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

ABSTRACT

PRA-Aided Design of Advanced Reactors with an Application to GFR Safety-Related Systems

Principal Investigator (U.S.): K. Weaver, Idaho National Engineering and Environmental Laboratory (INEEL)

Principal Investigator (France): N. Devictor and J. Rouault, Commissariat à l'Energie Atomique (CEA)

Collaborator: Massachusetts Institute of Technology

Project Number: 2004-010-F

Project Start Date: August 2004

Project End Date: August 2007

Gas-cooled fast reactors (GFRs) are contenders of international interest for advanced nuclear power service. It is well recognized, however, that particular attention must be paid to reliable decay heat removal, if GFRs are to meet the high expectations for safety assurance established for new reactor designs. Probabilistic Risk Assessment (PRA) has matured over the last thirty years and is expected to play a key role in all aspects of system design and safety. The use of PRA will allow the designers to take advantage of lessons-learned from the vast array of PRA applications to Light Water Reactors (LWRs) and other reactor types.

There are two major issues that need to be addressed in order to take full advantage of PRA capabilities. First, since LWRs do not employ passive systems, PRA models for such systems will have to be developed for advanced reactors. Second, the use of PRA in design implies that there are probabilistic goals that can be used to determine which design is "good enough." Although there are activities by the U.S. Nuclear Regulatory Commission and the International Atomic Energy Agency to establish such probabilistic goals, the current licensing framework is largely "deterministic" and is not expected to change substantially in the near future. This state of affairs raises the issue of whether the design should satisfy the deterministic criteria or the probabilistic goals, especially when a particular design option meets the probabilistic goals but fails the deterministic criteria.

While the proposed project will address both of the issues mentioned above, its focus will be the formulation of the conceptual design of GFR decay heat removal systems that are effective in normal modes of operation as well as normal shutdown, refueling, and especially post-LOCA modes, under a range of scenarios including Anticipated Transients without Scram (ATWS) and station blackout. We will explore the possibility of having safety systems that would be initially active in order to promote economic feasibility. These active systems would be succeeded by passive, reliable systems that would take over after a pre-determined time for continued core cooling.