LWRS Newsletter
Light Water Reactor Sustainability
Issue 3 • February 2011

EPRI and LWRS Team Up to Sustain High Performance of Existing Plants for the Long Term

By John Gaertner
Electric Power Research Institute

The Electric Power Research Institute's (EPRI's) Long-Term Operation (LTO) Project objective is to develop the technical basis for high-performance operation of existing nuclear plants worldwide through at least 80 years of operation. EPRI is collaborating with the Department of Energy's (DOE's) LWRS Program to achieve this objective. Through a recent Memorandum of Understanding between EPRI and DOE, both parties have agreed to develop a joint strategic planning document that will further strengthen this relationship.

The LTO Project provides research results for informing industry decisions regarding long-term operations. Such decisions include whether life extension is technically sound, benefits of modernization are justified, and regulatory issues can be addressed cost effectively.

The project has clear criteria for selecting technical activities. Projects must address (1) aging and life-cycle management, (2) opportunities for modernization and uprates, (3) identification and assessment of potential life-limiting issues, or (4) advanced analysis and simulation. The promise of useful results in the 2014 through 2019 timeframe must exist to support generation planning and license renewal. Finally, projects using unique expertise and facilities at the national laboratories through the LWRS Program are favored.

The LTO Project draws technical expertise from other programs within EPRI to manage and conduct research. The project has strong advisory support, encompassing 16 utilities that operate plants in Europe, Asia, and a majority of the plants in the United States. Representatives of these organizations constitute the LTO Task Force, which participates in strategic planning, project selection, review of research and development activities, pilot applications, and demonstration projects.

Current technical focus areas include advanced online monitoring, life-cycle management, risk-informed safety margin characterization, materials aging and degradation, and advanced fuel analysis. These focus areas align closely with the research pathways of the LWRS Program. Key milestones have been defined in each of these research areas to support decision-making that is related to long-term operations in the 2014 through 2019 timeframe.

Plant pilots and demonstrations serve an important role in LTO research. EPRI, DOE, and Constellation Energy Nuclear Group are performing demonstrations through the EPRI LTO Project and the DOE LWRS Program at the Ginna and Nine Mile Point Unit 1 nuclear plants. Both plants are more than 40 years old. Current activities include a comprehensive concrete containment examination, an incremental reactor internals inspection of aging expected beyond 60 years, and development of a strategy to manage and test reactor vessel embrittlement throughout the extended life of the plant.

Steam generator replacement during the refurbishment and uprate of the OPPD Fort Calhoun Station.

Considering the Costs

By Don Williams
LWRS TIO Deputy Director

Consistent with the National Energy Policy Act of 2005 and the DOE Nuclear Energy Research and Development Roadmap, the LWRS Program manages and directs (in close collaboration with related industry programs) DOE's research and development efforts to provide the technical foundations for licensing and managing the long-term, safe, and economical operation of current nuclear power plants. The LWRS Program focuses on longer term and higher risk/reward research that contributes to the National Energy Policy Act of 2005 objectives of energy and environmental security. The importance of establishing the viability of long-term operation (beyond the current 60-year license limit) of these plants is recognized by all stakeholders, but there is a clear expectation that public sector funding will be undergirded by substantial private sector investments to "cost share" the overall effort.

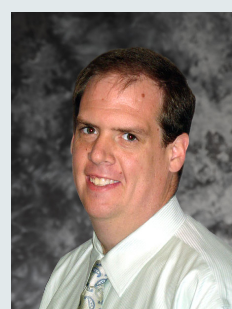
The authorization language (Senate Report 111-228) for Fiscal Year 2011 LWRS Program funding is very clear: "Regarding the Light Water Reactor Sustainability program, (Congress) expects a high cost share from industry." Cost sharing is important to leverage resources from multiple participants to achieve common objectives and to ensure the program has the right priority and focus in its planned work activities. The program collaborates with stakeholders (such as EPRI, the Nuclear Regulatory Commission, nuclear utilities, reactor vendors, universities, and international cooperatives) to pursue jointly funded projects and separately funding work directed at long-term plant operations.

The LWRS Program views cost sharing as the value received from a collaborating stakeholder that directly contributes to and supports the goals of a specific LWRS Program research and development activity. Cost sharing consists of three major activities: (1) life extension research and development that is jointly supported by DOE and industrial partners through established agreements; (2) "in-kind" contributions, where industry conducts research and development work that supports the LWRS Program mission; and (3) other federal investments, where appropriated funds in other agencies support the understanding and documentation of plant long-term operation considerations. The contributions by collaborators related to specific LWRS Program activities may include hardware, software, and staff time provided by collaborators in support of a specific LWRS Program project.

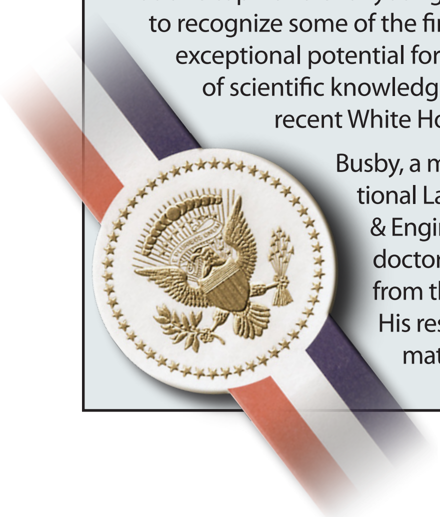
The level of cost share will be considered in evaluating the priority of program activities, with higher priority given to activities with high levels of cost share. Cost share is not required for every program activity. However, only program activities with high strategic value will be supported if they have limited or no cost share. To date, all indicators are that the cost sharing aspects of this program will be considerable.

For the latest information about the activities and accomplishments of the LWRS Program, please go to our web site: www.inl.gov/lwrs.

Researcher Receives Presidential Early Career Award



Jeremy Busby, LWRS Materials pathway lead, has received a Presidential Early Career Award for Scientists and Engineers (PECASE). This award, one of the nation's top honors for young scientists and designed to recognize some of the finest researchers who show exceptional potential for leadership at the frontiers of scientific knowledge, was presented during a recent White House ceremony.



Busby, a member of Oak Ridge National Laboratory's Nuclear Science & Engineering Directorate, holds a doctorate in nuclear engineering from the University of Michigan. His research focuses on structural materials for nuclear reactors, including the testing and development of advanced reactor materials. Jeremy's research contributions have been both substantial and diverse, ranging from support for light water reactors to space reactor systems as well as supporting research for the ITER (originally the International Thermonuclear Experimental Reactor) fusion project. For example, he helped develop a new cast stainless steel that is 70% stronger than comparable steels for possible use in the ITER reactor.

(Information for this article was adapted from the following source: http://www.science.doe.gov/News_Information/News_Room/2011/Science_Highlights/Jan6_EarlyCareerWinners.html)

Power Uprates – Where the Nuclear "Renaissance" Has Been Happening

By Hongbin Zhang
Economics and Efficiency
Improvement Pathway Lead

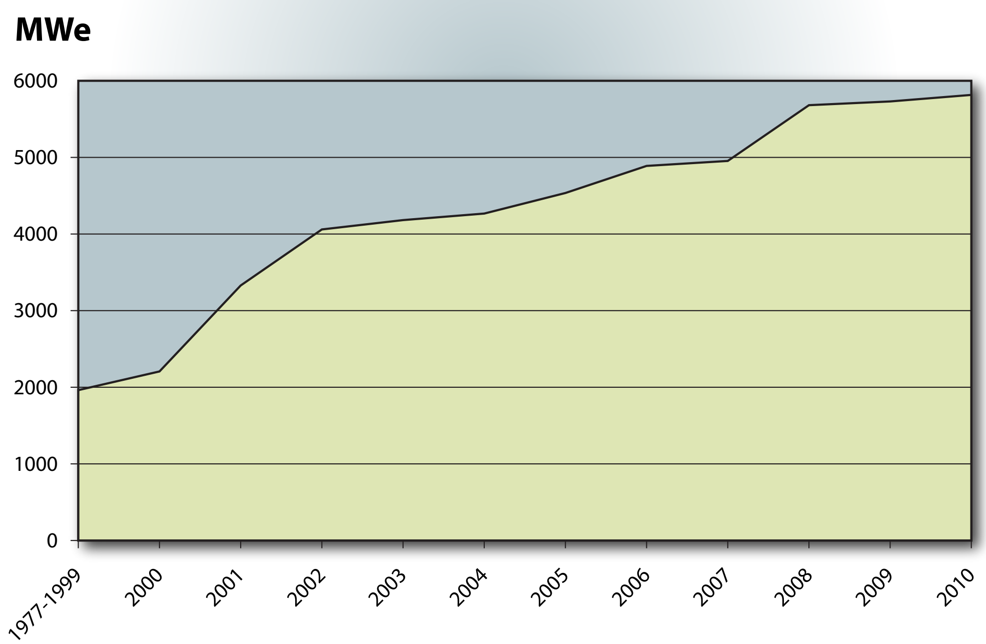
The nuclear industry has been making improvements in commercial nuclear power plants since the 1970s to increase their rated power output (i.e., power uprates). There are three types of power uprates: (1) measurement uncertainty recapture power uprates, which are usually less than 2% of a plant's licensed thermal power rating, (2) stretch power uprates, which are typically up to 7% and within the design capacity of the plant, and (3) extended power uprates, which have been approved for increases as high as 20%. Uprating a nuclear power plant reduces the operating cost per unit energy generated and significantly enhances asset value to the plant owner. As of September 2010, 135 power uprate submittals had been approved. The total extra power generated from those power uprates is equivalent to building almost six 1,000-MWe nuclear power plants.

Industry has achieved remarkable performance using plant modifications, incremental fuel improvements, and application of best-estimate modeling and simulation methodologies to recover conservatism in design and safety analysis. Through implementation of additional upgrades to physical systems, structures, and components and new safety analysis improvements, existing nuclear power plants are theoretically able to sustain higher power uprates than those already achieved. Consequently, the research and development required to support an additional cycle of extended power uprates is being planned under the LWRS Program. However, increasing the power level of a nuclear power plant by greater than 20% of its approved rating will require higher power density core designs and enhanced scientific understanding of plant performance issues at the higher power levels. Also, the integrity of reactor pressure vessels and core internals due to increased radiation damage and corrosion must be established. Additional requirements to be satisfied include confirmation of accident-based safety limits for ensuring fuel and containment integrity.

The Economics and Efficiency Improvement Pathway focuses on developing enabling technologies that can address uncertainties inhibiting the potential for additional power uprates greater than 20%. Development of deep science-based knowledge in this area will be augmented by the Energy Innovation Hub for Nuclear Energy Modeling and Simulation, which is run by the Consortium for Advanced Simulation of Light Water Reactors. Integrating these results with plant changes and operating conditions will be evaluated by the LWRS Program Economics and Efficiency Improvement Pathway to facilitate implementation of these new extended power uprates.

The ability to greatly uprate an existing nuclear power plant provides a national strategic benefit of increasing the total available electrical power supply from carbon-free generation sources at a lower cost per kW while the building of new nuclear plants progresses.

Cumulative Capacity Additions Approved by the NRC at U.S. Nuclear Power Plants (1977-2010).



Online Monitoring to Enable Improved Diagnostics, Prognostics, and Maintenance

By Leonard J. Bond
Advanced Instrumentation, Information, and Control Systems Technologies

For both existing and new plant designs, there are increasing opportunities and needs for application of advanced online surveillance, diagnostic, and prognostic techniques that continuously monitor and assess the health of nuclear power plant systems and components. The added effectiveness of such programs has potential to enable holistic plant management and minimize exposure to future and unknown risks.

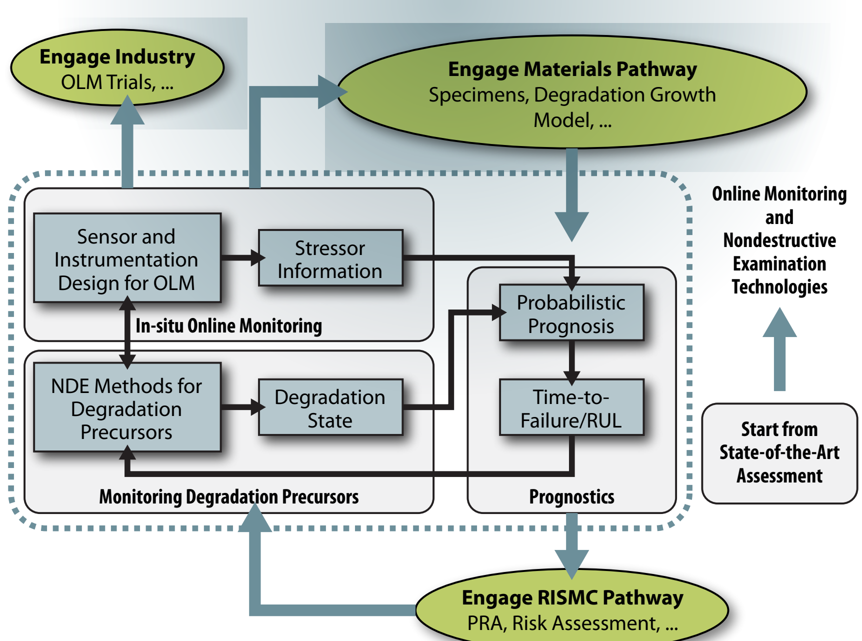
The nondestructive examination and online monitoring activities within the Advanced Instrumentation, Information, and Control Systems pathway are conducting research and development to establish advanced condition monitoring and prognostics technologies to understand and predict future phenomena derived from plant aging in systems, structures, and components. This research includes use of enhanced functionality and system condition awareness that becomes available through application of digital technologies at existing nuclear power plants for online monitoring and prognostics.

Current state-of-the-art for online monitoring that is applied to active components (e.g., pumps, valves, and motors) and passive structures (e.g., core internals, primary piping, pressure vessel, concrete, cables, and buried pipes) is being reviewed. This includes looking at current deployment of systems that monitor reactor noise, acoustic signals, and vibration in various forms; leak monitoring; and condition-based maintenance for active components.

The nondestructive examination and online monitoring projects are designed to look beyond locally monitored, condition-based maintenance. Current trends include centralized plant monitoring of systems, structures, and components; potential fleet-based, condition-based maintenance; and technology that will enable operation and maintenance to be performed with limited onsite staff. Attention also is moving to systems that use online monitoring to permit longer-term operation, including a prognostic or predictive element that estimates a remaining useful life.

Many, if not all, active components can be well managed, routinely diagnosed, analyzed, and upgraded as needed using periodic and online, condition-based maintenance. The ability to successfully manage passive systems and structures is seen as key to long-term operation, particularly in the United States. New approaches will be demonstrated, including prognostics for passive structures, which are critical to maintaining safety and availability and to reducing operations and maintenance costs for nuclear power plants. To provide proactive online monitoring that includes estimates for remaining useful life, new projects will include advanced sensors, better understanding of stressors, and challenges faced in quantification of uncertainty associated with remaining useful life. This program area will leverage insights from past experience in other industries and seek to demonstrate feasibility of online monitoring and prognostics to support long-term operation of nuclear power plants.

Advanced diagnostics employing online monitoring within the LWRS Program engages the materials and risk pathways and provides opportunities for industry online monitoring trials.



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