Design fax
Tech for OEM Design Engineers

Editor's note: Remember when they first came out with mini Halloween candy bars that were dubbed "fun size"? I always wondered how someone could define fun in physical dimensions, and how this fun could be so small. Sandia has deemed a scaled-down nuclear reactor design as "right-sized." Can't wait to hear your feedback on this. Mike

Energy watch:
Sandia team developing "right-sized" nuclear reactor

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A smaller scale, economically efficient nuclear reactor that could be mass-assembled in factories and supply power for a medium-size city or military base has been designed by Sandia National Laboratories.

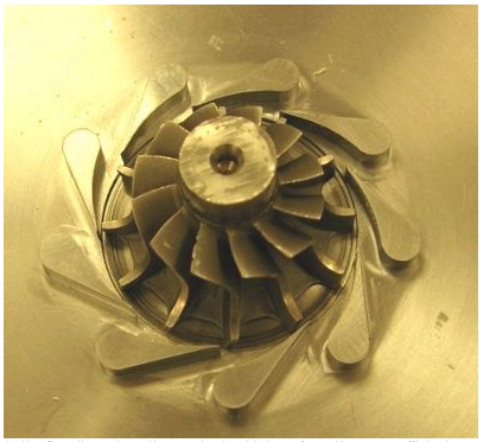
The exportable, proliferation-resistant "right-sized reactor" was conceived by a Sandia research team led by Tom Sanders.

Sanders has been collaborating with numerous Sandians on advancing the small reactor concept to an integrated design that incorporates intrinsic safeguards, security, and safety. This opens the way for possible exportation of the reactor to developing countries that do not have the infrastructure to support large power sources. The smaller reactor design decreases the potential need for countries to develop an advanced nuclear regulatory framework.

Incorporated into the design, said team member Gary Rochau, is what is referred to as "nuke-star," an integrated monitoring system that provides the exporters of such technologies a means of assuring the safe, secure, and legitimate use of nuclear technology.

"This small reactor would produce somewhere in the range of 100 to 300 megawatts of thermal power and could supply energy to remote areas and developing countries at lower costs and with a manufacturing turnaround period of two years as opposed to seven for its larger relatives," Sanders said. "It could also be a more practical means to implement nuclear base load capacity comparable to natural gas-fired generating stations and with more manageable financial demands than a conventional power plant."

About the size of half a fairly large office building, a right-sized reactor facility will be considerably smaller than conventional nuclear power plants in the U.S. that typically produce 3,000 megawatts of power.



In the Sandia system, the reactor heat is transferred to a very efficient supercritical CO2 turbine to produce electricity. This turbine wheel was developed by Barber Nichols for Sandia's Brayton experiments.

With approximately 85% of the design efforts completed for the reactor core, Sanders and his team are seeking an industry partner through a cooperative research and development agreement (CRADA). The CRADA team will be able to complete the reactor design and enhance the plant side, which is responsible for turning the steam into electricity.

Team member Steve Wright is doing research using internal Sandia Laboratory Directed Research and Development (LDRD) program funding. The right-sized reactor is expected to operate at efficiencies greater than any current designs, ultimately giving the reactor the greatest return on investment.

"In the past, concerns over nuclear proliferation and waste stymied and eventually brought to a halt nuclear energy R&D in the United States and caused constraints on U.S. supply industries that eventually forced them offshore," Sanders said. "Today the prospects of nuclear proliferation, terrorism, global warming, and environmental degradation have resulted in growing recognition that a U.S.-led nuclear power enterprise can prevent proliferation while providing a green source of energy to a developing country."

Sanders said developing countries around the world have notified the International Atomic Energy Agency (IAEA) of their intent to enter the nuclear playing field. This technology will provide a large, ready market for properly scaled, affordable power systems. The right-sized nuclear power system is poised to have the right combination of features to meet export requirements, cost considerations, and waste concerns.

The reactor system is built around a small uranium core, submerged in a tank of liquid sodium. The liquid sodium is piped through the core to carry the heat away to a heat exchanger also submerged in the tank of sodium. In the Sandia system, the reactor heat is transferred to a very efficient supercritical CO2 turbine to produce electricity.

These smaller reactors would be factory built and mass-assembled, with potential production of 50 a year. They all would have the exact same design, allowing for quick licensing and deployment. Mass production will keep the costs down, possibly to as low as $250 million per unit. Just as Henry Ford revolutionized the automobile industry with mass production of automobiles via an assembly line, the team's concept would revolutionize the current nuclear industry, Sanders said.

Because the right-sized reactors are breeder reactors — meaning they generate their own fuel as they operate — they are designed to have an extended operational life and only need to be refueled once every couple of decades, which helps alleviate proliferation concerns. The reactor core is replaced as a unit and "in effect is a cartridge core for which any intrusion attempt is easily monitored and detected," Sanders said. The reactor system has no need for fuel handling. Conventional nuclear power plants in the U.S. have their reactors refueled once every 18 months.

Sanders said much of the reactor technology needed for the smaller fission machines has been demonstrated through 50 years of operating experimental breeder reactors in Idaho. In addition, he said, Sandia is one of a handful of research facilities that has the capability to put together a project of this magnitude. The project would tap into the Labs' expertise in complex systems engineering involving high-performance computing systems for advanced modeling and simulation, advanced manufacturing, robotics and sensors, as well as its experience in moving from research to development to deployment.

"Sandia operates one of three nuclear reactors and the only fuel-critical test facility remaining in the DOE complex," Sanders said. "It is the nation's lead laboratory for the development of all radiation-hardened semiconductor components as well as the lead lab for testing these components in extreme radiation environments."

The goal of the right-sized reactors is to produce electricity at less than five cents per kilowatt hour, making them economically comparable to gas turbine systems.

Sanders said the smaller reactors will probably be built initially to provide power to military bases, both in the U.S. and outside the country.

Source: Sandia