Long Term Operations

Introduction

Mike Gallagher
Exelon, VP License Renewal

Sherry Bernhoft
EPRI, Sr. Program Manager

LTO Integration Committee Meeting
August 29, 2016

Date: August 12, 2016
Emergency Exits: Roosevelt BR (Mezzanine Level)

NOTE: ALL RED DOORS ARE EMERGENCY EXIT DOORS
Get Connected…

NEED TO ACCESS INTERNET DURING YOUR MEETING?

1. Navigate to your device's wireless network settings.
2. Select the SSID: **NOLA Conference**
3. Enter the passphrase: *roosevelt2016*
4. You are now connected to the meeting space wireless internet

*Note: SSID and Passphrase are case sensitive*

There may be other wireless networks present - but those networks will not provide the proper coverage, nor can we guarantee functionality. Please take care to use the correct network in order to experience the most reliable connectivity.
Meeting Purpose

- EPRI LTO program created in 2010 to accelerate and coordinate cross-sector research for safe, reliable and economic long-term operations

- Three major roles:
  - Technical basis for aging management
  - Opportunities for modernization and efficiency enhancements
  - Provide technology transfer
    - US – participation in NEI tasks force and working groups, and lead plant demonstration
    - International – participation with the IAEA and workshops at host sites

LTO Integration Committee
Provides strategic input for research direction and priorities
Long-Term Operations – *Global Need*

**In the U.S.**

License renewal – 40 to 60 years  
Second license renewal – 60 to 80 years

Without SLR the U.S. will lose 30,000 MWs between 2029 and 2035.

**Total Number of Reactors: 438**

As of October 2015:  
250 NPPs > 30 years of operations  
68 NPPs > 40 years of operations

**Projected U.S. Nuclear Power Capacity**  
(Megawatts)

Source: Capacity – Energy Information Administration; License Expiration – Nuclear Regulatory Commission
# Agenda

**Long Term Operations Integration Committee**

**Meeting Holder:** Sherry Bernhoft, (sbernhoft@epri.com)

**Room Location:** Roosevelt Ballroom, Salon IV (Mezzanine Level)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Lead</th>
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<tbody>
<tr>
<td>1:00 pm</td>
<td>Welcome and Introductions</td>
<td>M. Gallagher, Exelon</td>
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<tr>
<td>1:15 pm</td>
<td>NEI Update and Second License Renewal (SLR) Activities</td>
<td>J. Hanson, NEI</td>
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<td>- Status Update</td>
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<td>1:45 pm</td>
<td>SLR Lead Plant Activities</td>
<td>P. Aitken, Dominion</td>
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<td>- Status Update</td>
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<td>- Topics related to research needs and support</td>
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<td>2:30 pm</td>
<td>Research Focus Area (RFA) &amp; LTO Project Plans for 2017 &amp; 2018</td>
<td>S. Bernhoft, EPRI</td>
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<td></td>
<td>- Results of member survey</td>
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<td>- Two year look ahead at project plans for the LTO program</td>
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<td>3:00 pm</td>
<td>Afternoon Break</td>
<td>All</td>
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<td>3:30 pm</td>
<td>LTO Issue Tracking Table Review</td>
<td>R. Tilley, EPRI</td>
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<td></td>
<td>- Member input on issue tracking table review and update</td>
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<tr>
<td>4:30 pm</td>
<td>Action Items and Adjourn</td>
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Antitrust Guidelines for EPRI Meetings and Conferences

The antitrust laws and other business laws apply to EPRI, its Members, participants, funders, and advisers; violations can lead to civil and criminal liability. EPRI is committed to both full compliance and maintaining the highest ethical standards in all of our operations and activities. These guidelines apply to all occasions: before, during, and after EPRI meetings, including in the hallways, over lunch, during breaks and at dinner.

EPRI’S PRIMARY PURPOSE

...is to conduct research and development relating to the generation, delivery and use of electricity for the benefit of the public. EPRI advisory meetings are conducted to further that purpose.

YOUR ROLE AT EPRI ADVISORY MEETINGS

...is to follow the meeting agenda and provide advice on EPRI’s R&D program and how to make EPRI results most useful. Consult with your company counsel if at any time you believe discussions are touching on sensitive antitrust subjects such as pricing, bids, allocation of customers or territories, boycotts, tying arrangements and the like.
Together…Shaping the Future of Electricity
NEI Update and
Second License Renewal (SLR) Activities

“Presentation Placeholder”
*Materials will be added on (TBD)
SLR Lead Plant Activities

“Presentation Placeholder”

*Materials will be added on (TBD)
LTO Research Focus Areas
Project Plans for 2017 & 2018

Sherry Bernhoft
Senior Program Manager

LTO Integration Committee Meeting
August 29, 2016

Date: August 11, 2016
Topics

- Strategic Research Focus Areas (RFAs)
  - Results of members feedback

- Key accomplishments for 2016

- Project plans for 2017 and 2018
  - Two year project look ahead

- High Priority:
  1. Reactor pressure vessel
  2. Primary system metals, welds and piping
  3. Electrical cables
  4. Concrete and containment structures

- Aging Impacts:
  - Increased thermal exposure
  - Increased radiation exposure
  - Stress corrosion cracking
  - Fatigue usage
  - Wear
  - Etc.....
Member Resources:

- LTO Program on EPRI.com
  - LTO cockpit page
  - Monthly updates
  - Project Status Updates (PSUs)
  - Project Overview Forms (POFs)
  - Publications

- Joint DOE-LWRS EPRI-LTO R&D Plan
  - Updated annually
  - INL LWRS website or LTO cockpit

- LTO Program Roadmaps
  - Updated every 6 months
  - Link to Sector Roadmaps at bottom right of LTO Cockpit Home Page
    - Opens at LTO Roadmaps but includes all for Nuclear Sector

- LTO Contacts:
  - sbernhoftepri.com
  - rtilley@epri.com
Research Focus Areas (RFAs)
Development of Strategic Focus Areas and Project Proposals

- Membership & industry expert interaction
  - Workshops
  - Conferences
  - Project Meetings
  - Webcasts

- Roadmaps
  - Specific topic/issue
  - Identifies integrated set of actions to address challenge

- EPRI staff formulates strategic focus areas and details of the type of research that should be conducted in that area
  - Drivers
  - Objectives
  - Tasks
  - Expected value

Use your engagement to identify research needs to address technical challenges

Consider topics that have broad applicability and are strategic in nature
How Does the EPRI Portfolio Get Developed?

EPRI Members are the focal point for the development of the R&D portfolio

Your engagement is needed for:

• Identification of strategic focus areas and project ideas
• Prioritization of strategic focus areas
• Technical evaluation of project objectives, tasks, and expected benefits
• Identification of specific project elements that are needed to address challenges at your plant
• Provision of technical data from your plant/country that applies to the project
• Participation development and review committees
Prioritization Process

- **EPRI:**
  - Provided a written description of *strategic focus areas* sent out in May 2016
  - Included a description of the types (examples) of projects
  - Ranking sheet for completion by IC and TAC advisors
  - Additional details provided in the LTO Program Plan (on the LTO Cockpit)

- **Advisors:**
  - Had four weeks to review and provide comments
  - Feedback was in the form of 1, 2, or 3 ranking (1-highest) and any written comments

- **Goal** - *Have the portfolio for 2 years out finalized in September*
  - Reviewed by TAC & IC at the August NPC
## Strategic Focus Areas (1 – High, 3 – Low)

<table>
<thead>
<tr>
<th>Strategic Focus Area</th>
<th>Ranking 2015</th>
<th>Ranking 2016</th>
<th>Comments - Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aging management for RCS metals, RPV</td>
<td>1</td>
<td>1.22</td>
<td>Critical area for interface with MRP, BWRVIP and reactor pressure vessel integrated surveillance programs</td>
</tr>
<tr>
<td>Aging management for concrete and structures</td>
<td>1</td>
<td>1.22</td>
<td>Support for concrete aging management programs, ASR and irradiation impacts</td>
</tr>
<tr>
<td>Aging management for electrical cables</td>
<td>1</td>
<td>1.67</td>
<td>Need to understand synergistic effects testing and impacts on cable qualifications (EQ)</td>
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<tr>
<td>Opportunities for modernization and efficiency improvements</td>
<td>2.75</td>
<td>2.78</td>
<td>Needed to ensure cost effective LTO</td>
</tr>
<tr>
<td>Support for industry and lead plant activities</td>
<td>1.5</td>
<td>2</td>
<td>EPRI needs to stay engaged in industry activities and provide support on technical issues</td>
</tr>
</tbody>
</table>
EPRI LTO R&D Projects - 2009 through 2014

- 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
EPRI LTO R&D Projects – 2015 through 2019

- **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 – Transitioned to Fleet-Wide Health Monitoring
  - Advanced I&C
  - Enhanced safety and risk analysis – Advanced PRA (Phoenix) Risks & Safety Management

- **Enabling Technologies**
  - Integrated Life Cycle Management – Transitioned to Plant Engineering
  - Plant Demonstration Projects
Key Accomplishments for 2016
Industry Support

- Technical reviews, comments and public meetings on NRC draft subsequent license renewal (SLR) GALL
- Research ‘deep dive’ meetings with NRC and DOE-LWRS
- Update the Advisory Committee on Reactor Safeguards (ACRS) on research status for SLR
- NEI Task Force and Working Group meetings
- IAEA IGALL, revision 3 – technical experts are participating on the steering committee, mechanical, electrical and structural working groups
- IAEA SALTO lessons learned workshop
- International member workshops on LTO
- COG R&D Strategic workshop
- Will be updating the IGALL EPRI product mapping
### Cable Aging Management

- Updated joint EPRI-DOE-NRC cable aging research roadmap
- IAEA IGALL working group on cable aging management
- Workshops with UNESA (Spain) and CEZ on cable inspection and condition monitoring programs
- Harvested cables from Crystal River for testing by NRC Research, DOE at PNNL, and EPRI
- Submerged cable condition monitoring (EPRI technical report under review by NRC)
- Temperature and radiation data capture (data loggers) continuing at Palo Verde
- Starting update of License Renewal Tools Report for Electrical Equipment
Concrete Aging Management

- Updated joint EPRI-DOE-NRC concrete aging research roadmap
- IAEA IGALL working group on containment structures
- Alkali Silica Reactions (ASR)
  - Developed roadmap with technical report milestones
  - First report on structural implications in draft
  - Will be supporting lead plant structural monitoring program walk downs
- Irradiation and gamma heating degradation of concrete support structures
  - Published report on structural implications on BWR cavity and support structures
  - Completed modeling and will be publishing a report on the impacts on the PWR biological shield wall
  - Completing assessment on the impacts of gamma heating
- Spent fuel pool leakage and boric acid corrosion
  - Report with results from a three year study on the impacts of boric acid on SFP concrete
- Working with Spain on harvesting irradiated concrete cores from Zorita
- Progress is being made on NDE techniques for concrete
RCS Metals and Reactor Pressure Vessel

- Completed the roadmap to update technical reports for SLR
  - Approval from the Materials program executives and funding to perform the work
  - Presented to the NRC
- Working closely with two lead US plants (PWR & BWR) to develop programs that will be the template for future SLRAs
  - Includes approach for BWR integrated surveillance monitoring program for 60 to 80 years
  - PWR supplemental surveillance program
- Working with ORNL (DOE-LWRS) completed installation of welding cubicle in the hot cell and irradiating additional specimens for welding demonstrations
- IAEA Working Group on materials aging management
- International workshops on use of EPRI reports to support technical basis for LR
- Starting work on updating the LR Mechanical Tools Report
Opportunities for Modernization

- Completed feasibility study and literature survey with INL (LWRS-DOE) for development of a Structural Heath Monitoring program
- Supporting INL (DOE-LWRS) on control room modernization project at APS
- Collaboration with INL (DOE-LWRS) on advanced risks informed safety margins analysis
- Application of risk informed safety margins to evaluate life cycle management (Xcel pilot)
- Integrated Life Cycle Management (ILCM) completed turnover to Plant Engineering
  - Pilot plant studies underway
  - Interest group being formed
LTO Project Plans for 2017 & 2018
LTO Funded Projects for 2017 & 2018

- Metals Materials Aging Management
  - Advanced welding project for repair and replacements
  - BWR Integrated Surveillance Program development

- Concrete Aging Management
  - ASR Aging Management studies
  - Structural assessment of irradiated concrete
  - Harvesting and testing irradiated concrete cores from Zorita

- Cable Aging Management
  - Cable vulnerability studies based on temperature and radiation data collection
  - Cable harvesting and testing
  - Advances in condition monitoring technology

- Modernization and Efficiently Improvements
  - Structural monitoring program
  - Interface with INL on control room upgrades
  - Risk Informed Safety Margin Characterization

- Industry Support
  - Subject matter experts
  - Lead plant support
  - Joint roadmaps and coordination with research partners
  - IAEA IGALL participation
  - International workshops
# Aging Management Roadmap

## LTO Aging Management

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<td>LTO</td>
<td>AMP R&amp;D Assessment</td>
<td>Product Mapping to IGALI</td>
<td>Product Mapping Update</td>
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<td>Mechanical Tools Update</td>
<td>Structural Tools Update</td>
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<td>BWR ISP to 80 Years</td>
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<td>BWR 80-Year ISP Program Development</td>
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<td>Advanced Welding of Irradiated Materials (Jointly funded by LTO)</td>
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## Equipment Reliability APC

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<td>Assessment of Field Harvested Cables for Aging Effects</td>
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<td>Concrete Aging Management Toolbox (Software)</td>
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## Goal Unity

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<td>Joint EPR and DOE Demonstration Project</td>
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## Milestones

- Key Milestone
- Completed Milestone
- LTO Funded Work
- Unfunded Work

## Final Report

- Software
- Interim Report
Enhancement and Modernization Technology Roadmap

LTO Enhancement and Modernization Technology

- Project Support and Review
  - Integrated Life Cycle Management (ILCM) Software Report
  - ILCM Technology Transfer
  - Plant Demonstrations of ILCM

MAT
- Adverse Radiation Resistant Materials: Phase 1 - Identify Candidate Materials
  - Phase 2 - Irradiate and Evaluate New Materials

Equipment Reliability APC
- Advanced Instrumentation & Control Working Group (Annual)
- Repository of Advanced Instrumentation & Controls Requirements & Guidance
  - Human Factors Engineering Station Program (Co-funded by LTO)
- APS Control Room Modernization
- Development of Tools, Pilots, & Guidelines to Implement COLM
- Diagnostic Advisor
- Fault Signature Database
- Fleet-wide Monitoring Interest Group (FWMIG) Annual
- Transient Analysis Software

RSM
- Risk Informed Safety Margin Characterization (RISM) Value Assessment
  - Needs Assessment
  - Industry Pilots
  - LWRS Pilots
- RELAP7 Application Pilot Study
- Pilot Projects
- PHOENIX Software Development and Release

NDE
- Advanced NDE to Characterize Cast Authentic Stainless Steel Degradation

Legend:
- Key Milestone
- Completed Milestone
- LTO Funded Work
- Unfunded Work

Milestones:
- Final Report
- Software
- Interim Report

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Together…Shaping the Future of Electricity
Updated LTO Issue Tracking Table

Rich Tilley
Sr. Technical Leader

LTO Integration Committee Meeting
August 29, 2016

Date: August 10, 2016
Issue Tracking Table Objectives

- Primary
  - Provide a expert input summary of key technical issues that will inform utility decision making regarding long-term operations (especially beyond 60 years)

- Secondary
  - Communicate with all stakeholders regarding R&D efforts and priorities
    - The right research and the right time
    - Focus on key issues identified by industry to satisfy regulatory needs
  - Emphasize linkage to aging management programs
Issue Tracking Table Success

- Current priorities align with issue areas as communicated by NRC in their EMDA and draft GALL-SLR
  - Reactor pressure vessels
  - Reactor internals
  - Cables
  - Concrete

- Opportunity to focus on-going R&D efforts on completion of specific items (technical reports and processes) to support issue resolution for licensing
  - Detailed project status available via Project Status Updates on LTO Cockpit
Changes to 2016 ITT

- Improved focus on specific technical issues
  - **No new issues identified**
  - Shift from broad areas (e.g., RPV Embrittlement) to specific issues that impact utility aging management programs.
    - Extending BWRVIP from 60 years to 80 years impacts GALL XI.M31 (= IGALL AMP118)
  - Organize items according to LTO Strategic Focus Areas
  - Eliminate inclusion of low priority/completed items
  - Still include technology areas that may impact licensing
    - Risk and Safety, I&C, and others
### Example: 2015 ITT Item on BWRVIP

#### BWR Vessel Surveillance Specimens

<table>
<thead>
<tr>
<th>Issue ID (New)</th>
<th>Primary Issue Description</th>
<th>Sub-issue Description</th>
<th>Detailed Description</th>
<th>EPRI LTO Status</th>
<th>EPRI Program (Other)</th>
<th>DOE LWRS</th>
<th>Category</th>
<th>AMP Impact and Category</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Primary System Metals Aging</td>
<td>BWR Vessel Surveillance capsules with fluence representativeness of 60-plus years of operation</td>
<td>Coupons placed in reactors to represent fluence to 60 years are important to validate analytical predictions of vessel embrittlement. The Boiling Water Reactor Vessel and Internal Program (BWRVIP) has a planned project to develop a replacement for or an extension of the existing Integrated Surveillance Program (ISP) from 60 to 80 years of operation. This work is planned to start in 2015.</td>
<td>LTO</td>
<td>BWRVIP</td>
<td>NA</td>
<td>A</td>
<td>XI.M31 TLAA Category 1 for M31 Specific EPRI Project started in 2015 to address needs and potential actions.</td>
<td>BWRVIP: Task 2.1 Task 2.11 Task 2.35 Task 2.36 Commitment to or implementation of the surveillance capsule program is needed for compliance with 10CFR50 and therefore an SLR application. Extension to 80 years will consider development of new capsule specimens, use of alternate means to monitor RPV.</td>
</tr>
</tbody>
</table>
Revised 2016 Issue Tracking Table

- Step through the table as sent out to IC Members
  - Final review prior to distribution
Discussion?
Together...Shaping the Future of Electricity