

**U.S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY RESEARCH INITIATIVE
ABSTRACT**

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Institution: Ames Laboratory

Title: On-Line NDE for Advanced Reactor Designs

The extended refueling interval of Generation IV nuclear reactors creates new maintenance challenges. Current commercial reactors achieve high levels of availability and reliability by employing methodical, periodic off-line inspections, coupled with preventative maintenance and component repair or replacement during planned refueling periods. The inspection and maintenance regulations imposed on current plants have been developed based on the current refueling schedule, which is typically 1 to 1.5 years. Therefore, to take advantage of the Generation IV reactor extended refueling interval, new approaches are required to keep maintenance from interrupting operation. A key component of our strategy is to replace current outage-based inspections with on-line inspection and monitoring, to ensure maintaining the current level of safe operation.

More specifically, our objectives are four-fold:

- To develop the concept of a built-in structural integrity monitoring system using electromagnetic, ultrasonic, and radiation detectors, to be integrated into the design of Generation IV nuclear power systems.
- To evaluate and characterize the performance of conceptual sensor systems by the use of physics-based simulation models.
- To enhance the capabilities of the simulation models to meet the challenges posed by unique power system environments.
- To perform basic studies on selection of sensor types and materials, on their compatibility with hazardous environments, and on their possible degradation.

In our approach, we will consider using electromagnetic, ultrasonic, and radiation detectors. In particular, we emphasize the use of physics-based simulation models, which numerically predict the sensor field interactions with structural materials. The models and their performance predictions will play a central role in performing conceptual design exercises, so that reactor designers can proactively take the inspectability predictions into design considerations. Indeed, this is the only cost effective way in which this can be done.

Our National Laboratory-Industry collaboration represents a unique capability of conceiving and designing such sensor systems, taking advantage of our many years of experience in nondestructive evaluation (NDE) research and the resulting accumulation of knowledge and expertise, supplemented by the Company's reactor design experience.

From a broader perspective, this program will have a major impact on the final design of a Generation IV reactor, where all potential material and component failures will be fully considered, and appropriate design steps will be taken to integrate either sufficient redundancy or adequate monitoring techniques.
