Materials Degradation/Aging Action Plan Committee (MAPC)

Bill Pitesa (Duke), MAPC Executive Chair

Scot Greenlee (Exelon), MAPC Technical Chair

Kurt Edsinger (EPRI), MAPC Program Manager

Robin Dyle (EPRI), Senior Technical Executive

Industry/NRC Executive Meeting on Materials Program

August 14, 2015

Outline

- Program Organization
- Technical Issues Update
  - BTP 5-3
  - CASS
  - Irradiated stainless steel crack growth rates
- Primary Systems Corrosion Research (PSCR)
  - New prioritization process
  - 2015 Project List
- EPRI / NRC Cooperative Research
- Current Materials Programs Roadmaps
- Contact Information

Programs to Manage Materials Issues

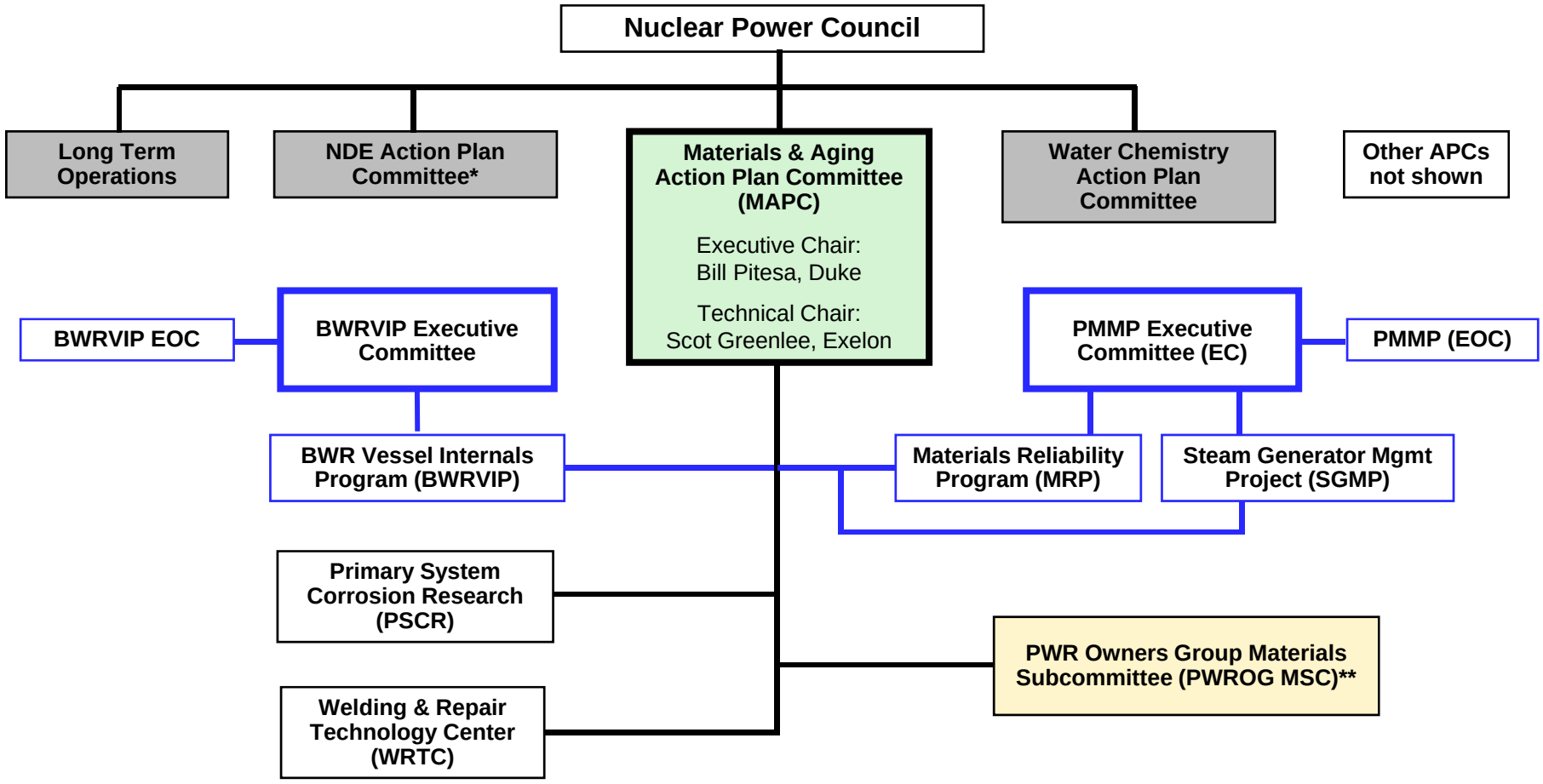
- EPRI Materials Programs
  - BWR Materials (BWRVIP)
  - PWR Materials (MRP)
  - Steam Generator (SGMP)
  - Primary Systems Corrosion Research (PSCR)
  - Welding & Repair Technology Center (WRTC)
- Other Coordinated EPRI Programs
  - NDE
  - Water Chemistry Control
- PWR Owners Group
  - Materials Subcommittee (MSC)

Materials Action Plan Committee (MAPC)

"Beginning January 1, 2010, the EPRI Materials Degradation and Aging Action Plan Committee has the principal role for overseeing industry activities related to primary system materials and the continuing commitment to the Industry Materials Initiative (NEI 03-08).

Source: EPRI Operations Protocol

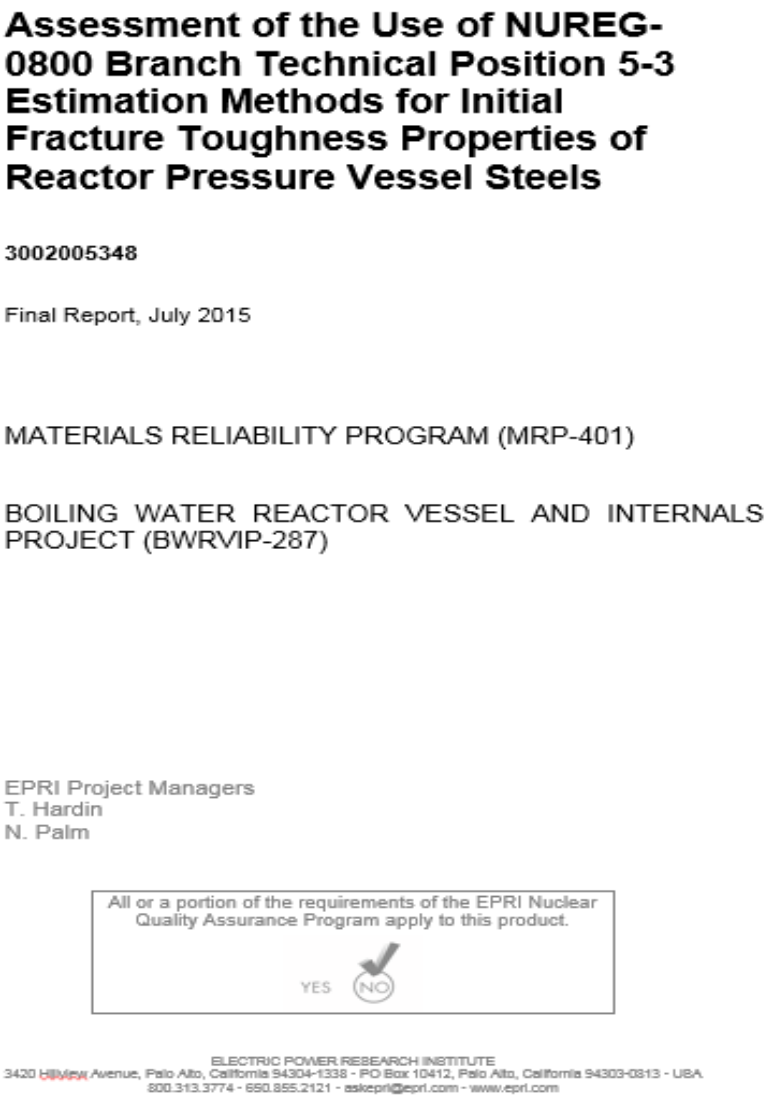
Materials Organizational Structure



**NDE APC coordinates with Materials APC and PWR Owners Group*
***Materials Subcommittee has a representative on Materials APC*

Update on Branch Technical Position 5-3

- MRP-401/BWRVIP-287 to be published in August 2015
- Report will be provided to NRC for information
- BWRVIP & MRP are also sponsoring a separate study by GEH to evaluate the "GE procedure" (NEDC-32399P-A) for determination of Initial RT_{NDT} for nozzles
  - Project is in progress and is to be completed by end of 2015



Assessment of the Use of NUREG-0800 Branch Technical Position 5-3 Estimation Methods for Initial Fracture Toughness Properties of Reactor Pressure Vessel Steels

3002005348

Final Report, July 2015

MATERIALS RELIABILITY PROGRAM (MRP-401)

BOILING WATER REACTOR VESSEL AND INTERNALS PROJECT (BWRVIP-287)

EPRI Project Managers
T. Hardin
N. Palm

All or a portion of the requirements of the EPRI Nuclear Quality Assurance Program apply to this product.

YES NO

ELECTRIC POWER RESEARCH INSTITUTE
3420 Hillview Avenue, Palo Alto, California 94304-1338 - PO Box 10412, Palo Alto, California 94303-0813 - USA
800.313.3774 - 650.855.2121 - askepri@epri.com - www.epri.com

CASS in Reactor Internals

- Issue affects BWRs (BWRVIP-234) and PWRs (MRP-227-A)
- BWRVIP and MRP met with NRC staff 2/18/2014 to understand issues related to thermal and irradiation embrittlement of CASS
  - NRC concerns were use of perceived non-conservative values for CASS chemical compositions (FN), and fluences for onset of irradiation embrittlement
- NRC issued RAIs to PWRs with a proposed new position
- BWRVIP / MRP CASS joint working group established technical position for screening CASS reactor internals
- BWR / PWR position for CASS internals sent to NRC May 23, 2014
- NRC position shared with Industry early June 2014
- Industry meeting with staff 7/15/2014 and follow-on calls to discuss technical issues
- Industry submitted an updated technical basis for CASS screening and a final response to BWRVIP-234 RAIs on 3/9/15
- Call 4/16/2015 NRC committed to provide a detailed review of the technical basis and provide the SE on BWRVIP-234.
- Current schedule for BWRVIP-234 review is for a draft SE to be issued 9/17/2015
- Industry still awaiting NRC response to its technical basis submittal for defining screening for irradiation and thermal embrittlement

Irradiated Stainless Steel Crack Growth Models

- EPRI report has been published: 3002003103 -- “Models of Irradiation-Assisted Stress Corrosion Cracking of Austenitic Stainless Steels in Light Water Reactor Environments”
- The models account for effects of irradiated yield stress (dose), stress intensity K, ECP (electrochemical potential), temperature, type of loading
  - Model for high ECP environment – BWR Normal Water Chemistry (NWC)
  - Model for low ECP environment – BWR Hydrogen Water Chemistry (HWC) & PWRs
- A common model can be used for BWR-HWC and PWR environments with a temperature term to account for higher PWR temperatures
- Report provides the technical basis for crack growth disposition curves for irradiated BWR and PWR stainless steel internals
- Technical basis papers based on the report were presented at the July 2015 ASME Pressure Vessel and Piping Conference in Boston and August 2015 Environmental Degradation Conference
- The papers provide the technical basis to develop an ASME code case
- Initial code case work started 8/5/15 by ASME Task Group

New Approach in Strategic Planning for PSCR R&D

<u>Objective</u>: Effectively integrate PSCR R&D activities into resolution of key materials degradation issues identified in MDM and IMTs

- Expected result will be more focused prioritization, coordination and support across materials programs to optimally utilize the resources and target research at the most appropriate gaps
  - Use IMTs as initial starting point
  - Consider key needs and existing tools
    - Mechanistic understanding -- degradation mechanisms and correlations/models to support model development and mitigation solutions
    - Engineering solutions – develop data, test methods and fundamental models to support IP efforts to close gaps and create engineering solutions in areas such as assessment methodologies, guidelines, codes/regulations, etc.

List of 2015 PSCR Projects

Irradiated materials	Development of Radiation Resistant Material (ARRM)
	CT size and orientation effects on IASCC (Zorita)
	IASCC CGR Models Codification
	Modeling of irradiated mechanical properties & Fracture Toughness
	Small-volume mechanical property evaluation for irradiated materials
	Effects of high fluence neutron irradiation on localized deformation and IASCC
	Develop engineering solutions to counter IASCC
	Rapid Simulation of High Fluence -- Ion radiation of LWR irradiated FTT
	Round Robin – APT Data Acquisition and Analysis for Irradiated SS
SCC	Determine distinct SCC dependence (e.g. effects of microstructures)
	Investigate GB oxidation of Alloy 600/600TT in PWR *(in discussion with PNNL)*
EAF	Mechanistic understanding of loading effects on EAF CGR
	Investigation the effects of irradiation on EAF CGR
	Mechanistic model for environmental fatigue CGR
MDM	Development of MDM-VVER & CANDU - IMT
	Revision of Materials Handbook
	Materials Information Portal (MIP) update

EPRI MRP/U.S. NRC - Cooperative Research

Current

- A690 PWSCC Initiation & Crack Growth Testing
- Extremely Low Probability of Rupture (xLPR)
- Welding Residual Stress (WRS) FEA Model Validation
- Irradiation Material Testing: Zorita Internals Research Project (ZIRP)
- Additional Testing on Additional Zorita Materials (Weld and HAZ)
- Crack Growth Rate expert panel
- Note: Master EPRI / NRC MOU expires September 2016

Materials Roadmaps

1. BWR and PWR Irradiated Materials Testing and Degradation Models
2. Steam Generator Foreign Object Management
3. Steam Generator Degradation Prediction and Mitigation
4. Management of Jet Pump Flow-Induced Vibration
5. Ensuring Reactor Pressure Vessel Integrity Through Eighty Years of Operation
6. PWR reactor internals aging management
7. Welding of Irradiated Materials for PWR and BWR Internals
8. Alloy 52 Nickel-Base Filler Metal Weldability Solution
9. High Chromium Weld Metal Development and Cracking Mechanisms
10. Aging Management of Alloy 600 and Alloy 82/182 in the Steam Generator Channel Head Assembly
11. Mitigation of Boiling Water Reactor Materials Degradation

Materials Roadmaps (cont'd)

12. Fatigue Management in Boiling and Pressurized Water Reactor Coolant Systems
13. Pipe Rupture Probability Re-Assessment (XLPR)
14. Primary Water Stress Corrosion Cracking Characterization of Alloy 690 and Weld Metals
15. Advance Welding Process development in the Nuclear Power Industry
16. Incorporation of Fabrication, Repair and Joining Technologies in Nuclear Codes and Standards
17. Steam Generator Tube Integrity Assessment
18. Understanding of Environmental Effects on Fracture Properties
19. Characterizing and Controlling Weld Residual Stress*
20. Stress Corrosion Cracking of Stainless Steel in a PWR Environment*
21. Powder Metallurgy – Hot Isostatic Pressing for RPV Internals and Pressure Retaining Applications*

* Denotes new roadmaps

MAPC Key Contact Information

- MAPC Executive Chairman

  Bill Pitesa, Duke, Senior Vice President and Chief Nuclear Officer
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  - E-Mail: bill.pitesa@duke-energy.com

- MAPC Technical Chairman

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  - Email: scot.greenlee@exeloncorp.com

- MAPC Program Manager

  Kurt Edsinger, EPRI, Director of Materials
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- Primary NRC Liaison for Materials

  Robin Dyle, EPRI, Senior Technical Executive,
  - Phone: 205-426-5371
  - Email: rdyle@epri.com

2016 International LWR Materials Conference

International Light Water Reactors

Material Reliability Conference & Exhibition 2016

August 1-4, 2016

Call for Abstracts out!

EPRI Long Term Operations Program

Mike Gallagher

VP License Renewal, Exelon

Sherry Bernhoft
Program Manager, EPRI

Senior Managers Meeting on Materials
August 14, 2015

EPRI LTO Program Goals and Objectives

- Technical basis for ***decision*** to operate through extended life time
  - Supports business case for life extension and refurbishments
- Technology to ***manage*** plant assets throughout the lifetime
  - Aging management, asset management and risk management
  - Addresses safety, performance and costs
- US supports Subsequent License Renewal (SLR)
  - Close coordination and collaboration with DOE-LWRS Program, NEI LR Tasks Force and Owners Groups
- International supports implementation of IGALL Aging Management Programs
  - Close coordination with IAEA and international R&D partners

On track to provide program deliverables in the 2014 through 2019 timeframe.

EPRI LTO Program Advisory Structure

EC

- EPRI Nuclear Executive Committee
- Meets twice per year

IC

- LTO Integration Committee – Executive Sponsor and Senior Utility Managers
- APS, CANDU Owners Group, Dominion, Duke, Entergy, NPPD, Exelon, EDF, FENCo, STP, Southern Co, Xcel
- Meets three times per year and conference calls
- Responsible for LTO Issue Tracking Matrix and Prioritization

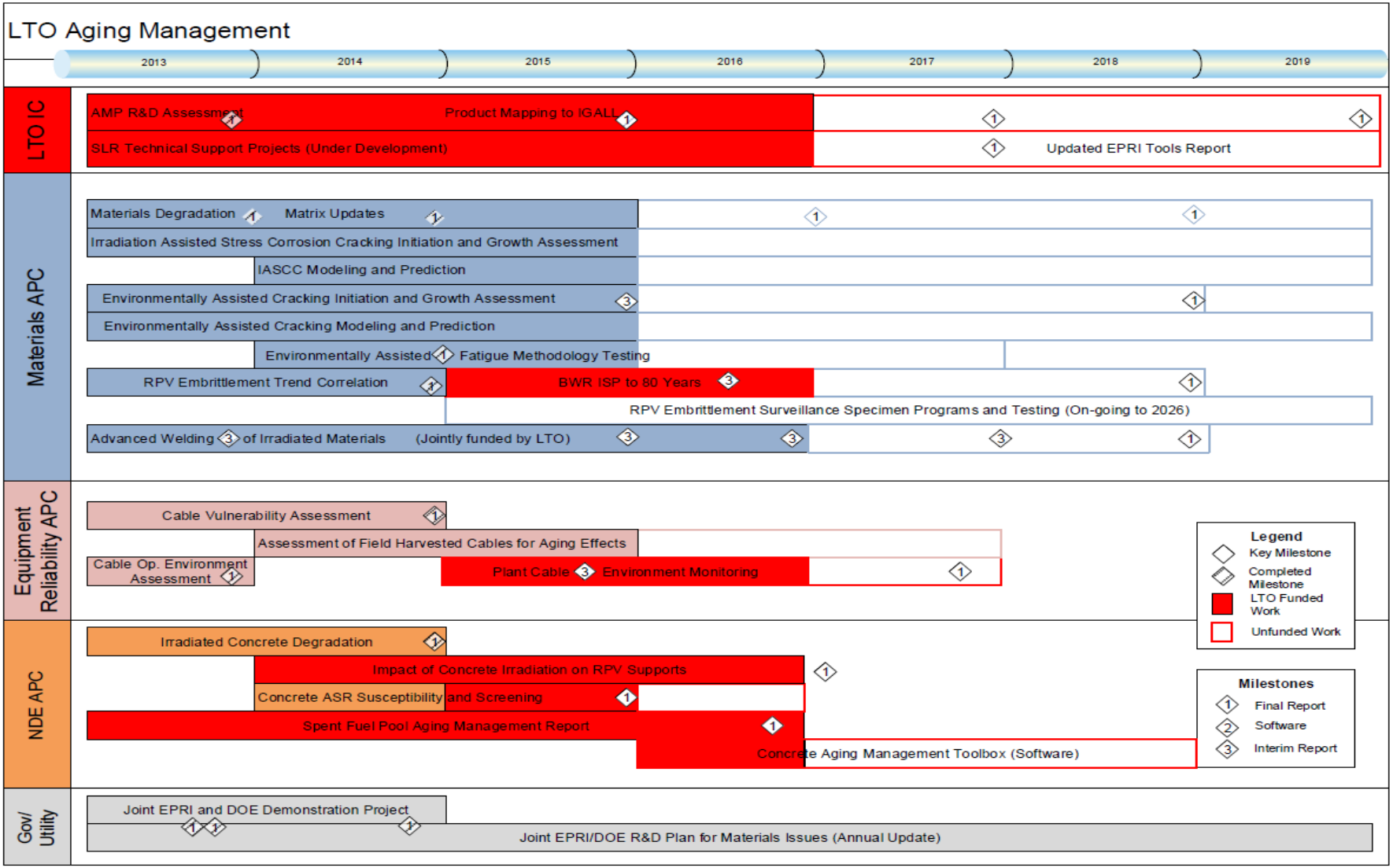
TAC

- Long-Term Operations Technical Advisory Committee
- Managers and Senior Engineering Staff
- Open to all EPRI Members
- Meets twice per year

EPRI LTO R&D Projects

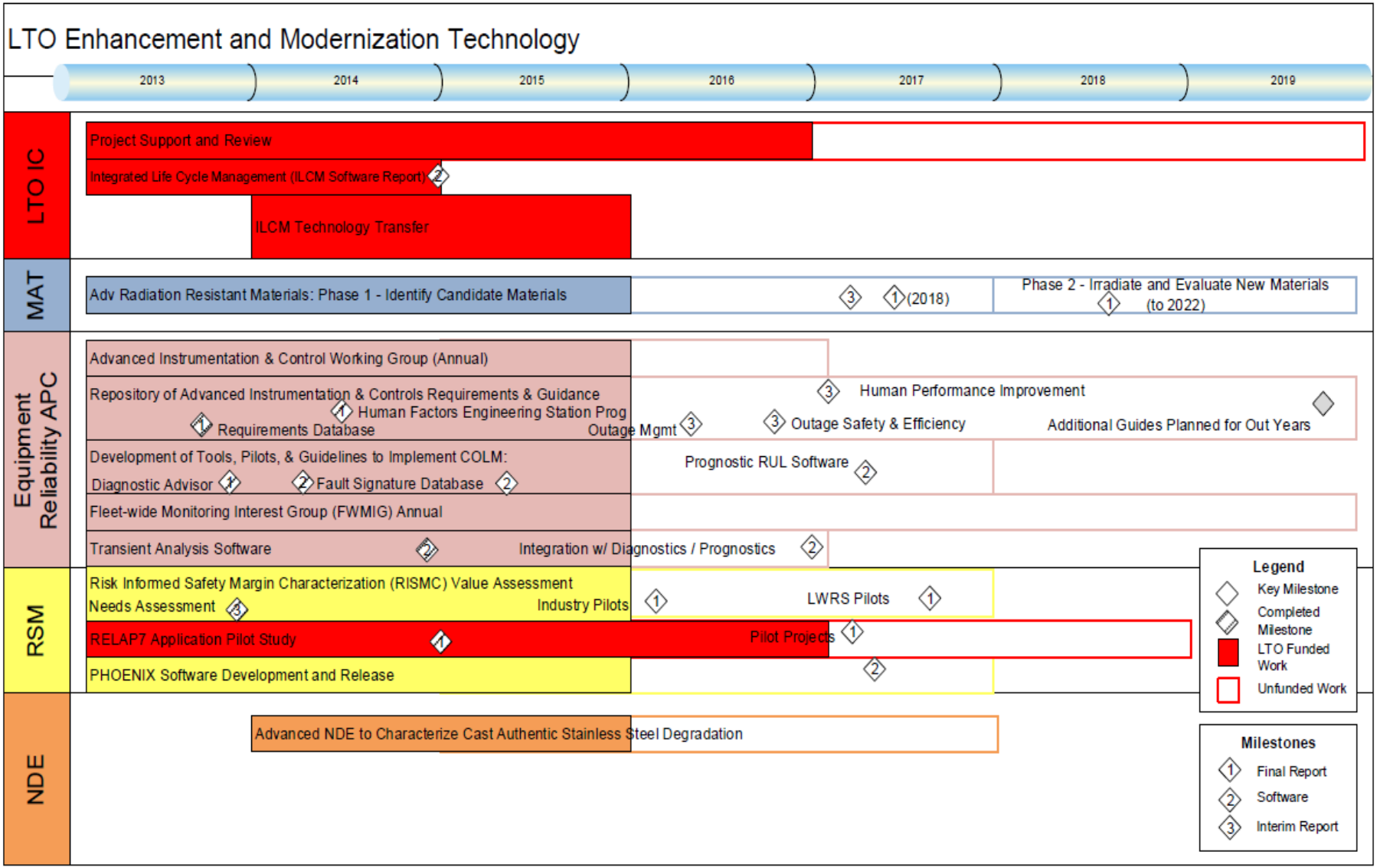
- **Aging Management Research**
  - RCS primary system metals
    - Advanced welding for highly irradiated materials - repair strategy
    - Advanced radiation resistant materials - future replacement strategy
  - Reactor pressure vessel embrittlement
  - Concrete and concrete structures
  - Electrical cable systems
- **Opportunity for Modernization**
  - Centralized on-line monitoring
  - Advanced I&C
  - Enhanced safety and risk analysis
- **Enabling Technologies**
  - Integrated Life Cycle Management
  - Plant Demonstration Projects

Aging Management Roadmap



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Opportunities for Modernization Roadmap



Initial Screening of EPRI Documents - Results

Purpose:

Identify EPRI documents that could potentially require revision or new content to support licensee implementation of an AMP for second license renewal (SLR)

Issue Program	# Documents Screened	# Documents Screened OUT	# Documents Screened IN For detailed review
BWRVIP	335	242	93
MRP	592	513	79
SGMP	501	478	23
TOTAL	1,428	1,233	195

Document Detailed Review Summary

No new / unanticipated issues identified

Relatively few documents require revision for SLR. A number of cases identified where clarifications would be helpful to users

Existing technical guidance is adequate to enter into the 60 year window of operation

Issue Program	# Documents Reviewed	NCR	NCR*	Change Needed
BWRVIP	93	47	25	20
MRP	79	46	13	16
SGMP	23	21	1	1
TOTAL	195	114	39	37

Results Summary

- Most significant BWRVIP issue identified is 80-year ISP
  - Driven by RPV material surveillance limitations
  - Most internals I&E guidelines already include periodic examination requirements not tied to plant life
- Most significant MRP issue identified is updating MRP-227 to address 60-80 year operations
- Prioritization and schedules for the document reviews are being developed and will be shared with Industry Executive Management
- Results will be shared with the NRC end of 2015

LTO Program Deliverables – EPRI.com

3002005545	WRTC: Weldability of Irradiated Materials	Dec 2015
3002005447	Feasibility Study of Using Nonlinear UT for Concrete Creep	Dec 2015
3002005517	Installation of Radiation and Temperature Monitors for Cable Aging	Nov 2015
3002005389	Tools for Early Screening of ASR in Concrete	Oct 2015
3002005325	Intelligent Plant Configuration Using Wireless Sensors	July 2015
3002005485	EPRI Product Mapping to IAEA International-GALL	July 2015
3002004656	Integrated Life Cycle Management v2.0	Dec 2014
3002003010	Integrated Life Cycle Management	Dec 2014
3002003110	Data Sources for Next Generation Safety Codes	Dec 2014
3002002770	Guidance for Developing a HU Engineering Program	Dec 2014
3002002998	2014 Long-term Operations Program Plans and Issue Tracking	Nov 2014
3002004304	Fleet-Wide Prognostics and Health Management Suite	Nov 2014
3002002996	Report on Containment Tendon Monitoring at R.E.Ginna	Oct 2014
3002004263	Fleet-Wide Prognostics and Health Monitoring Database	July 2014
3002002762	Fleet-Wide Prognostics and Health Monitoring v1.2	June 2014
3002003001	Evaluation of KEMA Smart Cable System for Discharge Detection	May 2014
3002002672	Expected Condition of Reactor Cavity Concrete After 80 Years	Mar 2014
3002000816	Temperature and Radiation Dose for Installed Cables	Dec 2013
3002002335	Augmented Containment Inspection and Monitoring	Dec 2013
3002000580	Reactor Vessel International Inspection at Ginna and NMP	Dec 2013

BWR Vessel & Internals Project (BWRVIP)

Tim Hanley (Exelon)
BWRVIP Executive Committee Chair

Andy McGehee (EPRI)
Program Manger, BWRVIP

Industry/NRC Executive Meeting on Materials Programs

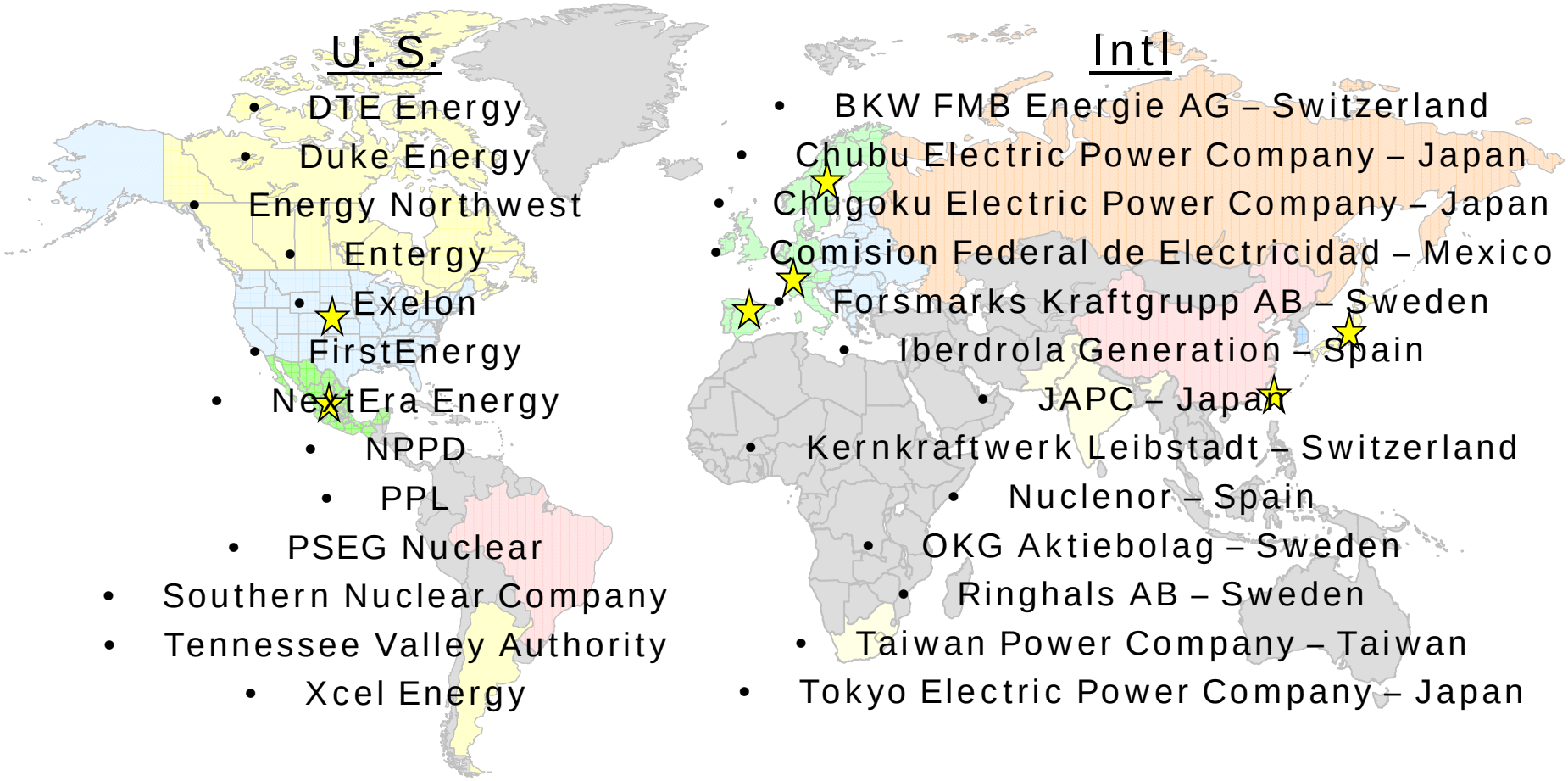
August 14, 2015

Overview Outline

- Current Members and Organization
- 2015 BWRVIP Major Tasks
- Status of Key Topics with NRC
- Contact Information

Current Members and Organization

2015 BWRVIP Member Utilities



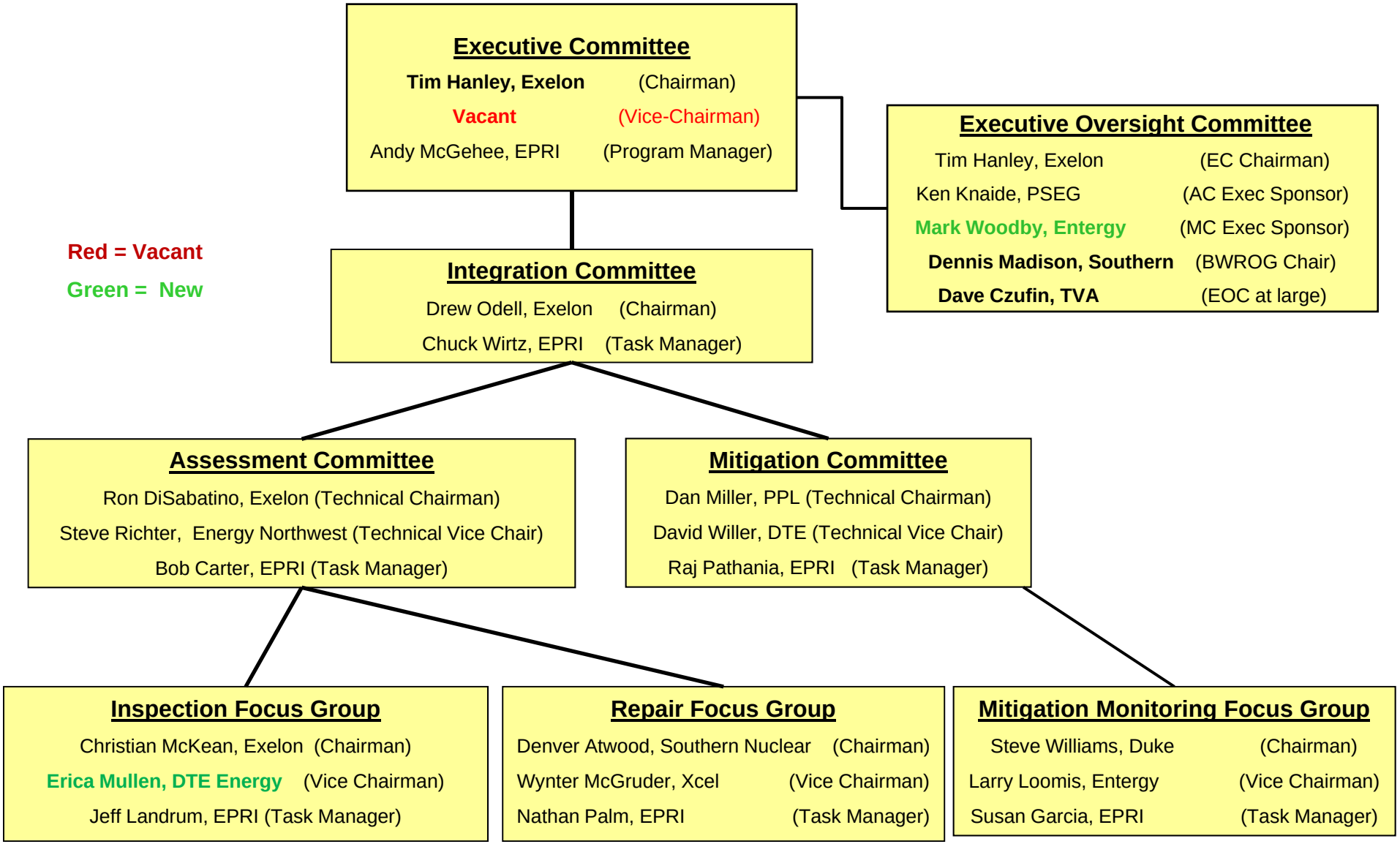
U. S.

- DTE Energy
- Duke Energy
- Energy Northwest
- Entergy
- Exelon
- FirstEnergy
- NextEra Energy
- NPPD
- PPL
- PSEG Nuclear
- Southern Nuclear Company
- Tennessee Valley Authority
- Xcel Energy

Intl

- BKW FMB Energie AG – Switzerland
- Chubu Electric Power Company – Japan
- Chugoku Electric Power Company – Japan
- Comision Federal de Electricidad – Mexico
- Forsmarks Kraftgrupp AB – Sweden
- Iberdrola Generation – Spain
- JAPC – Japan
- Kernkraftwerk Leibstadt – Switzerland
- Nuclenor – Spain
- OKG Aktiebolag – Sweden
- Ringhals AB – Sweden
- Taiwan Power Company – Taiwan
- Tokyo Electric Power Company – Japan

2015 BWRVIP Organization



2015 BWRVIP Major Tasks

2015 BWRVIP Major Tasks

- Evaluation of Shroud Cracking (NDE & Boat Sample Analysis at Hatch Unit 1)
  - See following slides for an update
- Address Jet Pump Flow-Induced Vibration Issues
  - See following slides for an update on the BWRVIP's Full Scale Jet Pump Test Facility
- BWRVIP activities addressing GEH Safety Communications (SC)
  - Industry survey showed site owners are aware of SC's and can apply them as applicable
  - BWROG is working on finite break opening time independent of BWRVIP actions
  - BWRVIP is focused on revising its I&E guidelines
- Optimization of BWRVIP I&E Guidelines
  - See following slides in NRC interaction for update

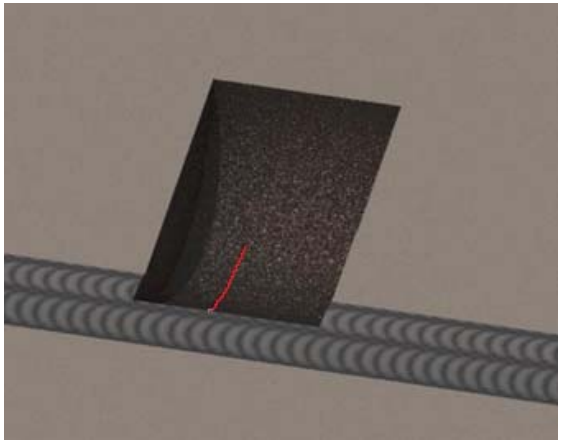
Core Shroud Inspection and Boat Sample Testing

Background

- Atypical cracking found during 2008 ID visual inspections of core shroud
  - Similar but less extensive cracking observed at several other BWRs
  - Cracking did not have characteristics typical of IGSCC
  - Cracking might be the result of IASCC
- BWRVIP Focus Group formed in 2010 to investigate cause of cracking
  - Focus Group recommended evaluation of Hatch cracking to determine cause and support recommend future actions
  - BWRVIP report issued in 2011 recommended UT inspection to further characterize length, depth and orientation of flaws, and removal of boat sample
  - UT development and boat sample removal performed in Spring 2014

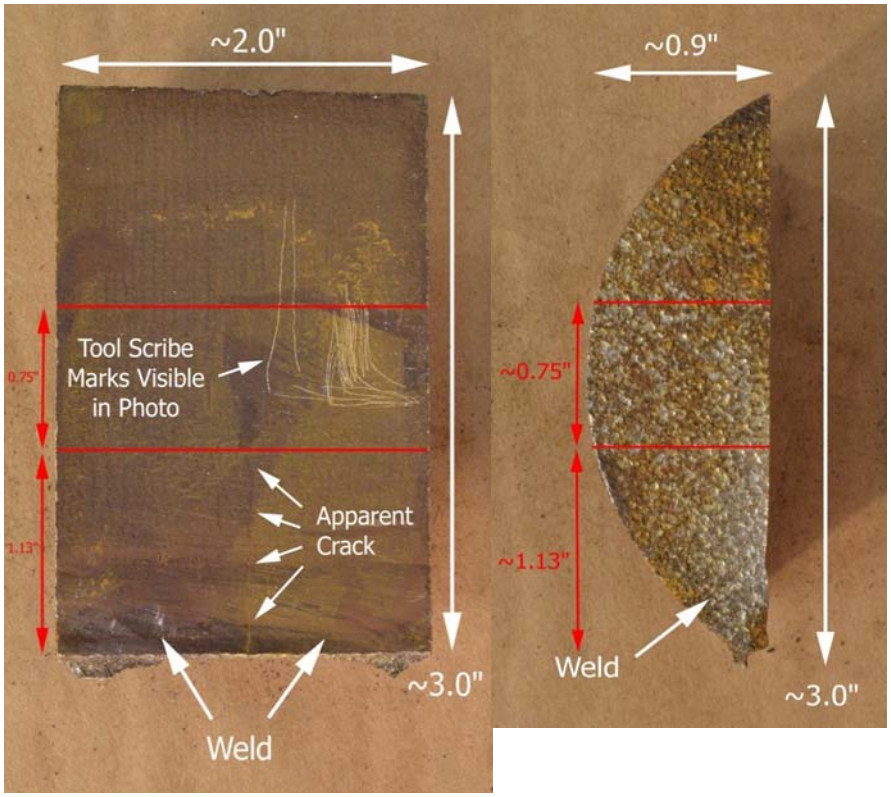
Boat Sample Location Selection

- Locations for boat sample were pre-selected based on 2008 visual inspection results
- Sample depth sizing and removal was a critical path activity, thus decision tree developed and used to select between locations based on UT results
- Sample taken at a location of high fluence where flaw was ~0.8” deep
- Boat sample:
  - Approximately 2”x3”x1”
  - Contains weld and base metal
  - Crack extends from weld into base metal (perpendicular to H4)



Boat Sample

- Sample taken at a location ~9.5” counter-clockwise from V4 and ~1.5” above H4
- Captured flaw - 0.82” max depth
- Weld, heat-affected zone, and base metal captured
- Utility removed boat sample
- BWRVIP is funding testing and evaluation of the boat sample
- Boat sample evaluation being performed by team of SIA, B&W, and PNNL



Boat Sample Evaluation

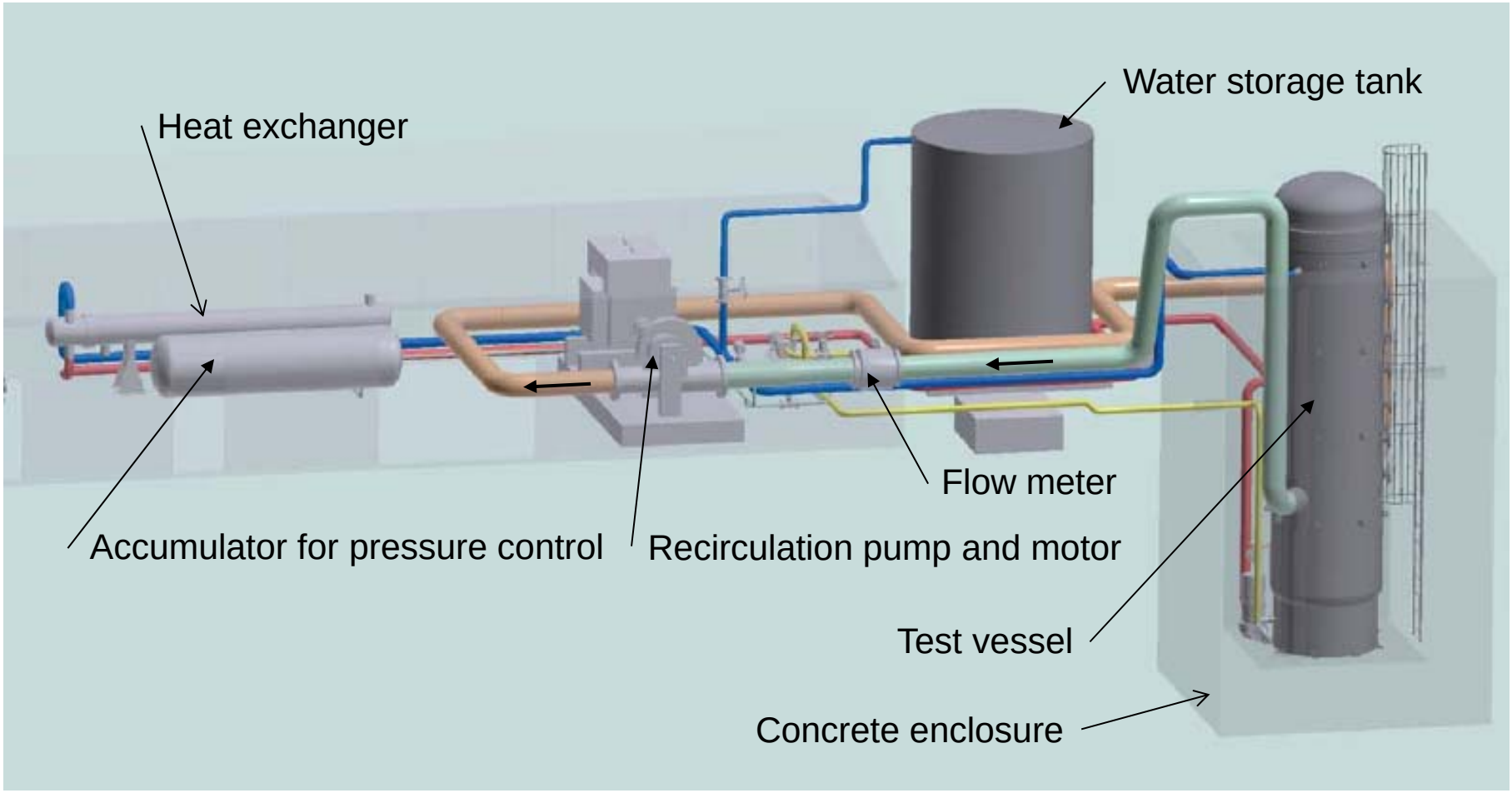
- Boat Sample testing is an example of proactive activities by the industry to support fundamental research versus being driven by requirement.
- BWRVIP is funding testing and analysis of the boat sample to determine cause of cracking
- Boat sample schedule:
  - Shipment of boat sample was completed September 2014
  - Laboratory analytical work completes 3rd quarter 2015
  - Final report to be published by end of 2015

Ongoing BWRVIP Activities

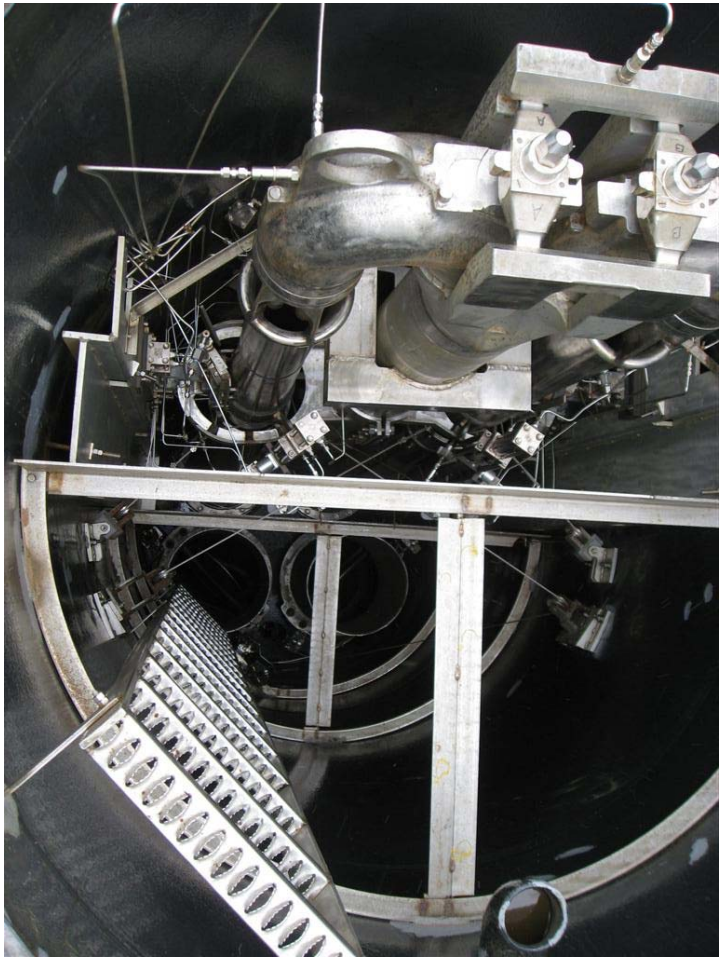
- BWRVIP Focus Group evaluating required actions
  - Near term
    - Interim inspections, prior inspection data review, etc.
    - Is adequate guidance available for evaluating indications (structural and leakage)
  - Longer term
    - Monitoring of fleet inspection results
    - Review boat sample results
    - Revise shroud inspection guidance as necessary

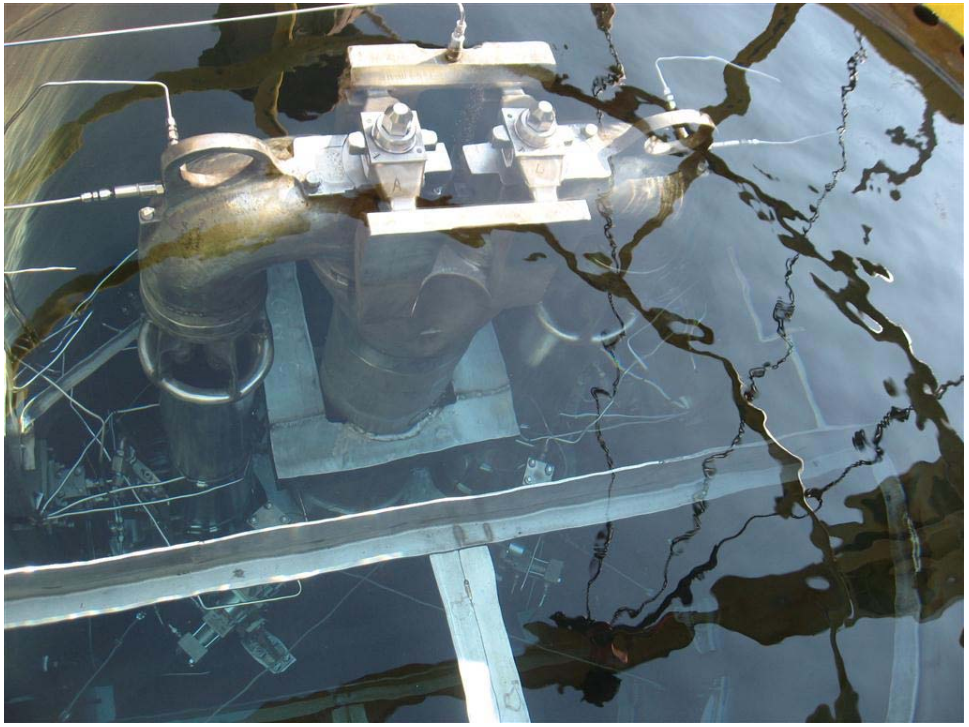
Jet Pump Testing

Full Scale Jet Pump Test Facility



View from Top of Pressure Vessel





Filled with water

Status of Full Scale Jet Pump Testing

- Testing of the facility in the BWR/5 jet pump configuration was completed in Fall of 2012 and demonstrated that the test facility met all flow, temperature and pressure requirements, and was able to replicate the flow-induced vibration (FIV) phenomena.
- The test facility was reconfigured to a BWR/4 jet pump design in late 2014 thru early 2015.
- BWR4 testing has been initiated with expanded testing scope being considered.
- Upon completion of BWRVIP testing, vendor demonstrations of FIV repair hardware can be performed.
- Vendors and utilities may use the facility for hardware developmental testing.

Jet Pump Interim Guidance

- Based on operating experience in the U.S. and international BWR fleets, and the results of the BWR/5 testing at the BWRVIP's full scale jet pump testing facility, interim jet pump inspection guidance has been issued for certain BWR/5 plants.
  - The guidance requires accelerated inspection frequencies for riser brace to riser pipe (RS-9) welds for the susceptible BWR/5 plants unless they have installed flow induced vibration (FIV) mitigation devices.
- The interim guidance was issued as NEI 03-08 guidance and is consistent with the BWRVIP's commitment to consider the impact of research results and OE on BWRVIP guidance and adjust that guidance where necessary.

Status of Key NRC Topics

Status of Key Topics with NRC

- BWRVIP Optimized Inspection & Evaluation (I&E) Guidelines
  - BWRVIP-18, Revision 2, Core Spray I&E Guidelines
  - BWRVIP-41, Revision 4, Jet Pump I&E Guidelines
- BWRVIP-183, Top Guide Grid Beam I&E Guidelines
- BWR Integrated Surveillance Program (ISP) Capsule Report Extension Requests

BWRVIP Optimized I&E Guidelines

- BWRVIP I&E Guidelines were developed from 1994 to 1999 and largely based on safety considerations and potential degradation mechanisms including limited inspection results
  - Program based on normal water chemistry, thus no credit taken for or consideration of SCC mitigation via improved water chemistry (MHWC/NMCA)
- Post-implementation of I&E Guidelines
  - Significant inspection data generated which provides insight regarding component degradation trends 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

BWRVIP Optimized I&E Guidelines

- What is changed
  - Incremental changes to the inspection requirements
  - In general, inspection frequency and/or sample size requirements are relaxed, but some are increased
  - More credit for volumetric exams (incentivize its use)
- What is not changed
  - Safety bases
  - Flaw evaluation methodologies
  - Leakage analysis requirements
  - Hidden weld guidance
- Two Optimized I&E Guidelines currently under NRC review
  - BWRVIP-18, Rev. 2, Core Spray I&E Guidelines
  - BWRVIP-41, Rev. 4, Jet Pump I&E Guidelines

Status of BWRVIP-18, Rev. 2

- BWRVIP-18, Rev. 2 submitted to the NRC in May 2012.
- Draft SE received from the NRC on February 23, 2015.
  - Draft SE did not accept the Rev. 2 guidance for creviced welds
  - Draft SE included significant conditions on the use of the Rev. 2 guidance for uncreviced welds
- BWRVIP notified NRC of concerns with the draft SE and a meeting was held May 27, 2015 to discuss them.
- NRC was open to BWRVIP feedback and said it would be considered before issuing final SE.
- On a July 8th call to discuss the NRC review status for BWRVIP reports, the NRC informed the BWRVIP that a revised draft SE that addresses many of the BWRVIP's concerns is expected to be issued within a matter of weeks.

Status of BWRVIP-41, Rev. 4

- BWRVIP-41, Rev. 4 submitted to the NRC in Sept 2014.
- Initial Feedback from NRC during acceptance review included many questions on guidance within Rev. 4 that was unchanged from the previously NRC approved revision of BWRVIP-41.
- Number of review hours spent on acceptance review and initial estimates for hours to complete the review were much higher than typical for BWRVIP I&E guidelines.
- BWRVIP's concerns discussed on April 16, teleconference between the BWRVIP Chairman, Tim Hanley, and John Lubinski.
- Since the call, the NRC indicated they will concentrate their review on the incremental changes to the inspection requirements in BWRVIP-41, Rev. 4 and issued the acceptance for review letter on 4/23/15.

Status of BWRVIP-183

- BWRVIP-183, Top Guide Grid Beam I&E Guidelines, submitted to the NRC in January 2008.
- Draft SE received from the NRC on December 13, 2011
  - Draft SE contained unanticipated significant conditions
  - Conditions were based on NRC not accepting the BWRVIP's evaluation methodology for grid beam flaws and thus requiring inspection of existing flaws every outage
- BWRVIP notified NRC of concerns with the draft SE and asked the NRC to hold issuance of the final SE in abeyance until the BWRVIP had an opportunity to respond to the draft SE.
- However, the BWRVIP failed to provide a response in a timely manner.

Status of BWRVIP-183 (cont.)

- In the mean time, the NRC included BWRVIP-183 as an acceptable aging management program for grid beams without the conditions.
- License Renewal (LR) Division currently leveraging LR applicants to commit to the conditions based on the draft SE.
- NRC notified BWRVIP via a June 12, 2015 letter that they intend to proceed with issuing the SE for BWRVIP-183.
- On July 27, 2015, the BWRVIP did provide a response to the BWRVIP-183 draft SE. Although the response was not timely, the extra time allowed the BWRVIP to collect several years of grid beam inspection experience, including reinspections of existing flaws, that supports the BWRVIP's position.
- The BWRVIP asks that the NRC consider our response to the draft SE before issuing the final SE.

BWR ISP Capsule Report Extension Requests

- To facilitate the BWRVIP's ISP capsule testing process, capsule reports cannot be completed within the 10 CFR 50, Appendix H one-year requirement and thus extensions to 18 months are necessary.
- Most recently, formal submittals for ISP capsule withdrawals at Susquehanna 1, Duane Arnold and Perry were made. All were submitted 6 months in advance of the need date.
- The extension requests were reviewed by the technical staff, but only Perry received an approval letter from DORL before the capsule pull anniversary date.
- NRC informed BWRVIP that DORL did not issue approval letters for Susquehanna and Duane Arnold because they would have been after the fact (i.e., the NRC completed the reviews after the one year date had already passed and the capsule reports were already submitted).
- BWRVIP would like to work the NRC so future requests and approvals can be provided before the capsule one year anniversary date.
- ISP capsule at Hope Creek pulled April 18, 2015 and extension request submitted May 11, 2015.

BWRVIP Key Contact Information

- BWRVIP Executive Chairman

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  Andy McGehee

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PWROG Materials Committee Update

Scot Greenlee (Exelon)

Technical Chairman of the Materials Action Plan Committee

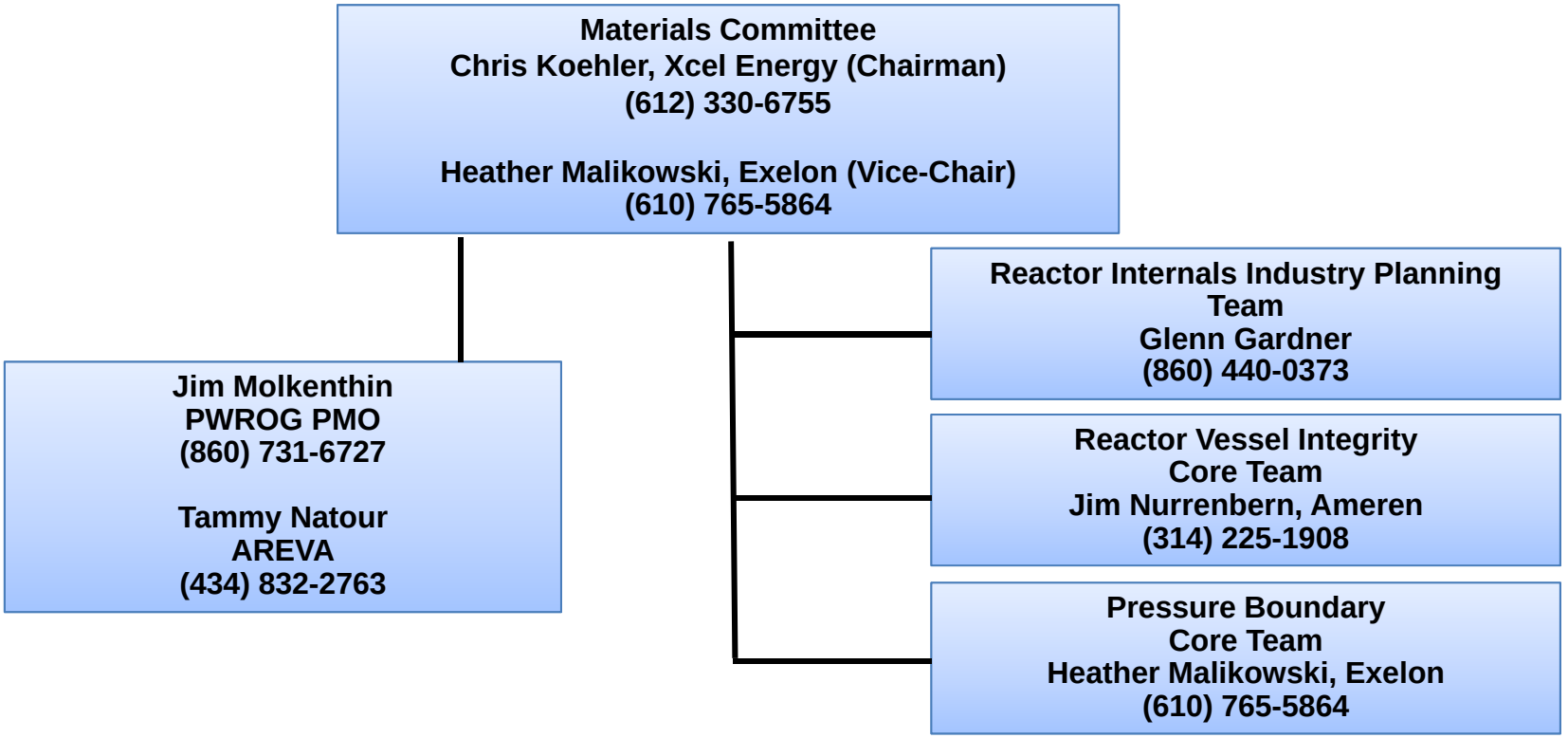
Annual Materials Programs Executive Information Exchange Meeting August 2015

PWR Owners Group MSC Agenda

- PWROG MSC Key Strategic Areas Core/Planning Team Organization
- PWROG MSC/NRC Interactions
- PWROG MSC Areas of Coordination & Strategic Planning with MRP
- PWROG MSC Focus Areas for 2015-2016

Annual Materials Programs Executive Information Exchange Meeting August 2015

PWROG MSC Key Strategic Areas Core/Planning Team Organization



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PWROG MSC/NRC Interactions

- **NRC Staff has requested PWROG-15003, "Materials Orientation Toughness Assessment" (MOTA), for information**
  - NRC/Industry meeting held in February and June 2015 to discuss BTP 5-3 issue.
  - Official request via email made for the subject report. On schedule to be provided to the Staff in September 2015.
- **Responded to Additional RAIs on WCAP-17096, "Reactor Internals Acceptance Criteria Methodology"**
  - Draft SE received in February 2013. The PWROG has worked to eliminate or simplify compliance demonstration where possible for some of the SE requirements.
  - Additional RAIs received and responses provided in May of 2015 to support NRC schedule.
  - NRC schedule:
    - Original: Provide final SE in August 2015.
    - Current: Final SE delayed to the end of November 2015 due to NRC resource constraints.
  - Working on "A" version of report, which is now scheduled to be completed in early 2016.

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PWROG MSC/NRC Interactions – Cont'd

- **WCAP-14048, "Lower Support Column Functionality"**
  - Meetings held in October and December 2014 with the NRC to review the lower support column functionality analysis methodology and sample plant application.
  - Report submitted to the NRC for information in March 2015. Questions received from the NRC in May 2015 and a call with the Staff took place in June 2015. These questions were generally aligned with the planned direction of follow on phases of the project
  - Working with the NRC to address additional questions.
  - Goal is to provide guidance for the fleet to assess potential for and manage aging.

- **WCAP-17451 "Guide Card Wear"**
  - WCAP submitted to the NRC for information as part of industry effort for generating MRP-227 revision 1.
  - Guidance in the PWROG document directly included in revision 1 of MRP-227 which is currently in process for MRP approval and publication.

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PWROG Areas of Coordination & Strategic Planning with EPRI MRP

- **Reactor Vessel Integrity**
  - ✓ Participating in ASTM E10.02 to remove conservatism from sigma term of consensus embrittlement trend curve (ETC).
  - ✓ Creating plan to transition RV integrity to direct fracture toughness.
  - ✓ Following BTP 5-3 non-conservatism issue and demonstrated “MOTA” margin.
  - ✓ Industry/NRC Reactor Vessel Integrity meeting held on February 19, 2015.
  - ✓ Working to demonstrate generically that nozzles are never bounding for P-T limits.
- **Reactor Internals**
  - ✓ Coordinating with EPRI MRP on MRP-227 LAI/RAI Responses. March 2015 meeting with NRC staff to discuss the next revision of MRP-227.
  - ✓ Supporting utilities in plant-specific Applicability Determinations, including MRP-191, Fluence, and Cold Worked Stainless Steel.
  - ✓ May 2015 PWROG call with NRC on a statistical approach for generically assessing CASS material in PWR Reactor Internals aligned with published industry and regulatory positions.

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PWROG Areas of Coordination & Strategic Planning with EPRI MRP – Cont'd

- **Stainless Steel Degradation**
  - ✓ Working with the EPRI MRP on the development of I&E guidance for ID and OD initiated Stress Corrosion Cracking (SCC) of PWR Stainless Steel (SS) pressure boundary components.

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PWROG MSC Focus Areas for 2015-2016

- **Work to Support MRP-227-A - Reactor Internals – Ongoing Programs**
  - ✓ PA-MSC-1299 – Guide Card Wear RAI Support
  - ✓ PA-MSC-1288 – PWR Materials Assessment
  - ✓ PA-MSC-1286 - Evaluation of Potential Wear: Thermal Sleeve Flange
  - ✓ PA-MSC-1198 – Clevis Bolt Fabrication and Inspection Status
  - ✓ PA-MSC-1122 - Reactor Vessel Internals Industry Coordination
  - ✓ PA-MSC-1103 - Functionality Analysis: Westinghouse Lower Support Columns
  - ✓ PA-MSC-0983 - Support for Applicant Action Items 1, 2, and 7 from the Final Safety Evaluation on MRP-227, Revision 0 (Working on plant specific requests)
  - ✓ PA-MSC-0473 - Reactor Internals Acceptance Criteria Methodology & Data Requirements (working to complete A-version of WCAP-17096 report)

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PWROG MSC Focus Areas for 2015-2016 – Cont'd

- **Work to Support Reactor Vessel Integrity– Ongoing Programs**
  - ✓ PA-MSC-1207 – Proactively Drive Changes in Reactor Vessel Embrittlement Regulations
  - ✓ PA-MSC-1123 - Reactor Vessel Integrity Industry Coordination and NRC Interaction
  - ✓ PA-MSC-1091 – Demonstrate Excessive Appendix G Margins for PWR RPV Nozzles
  - ✓ PA-MSC-0938 – Update of Surveillance Capsule Fluence Summary Report WCAP-14044
- **Other Programs – Ongoing Programs**
  - ✓ PA-MSC-1300 – PWROG Subsequent License Renewal
  - ✓ PA-MSC-1294 - Development of Contingency Weld Repair Design for Applicable Dissimilar Metal Welds Joining Alloy 600 Branch Connection Nozzles to Primary Loop Piping
  - ✓ PA-MSC-1283 - Evaluation of Applicable Dissimilar Metal Welds Joining Alloy 600 Branch Connection Nozzle to Primary Loop Piping (B&W and Palisades only)
  - ✓ PA-MSC-1182 - Revision to BAW-1543 for Master Integrated Reactor Vessel Program

Questions?

The Materials Committee is established to provide a forum for the identification and resolution of materials issues including their development, modification and implementation to enhance the safe, efficient operation of PWR plants.

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SGMP Program Overview

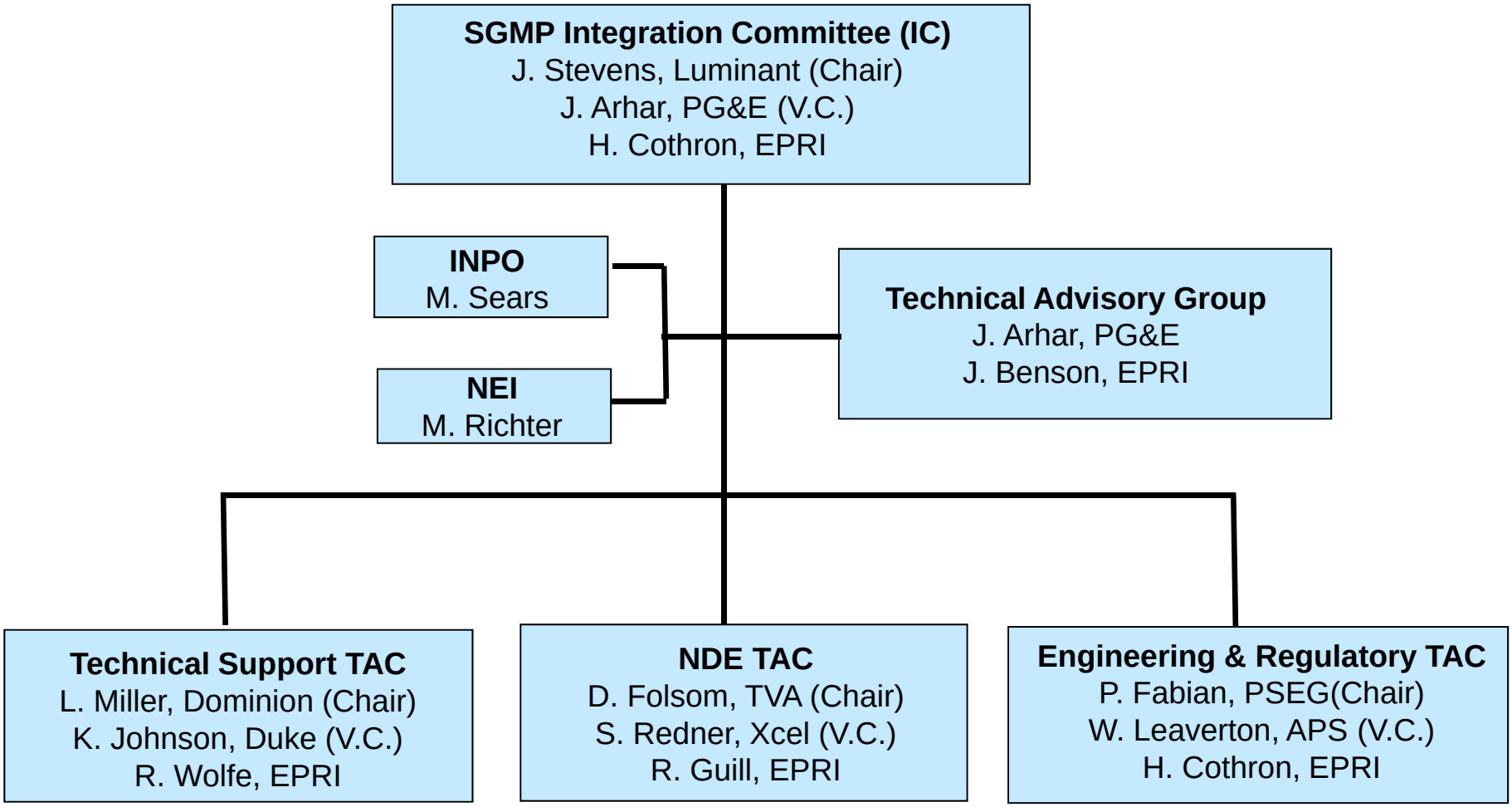
David Czufin (TVA)
PMMP Chairman

Helen Cothron (EPRI)
Program Manager, SGMP

Industry/NRC Executive Meeting on Materials Programs

August 14, 2015

EPRI SGMP Organization



SGMP Guideline Status (Page 1 of 2)

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comments
SG Integrity Assessment Guidelines	3	1019038	Nov 2009	9/1/10	SGMP-IG-10-01 SGMP-IG-12-01	N/A	Rev 4 in progress
EPRI SG In Situ Pressure Test Guidelines	4	1025132	Oct 2012	10/10/13	SGMP-IG-15-01	N/A	Rev 5 in progress
PWR SG Examination Guidelines	7	1013706	Oct 2007	9/1/08	SGMP-IG-08-04 SGMP-IG-12-01 SGMP-IG-14-02	N/A	Rev 8 in progress
PWR SG Primary-to-Secondary Leakage Guidelines	4	1022832	Sept 2011	4/11/12 7/11/12	None	2015	

SGMP Guideline Status (Page 2 of 2)

Guideline Title	Current Rev #	Report #	Last Pub Date	Implementation Date(s)	Interim Guidance	Review Date	Comments
PWR Primary Water Chemistry Guidelines	7	3002000505	April 2014	1/28/2015	None	2017	
PWR Secondary Water Chemistry Guidelines	7	1016555	Feb 2009	8/20/09 11/20/09	SGMP-IG-13-01 SGMP-IG-14-01	N/A	Rev 8 in progress
Steam Generator Management Program Administrative Procedures	4	3002005168	March 2015	12/9/15	None	N/A	
Steam Generator Degradation Specific Flaw Handbook	1	1019037	Dec 2009	N/A	None	N/A	Rev 2 in progress

Steam Generator Task Force

- Steam Generator Management Program meets biannually with the NRC staff to discuss:
  - Ongoing research
  - World-wide operating experience
  - Technical issues
  - NEI 03-08 guidance
    - New requirements
    - Deviations

Steam Generator Management Program
Current Issues for the SGMP

- Divider plate and tube-to-tubesheet weld crack propagation
  - NRC staff reviewing final report
  - SGMP provided answers to questions July 30th
- Mechanical wear of tubes due to contact with support structures and foreign objects
  - In-plane fluid elastic instability project
  - Improved thermal-hydraulics code (Triton)
- Improved inspection capabilities
  - Total system performance indices
  - Automated data analysis

Schedule for In-Plane Fluid Elastic Instability Tests

- Prepare for air tests incorporating actions from July 14-15 industry meeting and commissioning tests: August 2015
- Perform air tests: Fall 2015 – March 2016
- Review air-tests and plan Freon tests: April 2016
- Prepare for Freon tests: May – November 2016
- Freon tests: December 2016 – March 2017
- Final reporting: April – August 2017

Materials Reliability Program Overview

David Czufin (TVA)
PMMP Chairman

Anne Demma (EPRI)
Program Manager, MRP

Industry/NRC Executive Meeting on Materials Programs

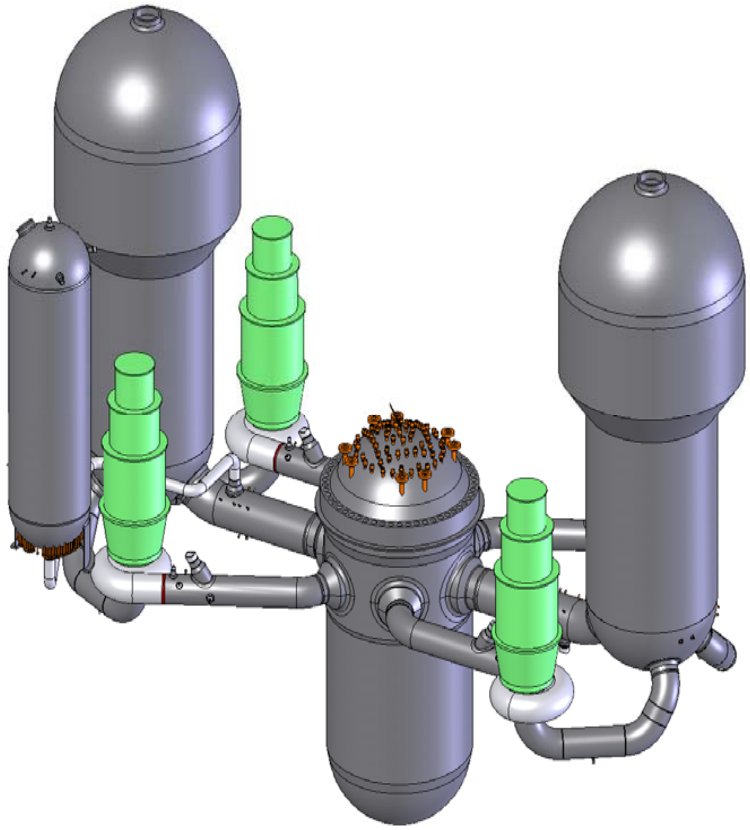
August 14, 2015

Contents

- History, Membership and Organization
- MRP Guidelines
- 2015 MRP Key Deliverables
- Status of Key MRP Topics with NRC
- Contact Information

MRP Brief History

- PWR specific materials issues in the late 1990s led to the formation of the EPRI Materials Reliability Program (MRP) within the Nuclear Sector
- The objective of the MRP is to resolve existing and emerging PWR materials issues
- Key legacy deliverables:

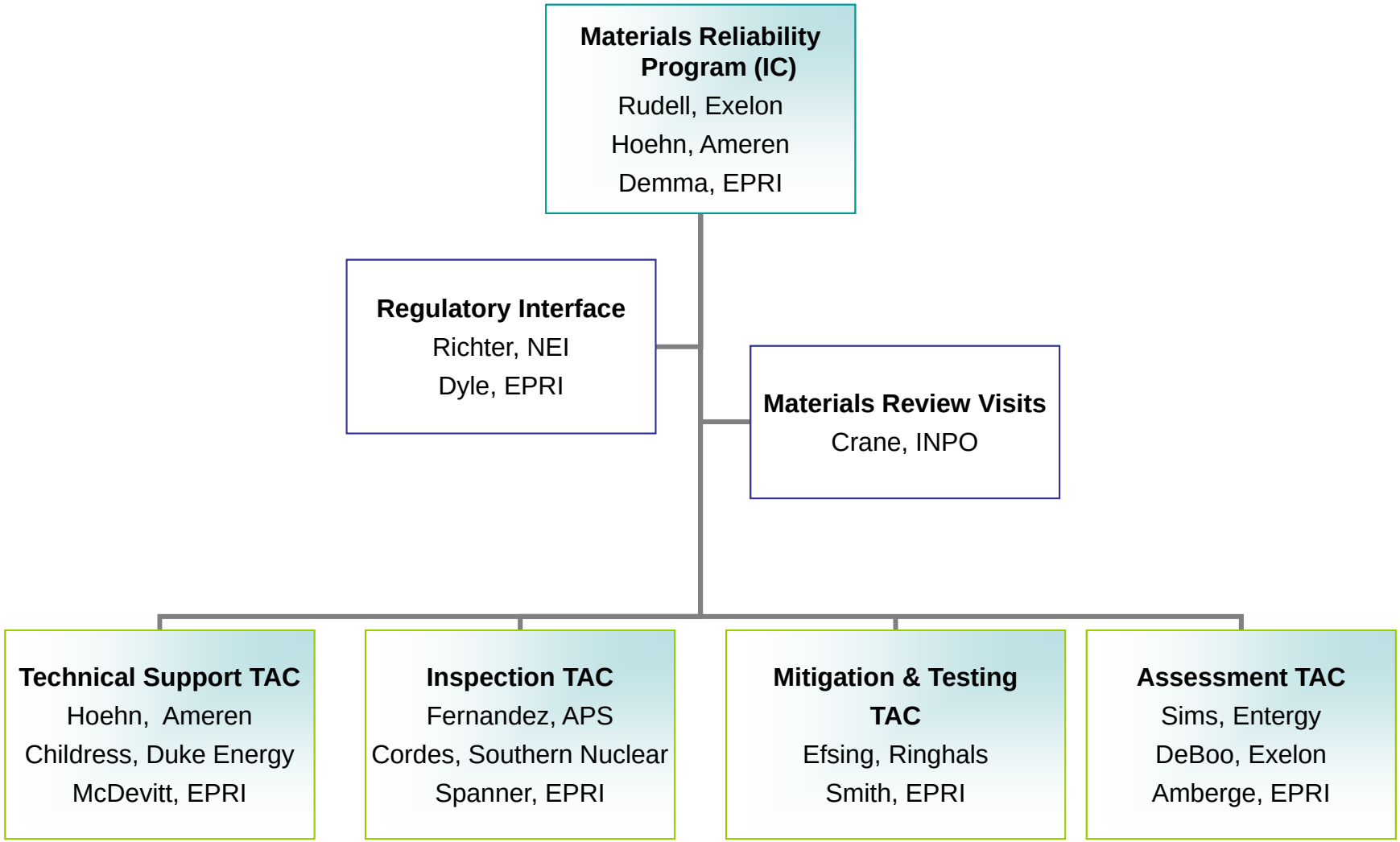


Doc Number (EPRI PID)	Document Title
MRP-126 Rev 0 (1009561)	Generic Guidance for an Alloy 600 Management Plan
MRP-227-A (1022863)	Pressurized Water Reactors Internals Inspection and Evaluation Guidelines

MRP Membership

New members & participants since 2013: EDF Energy, Vattenfall and IHI
Rejoined in 2014: JAPC

MRP Organization



MRP Guidelines Active Requirements

Doc Number	Document Title	Date	Level
MRP-126 Rev 0 (1009561)	Generic Guidance for an Alloy 600 Management Plan	Nov 2004	Mandatory
MRP-146 Rev 1 (1022564)	Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines	Jun 2011	Needed
MRP-2015-019 Rev 0	MRP-146 and MRP-192 Interim Guidance NEI 03-08 Needed and Good Practice Interim Guidance Requirements for Management of Thermal Fatigue	May 2015	Needed
MRP-146S Rev 0 (1018330)	Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines – Supplemental Guidance	Jan 2009	Needed
MRP-192 Rev 2 (1024994)	Assessment of RHR Mixing Tee Thermal Fatigue in PWR Plants	Aug 2012	Good Practice
MRP-227-A (1022863)	MRP 227-A, Pressurized Water Reactors Internals Inspection and Evaluation Guidelines	Dec 2011	Mandatory
MRP 2014-006 Rev 0	MRP-227-A Interim Guidance to inspection requirements of Westinghouse Control Rod Guide Tubes	Feb 2014	Needed
MRP-228 Rev 1 (1025147)	MRP-228 Inspection Standard for PWR Internals	Dec 2012	Needed
MRP 2013-023 Rev 0	MRP-228 Interim Guidance for Ultrasonic Examinations of Reactor Internal Baffle-Former Bolting	Oct 2013	Needed
MRP-384 Rev 0 (3002002963)	Guideline for Nondestructive Examination of Reactor Vessel Upper Head Penetrations	Sep 2014	Good Practice

MRP Key 2015 Products

- Assessment of the Use of NUREG-0800 Branch Technical Position 5-3 Estimation Methods for Initial Fracture Toughness Properties of Reactor Pressure Vessel Steels (MRP-401, BWRVIP-287)
- Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227, Revision 1)
- Inspection Standard for PWR Internals-2015 Update (MRP-228, Revision 2)
- Topical Report for Primary Water Stress Corrosion Cracking Mitigation by Surface Stress Improvement (MRP-335, Revision 2)
- PWR Bottom Mounted Nozzle (BMN) Issue Response Handbook (MRP-372, Revision 1)
- Welding Residual Stress Dissimilar Metal Butt-Weld Finite Element Modeling Handbook (MRP-317, Revision 1)

Status of Key MRP Topics with NRC

- Thermal Fatigue Management
- Topical Report for Peening Mitigation of PWSCC (MRP-335)
- Reactor Internals Guidelines (MRP-227) Revision
- Bottom Mounted Nozzles

Thermal Fatigue Management Status (1/2)

- Adverse Change in Thermal Fatigue Operating Experience

	2000-2012	2013-2015
Frequency	3 events (0.25 per year)	10 events (5 per year)
Significance	Part Thru detected during planned exam	3-through wall leaks Others exceed Code Limit

- Industry Emergent Issue Response – Focus Group
  - Notified owners of change in OE trends in February 2015
  - Analyzed cause of each event to reveal Guidance breakdowns
  - Published Interim Guidance to manage significance on May 28, 2015
  - Identifying R&D needed to refine and strengthen management programs
    - Develop knowledge to reduce thermal fatigue event frequency

Thermal Fatigue Management Status (2/2)

- Interim Guidance Published to manage event significance
  - 8 NEI 03-08 Needed requirements: Screening, Operations, Examination coverage, NDE
    - NDE improvements in refueling outages after October 1, 2015
    - Additional Examinations in refueling outages after June 1, 2016
  - Interim Guidance is not designed to reduce event frequency
  - 2 NEI 03-08 Good Practice recommendations
  - 8 Beneficial Practices
- On-going and Future Activities
  - Refine thermal fatigue guidance documents
  - Benchmark international thermal fatigue management practices
  - Enhance plant staff expertise
    - Provide updated fatigue management training opportunities
    - Update fatigue reference documents

Topical Report for Peening Mitigation of PWSCC Status (1/2)

Industry-NRC Alignment on Key Issues

- ***Schedule for Topical Report Review and SE***
  - RAI response packages submitted on October 10, 2014 and June 12, 2015
  - Periodic meetings and conference calls to address questions – next call is August 24, 2015
  - NRC is now considering detailed requirements for peening inspection credit, with SE expected by end of 2015
- ***Approach to Peening Mitigation Regulation***
  - Performance criteria of the topical report (MRP-335, Revision 2) define the minimum stress effect needed for inspection credit
  - Until ASME requirements are finalized and accepted by NRC, application-specific relief requests will be submitted to show how the performance criteria are met through demonstration testing and analyses
- ***NRC Confirmatory Testing Not Required for SE***

Topical Report for Peening Mitigation of PWSCC Status (2/2)

Open Issues Still to Be Resolved

- NRC position regarding whether the ASME B&PV Code as incorporated in the regulations prohibits peening for surface stress improvement, i.e. whether peening without inspection credit would necessarily require submittal of a relief request
- NRC concerns regarding some of the detailed requirements proposed by MRP such as required stress levels and examination methods for top head nozzles
- NRC not giving substantial weight to the MRP probabilistic analyses supporting the topical report, despite similar analyses having been applied for many years, for example in the original 2004 technical basis for inspection intervals for unmitigated top heads
- NRC concerns whether the peening requirements should use the type of detailed wording found in ASME B&PV Code requirements
    - The topical report to be approved by NRC should include detailed, comprehensive requirements
    - The topical report and SE will provide the requirements in the short term, with ASME requirements in the future as approved by NRC

PWR Internals MRP-227 Revision 1 Status

- MRP-227 Revision 1 I&E Guidelines to be published in 2015
- Revision 1 addresses Applicant/Licensing Action Items from MRP-227-A SE and outstanding comments for improvement from the Revision 0 TR reviews that were not ready before MRP-227-A issuance
- Incorporates latest requirements for guide card wear
- Addresses lower support clevis bolting Technical Bulletin
- Incorporates acceptance criteria from WCAP-17096 (under NRC review - draft SER expected soon)
- Adds technical and examination scope criteria specificity
- Adopts technically-based Westinghouse and CE core barrel weld exam selection
- NRC has an action item to formally request MRP-227 Revision 1

PWR Internals MRP-227 Revision 1 Review

- Industry's preference is NRC's approval of MRP-227 Revision 1 via SER without burden of plant-specific reviews for each licensee (like BWRVIP)
- Owner required application will remain through GALL and NEI-03-08

PWR Internals Cold Work RAIs

- Plant-specific NRC RAIs call for plants to identify “Non fastener materials that may contain more than 20% cold work in austenitic stainless steels”
- This topic was not a formal A/LAI from MRP-227-A
- Many PWROG plant specific assessments have been conducted in response to RAI’s over the last two years
  - Nearly half of operating PWRs assessed to-date
  - No non-fastener austenitic stainless steel materials with >20% Cold Work found to date
- PWROG MSC project underway to document and generically address cold-work of stainless steel in reactor internals parts

Bottom Mounted Nozzle Update (1/2)

- Operating Experience
  - Two OE (one involving 2 nozzles) of minor leakage detected in US plants
  - One partial depth indication in international OE
  - Over half of US & EdF BMNs now examined by non-visual techniques and additional planned
- MRP presented a safety case concluding the current approach is adequate and safe
  - Visual exam is effective for detecting tube and weld cracking
  - Non-visual NDE ineffective for J-groove weld thus cannot replace frequent visual exams
- Agreement reached to pursue Code Case that would incentivize licensees performing volumetric exams and eventually eliminate need for relief requests
  - Support NRC desire for non-visual NDE data to broaden knowledge base
  - Support licensees with simplified qualification requirements & relaxed visual exam frequency

Bottom Mounted Nozzle Update (2/2)

- ASME Task Group HSNAI worked two years on the Code Case but reached an impasse and voted in April to drop the action
  - Practical, technically defensible incentives were not identified *(e.g., visual exam frequency relaxation)*
  - The level of non-visual NDE qualification not resolved

- No feedback from NRC at recent code meeting regarding industry's position to maintaining current requirements

Program Key Take-Aways

- MRP is focused on the resolution of materials issues for PWR primary components
- MRP has made significant contributions to the industry in nickel-base alloys, reactor internals, RPV integrity and fatigue areas
  - Generating data, assessments, guidelines and closing gaps
- Continued proactive research is needed

MRP Key Contact Information

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Final Topics

Operational Leakage and Branch Connections

- Operational Leakage
  - Industry has tracked ASME Code work on operational leakage
  - Correspondence between NRC and ASME has been reviewed
  - Need to preserve a path for operability evaluations in Class 2 and 3
- Branch Connections
  - NRC has issued RIS 2015-10
    - Differs with ASME interpretation of N770-1 applicability
  - Industry working with ASME to determine if other actions are needed
    - PWROG conducting PFM of those connections as part of a technical basis
  - The Task Team working on the issue will propose resolution when technical bases are complete

Document Revisions and Reviews

- Materials programs are committed to updating guidance based on operating experience and laboratory data
- Many of these require implementation via NEI 03-08
- Most are also credited as Aging Management Programs in GALL
- Implementation is often delayed awaiting NRC review / SE
  - Review / approval process can take more than 3 years
  - Once approved, the document revision is often in conflict with GALL creating another implementation hurdle
- How can the process be improved for all parties?
  - Reduce or eliminate submittals?
  - Screening process to determine when revisions need submittal
  - NRC credited NEI 03-08 as a control process for License Renewal
- Discussion

Together…Shaping the Future of Electricity