The Gas Reactor Makes a Comeback

A boomlet in Congress backs the HTGR as the "inherently safe" answer to the nuclear industry's troubles

In a building at the Oak Ridge National Laboratory in Oak Ridge, Tennessee, there sits a unique old machine known as the Experimental Gas-Cooled Reactor. Although completed and ready to run 18 years ago, it has never been turned on. It is a neglected relic of the nation's early affair with the atom and a reminder of where unchecked enthusiasm can end. It may be wise to keep the old machine in mind this year, for the Administration has become intensely interested in gas reactors after a long hiatus and may be ready to endorse them on a grand scale.

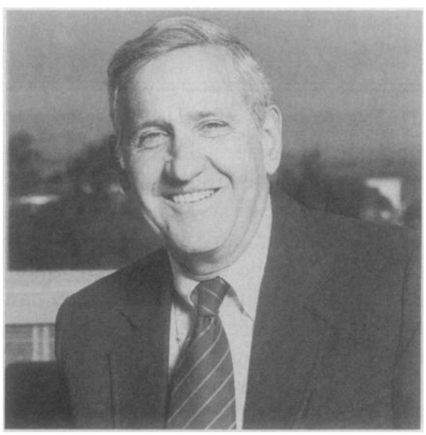
On orders from Congress, the government spent millions of dollars in the late 1950's and early 1960's building the Oak Ridge gas reactor. The Joint Atomic Energy Committee had seen the British unveil the world's first "commercial" reactor in the 1950's (actually a gas-cooled weapons reactor that made some electricity on the side). The committee wanted the United States to have one, too. However, by the time the U.S. version at Oak Ridge was ready to run in 1966, the Johnson Administration decided at the last moment to stop the fuel loading. The machine had become irrelevant.

Thus, the first large-scale U.S. demonstration of gas cooling stopped dead in its tracks. Water-cooled reactors grew in popularity and came to dominate the commercial scene. But recently there has been a change of attitude. Water-cooled reactors, a class that includes the twin units at Three Mile Island, have gone down in U.S. public esteem. Suddenly gas reactors seem to be coming into vogue again and are being cast as part of the forefront of a new technology described as "inherently safe reactors."

One sign of change is that for the first time in 6 years, the President proposed spending a sizable sum on gas reactors, around $35 million. Until now, the usual pattern has been for the President to ask for nothing, on the grounds that this technology had little research value, and for Congress to contradict him, inserting around $40 million in the budget. Every year the manufacturers have gone to Congress and lobbied for federal help. Each year they have come up with a plausible rationale. And each year they have succeeded. This year they succeeded on a larger scale, winning the White House as well as Congress.

The leaders of this campaign have been in the business for some time. Among the more prominent are Harold Agnew, president of G.A. Technologies, which under its former name of General Atomic built the only private gas reactors in this country; Representative Marilyn Lloyd (D–Tenn.), whose district includes Oak Ridge; Senator James McClure (R–Idaho), whose state is home for a federal nuclear research laboratory and could be the site of a new military reactor; and the Gas-Cooled Reactor Associates, a group of utilities that are potential buyers.

Two federal officials gave the following account of how the budget came out



Harold Agnew
President of G.A. Technologies.

as it did this year. Donald Hodel, secretary of the Department of Energy (DOE), was said to resist pressure from these gas reactor advocates at first. Hodel's draft budget went to the White House last September requesting no money. But presidential adviser Edwin Meese III apparently stepped in, arguing that the Administration ought to do something for nuclear power, particularly if it could also gain credit with someone as influential as Senator McClure, chairman of the Senate Energy Committee and a contender for the majority leadership when Howard Baker (R–Tenn.) retires.

McClure is a fan of the gas-cooled reactor and a beneficiary of campaign contributions from executives at G.A. Technologies. In addition, McClure has said he would like to have a gas-cooled military reactor complex in Idaho. The Office of Management and Budget decided not to resist McClure and Meese, since it needed Meese's support in bigger battles. The White House Office of Science and Technology Policy, headed by George A. Keyworth, II, a protege of Agnew in the 1970's when both were at the Los Alamos National Laboratory, raised no objection. Thus, Hodel's revised budget provided around $35 million for the gas reactor. It is no more than Congress would have given in any case, but now it carries an official blessing—very desirable in a deficit-cutting year.

The campaign for the gas reactor is fueled by a mixed broth: part desperation, part opportunism, and part safe design. The desperation arises from the desire to find a way out of the stalemate that grips the nuclear industry. Around 80 plants have been canceled since the 1970's, and more fall by the wayside each quarter. Some engineers think that the way to break out of the doldrums is to come up with a radical innovation, one that will be so safe as to escape the heavy bureaucracy that oppresses the light water reactor. The gas reactor could offer a way out, they think.

The opportunist part of the recipe is the pork barrel potential that some congressmen see for replacing a dead project, Oak Ridge's demonstration breeder reactor, with an alternative demonstration plant, or for starting something entirely new based on an unblemished technology.

Improved safety is the most substantial part of the recipe. The gas reactor has at least two genuine advantages over the water reactors that now dominate the marketplace: (i) it dumps less radioactivity into the cooling system, reducing workers' exposure and making maintenance easier and safer, and (ii) it tolerates much higher temperatures in the core, absorbing heat for a longer period, allowing the owner to be more relaxed about what the operators do. As Agnew likes to say, a major error in running a pressurized water reactor must be corrected in minutes, while the operators of a gas reactor can leave the building, go home and have a beer, and come back hours later to fix the mistake.

Agnew said in a recent interview that "the utilities have been hostile to me" because he stresses the safety of his high temperature gas-cooled reactor (HTGR). The utilities have invested in conventional reactors and their executives worry that Agnew's sales pitch will make their equipment appear unsafe. That is narrow thinking, in Agnew's view. "We all used to fly in DC-3's," he says, "and we know that jets have made flying much safer. That doesn't mean the DC-3's were unsafe or that we shouldn't have used them. It just means we have improved the technology."

Agnew gives out a table comparing workers' exposure at light water reactors and HTGR's in the United States between 1978 and 1982. It shows that exposures at the former are increasing, and those at the latter are decreasing. It also indicates that the rate of exposure at conventional reactors is about 200 times greater than at HTGR's. The gap is likely to widen as reactors age, Agnew believes, for the more maintenance work, the sharper the contrast will become. The industry ought to face this problem now and begin reducing it, Agnew says.

In addition to minimizing these chronic problems, the HTGR is advertised as being quite "forgiving" in an acute crisis. Its radioactive fuel is sealed in triple-coated ceramic "seeds" with a very high melting temperature. In the latest "pebble-bed" design borrowed from Germany, the seeds are sealed in graphite balls about 2 inches in diameter, also very resistant to heat. The small reactor (300 megawatts electric) now being proposed by Agnew would be so efficient in dissipating heat that Agnew claims its fuel would not melt even if all the coolant escaped and if the ability to circulate air through the core were lost. In a total breakdown, the reactor could be cooled by natural air circulation. Thus, it is sometimes said to have "walk-away" safety, meaning the operators could walk away from an accident and forget it. This is not true of larger versions of the HTGR, but these still would take longer to overheat than any water-cooled system.

While they agree that the HTGR's heat resistance is a great virtue, skeptics point out that overheating may not be the main hazard to worry about in the HTGR, as it is in water reactors. Instead, risk assessment should probably focus on ways in which steam from the highly pressured turbine drive system might get into the fuel bed. Steam would react with graphite, and if the process continued long enough, it could corrode the fuel, releasing fission products into the system at large. Furthermore, the reaction would produce combustible gases, creating the potential for an explosion. The dangerous fission products might be widely dispersed in an HTGR accident, for the HTGR's coolant—helium—would not react with and tie down the radioactive material as water would. In a less likely but worse scenario, air might leak into the core and set the hot graphite on fire. The only serious fire ever to occur in a nuclear reactor occurred in a gas-cooled plant in Britain called Windscale.

Accident sequences such as these have been studied by G.A. Technologies and by the Nuclear Regulatory Commission and judged to be of little likelihood. However, if HTGR's were to become important commercially, they would have to endure the kind of scrutiny given water-cooled reactors, and they might not come through any more easily.

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HTGR's may be safer than light water reactors, but it is not clear that they can compete economically. Their history is a record of disappointment. When commercial nuclear power was in its infancy, both Britain and France set out on a different course from the United States, favoring gas reactors. The French were the first to concede the superior efficiency of light water systems, dropping their own gas reactor in favor of Westinghouse's pressurized water machine in the 1960's and making it the standard model of the French nuclear line. The British likewise abandoned the gas-cooled reactor, but much later, and are still debating the shift to water reactors.

General Atomic, the only vendor of gas-cooled reactors in the United States, built two commercial prototypes: Philadelphia Electric's Peach Bottom I, a small 40-megawatt plant that ran from 1967 to 1974, and the Public Service Company of Colorado's Ft. St. Vrain reactor, a 330-megawatt plant that began running in 1974 and is still going.

Peach Bottom I ran smoothly but with leaky fuel. The original fuel core, according to Edward Kohler of Philadelphia Electric, had a "design flaw" that caused swelling in the fuel sleeves, leading to the release of excess reactivity into the helium coolant. Although the leak never reached one-fourth of the design limit, it was worrisome. The core was redesigned and replaced. The second core ran well until the plant was shut down in 1974, at the end of the experimental period which had been contracted for. Kohler says the utility turned the plant off because it required too much technical support. "Eighty people for 40 megawatts" didn't seem worthwhile.

The Ft. St. Vrain plant was originally designed for a utility in New York, but the deal apparently fell through when the utility insisted that General Atomic guarantee a maximum price of electricity. Colorado bought the plant instead. There was no trouble with the fuel but there was a problem called "instability of the core." The graphite blocks that held the fuel refused to sit still, allowing the helium to follow irregular pathways through the ever shifting core. The plant ran at less than 70 percent of power until 1978 and was not granted a full power license until 1982, after devices were installed to clamp down on the core and keep it rigid. During this extended developmental period, General Atomic had to pick up the tab for some of the utility's electricity requirements.

An improved, scaled-up version of this plant was offered for sale in the 1970's, and ten utilities signed up to buy it. Agnew says that this promising start was snuffed out by the OPEC price increases in 1973 that sharply reduced the demand for new electric power. Six orders were canceled, and the corporate financial office decreed that it would cost too much to complete the remaining contracts. So General Atomic negotiated its way out, at a cost of more than $200 million.

Agnew and the vice president for power reactors at G.A. Technologies, Thomas Johnston, say that the new reactor they are proposing would be quite different from and economically more competitive than earlier models. In truth, they are proposing an ambiguity, for the company is taking a year to decide whether its first priority will be to sell a small version of the HTGR it has been peddling for a decade or a new "modular" HTGR using the design of the German pebble-bed reactor.

In either case, Agnew thinks several new qualities will make the product economically attractive. It will be standardized and possibly deliverable by truck. The nuclear components will be well isolated from the other steam-generating elements of the plant. Both aspects are intended to make licensing simpler by reducing the time spent on safety reviews. In addition, the pebble-bed core may be considered virtually fail-safe because of its heat dissipating features. It also provides for continuous refueling, avoiding costly shutdowns. And finally, the small size of these new reactors could make them more attractive to companies needing a source of process heat. While there are only a handful of sites that could use the amount of heat put out by a large HTGR, Johnston estimates that in theory there ought to be enough demand for the heat output of the small plant to sell 400 copies.

The backers of the HTGR have another trump card they may be able to play. It is the perceived need for a new military reactor. An independent panel of experts told DOE secretary Hodel late in 1982 that if it is necessary to erect a new reactor to produce weapons material, the cheapest and quickest option would be to expand the existing heavy-water facilities at Savannah River, S.C. However, about eight months later, Hodel announced that he thought Idaho would be a good location for the new defense reactor. Senator McClure helped plant this independent view at DOE. Along with it goes the option of using the HTGR as a military reactor.

The HTGR comes into the picture indirectly. Because it would be an entirely new technology for the U.S. defense program, no existing federal center has an obvious claim on it. And since the gas-cooled reactor does not require water, it certainly would not have to be located near a river, as existing military reactors are. In this way, it is a technology that opens up geographical horizons, a quality Idahoans admire.

Furthermore, Agnew has been promoting his company's technology as a self-financing system. It is capable of simultaneously producing tritium for the weapons program and electricity for sale to utilities. Thus, Agnew claims, the government could not only finance its new investment using a gas reactor but make a profit. The House Armed Services Committee has not bought this concept, or even the argument that a new defense reactor is needed. Seymour Shwiller, who recently left the staff of the procurement subcommittee, says: "My objection was that this could commit the government to $8 to $18 billion for a system that may not be necessary. This is a big dollar item. A whole new nuclear park." DOE has been asked to reanalyze the entire matter.

In considering commercial plants, it is clear that the HTGR has been a less than competitive technology in a decreasingly competitive industry. Perhaps then the new HTGR's should be placed in a category labeled "post-commercial." It would include ideas that have been through the developmental stage, been sold commercially, and are now back in the shop for an overhaul. In a sense, light water reactors fall in this category, too.

However excellent the new HTGR's may be, Congress may want to take care in designing an R&D program for "inherently safe" reactors to avoid clinging too closely to the past. It might be wise to define the terms of entry to this program broadly and set the criteria for large-scale funding quite narrowly. It would be useful to learn how well the modular HTGR competes with other advanced, ultrasafe designs, including new versions of the light water reactor.

—ELIOT MARSHALL

Mosher Case Enters Final Phase

Stanford University president Donald Kennedy has posed more questions to Stephen W. Mosher, a graduate student who was expelled last year from the anthropology department for allegedly engaging in "seriously unethical conduct" while conducting research in China.

In a letter to Mosher dated 1 May, Kennedy asked for detailed answers to several questions raised during the department's original investigation. Details of the letter were disclosed in part by a university press release and an article in the campus newspaper, which was given a copy of the letter. Mosher characterizes Kennedy's actions as a "delaying tactic" and has threatened legal action if he is not reinstated.

Stanford has repeatedly refused to state the exact reasons for Mosher's dismissal, arguing that disclosure might endanger Chinese villagers. Mosher contends that the university bowed to political pressure from the Chinese and American sinologists after he published an article in Taiwan about birth control practices in China and included photographs of Chinese women undergoing abortions (*Science*, 22 July, p. 348 and 13 May 1983, p. 692).

Kennedy's review of the matter represents the final stage in a lengthy appeals process begun by Mosher last May. Although Kennedy states in the letter that "On the basis of the existing record, I would find that the proper facts and considerations were taken into account and do support the [department's] decision," he said he is seeking clarification of some details. If Mosher's answers "add significantly to the evidence," Kennedy said he would consider referring the matter back to the department for limited reconsideration.

The letter also states that Kennedy has received a letter from a "Ms. Vaquer," that apparently provides some fresh information. In an interview, Mosher said that Vaquer several months ago testified on his behalf and that her letter will cast serious doubt on allegations made by Maggie So, Mosher's former wife and a former friend of Vaquer. The department's decision to dismiss Mosher rested heavily on allegations made by So. Mosher declined, however, to elaborate further about Vaquer or even disclose her full name.

Kennedy's letter also lists nine specific questions that were originally posed to Mosher by the department but not publicly disclosed until now. Kennedy said that "you have not in fact responded to those statements except with a blanket denial of all adverse statements; I wish to give you the opportunity to supplement the record . . . " Several of the questions relate to Mosher's use of grant money, according to Stanford sources.

Mosher, who now lives in Fresno, California, said that he has already answered these questions in detail, and added "I think I accounted satisfactorily for the small amount of grant money that I got."

Mosher says he is "appalled" that Stanford, in releasing a copy of the letter to the campus newspaper, divulged the name of the Chinese village where he had conducted his research. He contends that Stanford breached its own ground rules. The university now refuses to release further copies of the letter.

The central question still remains publicly unanswered. On what grounds did the department expel Mosher? Neither Stanford or Mosher are willing to say, so the case remains baffling to outsiders.—MARJORIE SUN