“We have to build something totally different. To do that, we’ve got to solve the challenging problems.”

Tara Pandya, Nuclear Engineer

Advanced Reactors: The Next Step in Nuclear Energy

The Oak Ridge National Laboratory (ORNL) pioneered nuclear energy and is ushering in the next era of nuclear innovation. Since building and operating the first permanent nuclear reactor more than 75 years ago, ORNL has shaped the development of reactors that now generate 20% of America’s electricity. Today, ORNL leads efforts in advanced reactor technologies to address challenges related to our nation’s aging reactor fleet and an ever-growing demand for safe, clean energy.

Reactors Reimagined

America’s nuclear reactors operate on 40-year licenses from the US Nuclear Regulatory Commission (NRC), with 20-year extensions possible. Because most reactor licenses will expire by 2030, America could face a significant energy deficit, with devastating effects on our electric grid and economy.

To address this challenge, ORNL is working with other national laboratories, universities, and industry leaders to research, develop, and eventually commercialize new nuclear power plants. These “advanced reactors” could improve nuclear energy’s performance through enhanced safety features, increased power production, and significant decreases in nuclear waste. ORNL offers important resources to assist in deploying advanced reactors.

- **Computing:** ORNL’s supercomputing facilities provide tools for modeling and simulation to investigate advanced reactor designs and safety features, potentially reducing the time required to develop and license new designs.

- **Materials science:** ORNL facilities and instruments at the Spallation Neutron Source and High Flux Isotope Reactor allow ORNL scientists to develop and test materials—including current and new types of nuclear fuels—used in nuclear environments.

- **Design expertise:** While ORNL is equipped to support the development of any advanced reactor design, its expertise in molten salt reactors (MSRs) is particularly extensive and has influenced several advanced reactor concepts from the nuclear industry.

13 Nuclear reactors built at ORNL for a variety of purposes from research to radioisotope production

20% Total US electricity generated by nuclear reactors in 2017, up from 11% in 1980

59 Reactors expected to close by the end of 2030, more than 60% of the current fleet

475,000 American jobs associated with nuclear energy production*
Partnerships and Collaborations

ORNL has worked with other national laboratories on initial drafts of advanced reactor design criteria, which are instrumental in the NRC’s guide for new reactor development. Published in 2018, this regulatory guide will help designers and applicants through the licensing process. ORNL also participates in a variety of efforts to support the development and implementation of advanced reactors, including the following.

- DOE’s Gateway for Accelerated Innovation in Nuclear (GAIN), where ORNL participates in various projects to move nuclear energy technologies toward commercialization. Partners include Southern Company Services, X-energy, SMR Inventec, LLC, TerraPower, Electric Power Research Institute, Vanderbilt University, BWX Technologies Inc., Oregon State University, Teledyne-Brown Engineering, SGL Group, and NuVision Engineering Inc.

- Additional agreements that connect the Lab’s expertise to industry’s efforts to move reactor designs closer to reality. Partners on these projects include Terrestrial Energy Inc., the Tennessee Valley Authority, and NuScale Power.

- The fourth Molten Salt Reactor Workshop, held at ORNL in 2018, where attendees from industry, utilities, reactor design firms, DOE, NRC, and universities convened. The Lab also recently hosted a workshop on the use of advanced manufacturing to enhance current and future nuclear energy systems.

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The Liquid Salt Test Loop is a dynamic test facility for developing molten salt technologies to further enable the deployment of advanced reactors.

*Source: The Nuclear Energy Institute