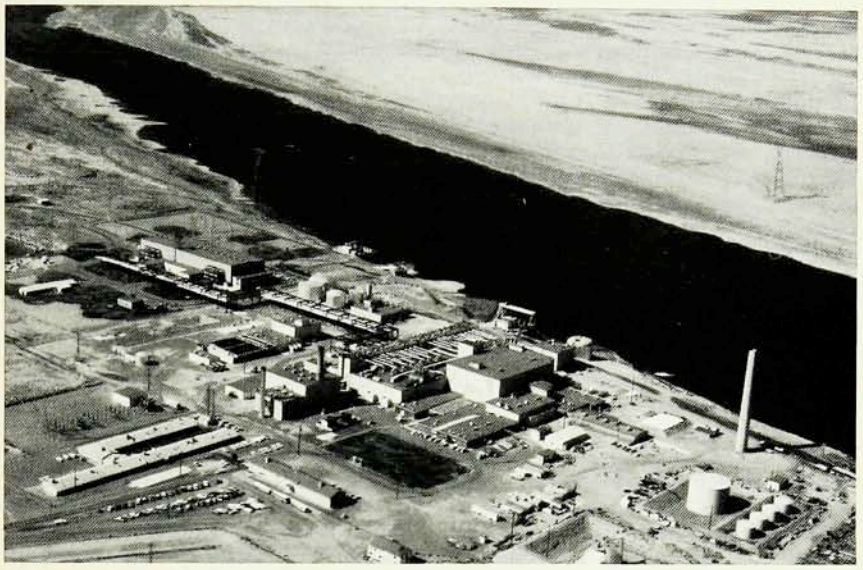
DOE shuts N-Reactor for safety repairs but fears persist

Halfway around the world from Chernobyl, the Soviet nuclear reactor that blew up last 26 April has claimed its most famous victim—the N-Reactor at the Hanford nuclear reservation, located on an arid and (relatively) isolated site of 570 square miles along the Columbia River near Richland, Washington. A graphite-moderated plant structured nearly like the Chernobyl unit 4 power plant, the Hanford reactor produced about 20% of the plutonium that winds up in US nuclear arms. One of the ironies of the similarity is that Chernobyl's explosion has forced the Department of Energy to shut down for the next six months the principal facility producing plutonium for the weapons the US points at the USSR.

The dependence on the N-Reactor as the nation's largest producer of weapons-grade plutonium is reason enough why the Department of Energy's announcement on 12 December took many people by surprise. Possibly just as surprising is DOE's decision to spend $50 million on extensive improvements of the safety systems and operating procedures but not to shut the reactor permanently. Still, with the memory of Three Mile Island unit 2 and Chernobyl unit 4 so clear in the public mind, the department's under secretary, Joseph F. Salgado, said the N-Reactor would be closed for good by the mid-1990s.

Even after the overhaul, say members of the independent panel that reviewed the N-Reactor, it is likely to remain vulnerable to a runaway critical excursion, a steam surge and a potentially catastrophic hydrogen explosion, perhaps worse than the sequence of events that led to the Chernobyl disaster (PHYSICS TODAY, December, page 17). Two out of the six reviewers urged DOE to close the N-Reactor immediately and permanently unless to do so would threaten national security. Worries about the reactor's safety come only weeks after DOE reversed the position it had steadfastly held throughout the Chernobyl crisis—that the department's 11 reactors, located in five states, are entirely safe to operate as they stand.



N-Reactor site at Hanford, Washington, produces much of the plutonium used in US nuclear weapons. Its structure is much like that of the Chernobyl reactor.

Comparisons. Built 23 years ago at the Hanford Engineering Works, the N-Reactor was designed in the 1950s to have a life expectancy of 20 years. Like the RBMK-1000 reactors in the Soviet Union, including the four at Chernobyl, the Hanford plant is not only graphite moderated and water cooled, it also lacks a concrete containment dome capable of withstanding steam and hydrogen explosions that might occur in a runaway accident. Unlike the RBMK design, the N-Reactor has 365 metric tons of uranium metal in its core along with 1800 tons of graphite (Chernobyl unit 4 had 2000 tons). Besides plutonium, the Hanford plant produces 4000 MW of electricity, by far the highest power in the US.

After conducting three of its own audits of the Hanford reactor and finding that nothing drastic had to be done to restore it to relative fitness, considering its age, DOE appointed six nuclear plant experts to perform separate examinations. The consultants agreed that it is either "impossible" or "not plausible" that a Chernobyl-type catastrophe could occur, given the design differences and additional operational safeguards of the N-Reactor. Even so, they each concluded that radioactivity might be released following a minor accident because of uncertainties about the reactor's safety system, which is designed to lower the pressure of steam or hydrogen when cold water is sprayed on the core.

The N-Reactor has never been tested under conditions involving rupture of many of its 1000 metal process tubes and accumulation of large amounts of hydrogen. It is like no other reactor in the world. Thus, experience in running it grows at the rate of one reactor-year per year. The reactor has no hydrogen control system or hydrogen monitors around the graphite stack, though such instrumentation has been recommended in the past.

Reviewers. The strongest statements about the reactor came from the chairman of the review group, Louis H. Roddis Jr, a nuclear engineer who was once president of Consolidated Edison

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of New York. The other reviewers, performing independently to avoid the public meetings required of an advisory committee, were Miles C. Leverett, a consultant with 25 years of experience with the N-Reactor; Harold Lewis, a physicist at the University of California at Santa Barbara with a long record of advising the government about nuclear safety; Thomas A. Pigford, chairman of the nuclear engineering department at the University of California at Berkeley, who has experience in nuclear plant studies for the National Research Council; Gerald F. Tape, a physicist who was once deputy director of Brookhaven National Laboratory, served on the Atomic Energy Commission and headed Associated Universities Inc, which functions as a board of directors for Fermilab; and retired Admiral Eugene P. Wilkinson, former president of the industry's Institute for Nuclear Power Operations.

Roddis begins his report by quoting the last independent report on the N-Reactor, completed in 1966 by the Advisory Committee on Reactor Safeguards. In the unlikely event of severe accident, the committee said, the N-Reactor would release more radioactivity than a commercial power reactor. Writing only three years after the plant's start-up, ACRS warned that operating the N-Reactor was riskier than running a civilian reactor and that it was justified only by military requirements for plutonium.

Two decades later Roddis recommends that DOE "shut down the N-Reactor unless a positive judgment is made that the requirements for defense material warrant accepting public hazards exceeding those of commercial reactors." Lewis agrees. Prudent policy, he asserts, requires DOE to close the plant in "the very near future . . . concomitantly forcing a decision on a new production facility." The other reviewers call for remedial work but do not believe it is dangerous to continue running the reactor for another three to five years.

In his review, Lewis attempts to answer those who defend the N-Reactor because it operated for 23 years without mishap and is likely to run safely for many more years. This was the argument used to defeat an amendment put before the House of Representatives last July by James Weaver, an Oregon Democrat, who sought to shut down the plant until the safety reviews were completed. Some members of Congress praised the reactor's redundant safety systems and reinforced concrete structure, which would minimize the risk of a radioactive release. DOE and the White House opposed the amendment on the grounds that the reactor had a superb safety record and that its plutonium output was necessary to meet current goals for nuclear weapons.

Lewis, however, regards what many see as virtues to be defects. He notes that the statistical record of the N-Reactor is specious and irrelevant. "The probability of a major accident can simply not be inferred from such short operating experience. TMI-2 happened after several hundred reactor-years of US commercial experience and Chernobyl after thousands of reactor-years of worldwide experience." He also recalls, somewhat sadly, that NASA boasted that 24 successful shuttle flights could justify another mission no matter what objections were raised (PHYSICS TODAY, August, page 41). In addition, because the reactor is unique, "it benefits only in part from operating experience, and I found little in the way of systematic effort to derive even those benefits." The problem, according to Lewis, is that management of the reactor "resembles a family operation" within DOE, with "no external peer pressure encouraging excellence of the entire structure," unlike what prevails in the commercial domain of reactors. All six outside reviews agreed that the facility's management was somewhat lax and that workers were unmindful of safety rules.

Complacency. Some problems, say Hanford's critics, involve what they call "widespread complacency" at the plant, which led to no less than 2800 pounds of plutonium unaccounted for more than a decade ago. Hanford's antagonists say it is already the world's biggest radioactive waste dump, and DOE would like to make it the permanent graveyard for 77 000 tons of waste with a halflife longer than human history on the planet.

According to a report issued last August by Congress's General Accounting Office, the N-Reactor's continued operation beyond the 1990s would require spending at least $1.2 billion for changes and repairs. One trouble is that equipment used to sample water in the plant for levels of radioactivity is inoperable, so that manual sampling of high-pressure and high-temperature steam is required, causing delays in obtaining readings. Another involves the primary coolant pumps, designed to function five years between major overhauls. These are so old that the work must be done every two years. What's more, electrical wiring often fails, causing reactor outages, and motors for running various valves often burn out but such motors are no longer made.

Operators of the plant say the N-Reactor encounters 20 to 25 "trips," or unplanned outages, each year. Commercial reactors average about seven trips per year, and the Nuclear Regulatory Commission wants to lower the number as a way of reducing wear and tear on operating parts and safety equipment.

Even routine operation is becoming more difficult. The N-Reactor building was designed to withstand only 5 psi above atmospheric pressure, compared with about 50 psi for a modern US nuclear plant and 26 at Chernobyl. Examinations reveal that neutrons are loosening the structure of the graphite blocks at the heart of the reactor with the result that the pile of blocks has been expanding vertically and is almost certain to "hit the roof" of shielding by 1990 or 1991, Roddis asserts, causing a shutdown. In addition, neutrons from the fission reaction bombard the metal tubes that isolate the fuel rods and high-pressure hot water from the graphite, causing them to become so brittle they are prone to rupture. If that were to happen, steam would strike the hot graphite, resulting in a catastrophic accident.

After Salgado announced DOE's plan to repair the N-Reactor, attorneys for the Natural Resources Defense Council asked for a delay in all work until a full environmental impact statement is completed. If the government is unwilling to do this, NRDC threatens to take the issue to court. Meanwhile, Washington's Governor Booth Gardner, a frequent critic of the Hanford nuclear facility, commended DOE for its action, while observing that the various reviews "read like a script from a disaster movie."

—IRWIN GOODWIN

Supreme Court hears arguments on teaching 'creation science'

The case argued before the US Supreme Court on 10 December had its genesis one evening in 1978 when Bill Keith arrived home in Shreveport, Louisiana, to find his wife in tears. Their teenage son's science teacher, she explained, had ridiculed the youth for saying he did not believe "we all came from monkeys." Keith commended his son for insisting that humans were created in the image of God. Three years later Keith, then a state senator,