Identifying Research Projects and Delivering the Results at EPRI

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Technical Executive

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EPRI Mission

Advancing safe, reliable, affordable and environmentally responsible electricity for society through global collaboration, thought leadership, and science & technology innovation.

Independent
Non-profit
Collaborative

Nuclear  Environment  Generation  Power Delivery and Utilization
To develop and provide the nuclear industry with safe, reliable, economic, and environmentally responsible technologies that:

1. Maximize the utilization of existing nuclear plants
2. Enable the deployment of advanced nuclear plants
3. Support long-term sustainability of nuclear energy
EPRI Nuclear R&D: Global Collaboration and Reach

GLOBAL PARTICIPANTS

>320 reactors worldwide

Participants Encompass Most Nuclear Reactor Designs

GLOBAL BREADTH & DEPTH

>75% of the world’s commercial nuclear units
Key EPRI Nuclear Interfaces
EPRI Is All About Input

- Board of Directors
- Advisory Council
- Research Advisory Committee
- Technology Management Committee
- Sector Councils (Nuclear, Generation, Energy and Environment, Transmission and Distribution)
- Program Committees (next slide)
Advanced Nuclear Technology (ANT) Program Advisory Structure
# ANT Research Focus Areas for Balanced R&D Portfolio

<table>
<thead>
<tr>
<th>TAC</th>
<th>Research Focus Area</th>
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<tbody>
<tr>
<td>Engineering, Procurement &amp; Construction (EPC)</td>
<td>Increase Efficiency and Reduce Cost of New Nuclear Construction</td>
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<td>Development of Collaborative Engineering, Design Tools, and Processes</td>
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<td>Improve Quality of Supply Chain for Nuclear</td>
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<td>Modern Technology Application (MTA)</td>
<td>Advanced Monitoring Technology and Data Management</td>
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<td>Technologies to Improve Human Performance, Machine Interaction, and Operational Effectiveness</td>
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<td>Gaps for Use of Digital Systems Technologies in New Plants</td>
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<td>Materials and Components (M&amp;C)</td>
<td>Advanced Fabrication and Manufacturing Techniques</td>
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<td>Material Performance and Inspection</td>
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<td>New Materials Development</td>
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## Two-Year Project Planning Cycle To Keep Pipeline Filled

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<thead>
<tr>
<th>EPC</th>
<th>M&amp;C</th>
<th>MTA</th>
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<tbody>
<tr>
<td><strong>Target 2019</strong></td>
<td><strong>Target 2020</strong></td>
<td><strong>MTA</strong></td>
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<tr>
<td>Advanced Welding for Infrastructure and Construction</td>
<td>A Pathway to Factory Fabrication for Modules and Components</td>
<td>Gaps and Opportunities for Sensor Applications</td>
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<td>Automated Quality Assurance Inspection for Embedded Items in</td>
<td>Additive Manufacturing Development Strategic Focus Area</td>
<td>Applications for Commercial Common Platform Robotic Systems</td>
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<td>Concrete Members</td>
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<tr>
<td>Best Practices for Self-Consolidating Concrete as Mass Concrete</td>
<td>Value Comparison between Manufacturing Techniques</td>
<td>Assessment of Advanced Security Technologies</td>
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<td>Prefabricated Structural Modules for Nuclear Construction</td>
<td>New Materials Scoping Assessment</td>
<td>Investigation of Virtual Technical Assistant</td>
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<tr>
<td><strong>Target 2020</strong></td>
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<tr>
<td>Enhanced Concrete Formwork Technologies</td>
<td>Development of Adaptive Feedback Welding for Repair and Fabrication</td>
<td>Guidance for Wired and Wireless Sensor Applications</td>
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<tr>
<td>Alternative Methods and Materials to Reinforce Concrete</td>
<td>Applicability of EPRI ASME Focused Products with International Codes</td>
<td>Updates to HFE Guidelines</td>
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<tr>
<td>Performance-Based Design for Civil and Structural Applications</td>
<td>Risk Informed Strategies Small Modular Reactors (SMRs)</td>
<td>Identification of Regulatory Challenges for Advanced Plant Data</td>
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<tr>
<td>Guide to Evaluating and Developing Supplier and Vendors</td>
<td>Advanced Reactor Material Development Strategic Focus Area</td>
<td>Investigation of Remote Shift Technical Advisor (STA)</td>
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# Longer Range Multiyear Plan To Maintain Strategic Vision

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<tbody>
<tr>
<td>1. Scouting</td>
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<td>Scouting for EPRI Technology Innovation Program</td>
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<tr>
<td>3. Technology Assessment and Tool Development</td>
<td>Technology Assessment</td>
<td>Revise EPRI siting guide for application to adv reactor deployment</td>
<td>Evaluation of advanced power conversion technologies for ARs</td>
<td>Evaluation of dry/hybrid cooling systems for ARs</td>
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<tr>
<td>3. Technology Assessment and Tool Development</td>
<td>Fuel Cycle Analysis</td>
<td>Fuel cycle mod/sim capabilities</td>
<td>Evaluation of AR back-end waste streams</td>
<td>Fuel cycle analysis of front-end and back-end impacts of new technologies</td>
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<td>4. Strategic Analysis and Thought Leadership</td>
<td>Safety Assessment and Risk Informed Methods</td>
<td>PHA to PRA: Best practices and methodology</td>
<td>Risk informed Strategies for ARs (50, 60)</td>
<td>Pilot ANS 30.1 implementation</td>
<td>Alternative end state PRA for ARs</td>
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<td>4. Strategic Analysis and Thought Leadership</td>
<td>Techno-Economic Analysis</td>
<td>Economic analysis for AR competitiveness</td>
<td>Quantifying value of advanced nuclear energy systems</td>
<td>Expansion of techno-economic modeling tools</td>
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<td>4. Strategic Analysis and Thought Leadership</td>
<td>Thought Leadership</td>
<td>Historical Review of Gov’t/Industry Roles</td>
<td>Reasonable build rates for new nuclear</td>
<td>AR attributes supporting energy network resiliency</td>
<td>Rethinking AR design-life</td>
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<tr>
<td>4. Strategic Analysis and Thought Leadership</td>
<td>AR Flexibility</td>
<td>Feasibility of MW-scale reactors for utility applications</td>
<td>Demo plan for MW-scale reactor</td>
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<td>5. Targeted Technology Development</td>
<td>Advanced Materials and Mfg</td>
<td>GEN IV Materials: Gap analysis, fabricability assessment and material optimization</td>
<td>Advanced material and manufacturing development program</td>
<td>Program on Materials and Manufacturing for Advanced Reactor</td>
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<tr>
<td>Completed</td>
<td>Advanced Technology R&amp;D</td>
<td>I&amp;C for high temp., non-LWR systems</td>
<td>NDE for advanced reactors</td>
<td>Primary system chemistry control and rad protection R&amp;D for non-LWRs</td>
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<td>Current</td>
<td>Qualification and Licensing Support</td>
<td>Limited scope TRISO/particle fuel topical report (AGR)</td>
<td>Topical reports on key R&amp;D issues for advanced reactor designs and classes, e.g., nuclear grade graphite (AGC), qualification of liquid fuels...</td>
<td>Code case support for new materials for AR designs and applications</td>
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Considerations in Proposal and Prioritization of R&D

- Current or emerging issue
- Importance or severity of issue
- Value across stakeholders, nuclear plant designs, geographical boundaries
- Available resources
- Timing (available soon enough?)
- Tactical-strategic balance in R&D portfolio
- Opportunities for collaborations and leveraging of resources and impact (e.g., standards)
EPRI Product Availability

“As a non-profit scientific research 501(c)(3) organization, EPRI has an obligation to make the results of its scientific research available to the public on a non-discriminatory basis.”

- Most EPRI research is available to the public, but not necessarily for free
- Pricing intended to fairly reflect cost to funders who supported research (among other considerations)
- EPRI annually evaluates products older than five years for reduced or zero pricing

Other circumstances may also compel public release at reduced or zero pricing

- The value of the report depends on public access or use in a public forum
- Examples include standards and code development or to inform regulatory process

Presence of proprietary or third-party intellectual property (IP) generally precludes public release unless...

- A non-proprietary public version can be prepared
- Permission for release is granted by IP holders
Selected Examples of Current ANT Program Projects
Integration of Safety Assessment into AR Design Process

Scope
- Assemble a “body of knowledge” on application of PHA and PRA methods
- Develop, describe methodology to support design-license-build-operate lifecycle
- Demonstrate application of approach with use cases
- Demonstrate utility of approach via pilot application

Value
- Leverages investment in design over entire lifecycle
- Supports more incremental step-wise approach to licensing
- Supports risk informed and performance based licensing framework
- Leverages and informs development of ANSI/ANS Standard 30.1 on risk informed advanced reactor design

Deliverables
- Preliminary methodology and best practices (September 2018)
- Case studies illustrating application for analysis of unique molten salt reactor systems (March 2019)
Advanced Manufacturing Strategic Program

- **Objectives**
  - Develop/demonstrate new methods for manufacture/fabrication of a reactor pressure vessel (RPV) in <12 months
  - Eliminate a minimum of 40% from the cost of an SMR RPV, while reducing the schedule significantly

- **Scope**
  - Manufacture major critical components to assemble a 2/3-scale SMR reactor pressure vessel
  - Jointly funded collaboration
    - EPRI, Nuclear-AMRC (UK), USDOE, NuScale Power
  - Advanced processes employed
    - PM-HIP
    - Electron Beam Welding
    - Diode Laser Cladding
  - ASME code development included

What once took weeks can now be done in hours.
Highlights and Accomplishments to Date

- 44% diameter (50-inch) A508 top head has been completed

- One-half section A508 lower head has been completed and dimensioned

- Forgings for flanges, PZR shell, lower RPV section, and HT have been completed

- EB welding parameters and geometry for SA508 Grade 3 Class 1 girth welds were established and demonstrated

- Diode laser cladding key performance variables (KPVs) were established for SA508 substrates and it was determined that it is possible to produce both 1-layer and 2-layer clads that meet ASME IX requirements

- Heat treatment work package developed for localized HT
New Vertical Response Motion Computation in SSI Analysis of Embedded Structures

- Objective: Develop a more accurate vertical motion model for soil-structure interaction (SSI) analysis for embedded structures to reduce unintended conservatism of existing methods.

- New Method: Horizontal motions are amplified through the soil and vertical motions are calculated as a ratio of the horizontal motions (V/H ratio), consistent with calculation of design basis motions.

- Findings: Traditional vertical amplification for embedded structures overestimates vertical ground motion; proposed new method estimates smaller vertical motions and resulting structural responses.

- ASCE 4 and ASCE 43 committees aware of work and further standards development planned.

Together…Shaping the Future of Electricity