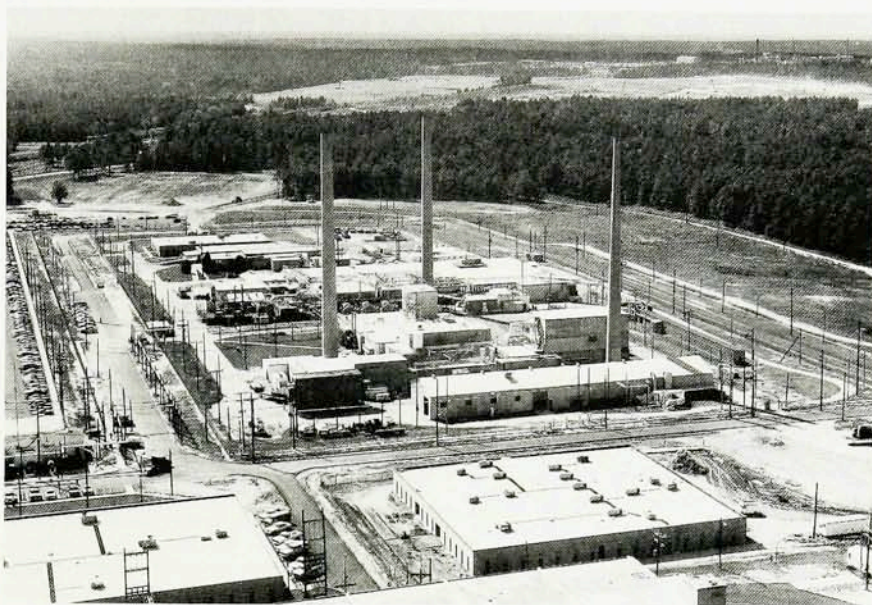


DOE WANTS NEW WEAPONS REACTORS TO REPLACE AGING, TROUBLED ONES

The political fallout from the explosion and meltdown at Chernobyl's Unit 4 in April 1986 led to reappraisals of reactor safety around the world—nowhere with such swift effects as on the materials production program for US nuclear weapons. Chernobyl led the Secretary of Energy, John S. Herrington, to order several independent studies of reactors producing plutonium and tritium. Before the end of 1986, one panel called for major modifications or a complete shutdown of the large N-Reactor at the Hanford Nuclear Reservation near Richland, Washington, which is like Chernobyl's four RBMK-1000 plants in having a graphite core. A few months later, the department turned off the N-Reactor to make mechanical changes (PHYSICS TODAY, February 1987, page 63). Since then, DOE has decided not to restart the reactor.

Other studies of DOE reactors, conducted by the National Research Council and by the department's independent Advisory Committee for Nuclear Facility Safety, found some either rapidly nearing or already past the ends of their expected lifetimes. This was especially true for defense production reactors at Savannah River, not far from Aiken, South Carolina, where deteriorating components and design changes since the reactors were turned on in the 1950s have put increased demands on control-room staffs and their supervisors. Indeed, for the past seven years the Government Accounting Office, Congress's watchdog over executive agencies, has criticized operating practices at Savannah River and designated the reactors as "high-hazard facilities."

So it came as no surprise when Herrington called in the news media on 3 August to announce that DOE proposed to replace the three tritium production plants at Savannah River with a single reactor that is similar in concept to those now there but would provide 100 percent of current military requirements. Experts have warned that the P, K and L reactors, all more than 30 years old, may not last the ten years it will take to design and build the successor, which would



Savannah River facilities include three tritium production reactors and processing plants at which the isotope is separated from irradiated lithium-aluminum targets.

be capable of yielding plutonium as well as tritium.

Herrington's statement also contained a surprise: A smaller reactor, based on a novel high-temperature gas-cooled technology, would be constructed at the Idaho National Engineering Laboratory near Idaho Falls. This reactor would also take ten years to complete and would yield another 50 percent of the tritium the Pentagon currently uses.

The reason the Energy Department wants the capability of producing so much tritium is that this isotope, the basic fuel of thermonuclear bombs and useful in upgrading the power of fission warheads, must be replenished periodically. Tritium degrades at a rate of 5.5 percent each year. Plutonium, by contrast, is a relatively stable material, with a halflife of about 23 000 years.

"As long as this nation relies on the nuclear deterrent," explained Herrington, "we must have the capability for a steady, reliable supply of tritium and plutonium." The need for two production plants at widely dispersed locations, he said, will "minimize the

technical risks to national security." This "two-reactor strategy," he declared, "involves proceeding on an urgent schedule" to make the US less vulnerable to operating interruptions. DOE estimates the price tag for the two reactors would be \$6.8 billion if built today. Critics say the final cost is likely to be more.

The reactor for Savannah River would be based on proven technology for making weapons-grade material, using heavy water or deuterium. The Idaho reactor would be based on technology developed in the US and the Federal Republic of Germany. The concept originated in Britain in 1956 with the Magnox-class power reactors, which use carbon dioxide as a coolant and natural uranium as fuel. In the US, GA Technologies of San Diego pioneered the development of a reactor using helium as the coolant and graphite as the moderator. In 1967, the 40-MW Peach Bottom No. 1 plant, designed by GA Technologies (then known as General Atomics) went on line in the Philadelphia Electric Co system as part of the Atomic Energy Commission's power

reactor demonstration program. The reactor was shut down in 1984 when scheduled tests were completed. The Fort St. Vrain plant was another experimental reactor built by GA Technologies for Colorado's Public Service Co. It went critical in 1974 and continues to operate. But as a commercial demonstration it was not a good advertisement for the concept. It produced only about 10 percent of the power it was designed to provide if it could have run at full capacity. Although GA Technologies claims the plant showed the benefits of helium instead of ordinary water as a coolant, frequent breakdowns of the helium circulator raise questions about its reliability.

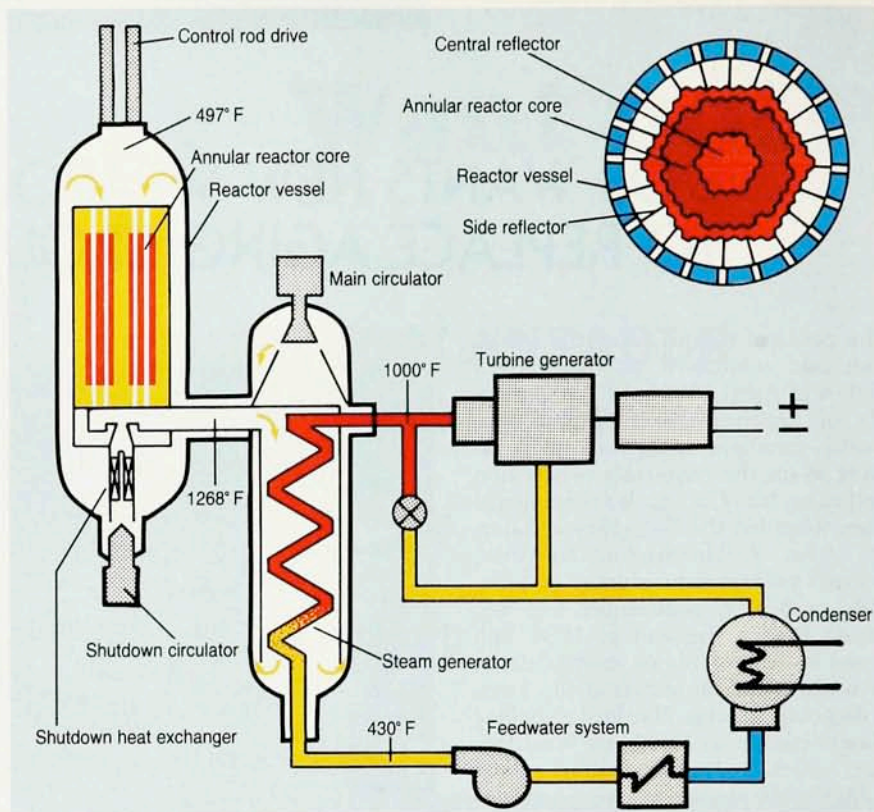
High-temperature gas-cooled reactors have been developed in West Germany for a 15-MW power plant that has been operating since 1968 and a 300-MW plant that is set to start up soon.

The use of graphite is uncommon among nearly all reactors. Graphite was used in Hanford's N-reactor, which produced plutonium, and in Chernobyl's RBMK-1000 types. The GA design departs markedly from those reactors. A major difference from the Chernobyl reactors is that as the core temperature rises in the high-temperature, gas-cooled reactor, the nuclear reaction is choked off. At Chernobyl the opposite was true.

Unfortunately, six days after Herrington's announcement, an incident at Savannah River called into question the safety of the aging weapons-material reactors. A DOE source called the episode a "complete collapse" of safety procedures that, in worst circumstances, could have resulted in a Chernobyl-type calamity.

The history of the problem has its origin in power cutbacks of the Savannah River defense reactors to 45 percent capacity because of safety concerns. According to DOE officials, the P reactor, which had been shut down since early April for safety modifications and routine maintenance, was being restarted on 7 August when operators found that the position of its control rods apparently prevented a sustained reaction. When they attempted to restart the reactor on 9 August, its temperature and pressure surged unexpectedly in what is termed a "power spike."

Instead of trying to control the surge, however, operators not only continued to run the reactor but did exactly the wrong thing: They turned up the power. It seems that when the operators had trouble getting the reactor to sustain a chain reaction, they did not do the customary thing,



High-temperature, gas-cooled reactor, shown schematically, is being developed to satisfy worries about nuclear safety. Based on technology demonstrated in the US and West Germany, the system used refractory coated nuclear fuel, helium gas as an inert, noncorrosive coolant and graphite as a core moderator that remains stable at extremely high temperatures. The Department of Energy has selected the HTGR to produce tritium and plutonium at the Idaho reactor test station. DOE proposes to build a more conventional reactor at Savannah River to replace three old tritium production reactors.

pushing in the control rods to suppress the reaction, but instead pulled the rods further out. If the reactor had been running at higher power, a tragedy might have resulted, said an official at Du Pont, which operates the Savannah River complex.

John F. Ahearne, the former chairman of the Nuclear Regulatory Commission, who heads a special DOE safety advisory committee named by Herrington last year (see page 38 for an article by Ahearne) expressed anger that the problems at the P reactor were not reported instantly. In an electronic mail message to plant managers, Ahearne admonished operators for not informing him of the problem. When Ahearne was asked what he would do in the circumstance, he recommended an immediate shutdown. That was done.

DOE's assistant secretary for environment, safety and health, Ernest C. Baynard III, said that at one point the operators increased the reactor's power to 60 percent, one-third higher than the 45-percent maximum approved by the board. The operators

detected more decay products—primarily helium-3, which acts to absorb neutrons and suppress the reaction. The presence of helium-3 made the reactor more difficult to start. Puzzled by this, the operators pulled more control rods in an effort to boost the reaction. Each time they pulled the rods, the reactor surged briefly and then subsided. "You can't have people operating a nuclear reactor acting as if it is business as usual when something unusual occurs," said Baynard.

After interviewing the operators, DOE issued a report explaining that the reactor did not "exhibit uncontrollable behavior." The surge had never been more than 1 percent of the authorized power level. But the DOE criticized the operators for neglecting the "checks and balances that would prevent a recurrence of the events." Still, members of Congress have expressed concern that this worrisome episode happened at the very time that DOE is seeking their support for the new reactors.

—IRWIN GOODWIN