U.S. DEPARTMENT OF ENERGY
INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE
DOE/ROK

ABSTRACT

The Numerical Nuclear Reactor for High-Fidelity Integrated Simulation of Neutronic, Thermal-Hydraulic, and Thermo-Mechanical Phenomena

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Collaborators: Purdue University; Seoul National University

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Project End Date: December 30, 2004

This ANL- and KAERI-led collaborative project will develop a comprehensive high-fidelity reactor-core modeling capability that could be used for detailed analysis of both current and advanced reactor designs. The work will involve the coupling of advanced numerical models such as computational fluid dynamics (CFD) for thermal-hydraulic calculations, whole-core discrete integral transport for neutronics calculations, and thermo-mechanical techniques for structural calculations. To achieve highest fidelity possible, the product code will be designed to run on massively parallel high performance computers, although it will be structured to run efficiently on a cluster of workstations or PCs and scalable systems.

The goals of this project are to:

- Assess the various methods and code systems that could provide the detailed information pertinent to the project.
- Demonstrate and evaluate high-fidelity CFD, neutronic, and thermo-mechanical techniques for whole-core transient applications.
- Develop efficient numerical methodology for coupling the neutronic, thermal-hydraulic, and thermo-mechanical capabilities that are based on high-fidelity methods.
- Evaluate performance of capability on different computer platforms, from small cluster of workstations to massively parallel machines.
- Validate analysis capability against selected experiments and numerical test cases.

The advanced computer simulation capabilities developed under this project would provide a verifiable computational tool for calculation of detailed numerical estimates of the neutronic, thermal-hydraulic, thermo-mechanical performance of current and advanced nuclear systems. The coupled code system would also enable analysts to perform intensive studies on the operational and safety characteristics of various design alternatives, and to compare results obtained with presently available tools to those from this high-fidelity capability.

2001-010-K (continued)

The project team includes international experts from the U.S. and ROK in the area of coupled code development and applications. The U.S. effort is led by ANL, while the ROK team is lead by KAERI. Two universities, Purdue (U.S.) and Chosun (ROK), will also participate in the project.