



U.S. Department of Energy

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## Integral Inherently Safe Light Water Reactor (I2S-LWR)

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**Program:** IRP: Inherently Safe Light Water Reactors

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### ABSTRACT

Over a three year period, this project will engage nine domestic organizations in seven states and two international organizations from UK and Italy to develop a novel concept of a high-power (on the order of 1,000 MWe) LWR with inherent safety features. The new reactor is referred to as the Integral Inherently Safe Light Water Reactor, or I2S-LWR. The inherent safety features will advance its safety level beyond that of advanced passive Gen-III+ LWRs. The I2S-LWR design will incorporate lessons learned from the recent events induced by the natural disaster in Japan. At the same time, economic competitiveness will be maintained and other Gen-IV requirements will be considered and accommodated to the extent possible.

The novel concept is based on an integral primary system configuration, which is more conducive to the implementation of inherent safety features by eliminating potential accident initiators: a design philosophy well known as “safety-by-design”. Representative examples include elimination of large loss-of-coolant and control rod ejection accidents. Additionally, the level of passivity of passive systems will be improved (i.e., shifted toward fully passive) as much as possible and practical. Another safety-significant improvement is the novel decay heat removal system. Specifically, the target design will be able to remove decay heat indefinitely, by natural circulation, without the need for either an external power supply or replenishment of coolant supply, since ambient air will be the ultimate heat sink. Moreover, a novel approach to instrumentation and monitoring will ensure that plant status is reliably known in normal, off-normal, and especially post-accident conditions. Finally, the whole nuclear island will be seismically isolated to guarantee its protection against earthquakes with magnitude within the historical record, and to limit the consequences of stronger earthquakes.

The enabling innovation is the use of high power density technologies/components in synergy with an integral configuration. A compact core design is achieved by using a non-oxide fuel form with improved heat removal capability, combined with fuel/clad design of enhanced accident tolerance. This allows increasing core power density while at the same time improving the core safety performance and response in transient/accident scenarios. The novel steam generating system is based on very compact printed circuit heat exchangers (PCHE) which make a 1,000 MWe power level “compatible” with an integral configuration.

Typically, integral configuration for LWRs has been considered only for smaller power levels, not exceeding 350 MWe, due to manufacturing constraints for high pressure reactor vessels. The compact design leads to a small plant footprint, which helps reduce the construction cost and facilitates deployment of seismic isolators. The design concept will be proven by the research team through integration of analysis, method development and validation, and experimental work at several experimental facilities, leveraging previous results of DOE funded research and the National Scientific User Facilities (NSUF) to the highest degree possible.

Inter-disciplinary expertise has been assembled in all key areas with unique capabilities. In addition to academia, the team includes the only domestic vendor and utility that are currently building new nuclear power plants. International academic partners will be independently funded. Educational outreach is achieved by inclusion of the top-ranked historically black college and university in the United States.

This proposal is a collaborative effort by the Georgia Institute of Technology (lead institute) joined by five academic organizations: University of Idaho, University of Michigan, Morehouse College, University of Tennessee, and Virginia Tech; two industry partners: Westinghouse Electric Company (nuclear vendor), Southern Nuclear Company (utility); one national laboratory: Idaho National Laboratory; and two international academic institutions at no cost to the project: University of Cambridge, UK, and Politecnico di Milano, Italy. Synergistic use of top expertise available in academia, industry, and national laboratories in seven states ensures a maximum “return on investment” for the proposed DOE research funding.