Electricity Production

Herbert Pomerance discovered that hafnium, a common zirconium contaminant, absorbed many neutrons, and that pure zirconium soaked up very few. Oak Ridge researchers developed a separation process for producing pure zirconium, which was used in reactor fuel cladding for submarines and power plants.

Atomic Energy Commission officials, who had centered reactor development work at Argonne, realized that ORNL had much to contribute. The Laboratory was allowed to upgrade the mockup's shielding and cooling systems, increasing its power level to 10% of the MTR's. Labeled the "poor man's pile" by Wigner, the mockup was formally named the Low Intensity Test Reactor.

Experiments at the LITR established the feasibility of the boiling-water reactor, later a design prototype for commercial plants. ORNL researchers also developed principles of reactor control and protection systems that are used today.

Graduates of the Oak Ridge School of Reactor Technology (ORSORT), which was started by Wigner, designed a variety of reactors. One was the Aircraft Reactor for the ill-fated nuclear airplane project, whose aim was an aircraft that could fly indefinitely without refueling. The Bulk Shielding Reactor and Tower Shielding Facility were built to provide data on constructing lightweight radiation shielding for the aircraft. Another ORNL-developed reactor was built for display at the 1955 United Nations Conference on the Peaceful Uses of Atomic Energy. Yet another ORNL design was the Army Package Reactor, a transportable device built by a private contractor in 1957 for the Army Corps of Engineers to generate electric power at a remote base.

ORNL developed several homogeneous reactors that were fueled, cooled, and moderated by uranium-containing fluid, rather than the solid fuel and liquid coolant and moderator typical of most power plants today. A promising design was the molten-salt reactor, an outgrowth of the Aircraft Reactor project. Its fuel solution circulated continuously between the core and a processing plant that removed unwanted fissionable products. It was designed in the late 1960s to produce both electric power and new fuel, uranium-233. Today there is interest in Europe, Japan, and Russia in developing MSRs as actinide burners.

In the late 1950s there was international interest in gas-cooled reactors, and ORNL had a strong role in the U.S. commercial HTGR program. Responsibilities included developing an improved graphite moderator and developing and testing advanced coated-particle fuels that retain fission products at high temperatures. ORNL's experience in developing and testing spherical ceramic fuel has been sought to support development of the next-generation gas-turbine-modular-helium-cooled reactor and pebble-bed modular reactor.

Because of its researchers' extensive reactor experience and expertise, ORNL is the only national lab in Westinghouse Electric Company's international consortium to design the International Reactor Innovative and Secure power plant, a next-generation PWR. ORNL also is a co-leader of the Department of Energy's nuclear power programs.

ORSORT graduates also designed the many research reactors that have operated at ORNL (a half dozen in the 1960s). Among these were the Oak Ridge Research Reactor (1958-88) and the 37-year-old High Flux Isotope Reactor, still in operation for possibly another 30 years. In addition to producing isotopes for agricultural, industrial, and medical uses, the 85-megawatt HFIR is a valuable tool for materials testing and neutron-scattering research; it is one reason why ORNL will be the center of the neutron science universe at mid-decade. Thanks to neutrons, which make nuclear power possible, ORNL will soon become a world power in physical and biological materials research.

Discovery of Promethium

61

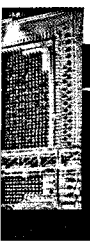
In 1914, one year before he was killed in action during World War I, Henry Moseley, a brilliant 26-year-old British physicist whose work influenced the final order of elements in the Periodic Table, demonstrated that element 61 should exist between the rare earths neodymium and samarium. In 1941-42 American chemists tried to create element 61 but could not prove they had produced it.

In 1945, chemists Jacob Marinsky and Larry Glendenin, working at the Graphite Reactor under the leadership of Charles Coryell, produced element 61. They did it both by uranium fission and by bombarding neodymium with neutrons from fissioning uranium in the reactor. Working in the nearby hot laboratory and chemistry building, they made the first chemical identification of two radioisotopes of element 61 by using ion-exchange chromatography.

Marinsky and Glendenin announced their chemical proof of the existence of element 61 at the 1947 American Chemical Society meeting. In 1948 when they were working at the Massachusetts Institute of Technology, they proposed the name "promethium" (Pm) for element 61 after Prometheus, the Titan in Greek mythology who stole fire from heaven for human benefit. The idea came from Coryell's wife Grace Mary. The name was accepted by the International Union of Chemistry in 1949.

Promethium is a radioactive beta-emitting metal not found in the earth's crust. It has been identified in the spectrum of a star in the Andromeda constellation.

Promethium-147 has been used in nuclear-powered batteries for instruments in guided missiles—one way to return fire to the heavens.



1945

Discovery at Graphite Reactor of element 61 (promethium)

First neutron scattering studies at a reactor (by Ernie Wollan and Cliff Shull; Shull won 1994 Nobel Prize for physics for his pioneering work at the Graphite Reactor)

1946

First shipment to a cancer hospital of a radioisotope from a reactor

Pressurized-water reactor conceived (later used for nuclear power and submarine propulsion)

Radiation detectors and dosimeters devised