



EPRI Research on Long Term Operations: Considerations for Life Beyond 80

NRC Hybrid Workshop on Structural Materials: What Research for Beyond 80



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October 3rd, 2024

Why is LTO needed?

Extending the life of existing reactors is one of the most cost-effective ways to produce carbon-free electricity and meet future power demand needs.



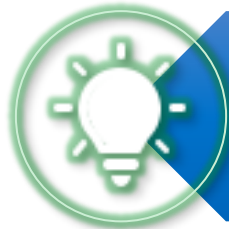
Energy Security

- Reduces dependence on fossil fuels & energy imports



Energy Diversity

- Supports generation portfolio risk management



Reliability

- Consistent supply with high-capacity factors

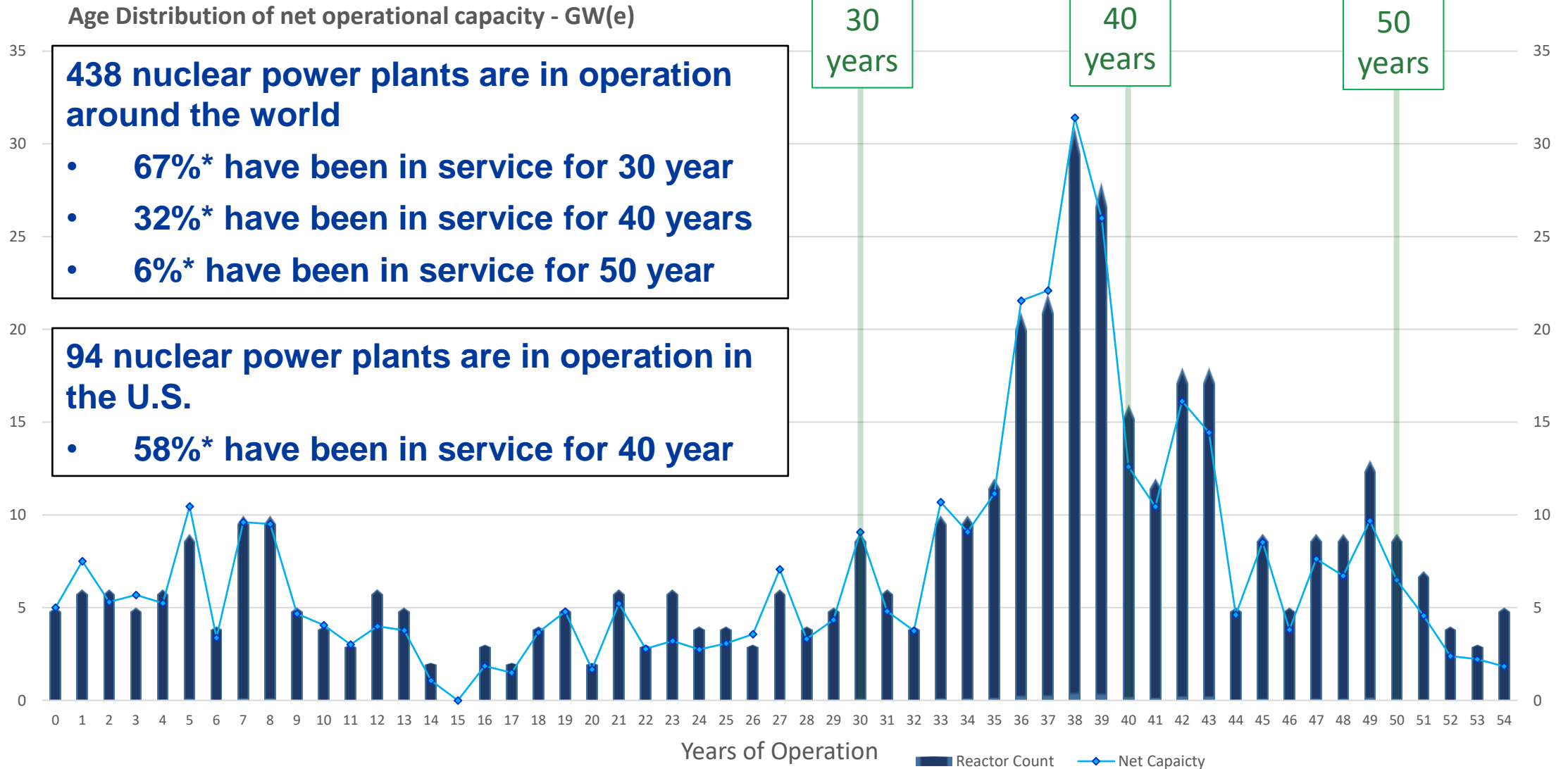


Carbon Free

- Existing nuclear is essential to meeting carbon reduction goals

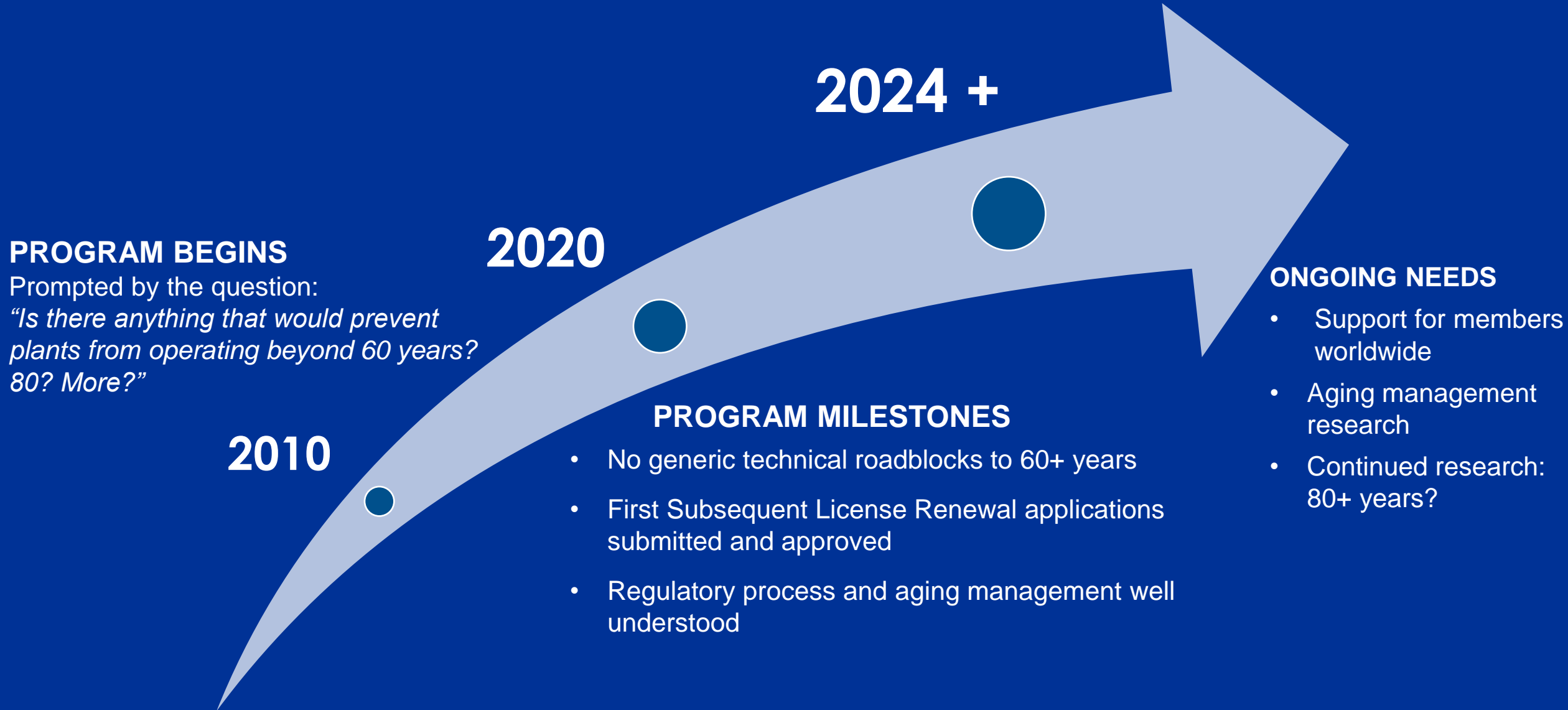
LTO is key to accomplishing carbon reduction goals around the world

Status of LTO Worldwide

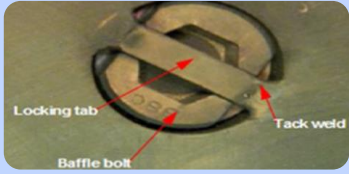


*IAEA PRIS database, end of 2023, % of global operational nuclear capacity

Nuclear Long Term Operation Research at EPRI



LTO and Aging Management Major Focus Areas



Reactor Vessel, Core Internals, Primary Components

- Technical bases to support the aging of RPV, internals materials, steam generator, etc. (MRP, BWRVIP, SGMP)
- Advances in repair options such as welding for highly irradiated materials (WRTC)
- Water chemistry to protect and mitigate potential aging effects



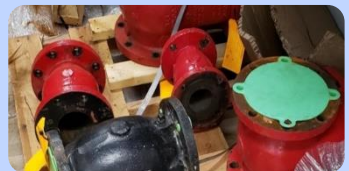
Concrete and Civil Structures

- Developed guidance on Alkali Silica Reaction
- Developed guidance on irradiation effects on the concrete biological shield and on structures
- Developed guidance on best practices for structural aging management programs



Electrical Cables

- Research that supports cable reliability through end of plant operation
- Advances in condition monitoring technology and cable testing methods for aging management programs
- Cable Users Group (CUG) to share OE and best practices



Other Projects

- Risk Insights for Aging Management Program implementation + LAMBDA software for asset management
- Spent Fuel Pool Coupon International Database to support an industrywide AMP, i-LAMP
- Advancing the state of practice relative to Selective Leaching and advanced NDE



Ongoing Knowledge Transfer

- **EPRI Training** – Distance learning, computer based, classroom, and on-site technical training on aging management processes and practices
- **EPRI Tech Apps** – (1) LTO Assessment & Program Review, and (2) LTO Workshop & Training Support

Concrete Research Program Support of LTO

- Research Reports on guidance for aging management of civil infrastructure for LTO 60+
 - Concrete Irradiation, ASR, Corrosion, Visual Inspections (see next slide)
- Participants in Various Industry Working Groups
 - NEI LR Task Force
 - IGALL Working Group 3 – Civil Infrastructure
 - ICIC
- Utility Support of Aging Management Implementation
 - Procedure Review, Training, Workshops, etc.

EPRI Research on Concrete Aging Management Highlights

Topic	Title	Deliverable Number
Structures Monitoring	Structures Monitoring Program Guidelines: Best Practices and Example Procedure	3002018488
	Structures Monitoring Best Practices: Personnel Qualifications	3002016085
	Long-Term Operations: Subsequent License Renewal Aging Effects for Structures and Structural Components (Structural Tools)	3002013084
	Field Guide: Visual Inspection of Concrete Structures	3002007799
	Materials Reliability Program: EPRI Review of the Kansai Takahama Units 1 and 2 Aging Evaluations for Extending Operational Periods (MRP-429)	3002012037
Reinforcement Corrosion	Field Guide: Corrosion Inspection of Reinforced Concrete Structures in the Nuclear Fleet	3002010446
	Nondestructive Evaluation Inspection of Concrete Structures Subjected to Corrosion	1025627
	Tools to Develop Aging Management Programs for Corrosion-Affected Concrete Structures	3002010299
	Modeling Platforms for Chloride-Induced Corrosion of Concrete Structures	3002013195
	Guidelines for Selecting Remediation Strategies for Corrosion Control of Reinforced Concrete Structures	3002013236
	Program on Technology Innovation: Corrosion Mitigation of Conventionally Reinforced Concrete Structures	3002003090
Alkali Silica Reaction	Long-Term Operations: Aging Management of Concrete Structures Affected by Alkali-Silica Reaction	3002016056
	Evaluation of Laboratory Tests to Detect Up-to-Date Expansion and Remaining Expansion in Concrete Structures Affected by Alkali Silica Reaction	3002013192
	Tools for Early Detection of ASR in Concrete Structures	3002005389
	Modeling Concrete Structures Affected by Alkali Silica Reaction: Hydro-Quebec Approach for Hydraulic and Nuclear Power Plants	3002013190
Concrete Irradiation	2020 Update to Irradiation of Concrete Guidance: Basis for Evaluation of Concrete Biological Shield Wall for Aging Management, Rev 1	3002018400
	Structural Model of PWR Concrete Reactor Pressure Vessel Supports – Effects of Chronic Radiation Exposure on Margin	3002007347
	Structural Disposition of Neutron Radiation Exposure in BWR Vessel Support Pedestals	3002008128
	Long-term Operations: Estimation of Gamma Dose in Boiling Water Reactor Concrete Biological Shield Walls	3002016055



LTO Beyond 80

EMDA Summary of Concrete

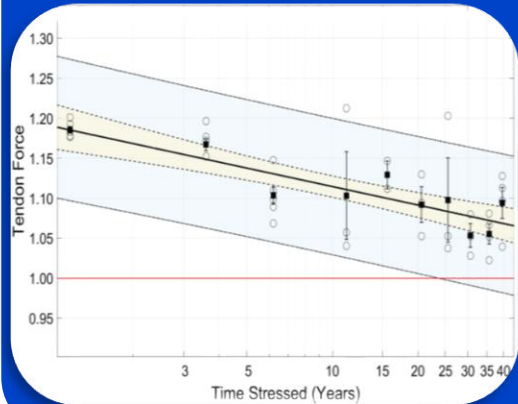
- The EMDA (NUREG/CR-7153 Vol 4) identified the following as potential knowledge gaps for assessing concrete up to 80 years of operations
 - Alkali Silica Reaction
 - Concrete Irradiation
 - Creep of Post Tension Containments
 - Boric Acid Attack of Concrete
- EPRI, NRC, and DOE have coordinated and communicated on research for Alkali Silica Reaction, Concrete Irradiation, and Nondestructive Evaluation

Aging Management Activities

Inspection /
Monitoring



Analysis /
Evaluation



Mitigation /
Modernization



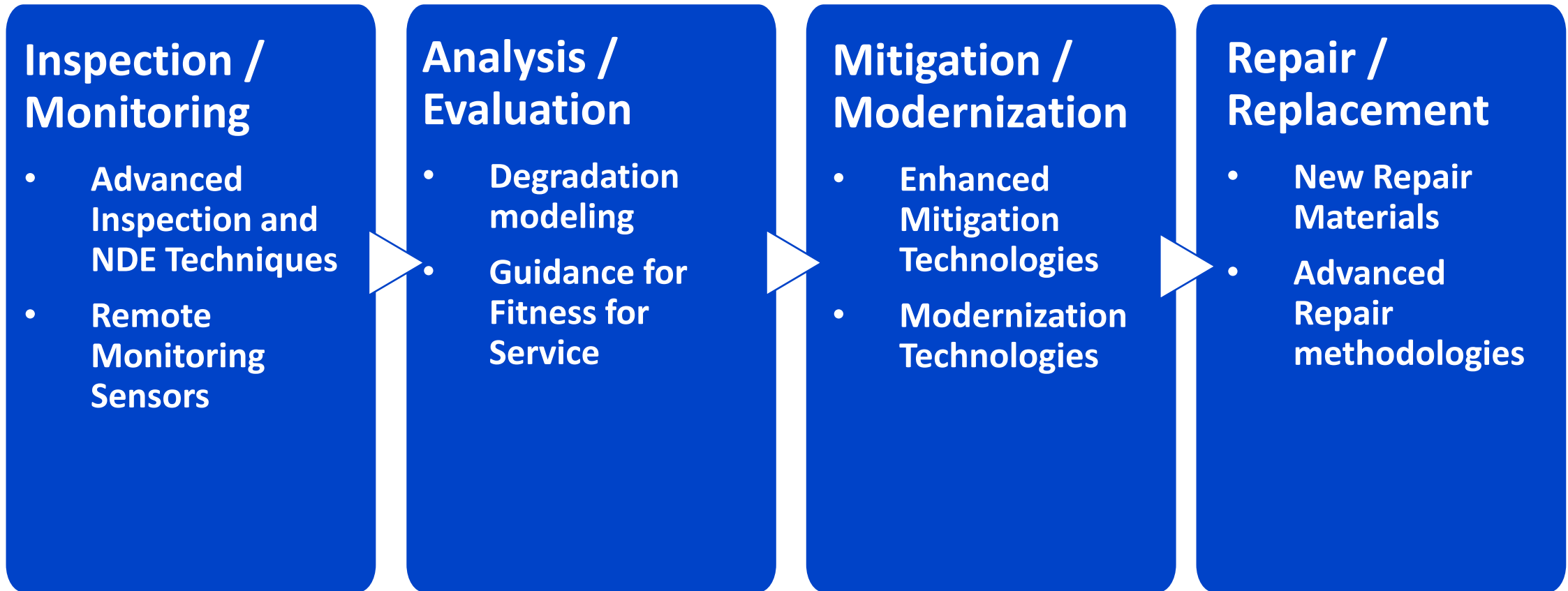
Repair /
Replacement



Concrete and Civil Structures Beyond 80 Years

- There are no new degradation mechanisms for concrete structures operating beyond 80 years
- Structural Functionality is not dependent on age
- Potential for degradation to occur and progression of degradation can increase with time
 - Corrosion of reinforcement due to Chloride Ingress, Carbonation
 - Cracking due to expansion (ASR, DEF)
 - Concrete Irradiation (More plants to exceed threshold)
- Mitigation Strategies and Modernizations can be implemented and optimized for longer operations
 - Cathodic Protection Systems
 - Enhanced Inspection and Monitoring (Drones, Remote Monitoring)

Aging Management Activities – The Path Forward



EPRI research moving forward will focus on tools to provide more reliable and efficient aging management of civil infrastructure



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