Management Of Materials Issues

Chris Crane

President & Chief Nuclear Officer, Exelon Nuclear

Materials Initiative

- Coordinates over $59.5M in industry sponsored materials research & development
- Prioritization, management and resolution of current and future issues
- Accountability to assure plant safety and reliability

NEI

Management of Materials Issues

- Background
- Industry Initiative
- Strategic Plan
- Deliverables
- Accomplishments
- Expectations
- Regulatory Process

Background

- NEI Executive Committee Resolution
  - Fully support industrywide effort to improve management of materials issue
- Self-Assessment of Materials Programs
  - Driven by recent plant events
  - Develop a more proactive process

Backround

- Self-Assessment
  - Identify barriers or gaps in current materials programs
  - Integrate industry programs
    - SG Management (SGMP)
    - PWR Materials Reliability (MRP)
    - BWR Vessel & Internals (BWR VIP)
    - Fuel Reliability Program (FRP)
    - Chemistry, Corrosion and NDE
    - NSSS Owners Groups

Background

- Self-Assessment Conclusions
  - Limited coordination of industry efforts on materials issues
  - Limited ability to enforce implementation of industry guidance
  - No verification of implementation
  - Inadequate participation and support of Issue Programs (IP)
  - NSIAC Initiative warranted

Background

- Self-Assessment Recommendations
  - Create executive-level and technical oversight groups
  - Establish policy on the management of materials issues
  - Use the NEI Initiative Process
  - Expand INPO's role
  - Enhance communications
  - Define regulatory interface

Materials Initiative

- The objective is to assure safe, reliable and efficient operation of U.S. nuclear power plants in the management of materials issues.
- Each licensee will endorse, support and meet the intent of NEI 03-08, G*uideline for the Management of Materials Issues*. This initiative was effective January 2, 2004.

Materials Initiative

- Purpose is to provide
  - Consistent management process
  - Prioritization of materials issues
  - Proactive, integrated and coordinated approaches
  - Oversight of implementation

Materials Initiative

- Required actions
  - Commitment of Executive leadership and technical personnel
  - Commitment of funds for materials issues within scope
  - Commitment to implement applicable guidance documents

Materials Initiative

- Approved by NSIAC in May 2003
- Each licensee will meet the intent of NEI 03-08, Guideline for the Management of Materials Issues
- Initiative effective January 2, 2004
  - Includes $12M for 2004-2005 to fund high priority materials issues in addition to the $47.5M currently budgeted by Issue Programs for 2005

NEI 03-08 Guideline

- Establishes two standing committees
  - Executive Oversight
  - Technical Advisory
- Establishes policy
- Defines roles, responsibilities and expectations
- Provides for an integrated approach

Policy Commitment

- Policy Statement
  - "… the industry will ensure that its management of materials degradation and aging is ***forward-looking and coordinated*** to the maximum extent practical. Additionally, the industry will ***continue*** to rapidly identify, react and ***effectively respond to emerging issues***. The associated work will be managed to emphasize safety and operational risk significance as the first priority, appropriately balancing long term aging management and cost as additional considerations. To that end, as issues are identified and as work is planned, the groups involved in funding, managing and providing program oversight will ensure that the ***safety and operational risk significance of each issue is fully established prior to final disposition***."

Materials Issue Programs Governed by the Initiative

- EPRI
  - BWRVIP
  - MRP
  - SGMP
  - Fuel Reliability Program (as impacted by materials management strategies)
  - Corrosion Research
  - Chemistry Control
  - NDE

Materials Issue Programs Governed by the Initiative

- NSSS Owners Group Subcommittees
  - Materials
  - Chemistry
  - RPV
  - NDE
  - Steam Generators

Strategic Plan

- Comprehensive, integrated view of materials issues
- Framework for planning, coordinating and directing efforts
- Contains elements for an effective management program

Strategic Plan

- Defines high priority materials issues and short and long term technical gaps
- Used as industry guidance for prioritizing materials issues
- Revision 0 Issued in March
- Revision 1 planned for Early 2005
  - Degradation Matrix and Issue Management Table

DEGRADATION MATRIX

- Lists all materials within scope of the Materials Initiative
- Identifies potential degradation mechanisms for applicable materials
- Information obtained from materials experts, laboratory R&D, and operating experience

Issue Management Tables

- Addresses significance of material degradation on applicable materials
- Defines where materials are used and consequences of failure
- Identifies existing programs/guidance available for effective management
  - Assessment, inspection/evaluation, mitigation, repair/replacement

Deliverables - Implementation Protocol

- General guidance for implementation of IP work products
- Mandatory, Needed & Good Practice implementation categories defined
- Deviations from Mandatory & Needed action will be tracked in Corrective Action Program
- Executive concurrence required for
  - Mandatory & Needed elements
  - Deviations from Mandatory and Needed

Deliverables - Emergent Issue Protocol

- Oversight and Coordination
  - MTAG phone call when emergent issue occurs
  - Lead and support roles defined and communicated
  - IP will lead technical resolution and NRC interface strategy
  - Keep MTAG informed of status and NRC interactions
  - MTAG / MEOG support if needed

Deliverables

- SG Management
  - License Change Package
- MRP Inspection and Evaluation Guidelines
  - RPV head and bottom mounted instrument nozzles
  - Primary system butt welds
- WOG
  - Pressurizer heater sleeves
  - Boric Acid Corrosion Control Guidelines

Deliverables

- BWR VIP
  - Steam Dryers
- Fuel Reliability
  - AOA Guideline Revision 1
- Performance Metrics
- Overall coordination with ASME

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Proposed Performance Metrics

- Unexpected materials related NRC generic correspondence
- New materials degradation operating experience
- Lost capacity or unplanned/extended outages due to materials issues
- INPO materials program related AFIs
- Corrective action program effectiveness
- Issue Program products related to Strategic Plan technical gaps

Materials Initiative Funding

- 20 projects approved for $9.2 million
  - 7 NDE projects for $3M
  - 5 MRP projects for $2.4M
  - 3 BWRVIP projects for $1M
  - 2 Corrosion Research projects for $600K
  - 1 Fuels Reliability project for $1.2M
  - 1 SGMP project for $615K
  - 1 Chemistry Control project for $350K

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Accomplishments

- NEI Initiative
  - NEI 03-08
- Strategic Plan
- Protocols
- Funded projects

Future Activities

- Complete the Issue Management Tables and revision 1 of the Strategic Plan
- Develop industry performance metrics and self assessment guidance
- Monthly MTAG phone calls – materials issue oversight & coordination
- Quarterly meetings with the NRC
- Complete self assessment and report results

Expectations for Industry

- Adopt a proactive approach to materials issues
  - Communication of OE with IP / NEI
- Develop an integrated materials plan that reflects industry's Strategic Plan priorities
- Be prepared to fully implement applicable IP recommendations
- Support materials IPs and their need for technical and leadership personnel
- Support funding to address materials issues
- Self assessment of activities

Changes to Expect

- Industry guidance from IPs will have mandatory and needed actions
- Improved communications on materials issues and related interactions with the NRC
- Improved integration/coordination among IPs
- Improved industry performance relative to materials degradation
- Successful transition to a proactive approach for materials issues

Regulatory Process

- Implementation of mandatory and needed actions that fall within the scope of 10 CFR 50
  - Primary system components
  - Subject to NRC inspection
- Performance-based approach
- Areas of Concern
  - Unnecessary duplication
  - Diversion of resources

Conclusion

- Actions Taken by Industry
  - Proactive, integrated and coordinated
  - Focus to assure plant safety and reliability
  - Continuous improvement and feedback

Additional Background

ACRONYMS

AFI – Area For Improvement

AOA – Axial Offset Anomaly

ASME - American Society of Mechanical Engineers

BWR – Boiling Water Reactor

BWR VIP – Boiling Water Reactor Vessel & Internals Program

CFR – Code of Federal Regulations

EPRI – Electric Power Research Institute

FRP – Fuel Reliability Program

INPO – Institute of Nuclear Power Operations

IP – Issue Program

NDE – Nondestructive Examination

ACRONYMS

NEI - Nuclear Energy Institute

NSIAC – Nuclear Strategic Issues Advisory Committee

NSSS – Nuclear Steam Supply System

MEOG – Materials Executive Oversight Group

MRP - Materials Reliability Program

MTAG – Materials Technical Advisory Group

OE – Operating Experience

R&D – Research and Development

RPV - Reactor Pressure Vessel

SG – Steam Generator

SGMP – Steam Generator Management Program

WOG - Westinghouse Owners Group

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Materials Executive Oversight Group (MEOG)

- Chris Crane (*Chairman*) - Exelon
- Jim Levine (*Vice-Chairman*) - APS
- Garry Randolph – AmerenUE
- Joe Sheppard – STP
- Bryce Shriver – PPL
- Art Stall – FPL
- Gary Taylor – Entergy
- David Mauldin – APS
- Rodney Webring – Energy Northwest
- Jim Klapproth - GE
- Nick Liparulo – West.
- Gary Mignogna – AREVA
- Mark Reddemann – INPO
- Dave Modeen – EPRI
- Alex Marion - NEI

Materials Technical Advisory Group (MTAG)

- Chairman – David Mauldin – APS
- Vice Chairman – Bill Eaton - Entergy
- BWRVIP/BWROG – Robin Dyle - SNOC
- MRP – Mike Robinson - Duke
- SGMP – Forrest Hundley – SNOC
- FRP – Charles Turk – Entergy
- WOG/CEOG – Greg Gerzen – Exelon
- BWOG – Dave Whitaker - Duke
- EPRI NDE – Mike Turnbow – TVA
- EPRI Chem – John Wilson – Exelon
- EPRI Corrosion – Craig Harrington – TXU
- At Large Members
  - Joe Donahue – Progress Energy
  - Dennis Weakland – FENOC
  - Bob Hardies – Constellation
  - Ralph Phelps – OPPD
- MTAG Support
  - EPRI – Chuck Welty
  - INPO – Steve Johnson
  - NEI – Jim Riley

Degradation Matrix

- DM

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

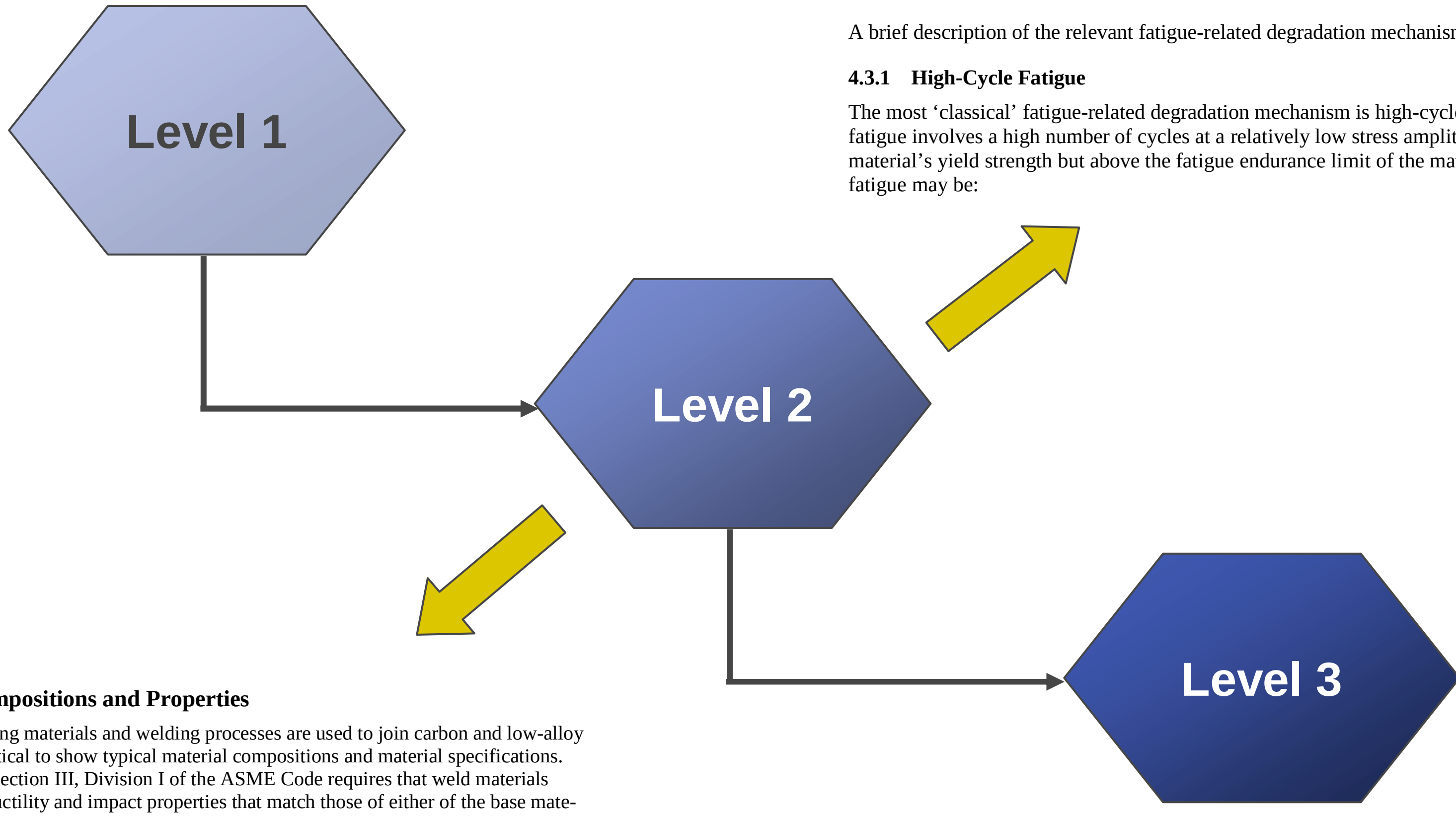
Level 2

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.

Materials Degradation Matrix



4.3 Fatigue Degradation Mechanisms and Mitigation Options

Fatigue is the structural deterioration that can occur as the result of repeated stress/strain cycles caused by fluctuating loads or temperatures. After repeated cyclic loading, if sufficient localized micro-structural damage has been accumulated, crack initiation can occur at the most highly affected locations. Subsequent cyclic loading and/or thermal stress can cause crack growth.

A brief description of the relevant fatigue-related degradation mechanisms is provided below.

4.3.1 High-Cycle Fatigue

The most 'classical' fatigue-related degradation mechanism is high-cycle (HC) fatigue. HC fatigue involves a high number of cycles at a relatively low stress amplitude (typically below the material's yield strength but above the fatigue endurance limit of the material). High cycle fatigue may be:

3.2 Material Compositions and Properties

A large variety of welding materials and welding processes are used to join carbon and low-alloy steels, and it is not practical to show typical material compositions and material specifications. Section NB-2431.1 of Section III, Division I of the ASME Code requires that weld materials have tensile strength, ductility and impact properties that match those of either of the base materials being welded, as demonstrated by tests using the selected weld material and the same or similar base materials. Section NB-2432.2 of Section III, Division I of the ASME Code requires that the chemical composition of the welding material be in accordance with an appropriate ASME Code welding specification (in Section II.C of the Code), but leaves the choice of the specific material up to the manufacturer.

The most common weld processes used to join carbon steel and LAS parts include submerged arc welding, shielded metal arc welding (SMAW), and gas tungsten arc welding (GTAW). Post-weld heat treatment is generally required per ASME Code rules after welding of the carbon and low-alloy steels used for reactor coolant system service.

EPRI

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Issue Management Table

- Draft example of BWR component evaluation

Draft BWR Issue Management Table

Equipment	Material	Failure Mechanism	Consequences of Failure	Mitigation	Repair / Replace	I & E Guidance	Gaps	Priority & Basis	Responsible Program(s)
BWR Recirculation piping	SS (lc and hc), Inconel welds	SCC, fatigue	Leakage, forced outage	Yes, chemical and stress improvement	Yes, replace pipe or weld overlay	Yes, BWRVIP-75		Low – solution available	BWRVIP, WCC
BWR Vessel	Cs/las, ss clad, welds	IGSCC, IASCC, TGSCC, FIV, Th & Env Fatigue, Emb, Th aging, Fluence	LOCA – loss of asset	Yes – HWC, NMCA	Yes – nozzle repair	Yes – covers embrittlement and weld degradation		Low – solution available	BWRVIP
BWR Internals	Ss, cass, cs, welds, Inc	IASCC, IGSCC, FIV, Wear, EF, Emb, Fluence – R&D needed	Core configuration	Yes – some, work needed	Yes – shroud and top-guide, costly – work needed	Yes (interim) – 13 BWRVIP I&E Guidelines – work needed		High – existing and potential unresolved issues	BWRVIP, WCC, FRP, Corrosion Research
Core Shroud	Stainless Steel	IGSCC, IASCC, Reduction in Toughness	This is a function of location. Vertical weld flaws have minor significance unless the intersecting circumferential weld is flawed through-wall. Very flaw	Hydrogen Water Chemistry at moderate levels can protect the shroud at lower levels and some benefit is available at higher levels in some plants. When augmented with Noble Metals, more shroud protect is	The repairs to date have been mechanical clamps that replace some or all of the circumferential welds. This is accomplished by developing high compressive loads on the shroud which	BWRVIP has developed a series of inspection guides that have been combined into one overall document (BWRVIP-76). This	Fracture toughness decrease with increasing fluence and there is limited data to help the industry understand long	High priority items for the shroud still exist. Initially was the number one priority. With programs in place for inspection, the needs for	BWRVIP with the Assessment Committee leading

			tolerant for circumferential flaws. Significance of circumferential weld flaws is based on location of the weld. Limiting accident scenario is main steam line break coupled with an earth quake. Even then, shroud circumferential welds were shown to perform adequately with 90% through wall flaw, 360° in circumference. It is worth noting that should a flaw develop for the full circumference, the shroud would lift enough to "burp" itself	possible due to the need for les hydrogen due the to the catalyst effect of the noble metals. Plant-specific assessments are needed to determine the exact level of protection. Other methods of protection are being investigated/considered such as water jet peening etc.	negates the need for the circumferential welds. This provides significant redundancy since no circumferential welds to date have come near a 360 degree through-wall flaw. Repair by welding is very limited in prospect due to difficulty in welding on highly irradiated stainless steels.	document includes inspection criteria for circumferential and vertical welds, and support ring welds, The criteria also address both repaired and unrepaired shrouds including repair hardware. The evaluation criteria exist for all locations and is based on long standing ASME criteria including safety factors. Evaluation methods also account for the changes in crack	term issues. Work is underway to develop additional data prior to the shrouds reaching fluence levels of concern. Similarly, work is underway to properly understand and characterize crack growth behavior in highly irradiated stainless steels.	the shroud are reduced.	

			and provide operators with an indication of a problem and allow safe shutdown.			growth rate and fracture toughness a irradiation damage increases. The methods also allow for crack growth to be adjusted based on water chemistry, residual stresses, changing K values, etc.			