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

PI: **Leonard J. Bond** **Proposal No.: 99-0168**

Institution: **Pacific Northwest National Laboratory**

Collaborators: **None**

Title: **On-Line Intelligent Self-Diagnostic Monitoring for Next Generation Nuclear Power Plants**

Operating experience from U.S. nuclear power plants indicates that degradation of power plant performance in terms of unscheduled shutdowns, extensive maintenance and operational efficiency occurs because of vibration, bio-fouling, and erosion/corrosion. This project designs and demonstrates an on-line intelligent Self-Diagnostic Monitoring System (SDMS) for next generation nuclear power plants that detects, monitors and, diagnoses these degradation mechanisms and their effects.

This project provides the proof of concept for SDMS technology. The four central components for the project are (i) the design and demonstration of the SDMS architecture and implementation methodology, (ii) the detailed design and fabrication of an SDMS Demonstration System, and (iii) validation of the performance of SDMS through implementation on test-bed systems. The program of research will be developed as a series of tasks. When implemented, this technology will improve the efficiency of reactor operation, reduce operating costs, and contribute to improved safety. The SDMS architecture, demonstration system, and project will incorporate:

Applying advanced/embedded sensor technology on test loops designed to provide or simulate bio-fouling, vibration, and erosion degradation. These test loops will demonstrate advanced real-time on-line monitoring, data processing, and root-cause diagnosis.

Developing predictive technologies that detect change, diagnose degradation root cause and present potential remedial actions. This analysis tool will also calculate the economic impact of the detected degradation and changes in process operation to achieve remediation effects.

The SDMS architecture and system combines data from a comprehensive sensor suite that measures parameters traditionally considered to be discrete in terms of process operation, monitoring, control, and Nondestructive Evaluation (NDE). For each test-bed, a combination of advanced distributed smart sensors and wireless (RF Tag) data transmission will be implemented. A hierarchy of both locally distributed and central processing will be employed. The data obtained from the test-bed operation will be analyzed using the SDMS system that will integrate the unique capabilities of three PNNL/Battelle software packages—Decision Support for Operations and Maintenance (DSOM); Turbine Engine Diagnostic using Artificial Neural Networks (TEDANN)/Life Extension Analysis and Prognostics (LEAP) architectures; and Cost-of-

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Ownership.

The SDMS system is designed to employ intelligent sensors and diagnostics, to evaluate the satisfactory operation of passive and active nuclear plant components. Diagnostics capabilities have expanded to levels that can detect emerging conditions that, if allowed to continue, could lead to system or component inefficiencies or failure.

Specific benefits that successful completion of this project would provide include

- Allow the next generation nuclear power plants to monitor and validate the performance of passive and active Systems, Structures and Components (SSC) against design basis criteria.
- Permit *just in time* maintenance activities through defined interfaces to plant support groups, such as Maintenance and Engineering. Operations staff can be provided with options to improve overall plant thermal efficiency and extend design basis operation.