

Advanced Nuclear Technology Program

Industry/NRC Materials Tech Exchange

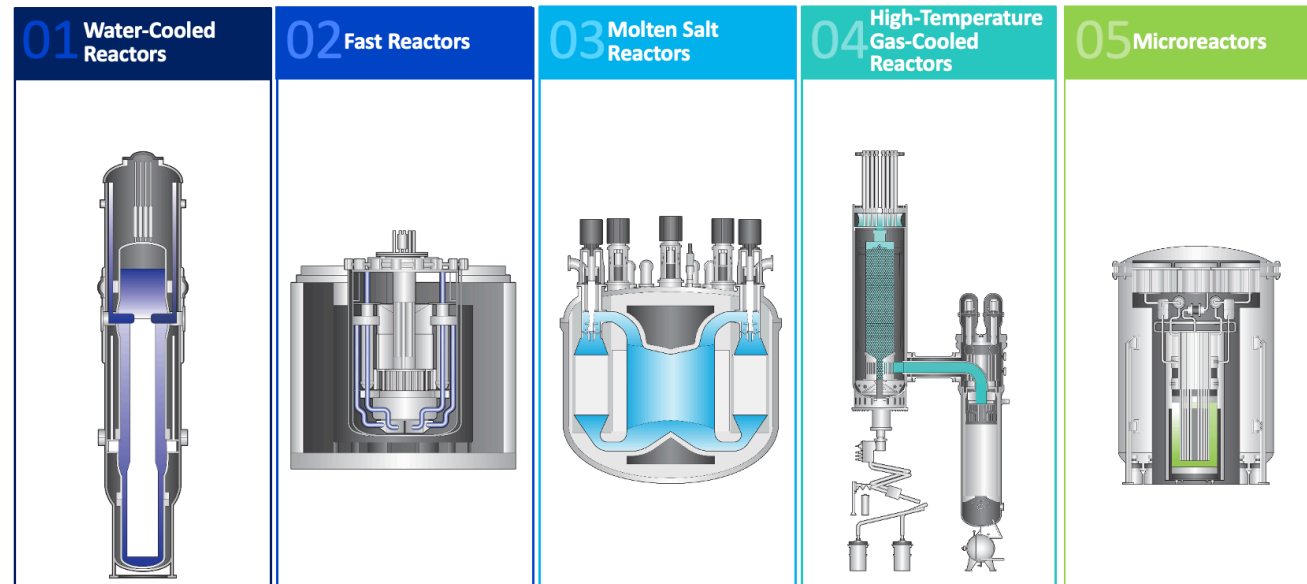
Chris Wax

Principal Technical Leader, EPRI ANT - AMM



Agenda

- Advanced Nuclear Technology (ANT) Program Overview
 - Advanced Reactor Roadmap
- Advanced Manufacturing and Materials Overview
- Materials Management Programs for Advanced Reactors
 - Reliability and Integrity Management Programs
 - Materials Degradation Matrices and Issue Management Tables

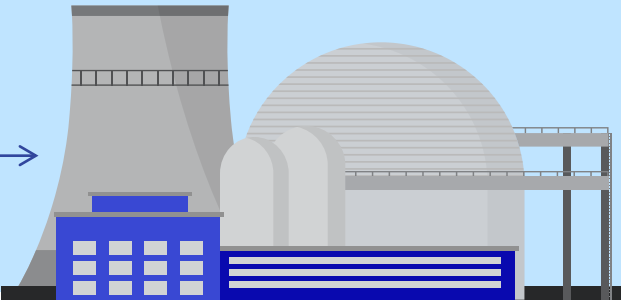




ANT Program Overview

Advanced Nuclear Technology Program Focus

MISSION Accelerating the deployment of nuclear power around the world




 Informing Resource Planning

 Technology Development

 Reducing Deployment Costs

 Supporting Plant Startup


 Training

Siting and Owner Requirements




 Energy Economics

Design and Engineering




 Technical Basis

Construction Optimization



 Advanced Manufacturing

Commissioning



 Initial Operations

More than 80 companies make up the broadest advanced nuclear collaborative

From project initiation through initial operation
ANT is an extension of your team

Extensive Portfolio
40+ Ongoing Projects
200+ Past Products

ANT's Research Portfolio

200+
Existing Products

40+
Ongoing Projects

STARTUP & OPERATIONS
60+ Documents



FABRICATION & PROCUREMENT
40+ Documents



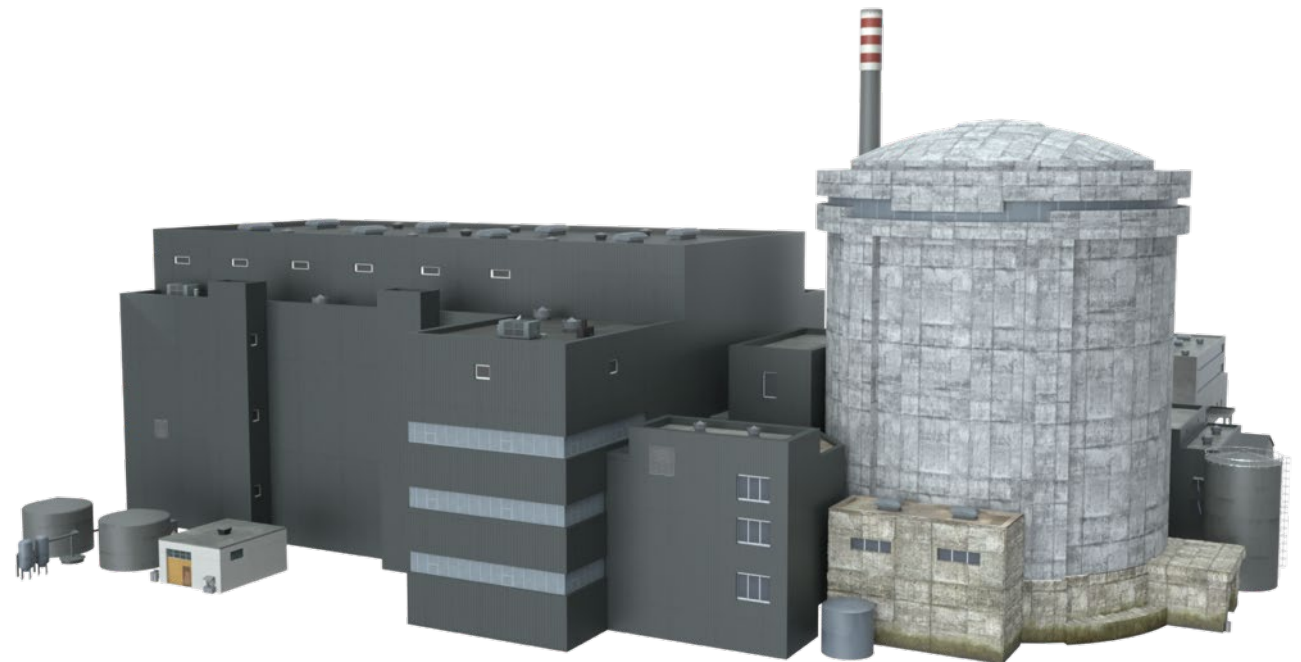
SEISMIC & PLANNING
20+ Documents



DESIGN
70+ Documents



CONSTRUCTION
70+ Documents



3002024386 - Advanced Nuclear Technology: 2022 Product Catalog

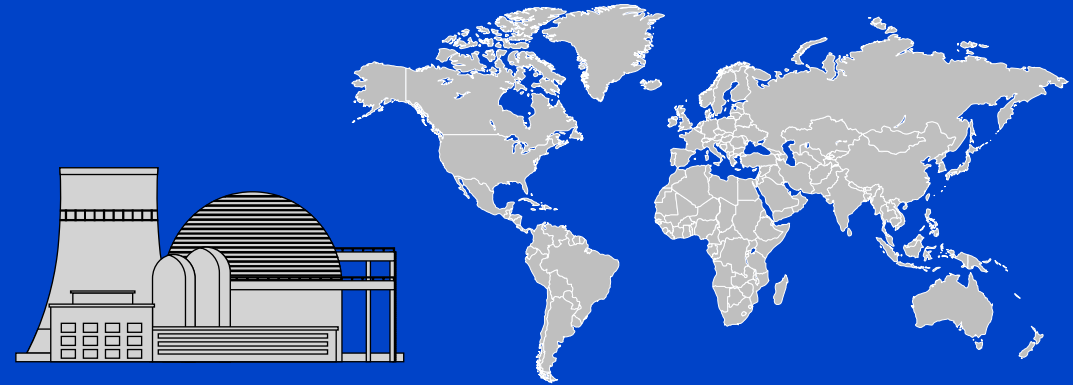
ANT Participation Continues to Grow

EPRI Nuclear Base Membership

22 US Members

29 Global Members

>360
Reactors Worldwide

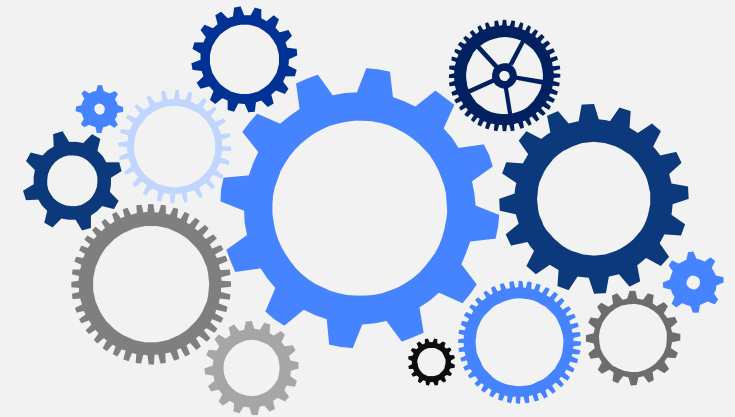


EPRI ANT Supplemental or AR Initiative Members

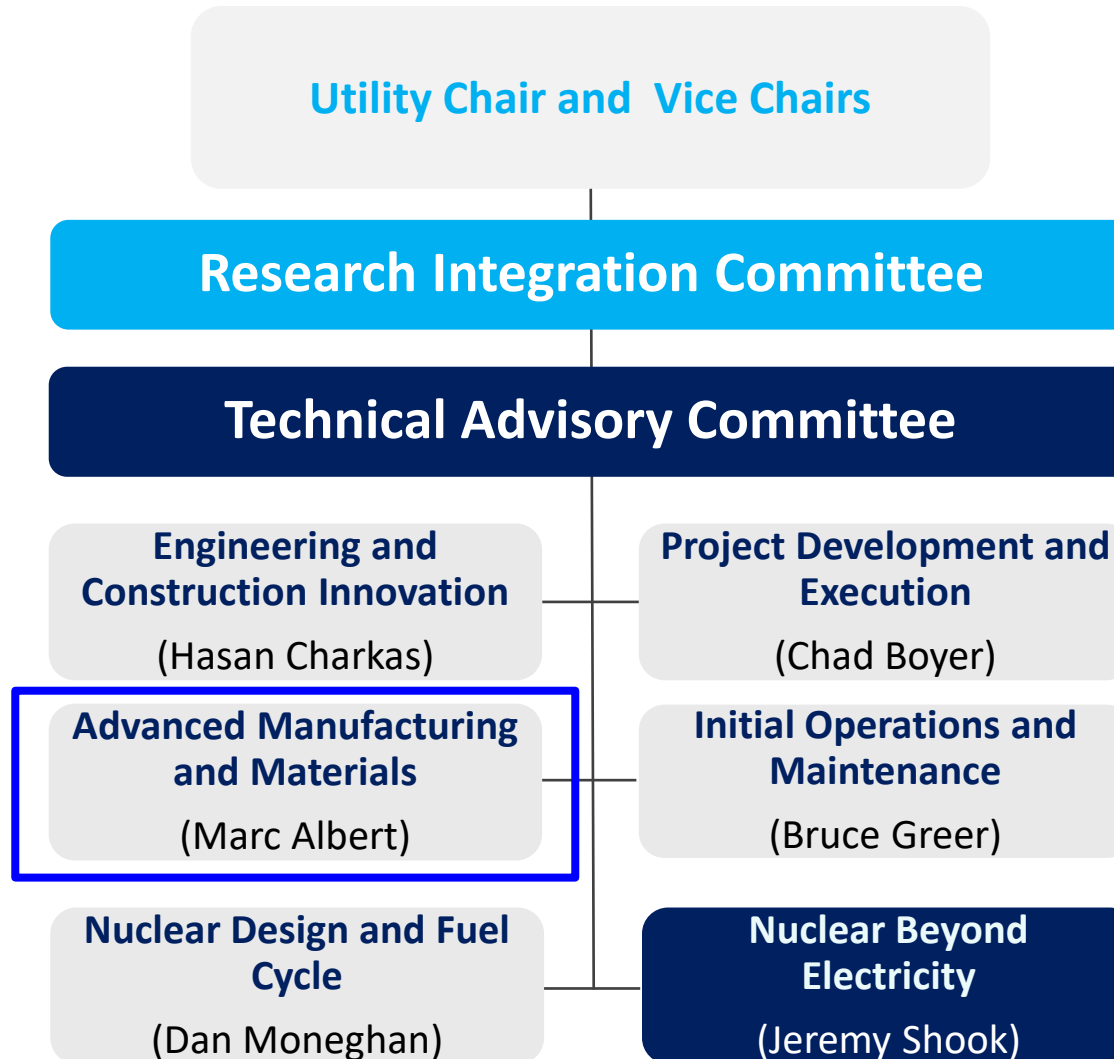
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COMPANIES

Vendor
Designer
Utility (Nuclear and Non-Nuclear)
Manufacturer
Architect & Engineering
Industrial
Researcher
...and more!



ANT's ADVISORY STRUCTURE

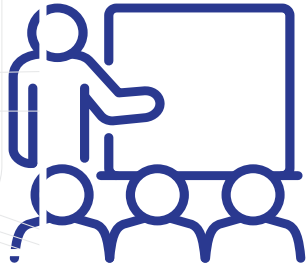
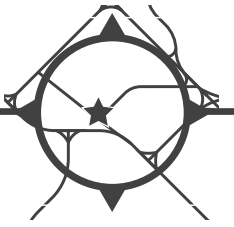




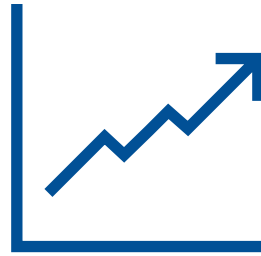
Advanced Reactor Roadmap

Advanced Reactor Roadmap

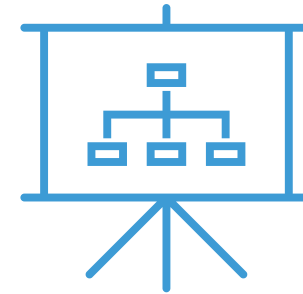
A shared strategy to ensure success at scale



Serving government, academic, industrial, and public **stakeholders**



Almost 100 GWe of **new nuclear** will be needed by 2050. This means around **300 ARs** in the next **30 years**



7 Enablers and **46 key actions** chart our path towards a **net-zero future**

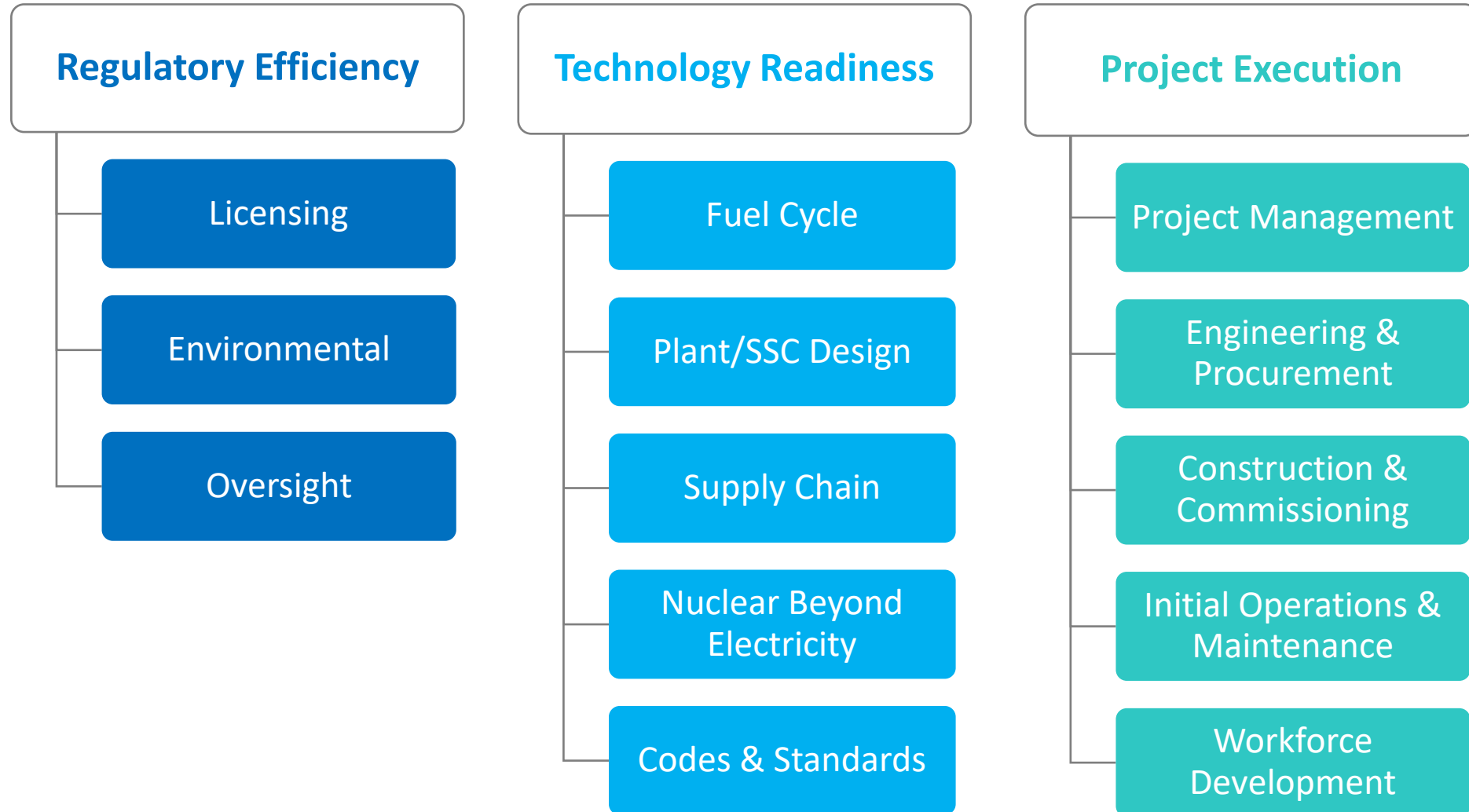


Convening the industry for **strategic action**

Industry's roadmap to the future fleet



Strategic Elements





Advanced Manufacturing and Materials

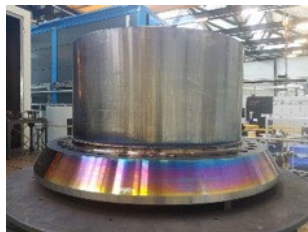
Advanced Manufacturing and Materials

GOAL
& VALUE

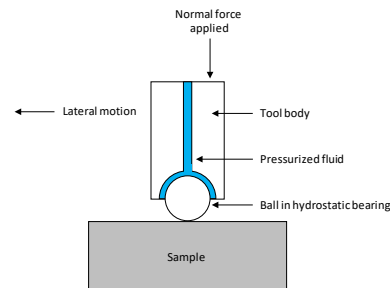
Identify, develop, qualify, & implement more economical manufacturing, inspection & new materials that enable:

Higher Quality Components | Reduced Lead Times | Alternative Supply Chains | Cost Competitiveness | Enable Deployment

- Evaluate, Qualify, Demonstrate Advanced Manufacturing Methods
- Additive Manufacturing
- PM-HIP
- Advanced Welding
- Mechanical Connections
- Advanced Cladding



- Mitigation Techniques
- Material Management
- Reliability & Integrity Management
 - ASME Section XI, Division II
- Enhanced Specifications



- AR Materials Development
- Materials Qualification
- Degradation Mechanisms (MMM/MDM)



Advanced Manufacturing

Material Performance
and Inspection

New Materials
Development



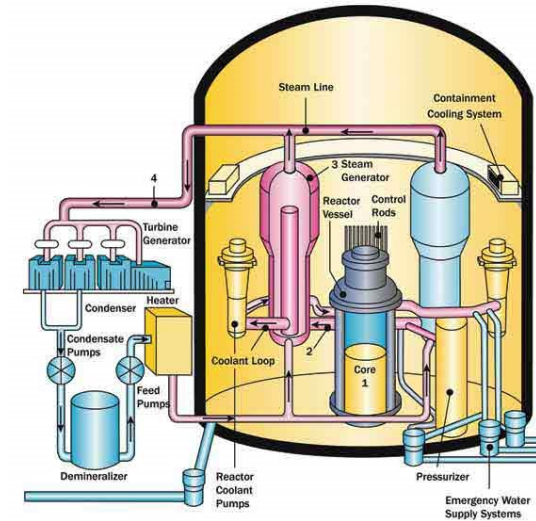
Materials Management Programs for Advanced Reactors

Materials Management Program Background

- For the operating, light-water reactor fleet, license holders use a deterministic approach to assure as-designed safety margins through a selection of mandated examinations and tests
 - ASME Section XI, Division I
 - Developed and evolved with over 40 years of operating experience guiding the requirements
 - NEI 03-08 Materials Initiative
 - Industry requirement, endorsed by NRC, to proactively manage aging and degradation of materials

- To support a broader range of reactor specifications/designs, a performance-based alternative approach to define an appropriate program of examinations and tests is now available
 - ASME Section XI, Division II

Typical Pressurized-Water Reactor

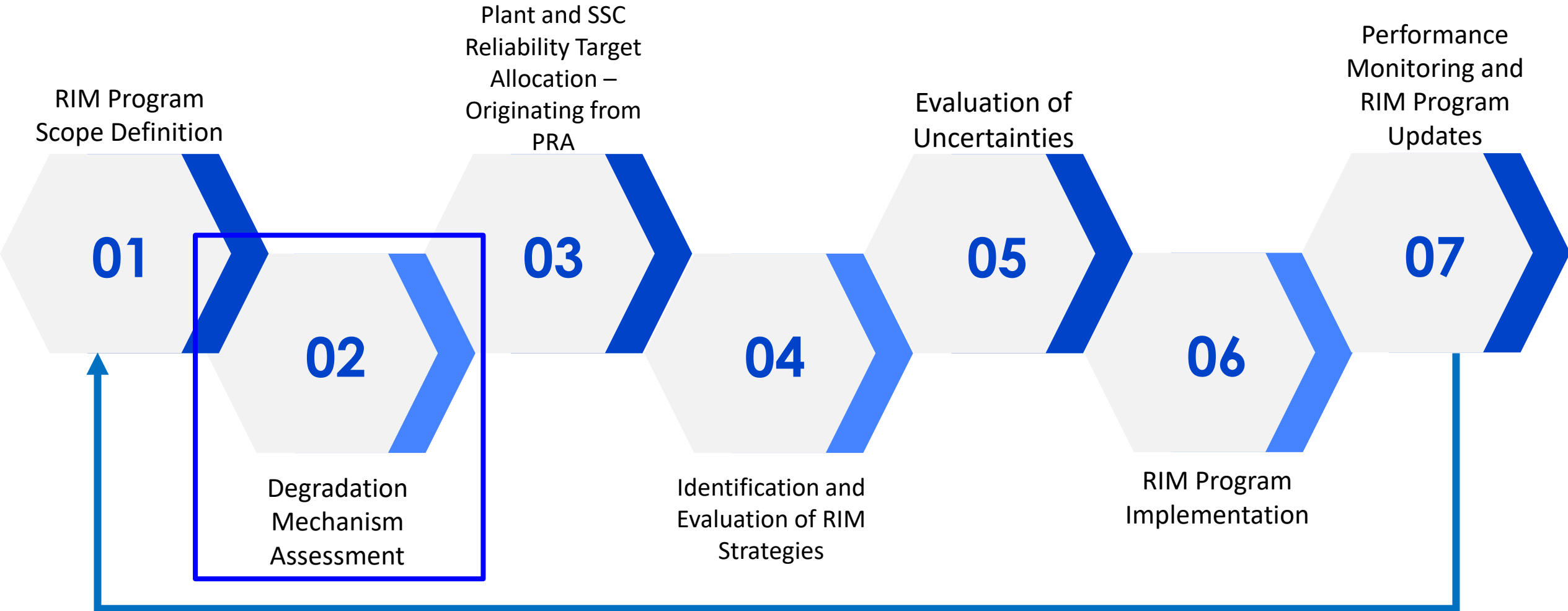


<p>Water-Cooled Reactors</p> <p>Schematic of the small modular light-water reactor (NuScale) power module by NuScale</p>	<p>Sodium Fast Reactor</p> <p>Design rendering of the Natrium reactor, TerraPower's SFR</p> <p>Natrium's integrated molten salt thermal storage loop, enabling 150% power peaking</p>	<p>Molten Salt Reactors</p> <p>Rendering of Molten Salt Reactor (MSR), which burns spent LWR fuel.</p> <p>Rendering of Southern Co. and TerraPower's molten chloride fast reactor.</p>	<p>High-Temperature Gas-Cooled Reactor</p> <p>Rendering of the Xe-100, X-Energy's pebble-bed HTGR.</p>	<p>Microreactors</p> <p>Design rendering of Westinghouse's eVinci microreactor supplying remote energy</p> <p>Artist's rendering of Oklo's microreactor power plant</p>
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The legacy Section XI, Division I ISI program requirements may be a poor fit for many new designs

Advanced Reactor Materials Management - The RIM Process

ASME Section XI, Division II – Article RIM-1, RIM-1.1 Scope



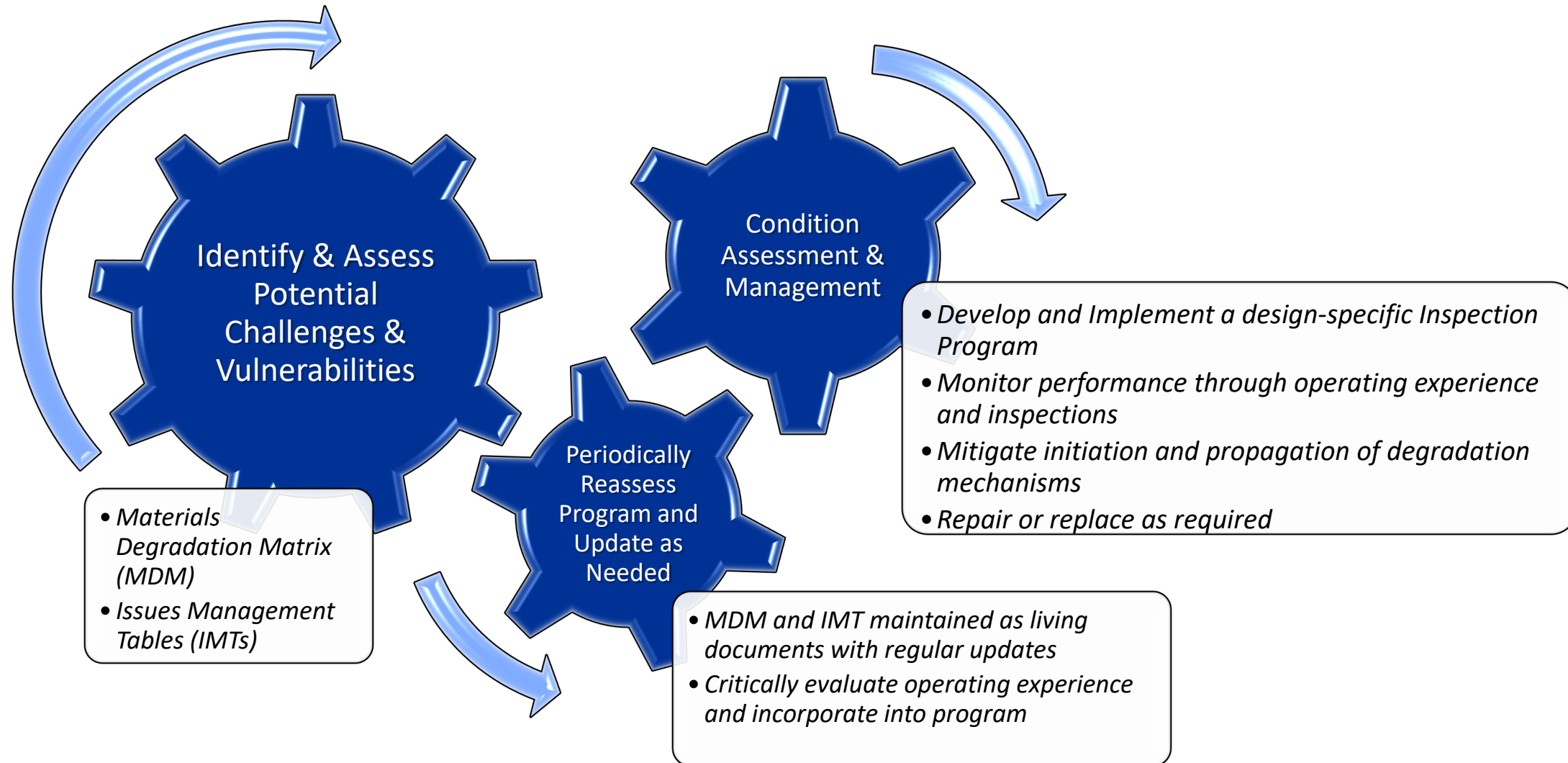
Development and demonstration of a RIM Program approach is lengthy and a cross-disciplinary task
Difficult for any one organization to tackle alone

RIM-2.3 Degradation Mechanism Assessment (DMA)

- The potential active degradation mechanisms for the SSCs within the RIM Program scope shall be identified and evaluated.
 - Design characteristics, including material, pipe size and schedule, component type (e.g., standard fittings, elbows, flanges), and other attributes related to the system configuration
 - Fabrication practices, including welding and heat treatment
 - Operating and transient conditions, including temperatures, pressures, quality of primary and secondary fluid, and service environment (e.g., humidity, radiation)
 - Plant-specific, industry-wide service experience and research experience
 - Results of preservice, in-service, and augmented examinations and the presence and impact of prior repairs in the system
 - Applicable degradation mechanisms, including those identified in Mandatory Appendix VII for the applicable plant type
 - Recommendations by SSC vendors for examination, maintenance, repair, and replacement

Materials Management - *Integrated and Strategic*

Building off successes from the light water fleet, EPRI is applying a similar approach to materials degradation assessments for the advanced reactor fleet



Systematic Approach Summarized

Materials Degradation Matrix

Rev. 4

3002013781

Issue Management Tables

PWR: 3002018255

BWR: 3002018319

Component Material Degradation Tables

Degradation Mechanism Explanatory Notes
(With R&D Status Notes)



Component Management Tables

R&D Gaps
(with Management Issue, Description/R&D Status and Needed Knowledge)

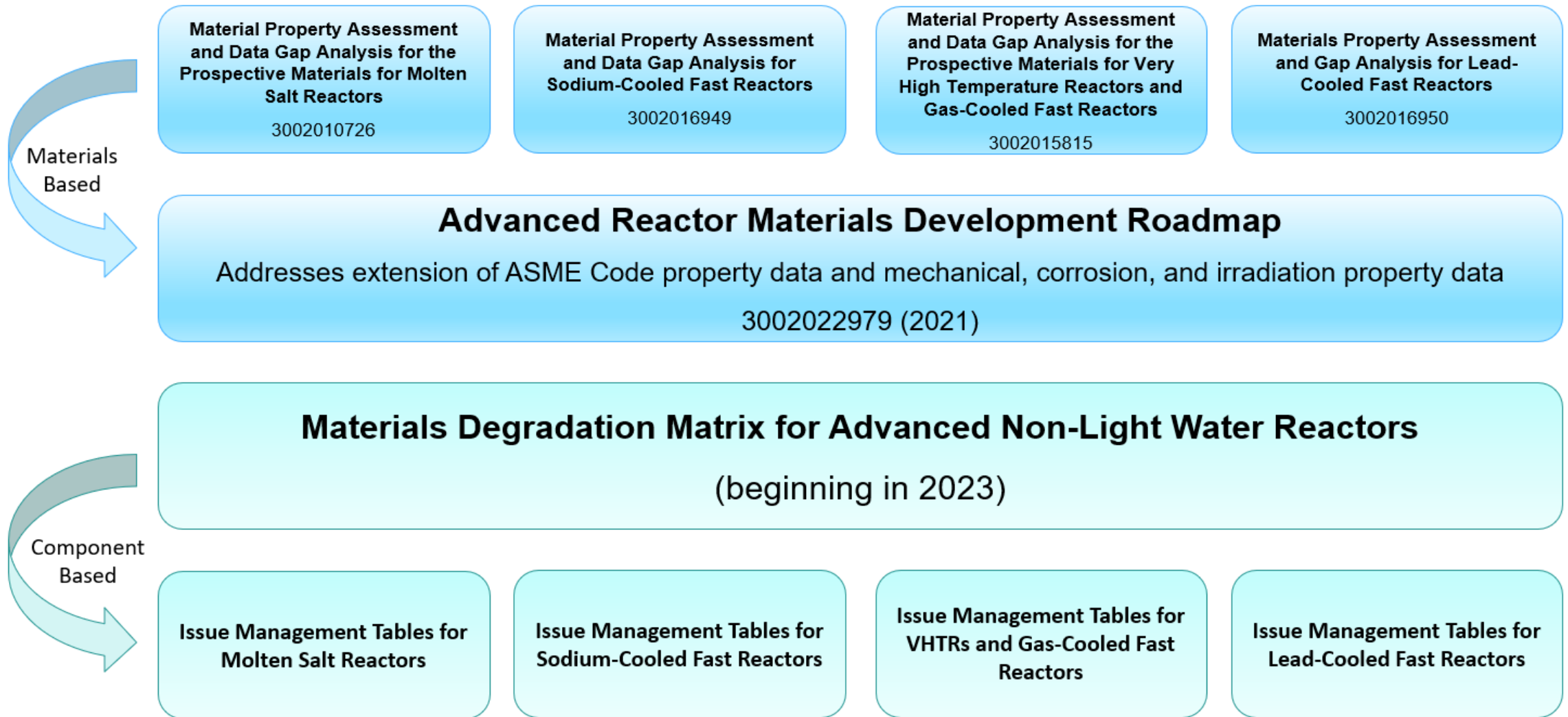
Every material, every potential degradation mechanism and status of knowledge

- Mapped to 80 years of operation
- Covering BWR, PWR, CANDU and VVER
- Planned: LW-SMRs & ANLWRs

Every component/material, failure modes, mitigation, repair/replacement, I&E Guidance → Knowledge Gaps identified and prioritized

- Covers BWRs and PWRs
- Planned: CANDU, VVERs, LW-SMRs & ANLWRs

Materials Support for Advanced Reactors



A blue-tinted photograph of four people, two men and two women, standing together. They are dressed in professional attire, including lab coats and a hard hat. The image is overlaid with the text 'Together...Shaping the Future of Energy®'.

Together...Shaping the Future of Energy®