

EPRI Update

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July, 2019



Plant Modernization

PLANT MODERNIZATION

Industry

Vision

Preserve nuclear power as a carbon-free, safe, and reliable energy resource.

Mission

Achieve nuclear power plant economic viability through collaboration, transformative technology and innovation to optimize operations and maintenance while ensuring safety and reliability.

Collaborators

- » Utilities
- » EPRI
- » Electric Utility Cost Group (EUCG)
- » Institute of Nuclear Power Operations (INPO)
- » Nuclear Information Technology Strategic Leadership (NITSL)
- » Nuclear Energy Institute (NEI)
- » Owners Groups, other R&D organizations, vendors
- » U.S. Department of Energy (DOE)

Strategic Goals

Feasibility

Show that modernization effort can be successful

Methods

Build confidence to make decisions to modernize

Deployment

Demonstrate modernization can be implemented

2018
Early R&D

2019
Feasibility

2020
Methods

2021
Deployment

PHASE I Feasibility

- End-state vision
- Basic economic return-on-investment
- Existing enabling technologies
- Research of new technologies
- Regulatory planning
- Demonstrate cost savings
- **Product: Plant modernization feasibility report**

PHASE II Methods

- Deployment methods
- Technology research continues
- Regulatory solution
- Candidate plants
- **Product: Plant modernization handbook**

PHASE III Deployment

- Technology business case
- Full modernization conceptual design
- Implementation business case
- **Final Product: Plant modernization handbook with case studies**

Technology Enablers

Enabling technologies & approaches



Wireless Connectivity / Electromagnetic Compatibility



Digital Upgrades (including cybersecurity)



Risk-Informed Engineering & Decision-Making

Immediate applications to save costs



Condition Based Equipment Maintenance



Integrated Monitoring & Diagnostics



Mobile Work Execution



Automated Chemistry Monitoring

Future applications to save costs



Radiation Monitoring



Structural Health Monitoring



Physical Security



Emergency Planning

Future enabling technologies & approaches



Data Analytics / Artificial Intelligence



Common Information Model

2018
Early R&D

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Deployment

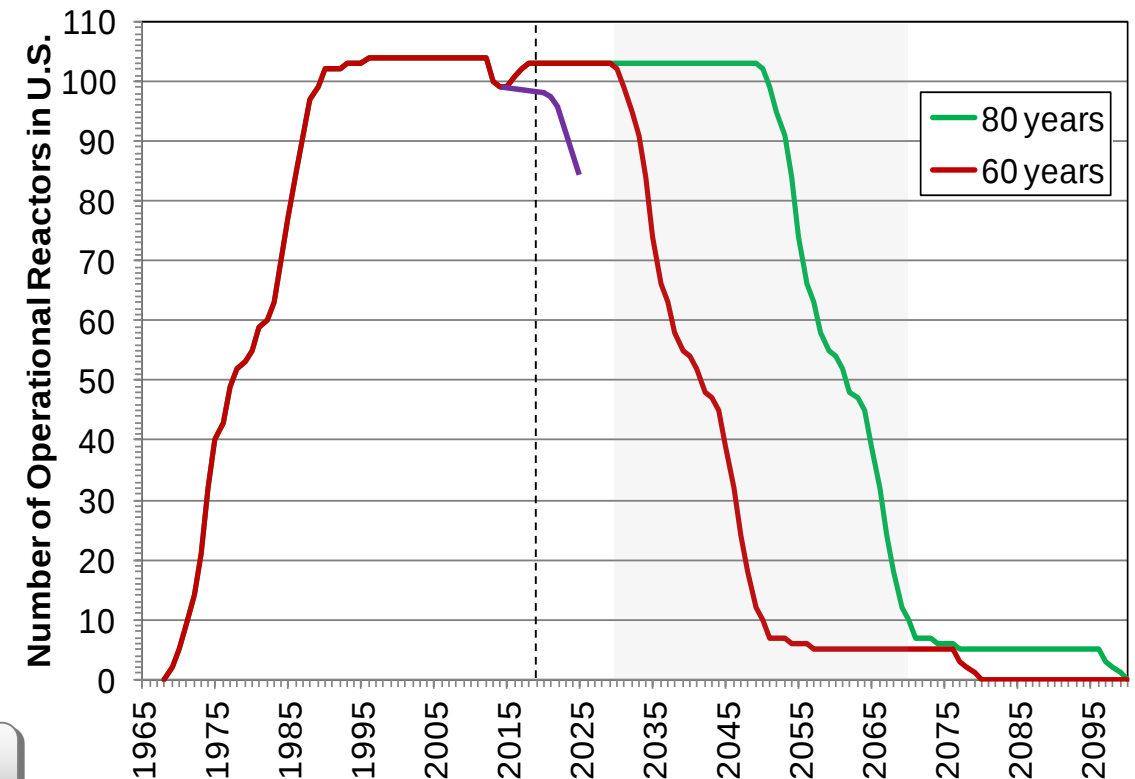
Accident Tolerant Fuel

U.S. Industry Need for Accelerated ATF Implementation

- Challenge: traditionally long fuel design to deployment timeframes
- Limited window of opportunity:
 - Existing fuel testing facilities
 - Abundant R&D programs
 - Limited economic viability for ATF benefits to the existing fleet
- Industry committed to ATF batch reloads into commercial reactors by 2023 and full reloads by 2026

Accelerating ATF is a Heavy Lift

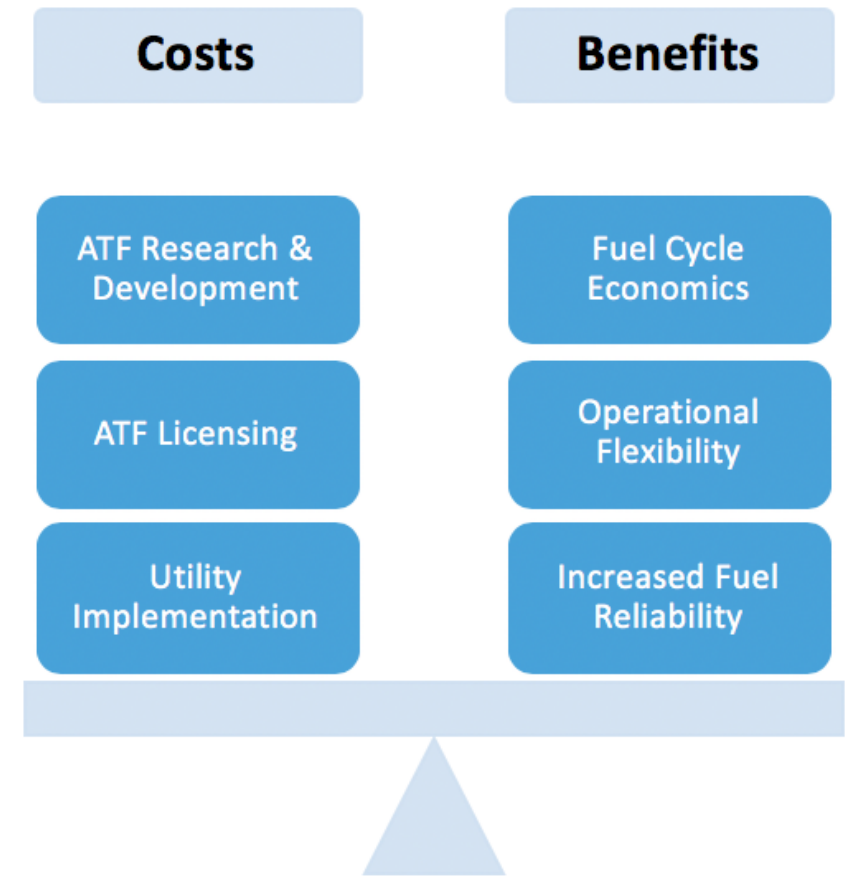
Projected operating life for Domestic LWR fleet



ATF Valuation 1.0: Key Conclusions

- Safety benefits vary among:
 - ATF cladding/fuel concepts
 - Accident scenarios
 - Reactor type and specifics
- For various accident cases:
 - Enhanced coping times of ~1-3 hours
 - ATF delays core damage, but, restoration of core cooling needed to prevent core damage
 - Potential greater benefits through safety margin improvements to support operational enhancements

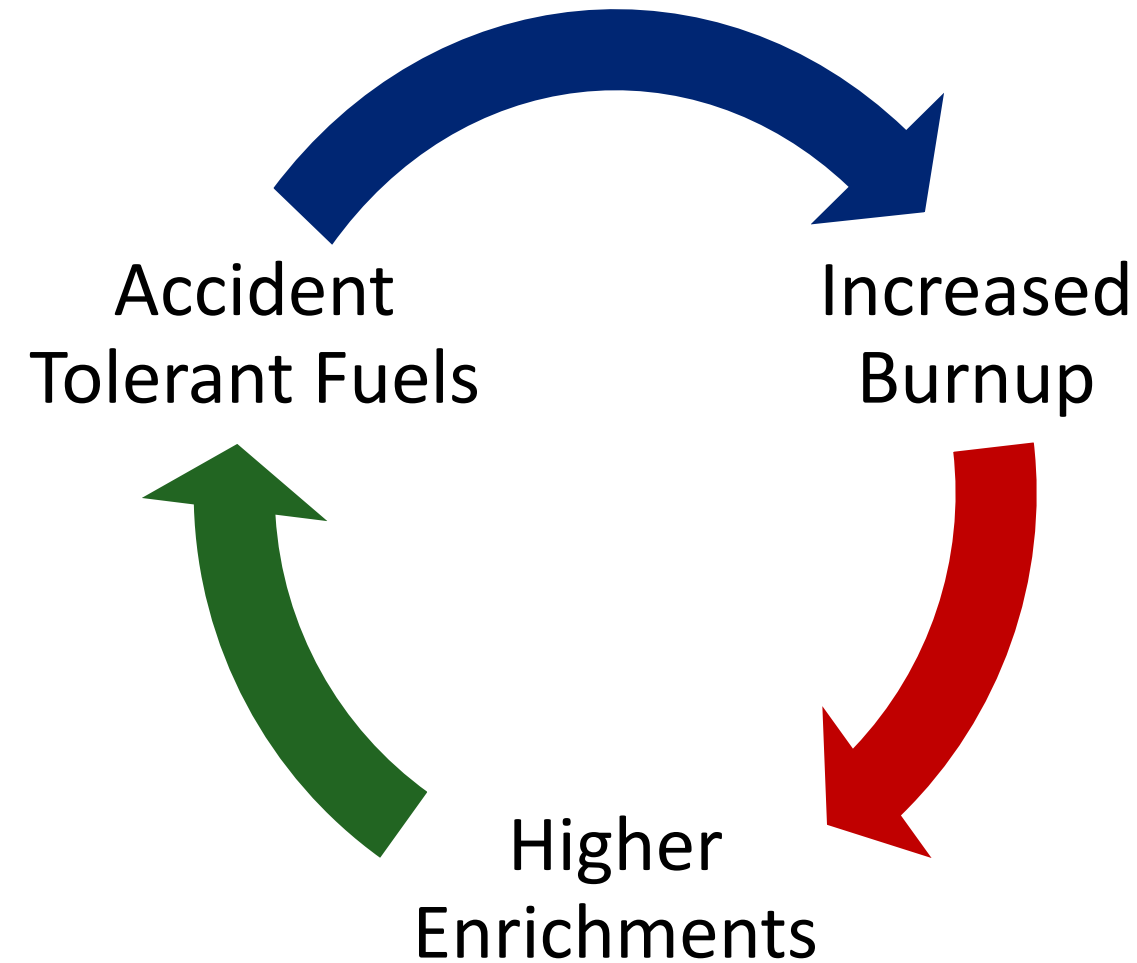
Industry ATF Business Case



ATF Valuation 2.0: Opportunities for Extending Benefits

- Enhanced Operational Limits:
 - Increasing PCT Limits and/or dryout (time-at-temperature)
- Enhanced Fuel Reliability & Performance:
 - Potential coating benefits:
 - Reduced Oxidation
 - Reduced Hydrogen pickup
 - Debris/Fretting Wear
 - Crud resistance/mitigation
 - Potential doped fuel benefits:
 - Reduce pellet-cladding interaction
 - Core maneuvering guidelines
 - Support enhanced flexible power operations
 - Fuel fragmentation
 - Fission product retention

ATF Enabling Fuel Cycle Operations which Enables ATF Transition



- Enhanced Safety of ATF:
 - Enhanced Fuel Performance
 - Enhanced Fuel Reliability
 - Improved Operational Flexibilities
- Less Waste Generation:
 - Potentially 20% Less Waste
 - ~\$3.5 Billion Savings*
- Improved Plant Economics (FCO):
 - 24 Month Refueling Cycles
 - ~\$9.4 Billion in Industry Fuel Savings*
- Enables ATF Fuel Transition

*total for existing US plants

Aging Management

Technical Bases Exist for Extended Operation

Aging Management Programs

Research
Results



Inspection
Findings



Global
Operating
Experience



Over 200 EPRI Technical Reports Contribute to the basis for Aging Management

Aging Management – Living Programs

- Continuous improvement is important
- Draw on global research and operating experience
- Share best practices
- Share results
- Guidance is updated as new information becomes available

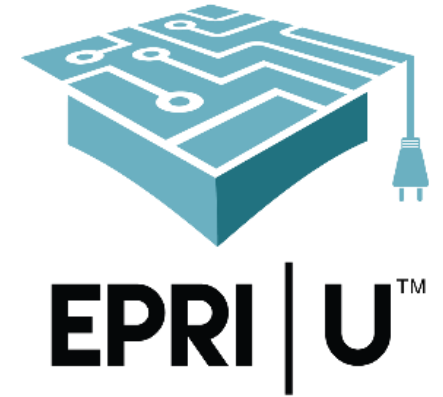
Training and knowledge transfer are critical



EPRI Identification and Detection of Aging Training

Training Modules :

1. Fundamentals of Aging Degradation and Management (1 Day)
2. Metals Aging Degradation Mechanisms (1 Day)
3. Concrete Aging Degradation Mechanisms (1/2 Day)
4. Polymers Aging Degradation Mechanisms (1 Day)
5. Protective Coatings and Linings Aging Degradation Mechanisms (1/2 Day)
6. Electrical, Electronic, and I&C Equipment Degradation Mechanisms (1 Day)
7. Selective Leaching (1/2 Day)
8. Radiation of Concrete (1/2 Day)
9. Fundamentals of Managing Aging Programs USA (1/2 Day)
10. Fundamentals of Managing Aging Programs (International) (1/2 Day)



Distance Learning approach can cost effectively train more people

Together...Shaping the Future of Electricity