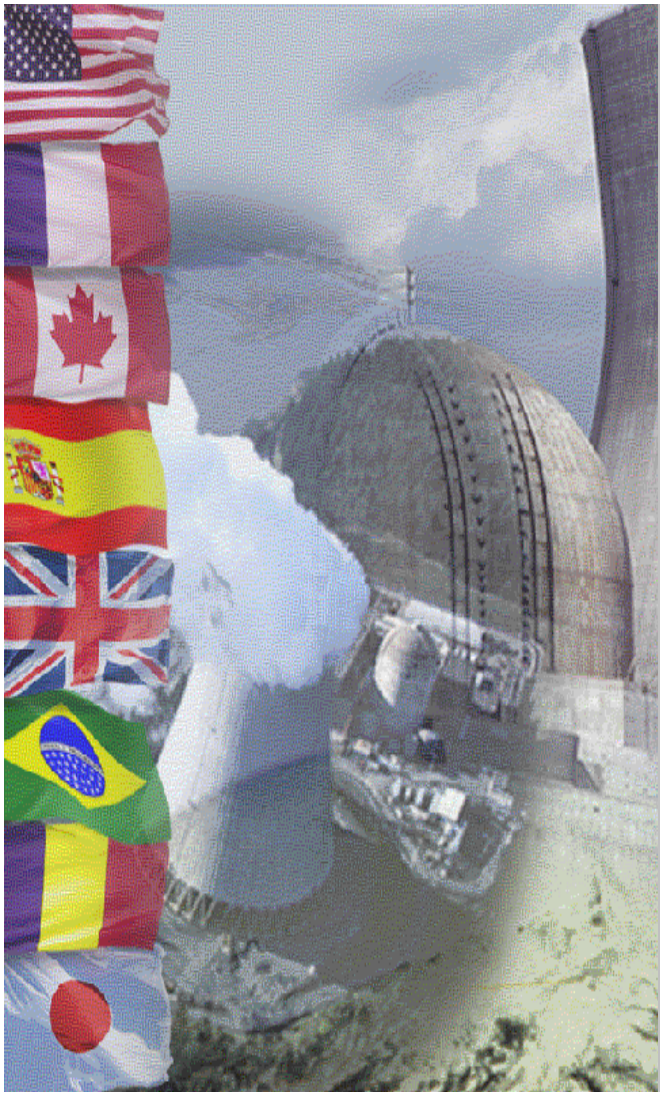

Alloy 82/182 Butt Weld Degradation
- I&E Guidelines (MRP-139)
- Impact on LBB

EPRI

Safety Assessment Conclusions

- No Immediate Safety Concern
  - Very small number of leaks/cracks given large numbers of locations worldwide
  - Axial cracking much more likely than circumferential cracking
  - Probabilistic analysis shows impact of butt weld PWSCC on CDF is insignificant
  - Potential for significant BAC considered low
- Low safety risk is not a basis for doing only what we are required to do by ASME code, now

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Alloy 82/182 Butt Weld Field Experience

Summary Status – Worldwide

- Plants with leaks
  - VC Summer
  - Tsuruga 2
  - Palisades (HAZ, not in the weld)
  - Navy test reactor (HAZ, not in the weld)
- Plants with cracks/indications
  - Ringhals 3 & 4
  - VC Summer
  - Tsuruga 2
  - TMI-1
  - Tihange 2?
  - Calvert Cliffs 2

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Current Required Inspections

- These welds are within ISI population and inspected per ASME Section XI
  - Visual inspections for leakage and BAC
  - BMV inspections associated with NDE for >1” NPS
  - Volumetric NDE for sizes ≥4” NPS

- UT performed must meet ASME Section XI Appendix VIII requirements
  - One way is through the EPRI Performance Demonstration Initiative

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Summary Alloy 600/182 Butt Weld NDE

- Flaw detection and sizing are reliable when access and surface conditions are adequate
- Flaw detection limitations due to configuration
- Sizing does not meet code requirements in all situations
- Lack of sufficient knowledge of details of as-built configurations
- The industry is investing significant resources in R&D to improve inspection reliability
- An intense effort to qualify procedures and personnel continues

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Technical Challenges in NDE

- Accessibility for inspection
- Rough/wavy surfaces
- Complex configurations
  - Tapered surfaces
  - Adjacent welds
  - Limitations to scanning
  - Configuration is often not known well enough in advance of ISI
  - Match between qualification in mockups and as-built configurations
- Qualification of NDE
  - Specific to configuration

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Alternatives to UT

- If configuration does not allow demonstrated UT, alternative/complementary techniques should be evaluated
  - Radiography
    - Acceptable by Code for volumetric NDE
      - Demonstration of effectiveness not required
    - May not be comparable to construction results
  - Eddy Current (in conjunction with UT)
    - Surface exam only
    - Has been used at VC Summer & foreign plants
    - No demonstration requirement
    - Detection only (conservative flaw depth procedure 1/1 aspect ratio assumed)
    - Requires access to ID

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R&D To Improve Inspection of Butt Welds

- Projects relating to Alloy 600/182 NDE (MTAG and EPRI funded)
  - Probe development
  - Qualification
    - UT phased array procedure
    - DM NDE Mockups representative of as built configurations
  - Databases
    - As-built configurations
    - NDE capability
- Parallel technology paths are being pursued to increase the chance for success and to speed up delivery of solutions

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Dissimilar Metal Weld Qualification Status Overview

- Qualified NDE (detection & sizing) is available for large population of DM welds
- The PDI DM sample set covers the majority of configurations present in plants
  - Some as-built configurations are not represented in the existing sample set
- Remaining challenges to detection are due to geometry
  - Tapers
  - ID geometry
  - Weld crowns?
  - Adjacent welds
  - Slope of vessel nozzle
  - Short safe-ends
  - Cast SS
- Limited resources (qualified people)

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Summary Dissimilar Metal Butt Weld NDE

- Where access can be achieved, detection is highly reliable
- Configuration has strongest effect on UT effectiveness
  - Still have some detection challenges for difficult configurations
    - 1 Gap closed in 2004 - Detection from ID with realistic geometry
  - Alternative examination techniques may be appropriate in order to fully characterize indications (ID Examinations)
- Sizing is qualified for many applications
  - Even where not qualified, sizing error is generally measurable
- Intense and high priority R&D and qualification effort in place to overcome challenges and eliminate limitations to qualifications

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Butt Weld Working Group

- Butt Weld Safety Assessment; Alloy 600/82/182 Weld Integrity
  - Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs (MRP-113), 1009549.
  - Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs: Westinghouse and CE Design Plants (MRP-109), 1009804.
  - Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs: Babcock & Wilcox Design Plants (MRP-112), 1009805.
  - Welding and Residual Operating Stresses in PWR Alloy 182 Butt Welds (MRP-106), 1009378.
  - Evaluation of the Effect of Weld Repairs on Dissimilar Metal Butt Welds (MRP-114), 1009559.
  - Probabilistic Risk Assessment of Alloy 82/182 Piping Butt Welds (MRP-116), 1009806.
- Expert Panel Review of Alloy 600/82/182
  - Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds (MRP-115), 1006696.

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Status of MRP Butt Weld Guidance

- MRP letter 2004-05, April 2, 2004, categorized butt weld portion of 2003-039 as "Needed"
  - "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
- 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.
- Issued April 2, 2004
  - 18 Month Cycle
    - Completed by end of Fall 2006
  - 24 Month Cycle
    - Completed by end of Fall 2007

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Current Draft of Alloy 82/182 Butt Weld Inspection Guideline Volumetric Inspection Schedule

PWSCC Category	Description of Weldments	Inspection Extent and Schedule
A	Resistant Materials	Existing Code Inspection Program or Approved Alternative
B	Non-resistant Mat. Reinforced by full structural weld overlay	Existing Code Inspection Program or Approved Alternative
C	Non-Resistant Mat. Mitigated by SI	Verify and return to code
D	Non-resistant Mat. No SI Pressurizer and Hot Leg	Supplement the code
E	Non-resistant Mat. No SI Cold Leg	Existing Code Inspection Program or Approved Alternative
F	Non-resistant Mat. Cracked Reinforced by full structural weld overlay	Verify and return to code
G	Non-resistant Mat. Cracked Mitigated by SI	Verify and return to code

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Volumetric Inspection Options

- What happens when you can't perform an examination that meets the requirements of Section XI and Appendix VIII
  - Mitigate through replacement, stress improvement, or primary water chemistry additions
  - Additional monitoring of the weld location for leakage considered by the utility until the weld has been mitigated
  - Modify the weld to make an inspection possible that meets the requirements
  - Augmentation with other NDE methods such as RT, ET, other non-qualified UT as justified by the licensee.

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Visual Inspection Requirements

- Bare Metal Visuals (Direct or Remote)

- Requirements will consider
  - Pipe Size
  - Location or Temperature
  - Not required when volumetric NDE is performed
  - Return to code requirements after replacement or mitigation

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Planning Implementation

- Ensuring that the proper infrastructure in place to support these guidelines
  - Gathering information on Alloy 82/182 butt weld volumetric inspection schedules from PWRs
  - Comparing to current planned 10 year ISI
  - Comparing to guideline implementation schedule
  - Evaluating resource capability to support inspections

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MRP-139 Publication Process

- Developing Implementation Schedule
- Briefing Executive Committees and NSIAC

- Final Industry Approval - mid 2005

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MRP LBB Evaluation Effort Overview

- Reviewed population of Alloy 82/182 welds where LBB has been applied
- Evaluated most highly stressed Alloy 82/182 LBB locations for each piping system within each reactor type
- Confirmed that high nickel alloy welds have high toughness
- Determined margins between critical flaw sizes and leakage flaw sizes including crack morphology effects
- Investigated expected crack shape for Alloy 82/182 cracking
- Evaluated the time available for plant action from leakage detection to failure

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Alloy 82/182 LBB Locations

- Most applications are in large diameter main loop piping

System	Number of Units		
	Westinghouse	CE	B&W
Main Loop Piping	30	11	7
Surge Line Piping	16	1	0
Core Flood Piping	NA	NA	3*
Shutdown Cooling Suction	NA	1	0
Safety Injection	0	1	0

* This project did not evaluate these locations because they are at containment temperature and are isolated from the RCS.

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Analytical Process

- Determine critical flaw length for a through-wall flaw
- Determine flaw size that will result in 1 and 10 gpm leakage (leakage flaw size)
- Leakage flaw size was computed by assuming that the crack is due to either fatigue or SCC (IGSCC and PWSCC)

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Leakage Flaws/Margins Summary

- All margins greater than 2
  - Westinghouse and CE calculations used fatigue crack morphology.
  - B&W calculations used SCC morphology.
- To evaluate sensitivity of morphology on margins, we looked at the effect of the crack morphology.
  - Adjusted for SCC morphology in leak rate calculations

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LBB Conclusions

The technical basis for LBB remains strong:

- PWSCC observed in Alloy 82/182 butt welds in several plants has been primarily axial in nature
  - Long part-through wall circumferential flaws not likely
- Adequate time between leakage detection and growth to critical flaw size to allow safe shut down
- Adequate margin remains considering alternative leak rate calculation methodologies
  - Thus, significant margin exists between the flaw sizes at which leakage requiring shutdown occurs and critical flaw sizes
- Increased plant sensitivity to unidentified leakage
  - Response to leak rates less than 1 gpm (Tech Spec Limits) improved
  - Generally the unidentified leakage is trended

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LBB Future Activities

- Detailed report has been finished and is pending ITG approval
- Report will be provided to the NRC
- Need to discuss what are appropriate changes and vehicle for those changes to the SRP for current and future LBB applications

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Summary

- Industry has a plan to address all Alloy 600 / 82 / 182 locations
  - RV closure heads
    - ASME Code Case in progress
  - RV bottom heads
    - SA and I&E Guidance - 2006
  - Pressurizer Heater Sleeves
    - WOG guidance issued 2004
  - NiCrFe DM buttwelds
    - I&E Guidance mid 2005
  - Other locations
    - IMT assessment – late 2005

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Concluding Remarks

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