ELECTRIC POWER RESEARCH INSTITUTE

EPRI MRP and NRC Senior Management Meeting

February 22, 2006
Washington, DC

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Meeting Agenda Topics

1. Introductions and Opening Comments
2. Materials Reliability Program
   - Historical Perspective
   - Objectives and Industry Role
   - Organization and Membership
3. MRP Re-Organization
4. MRP Major Initiatives and Focus
   - Alloy 600 Issues
   - Fatigue Issues
   - Reactor Pressure Vessel Integrity Issues
   - Reactor Pressure Vessel Internals Issues
5. Wrap Up and Closing Comments

Historical Perspective

- Potential susceptibility of plant components and systems to boric acid corrosion was recognized in the 1980s
- Discovery of PWSCC cracking in CRDM Alloy 600 nozzle in Bugey 3 was a major discovery for PWRs in early 1990's
- Aging related degradation associated with plants pursuing plant life extension confirmed the need for added attention on pro-active materials degradation strategies
- PWR utility executives formed the Materials Reliability Program in the late 1990s to pro-actively address reactor coolant system material condition issues

MRP Objectives and Industry Role

- Serve as the industry leader for material related issues that affect RCS pressure retaining vessels (except SGs), piping and piping components, RPV integrity and RPV internals for the PWR fleet of plants
- Resolve existing and emerging materials performance, safety, reliability, operational and regulatory issues
- Identify or develop generic, safety and reliability driven strategies from which the operating plants can implement the appropriate guidance
- Serve as the US repository for information on materials related issues for the fleet of PWR plants
- Integrate projects with Owner Group's work and when appropriate with ASME Code activities

MRP Organization and Membership

- MRP policies, procedures and strategic plan are in alignment with the NEI 03-08 Materials Initiative
- MRP work is coordinated with other industry Issue Programs (Primary Systems Corrosion Research, NDE, Chemistry, SGMP, FRP, BWRVIP) and Owner Groups through joint memberships of its utility advisors
- All US PWR owners are active members and participants in the Program.
  - 4 foreign utilities have joined as MRP members (Korea, Japan (2), EdF)

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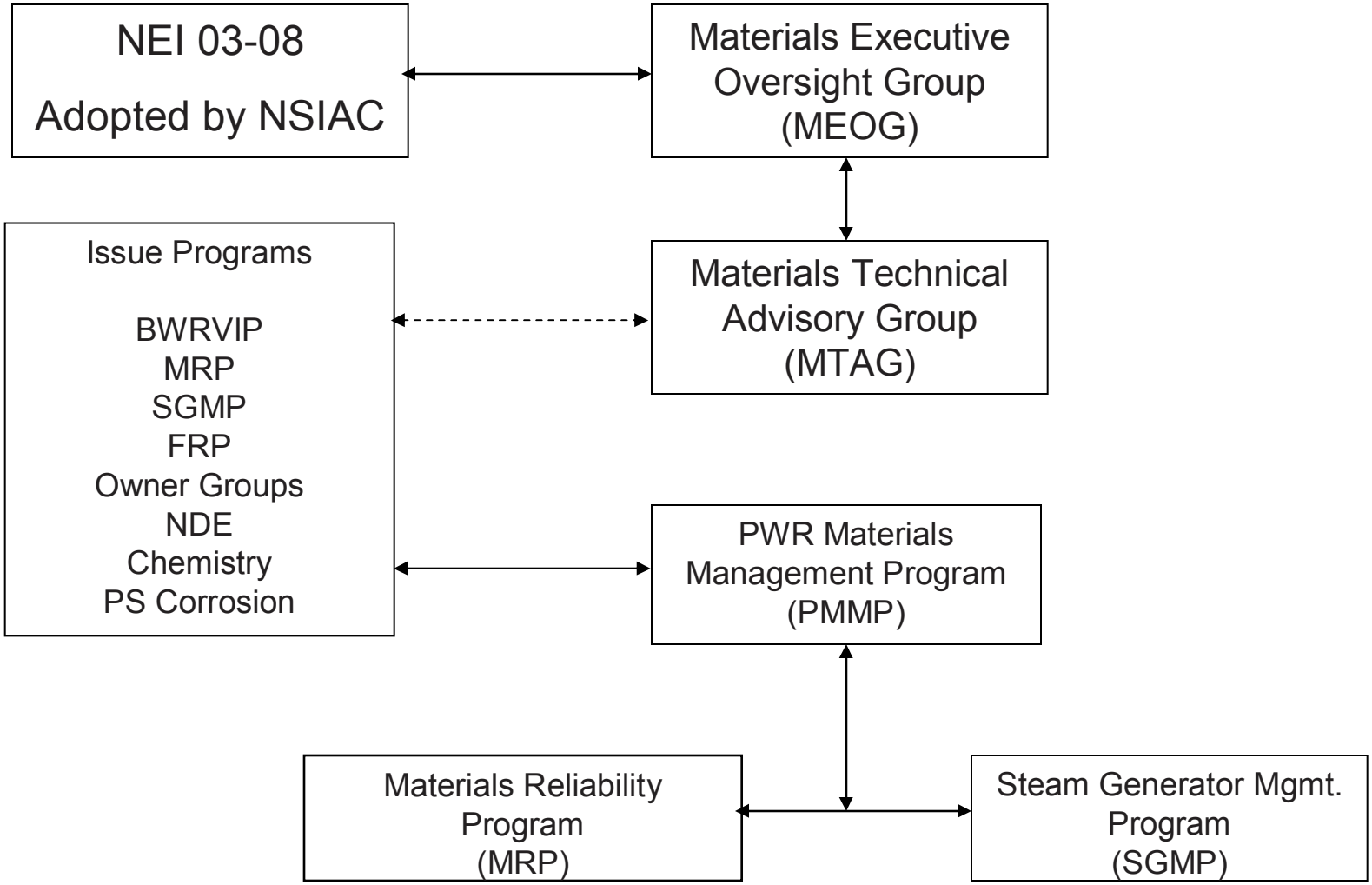
Reorganization of MRP

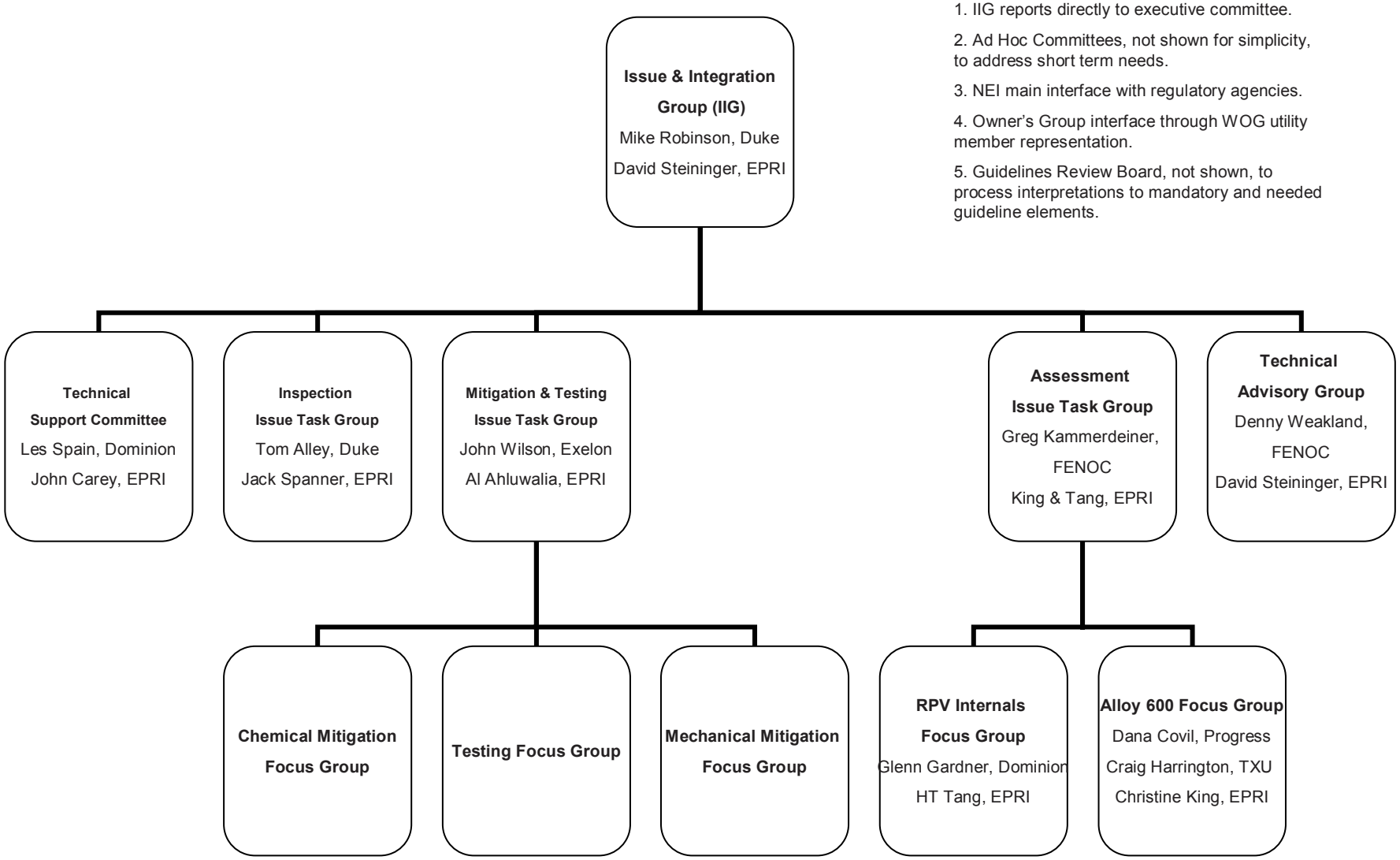
Industry Materials Organizations



New MRP Organization

Notes:

1. IIG reports directly to executive committee.
2. Ad Hoc Committees, not shown for simplicity, to address short term needs.
3. NEI main interface with regulatory agencies.
4. Owner's Group interface through WOG utility member representation.
5. Guidelines Review Board, not shown, to process interpretations to mandatory and needed guideline elements.



MRP Issues & Integration (IIG) Role and Responsibilities

- Strategic planning, priorities, and recommendation on issues to be included
- Program budget preparation, work scope and schedule development
  - Review and approval recommendation to executives
- Oversight of Task Group integration and coordination activities
- Program self assessment plans and processes
- Periodic status reports to executive and other oversight groups
- Each ITG chair and other at large members make up the IIG
  - 15 voting members

Assessment ITG Scope

- Safety assessments for various components, bounding assessments for component integrity
- Inspection criteria
  - What needs to be inspected
  - Locations to be inspected
  - Expansion criteria
  - Inspection and re-inspection intervals
- Engineering or technical studies and evaluations
- Flaw evaluations, flaw evaluation guidelines, structural analysis techniques, assumptions, PRA

Inspection ITG Scope

- Guidance on NDE inspection demonstration and qualification programs (CRDM, BMN, etc)
- NDE interface with regulator and other stakeholders
- Emerging NDE technologies and application capabilities
- Inspection methods and capabilities
- NDE mock-ups and protocols
- NDE Uncertainties

Mitigation and Testing ITG Scope

- Basic research and development for PWR material degradation issues, including chemistry effects, etc
- Mitigation strategies, studies, and evaluations for various degradation phenomena
- Mitigation methods development and validation
  - Chemical - zinc addition, hydrogen management
  - Mechanical - peening, overlays, inlays, etc
- Materials testing and crack growth rate studies
  - Irradiation Assisted PWSCC testing
  - Field specimen fracture toughness evaluations
- Data generation and report development

Technical Support Committee

- Repair technical requirements and techniques for various components
  - RCS Materials repair “tool box”
- MRP I&E Guideline revision management
- Issue Management Table (IMT) support
- Technical review of new or emerging issues and recommendations
- RPV integrity (Rulemaking support)
- Piping fatigue management
- Database development and support
  - RPVCH inspection results
  - BMN inspection results
  - MRP 139 inspection results

Technical Advisory Group

- New group for MRP
- Chaired by MRP IIG Vice Chair with one core member from each utility
- Provide utility recommendations to the IIG
- Distribute MRP information to appropriate personnel within the person's parent company
- Provide comments on MRP products as necessary
- Communicate MRP guidance per NEI 03-08 under review to utility executive
- Present utility experience reports at meetings

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MRP Strategic Plan and Program Initiatives

MRP Strategic Plan

- Comprehensive plan for providing high assurance of PWR RCS pressure boundary integrity by identifying highest priority RCS material issue challenges and gaps for the MRP to focus its energy and resources
- Key inputs to the Strategic Plan include the Degradation Matrix (DM) and Issue Management Tables (IMT)
  - Each will be maintained as living documents with annual updates
  - Lifeline for the MRP long range plans
- Provides systematic approach to resolving materials issues
  - Identify vulnerabilities and gaps
  - Assess condition (inspection and evaluation)
  - Mitigate degradation initiation and propagation mechanism
  - Repair or replace as required
- Provides framework for industry and regulatory interaction and communications

Alloy 600 Focus

- MRP Alloy 600 Management Plan and Status
  - Strategic plan is to identify all known Alloy 600 base material and Alloy 82/182 weld metal locations in PWR primary systems and develop an appropriate strategy for the various locations
    - Significant progress over past few years with:
      - Identifying all known Alloy 600/82/182 locations
      - Developing safety assessments
      - Developing industry I&E guidance with supporting technical basis
  - Alloy 600 Management Plan, MRP – 126, issued in 2005 and carries a Mandatory element for utilities to have a formal Alloy 600 Plan completed by June 21, 2006.

Alloy 600 Focus

- Key Considerations for Alloy 600 Management Plans
  - Maintain plant margins and at same time minimize risks to the plants
  - All Alloy 600 locations do not carry the same level of significance
  - The program management approach when considering all locations is one that involves a graded approach
  - Overall strategy should include the following:
    - Replacement with more corrosion resistant materials
    - Mitigation, either chemical or mechanical
    - Volumetric inspection
    - Visual inspection

Alloy 600 Management Plans

- RPVCH: MRP-117, technical basis document for RPVCH inspection protocol and basis document for ASME Code Case N-729
  - Reach concurrence with staff on use of Code Case N-729 as alternative to current RPV head inspection Order, EA-03-009
    - Awaiting final code case and NRC comments
  - NDE inspection qualification program under development for PWR components, including CRDM nozzle base materials and welds
    - Quality program for CRDMs, BMI, RPV Internals
    - Qualified procedures and personnel
- RPV head replacement status
  - 25 head replacements complete
  - 2006 – 2010 16 planned replacements
  - 2010 – 2013 8 replacements under consideration
  - Currently 20 units not considering head replacement

Alloy 600 Management Plans

- Dissimilar Metal Butt Welds: MRP-139, I&E Guideline that provides inspection guidance, visual and volumetric, and inspection frequency recommendations. MRP-113, Alloy 82/182 pipe butt weld safety assessment
  - Guideline issued in September of 2005 with “mandatory” elements for implementation, examination schedules, and examination requirements
  - Purpose to develop inspection regime to manage potential degradation well in advance of any structural integrity issues
  - Focus on higher priority welds which would serve as an early warning methodology for PWSCC potential in butt welds
    - Phased implementation based on temperature
  - Guidelines Review Committee established to:
    - Ensure consistent understanding and clarifications to utilities as plants begin plans for implementation and compliance
  - MRP recent survey of members plans for MRP-139 implementation and plans for any deviations
  - Recent ASME Code action to develop Code Case for DM butt welds inspections

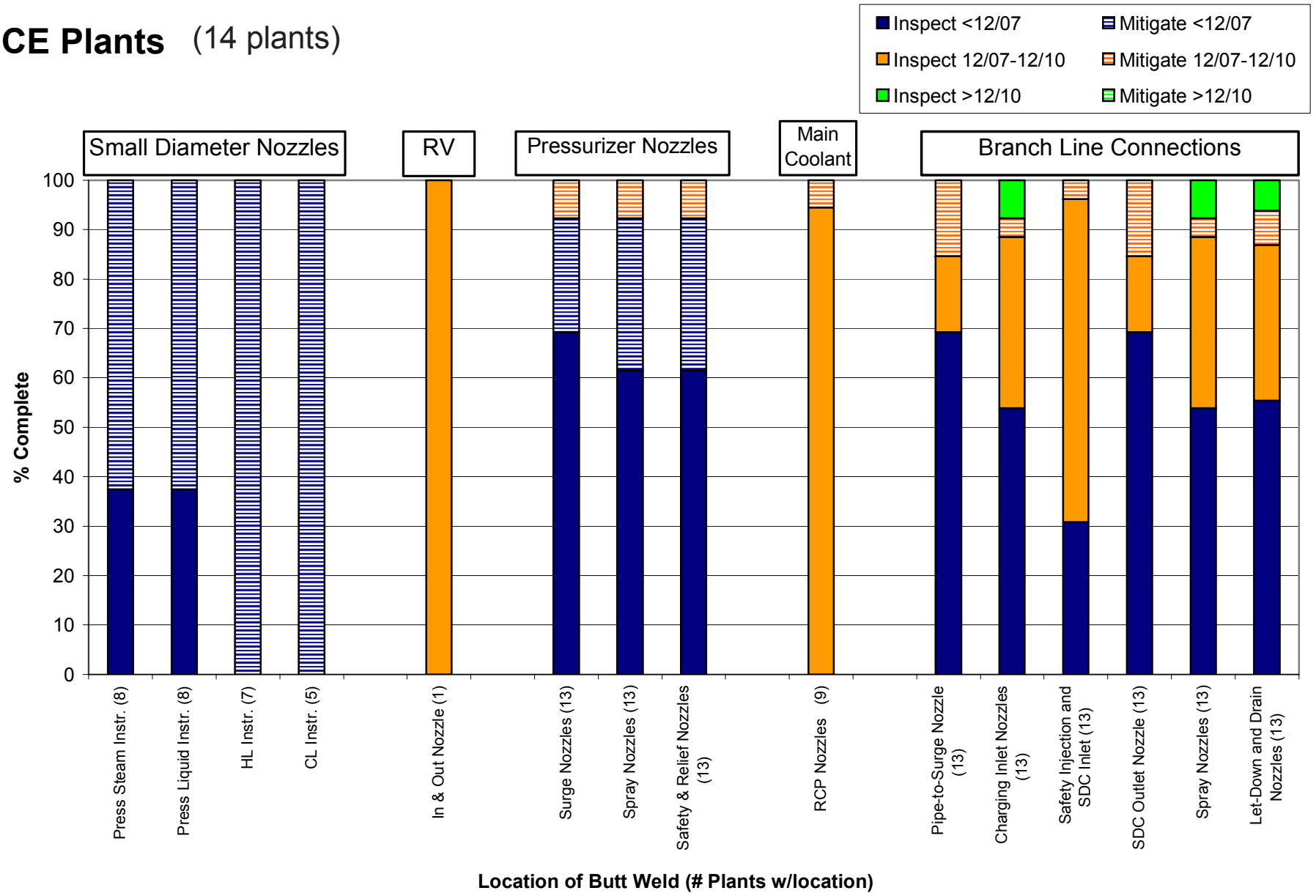
Alloy 600 Management Plans

- MRP-139 (cont'd)
  - Revising document to clarify issues identified in NRC comments
  - Key remaining issues
    - Extra measures for LBB lines that contain these alloys
    - Pre-stress improvement UT
    - Inspection requirements for lines <4 inches
- Pre-emptive Weld Overlays: MRP – 169, serves as basis document to qualify weld overlays as a mechanical mitigation technique for these Alloy 82/182 butt weld locations

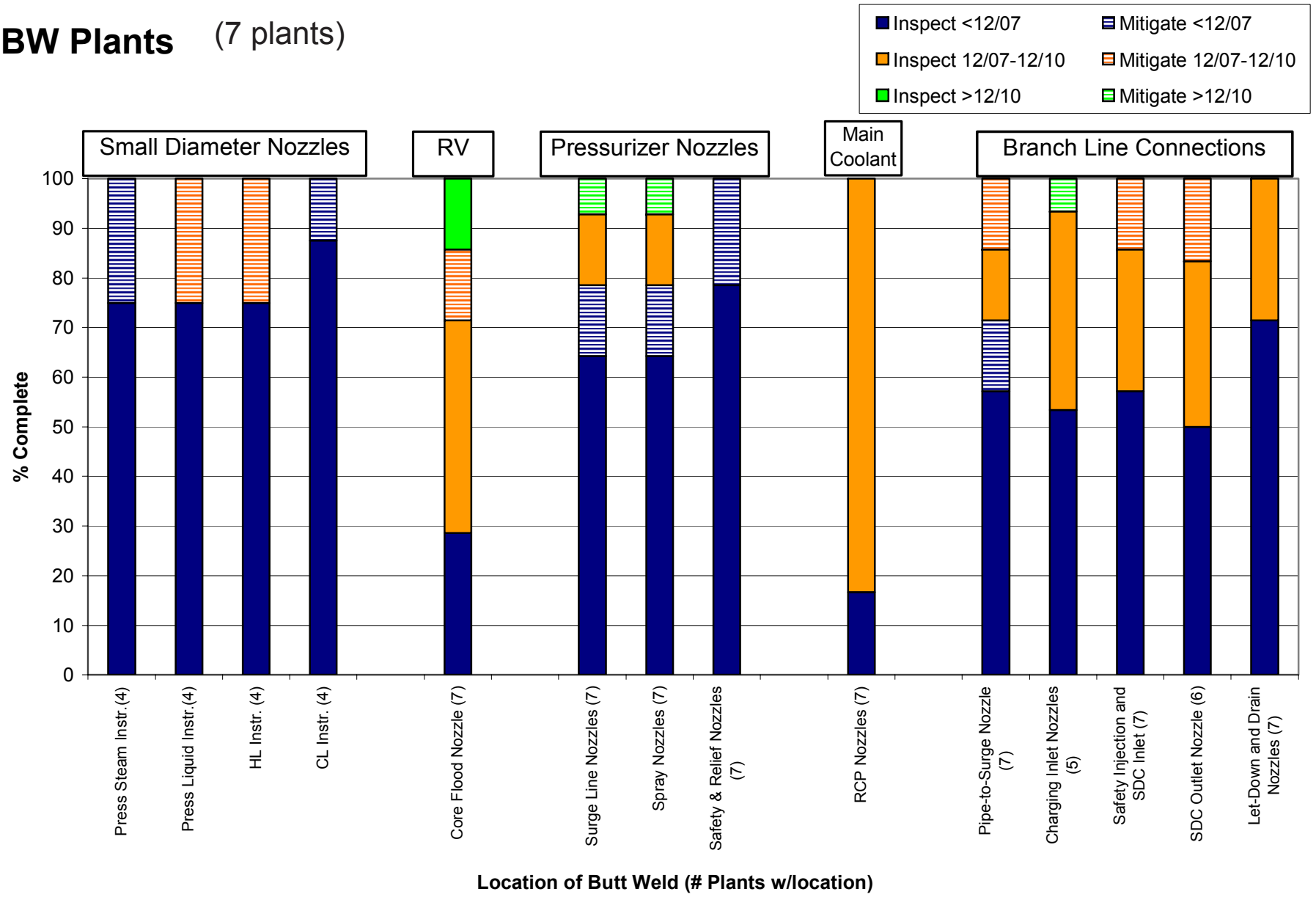
Plants with Location Type

	CE (14)	B&W (7)	West. (48)
Small Diameter Nozzles (>1” and <4.0")			
- Pressurizer Steam Space Instrument	8	4	
- Pressurizer Liquid Space Instrument	8	4	
- Hot Leg Instrument	7	4	4
- Cold Leg Instrument	5	4	
Reactor Vessels			
- Inlet & Outlet Nozzle	1		30
- Core Flood Nozzle		7	
Pressurizer Vessel Nozzles			
- Surge Line Nozzles	13	7	32
- Spray Nozzles	13	7	32
- Safety & Relief Valve Nozzles	13	7	32
Main Coolant Piping Loop			
- SG Inlet & Outlet Nozzles			4
- RCP Suction & Discharge Nozzles	9	6	
Branch Line Connections			
- Pipe-to-Surge Nozzle Connection	13	7	
- Charging Inlet Nozzles	13	5	
- Safety Injection and SDC Inlet	13	7	
- Shutdown Cooling Outlet Nozzle	13	6	
- Spray Nozzles	13		
- Let-Down and Drain Nozzles	13	7	

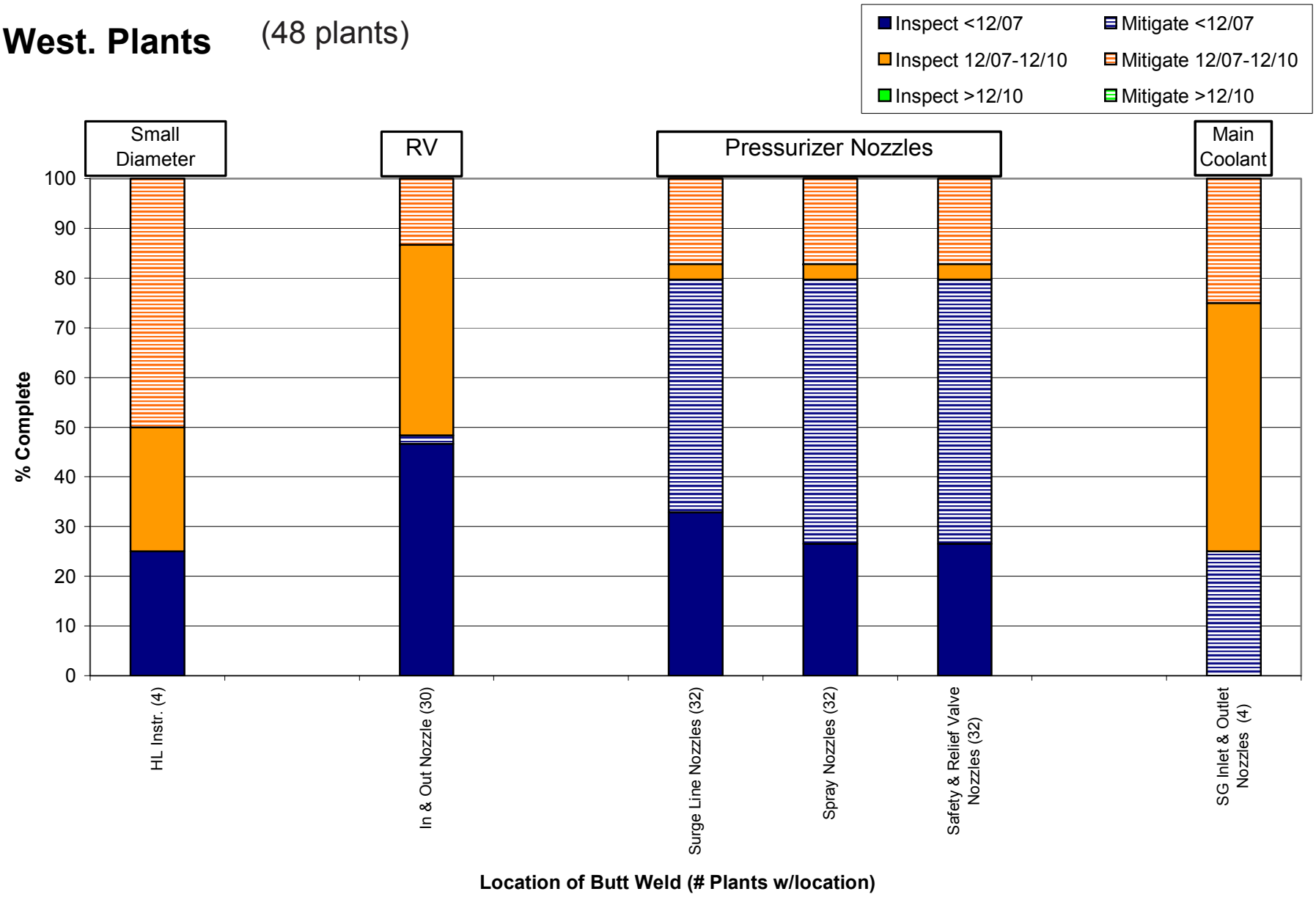
CE Plants (14 plants)



BW Plants (7 plants)



West. Plants (48 plants)



Anticipated MRP-139 Deviations

- Implementation schedules
  - 6 plants – Pressurizer locations – 3-4 months past 12/31/07 deadline (next outage season)
  - 3 plants – Moving inspection to coincide with 10 Year ISI Vessel
- Inspection coverage difficulties with welds
  - 7 plants - connected to cast safe ends – working to improve inspection methods
  - 4 plants – expecting <90% coverage – considering mitigation
- No access to profile weld – 3 plants
  - considering ID exam or mitigation

Alloy 600 Management Plans

- RPV Bottom Mounted Nozzles
  - Develop I&E guide to manage the RPV nozzle penetration cracking issue in spring of 2007
  - To date, 12 US plants have completed volumetric inspections of the BMNs with ultrasonic methods
    - 659 total nozzles volumetrically inspected
    - 3 plants with 10 year vessel ISIs also planning volumetric inspections in 2006
  - Bare metal visual inspections completed at all but 1 plant
    - 3045 total nozzles visually inspected
  - Only one instance of degradation found to date

Alloy 600 Management Plans

- Other Remaining Alloy 600 Locations
  - Identified other locations
  - Anticipate using a graded, risk informed approach in developing applicable I&E guideline
    - Visual only for some locations

Alloy 600 Research Plans

- Projects (cont'd)
  - Collaborative Programs with NRC Research
    - North Anna Head Destructive Examination: Ongoing research analyzing portions of the NA 2 RPV head to:
      - Obtain data on cracking morphology and characteristics in nozzle Alloy 600 base and 182 weld material
      - Obtain verification of field NDE techniques
      - Evaluate crevice chemical characteristics
      - Help develop basic understanding of Alloy 600 PWSCC cracking characteristics
    - Boric Acid Corrosion Testing: Conduct laboratory R&D and tests to:
      - Understand the corrosion characteristics of primary coolant on RCS materials in various configurations (e.g., nozzle/head crevice)
      - Use results to understand potential corrosion issues from leaking components throughout the RCS.
      - Completed test results simulating different stages of BAC in RPV CRDMs
      - Full scale CRDM BAC testing initiated

Alloy 600 Research Plans

- Low Temperature Crack Propagation
  - testing related to the residual stress contribution
  - FEA stress analysis to simulate if the stress levels required are present during shutdowns conditions
- A 600/690 HAZ CGR Testing
  - prepared and characterized special test blocks containing Alloy 182 and 152 welds with associated HAZ
  - quantify any CGR concerns in HAZ of Alloy 600 and 690 welds
  - integrate HAZ CGR data into overall CGR prediction report
- Chemical Mitigation
  - CGR tests at different Li/pH conditions
  - Examine hydrogen/temperature effects to seek optimized H2 levels
  - Assessment of effect of Zn additions on CGR
- A690/52/152 CGR Testing
  - Analysis of existing PWSCC data on 690/152/52 (summarized in MRP-111)
  - Development of test techniques to show PWSCC margins with replacement materials
  - Conduct tests on thick-section, Alloy 690 base metal
  - Conduct tests on appropriate Alloy 152/52 welds

Thermal Fatigue Management Plan

- MRP Thermal Fatigue Task Group has recently delivered industry guidance to the utility to:
    - Characterize the phenomena that causes the cyclic thermal stratification
    - Develops screening and evaluation methodologies for piping susceptibility to this phenomena
    - Assess the integrity of susceptible RCS-attached piping and systems/components
- Thermal Fatigue Management Guideline, MRP-146, issued in June 2005 and contains “needed” elements under the Materials Initiative
  – Site specific training underway
    - 9 sites completed; remaining plants either scheduled for 2006 with final training in 2007

Pressurized Thermal Shock (PTS)

- MRP Strategic Plan for PTS is to work with NRC on a final technical basis document that supports a revision to the PTS rule. Support the rulemaking process to ensure a timely completion to support plants that are projected to get near the screening criteria
- Final technical basis document to support PTS rulemaking is complete
- Rulemaking to commence in mid 2006 with expected completion in 2007
- Revised rulemaking expected to be significant benefit for those plants expected to challenge the current screening criteria limits

Reactor Pressure Vessel (RPV) Internals

- PWRs must manage degradation effects such as IASCC, embrittlement, stress relaxation, void swelling, etc on reactor core internals components.
- MRP management strategic plan is to develop:
  - Guidelines and analyses to identify, screen, and prioritize susceptible RPV internal components.
  - Inspection, mitigation, R/R strategies and guidelines for those components whose functions are critical to internals integrity.
- RPV internals components identified by IMT as a top priority for continued focus and R&D.
- MRP will work with the NRC in the development of inspection guidance.
  - License renewal plants have commitments to follow guidance contained within their license amendment

Summary: Key Issues for MRP for 2006

- Increase regulatory confidence in the organization
- Transition to new MRP functional organization
- MRP–139 implementation
- Complete the PWR IMT with gaps, priorities, and action plans
- NDE qualification program for MRP inspection activities
- Support NRC rulemaking on revised PTS, 10CFR50.61
- Continue as a leader for materials issues

Questions and Final Comments

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Background Slides

Degradation Matrix

- Comprehensive list of RCS materials
- Potential degradation mechanisms identified for various materials
- Determine if materials are susceptible for the degradation mechanism identified
- Solicited professional opinions from industry materials experts, laboratory R&D, industry OE
- An evaluation was performed to ascertain:
  - Is the issue currently adequately addressed through existing programs
  - Is work in progress that will develop tools to resolve the issues
  - If there is no program to address or no work in progress to address the vulnerability, then treat the vulnerability as a gap for potential future work scope

Materials Degradation Matrix

Level 1

PWR						BWR		
PWR Reactor Pressure Vessel	PWR Pressurizer	PWR SG Shell	PWR Reactor Internals	PWR Piping	PWR SG Tubes & Internals	BWR Pressure Vessel	BWR Reactor Internals	BWR Piping

Level 2

PWR Component	Material	SCC SCC					Corrosion/Wear C & W				Fatigue Fat.			Reduction in Toughness RiT					
														Aging	*Irradiation*				
	[1]*Subdivision →*	IG	IA	TG	LTCP	PW	Wstg	Pit	Wear	FAC	HC	LC/Th	Env	Th	Emb	VS	SR	Th_n	Fl
PWR Pressurizer (Including Shell, Surge and Spray Nozzles, Heater Sleeves and Sheaths, Instrument Penetrations)	C&LAS	? e002	N	? e002	N	? e003	Y e004	N	N	Y e005	N	Y e006	Y e007	Y e008	N/A	N/A	N/A	N/A	N/A
	C&LAS Welds	? e002	N	? e002	N	? e003	Y e004	N	N	Y e005	N	Y e006	Y e007	Y e008	N/A	N/A	N/A	N/A	N/A
	Wrought SS	? e012	N	? e012	? e013	? e012	N	N	N	N	N	Y e014	Y e015	N	N/A	N/A	N/A	N/A	N/A
	SS Welds & Clad	Y e016	? e017	Y e018	? e013	? e019	N	N	? e020	N	N	? e014	Y e015	Y e022	N/A	N/A	N/A	N/A	N/A
	Wrought Ni Alloys	N	N	N	? e023	Y e023	N	N	N	N	Y e014	Y e014	Y e015	N	N/A	N/A	N/A	N/A	N/A
	Ni-base Welds & Clad	N	? e024	N	Y e023	Y e025	N	N	N	N	N	Y e014	Y e015	N	N/A	N/A	N/A	N/A	N/A

Level 3

e030	Corrosion-assisted fatigue is a known phenomenon on secondary side (e.g., in the vicinity of girth welds in steam generator shells and in the region of feedwater nozzles) and is not like environmental fatigue described in other areas of this DM. Environmental fatigue research relevant to this specific phenomenon is not ongoing within MRP Fatigue ITG, and is a potential gap.

Issue Management Table(s)

- A Tool for Assessing Vulnerabilities and Priorities
  - Identify RCS equipment, components and sub-components and their materials of construction
  - Apply Degradation Mechanism to list of RCS materials
  - Perform a consequence of failure evaluation by assuming all components fail
  - Evaluate current capabilities to manage the expected degradation by mitigation, repair / replace, or I&E Guidance
  - Identify gaps and determine priorities and basis
    - Opportunity for collaboration between MRP and NRC Office of Research and project being led by Dr. J. Mascara
  - Assign gaps to responsible Issue Program(s) for necessary developmental work

Example IMT - PWR

Section 1
Issue Management Table, PWR Reactor Pressure Vessel

Component & ID No.	Material	Degradation Mechanism	Consequences of Failure	Mitigation	Repair / Replace	I & E Guidance	Gaps Priority & Basis	Responsible Program(s)
1.1 Upper Shell Assembly								
Upper shell flange	LAS/SS clad	SCC(IG, IA?, TG, LTCP?, PW?) C&W(Wstg, Wear?, FAC)(erosion, wastage (ext.), pitting) Fat.(LC/Th, Env) RiT (Th, Emb, FI)	A, B, E, F, G			ASME Section XI and Boric Acid Surveillance Program		
Upper shell forging	LAS/SS clad	SCC(IG, IA?, TG, LTCP?, PW?) C&W(Wstg, Wear?, FAC) Fat. (LC/Th, Env) RiT(Th, Emb, FI)	A, B, E, F, G			ASME Section XI, Boric Acid Surveillance Program, and RV Integrity Program		

Issue Management Table Status

- Ad-hoc Committee formed late 2004 to complete the IMT
  - Completed Consequence of Failure in mid year 2005
  - Completed Mitigation, Repair/Replace, I&E Guidance, Gaps end of 2005
  - NSSS vendors key contributors to IMT
- IMT in final review by vendors and utility personnel. Final step is gap and priority determination.
- IMT completion co-funded by MRP and industry materials initiative funds
- MRP to provide ongoing care and feeding, annual updates, etc