Advanced Nuclear Technology Supplemental Program: Near-Term Deployment of Advanced Light Water Reactors

The EPRI Advanced Nuclear Technology (ANT) program complements—and helps accelerate—industry activities aimed at enabling and building confidence in new nuclear plant deployment. The ANT Program addresses crosscutting issues focused around four core elements:

- **Facilitating standardization across the new fleet**
- **Transferring technology to new plant designs**
- **Ensuring top plant performance from start of operations**
- **Reducing the overall deployment risk and uncertainty**

New nuclear power plants incorporating advanced light water reactor (ALWR) technology must overcome a number of regulatory, economic, technical, and social barriers prior to licensing, construction and successful start-up. Many of these barriers can be addressed through focused EPRI technical products and targeted deployment tools that minimize deployment risks.

The EPRI Advanced Nuclear Technology (ANT) program complements—and helps accelerate—industry activities aimed at enabling and building confidence in new nuclear plant deployment through coordinated work on crosscutting issues. The ANT Program focuses on four core elements:

- **Facilitating standardization across the new fleet** – Nuclear plant developers around the world are working to ensure standardization is factored into all aspects of new project development. However, while the designs may be standardized, many of the supporting systems will not be, including startup testing, balance-of-plant components, equipment reliability programs, operational procedures, and configuration management procedures. EPRI’s ANT program will develop standardized guidance in those areas that provide greatest value to the industry.

- **Transferring technology to new plant designs** – Lessons learned from existing plants and from EPRI’s 30+ years of research and development results can be incorporated into new plant designs to drive overall improved performance. Technology advances
and lessons learned in key topical areas—including materials, chemistry, equipment reliability, nondestructive evaluation (NDE), and fuel performance—can be implemented into new plant designs through the utility’s technology vendor. EPRI will continue reviewing available information with subject matter experts, designers, and utility representatives to define and prioritize requirements, guidelines, and assessments, and ensure that new plants sustain top performance.

• **Ensuring top plant performance from start of operations**—Nuclear plant performance is a balancing act of equipment selection, material selection, design, operation, maintenance, management, and many other factors. Current financial models for evaluating new nuclear power plants are based on availability factors reflecting the fleet of existing nuclear plants. EPRI’s ANT program will provide guidance allowing utilities to maintain high availability factors from startup throughout the life of the plant. Specific guidance will be developed in those areas that provide greatest value to the industry.

• **Reducing overall deployment risk and uncertainty**—Constructing, starting-up and working through initial operations of new nuclear power plants present many large, first-of-a-kind challenges. These challenges establish a deployment risk and uncertainty that affects the ability to get plants sited, approved, financed, and licensed. EPRI’s ANT program will provide research to decrease the deployment risk in a wide range of areas as determined by the members.

**Project Summaries**

The ANT Program initiated various projects in 2008 and 2009 to increase the certainty and reduce the risks associated with deploying new plants. Several of the 2008/2009 “ongoing projects” will continue into 2010. New projects planned for 2010 include:

**Alloy 690/52/152 PWSCC Research for New Plants**

Ongoing primary water stress corrosion cracking (PWSCC) experience and research with Alloy 690 indicates that certain microstructures that can be present in Alloy 690 product forms (such as plates and bars) can reduce its PWSCC resistance significantly. The proposed task will conduct PWSCC tests to identify Alloy 690 microstructures and thermo-mechanical processing steps that can degrade its SCC resistance. Based on this research, Alloy 690 procurement and component fabrication and installation guidelines will be revised for use in new plant construction.

**Digital Radiography (RT)**

Advances in filmless radiography could benefit new construction in the examination of cast stainless steel, dissimilar metal welds, and austenitic welds. This project will evaluate the use of filmless radiography systems by conducting equipment performance demonstrations on planar and volumetric fabrication flaws using a variety of digital detector panels, phosphor plates, and high energy electronic sources.

Through repetitive construction of standardized plants and implementation of lessons learned from operating experience and technology advances, new nuclear plants can achieve reduced construction costs and schedules. Rigorous evaluation of equipment reliability practices and proactive assessments of current fleet guidelines can also ensure top plant performance from start of operations. This graphic illustrates the cost and schedule improvements South Korean utility KHNP has achieved and expects to achieve through its ambitious nuclear build program.

**New Plant Startup Program Guidelines**

Previous startup experience and lessons learned have not been effectively captured and the effects of new construction techniques, requirements and EPC arrangements upon startup need to be evaluated. This project will collect lessons learned from prior startups for incorporation into new plant startup programs, investigate and recommend methods to adapt prior startup strategies into the new plant construction environment, and assess the impact of new requirements on startup testing.

**Primary and Secondary Water Chemistry Guideline Assessment for New Plants**

EPRI develops and periodically updates Water Chemistry Guidelines for current operating plant designs. To ensure that new plant designs properly incorporate industry standard water chemistry controls, this project will identify potential gaps that may necessitate modifications or additions to the current EPRI Water Chemistry Guidelines to ensure their applicability to new plants. Special emphasis will be given to water chemistry control strategies used during hot functional testing, startup, and initial operation of new plants.

**NDE Digital Data**

Archival NDE data is required to support the quality assurance (QA) basis of new construction. In the past, this was typically a paper report or image for ultrasonic, eddy current, and radiography testing. With today’s technology, most NDE methods have the capability to provide digital records that should be acceptable for providing evidence of the examinations. This project will research current requirements for digital data archiving at member utilities and investigate the technical requirements for digital archiving NDE data.
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Ferritic Stainless Steel Testing
Duplex and ferritic stainless steel tubing is being used more frequently in balance-of-plant heat exchanger and condenser applications due to its enhanced material properties and corrosion resistance. Electromagnetic techniques available today are inferior in providing accurate and repeatable results for proper tube integrity assessments, and the challenges are even more formidable for detecting flaws underlying support structures. This project will identify advanced electromagnetic NDE methodologies that may be suitable to provide integrity assessment of duplex and ferritic stainless steel tubing and identify any gaps that impede its implementation.

Digital & C Training Modules for New Plants
Digital I&C training for new build engineers and managers is not currently available in the industry. New plants will use digital I&C throughout the plant, contrary to most existing plants. This project will leverage the 2009 updates to the existing/operating plant digital I&C training, and customize the modules to develop a new plant digital I&C training syllabus. The material will be delivered in multiple modules, as part of technical staff initial and continuing training. These modules will include one for program/project management familiarization and one for technical staff.

Human Factors Engineering Training Modules for New Plants
Utility personnel require training in the application of human factors engineering (HFE) principles and processes in design, verification and validation of new plant control rooms and other human-system interfaces (HSIs). Such training improves interface designs and reduces the likelihood of human errors and potential unplanned outages. This training is lacking for new build engineers. This project will develop an HFE training syllabus that provides competency in NUREG-0711 and SRP Chapter 18 requirements and implementation.

Impact of Radionuclide/Source Term
The U.S. Nuclear Regulatory Commission (NRC) has disallowed credit for the impact of radionuclides during AP1000 licensing activities. This project would scope out the possibility of increasing the Decontamination Factor for containment impaction credit by firming up the data and science to support NRC approval of impaction credit for new builds.

Concrete Sensors
Concrete structures are an integral part of the nuclear station and integrity assessments are needed for licensees to make informed mitigation and repair decisions regarding long-term operations. This project would evaluate the use of embedded sensors to monitor aging by identifying structures that are susceptible and then evaluating available sensor technology with consideration for 60+ years of life. Project results will identify technology gaps and recommend future R&D to close these gaps.

Methodology for Risk Informed Procurement
This project will develop a methodology document and define a pilot plant application needed to enable NRC approval of risk-informed procurement for new plants. This methodology will be used to identify low safety significant components that no longer need to meet stringent ASME (e.g., N-stamp) and other (e.g., QA) requirements, reducing the required number of N-stamp components and replacing them with less costly industrial/commercial grade components.

Technical Basis for HDPE Above-Ground Use
Carbon steel has not performed well in the raw water systems of the current fleet. A replacement material, high-density polyethylene (HDPE), is available that does not corrode, foul, or form tubercles. Material costs are approximately the same as carbon steel, but ¼ to 1/50th the cost of high alloys. This project would develop the technical basis and data to support an ASME code case for the use of HDPE piping in above-ground applications.

Updating the Seasonal/Annual Cooling Tower (Environmental) Impact (SACTI) Code
The SACTI code for modeling environmental impact of cooling towers is out of date and has not been updated with current industry knowledge. This project will improve the SACTI code from a suggested list of desired upgrade features and capabilities identified by the user community.

Deliverables
The deliverables produced under this program will vary by project and by year. Deliverables may include specification updates, guideline documents and reports, comparative analyses, detailed technical reports, and electronic databases, along with supporting documentation. Organizations funding this program will receive online access to the deliverables produced in the year(s) during which they funded the program.

Program Membership/Participation Fees
Organizations joining the ANT Program in 2010 and beyond will be asked to commit to a three-year (3-year) forward agreement. In addition, starting in 2011, organizations joining the ANT Program for the first time, as well as organizations that have dropped out of the ANT Program and are re-entering the Program, will be assessed an additional $100,000 for back-access to all products funded by the ANT Program in prior years.

Level 1: Nuclear Plant Operators/Projected Operators
Level 1 includes current nuclear operators and non-operators with announced intentions to pursue licensing for a new nuclear plant. The annual membership fee for Level 1 organizations is $275,000.

In addition, the Program will be open to current plant operators evaluating new nuclear generation, at an annual participation fee of $100,000.
Funding for the ANT Supplemental Program, at either participation level, is subject to a three-year agreement and is eligible for EPRI self-directed funding (SDF).

Non-EPRI Nuclear Power Sector members will be assessed an annual fee of $100,000 in addition to the fees listed above.

Level 2: Non-Operators
Level 2 encompasses utility entities that do not currently operate nuclear power plants, but are evaluating new nuclear generation and/or have a vested interest in ensuring best available technology is incorporated into new plant designs. Such “non-operator utilities” are eligible to participate in the ANT Supplemental Program as non-governing members.

Through a three-year, $50,000 per year commitment, non-operators can access and review Advanced Nuclear Technology products, for internal use only. To ensure effective representation, non-operators will be invited, where appropriate, to attend ANT working group and technical project meetings.

Level 3: Vendor Participation
EPRI has established an option to ensure the products being produced under the ANT Program are available to the various vendor and other interested organizations supporting the ANT utility members. A three-year, $50,000 per year commitment is required for all Level 3 funders. Under a Level 3 agreement, vendors and other interested organizations can participate in ANT meetings and technical advisory groups, and access all deliverables produced in the years during which they funded the program.

Technical Contact
For more information, contact Tom J. Mulford at 650.855.2298 (tmulford@epri.com).

Vendor Engagement Enhances Technology Transfer
Because new nuclear plant deployment requires close coordination between the developer, the nuclear steam supply system vendor and the many other critical suppliers, the ANT Program has been specifically designed to facilitate information exchange and technology transfer. Vendors can gain access to the products developed by the ANT Program and also provide input into the underlying research and development supporting these products. Such interactions ensure that new nuclear plants are developed, constructed and brought on-line with the greatest degree of technical confidence.

Photo courtesy of TVO.