A Novel Approach to Nuclear Fusion

Two small firms are betting that cheap, disposable reactors are the answer

by Niles Howard, Duns Business Month, November 1983

Over the past thirty years, the federal government has spent billions of dollars to develop nuclear fusion reactors that will generate cheap electricity from sea water. But progress has been slow — indeed, researchers have yet to achieve a substantial fusion reaction — and the Department of Energy predicts that significant commercialization of fusion will not occur for at least thirty years.

Lately, however, two LaJolla, California, firms — International Fusion Energy Company (INESCO), a venture capital company, and GA Technologies, a Gulf Oil subsidiary — have stirred up a good deal of attention by declaring their intentions to build and market commercial fusion reactors well ahead of that date, possibly within a decade.

Unlike the government, which envisions mammoth fusion reactors costing $2 billion or more, both INESCO and GA are concentrating on small, relatively simple designs. They believe that midget reactors, about the size of a compact car and capable of providing power for a small city, can be built in volume for about $2 million each. If these assumptions are correct — and even critics concede they may be — "the economic and social implications would clearly be staggering," says Dean Robert A. Gross of Columbia University's school of engineering and applied science.

That is because fusion reactors, which use hydrogen rather than uranium, would be so much cheaper and safer than the fission reactors now used. While nuclear fission splits uranium atoms, fusion forces hydrogen atoms together, forming helium — a reaction that releases large amounts of energy.

Most fusion research centers around the tokamak, a metal doughnut-shaped vacuum chamber wrapped with powerful superconducting magnets. The magnetic field compresses hydrogen gas, or "plasma," in the chamber while it is heated to 100 million degrees — a temperature at which the atoms will theoretically combine. But since the radiation thus generated would eventually destroy the sensitive and expensive magnets, they must be protected by thick steel and lithium shields. These shields account for much of the reactor's size, complexity and cost.

INESCO's proposed reactor, called the Riggatron, is also based on the Tokamak concept. But INESCO wants to substitute relatively inexpensive copper alloy magnets for the superconducting variety. Its theory is that since the magnets are cheap, they will not have to be shielded; when they are used up, after thirty days or so, the whole reactor core will simply be removed from its housing and discarded, like a burned-out light bulb, and a new one inserted in its place. And because copper magnets can work at a much smaller scale than superconducting magnets, the reactor can be one-tenth the size of the government model. According to INESCO Chairman Robert W. Bussard, a former assistant director of the Atomic Energy Commission's fusion program, each replacement core would cost $250,000 and produce energy equivalent to 1 million barrels of oil during its brief life. This works out to a price equivalent of 25 cents a barrel.

The idea of a disposable reactor was originally conceived by Massachusetts Institute of Technology physicist Bruno Coppi, who in 1976 joined with Bussard to form INESCO with a $637,000 federal grant and a credit line from Washington, D.C.'s Riggs National Bank (for

whom the machine is named). Despite skepticism from the nuclear establishment, the company subsequently raised $65 million through an investment partnership to help finance preliminary design work. For the past three years, INESCO's staff of 35 physicists and engineers has subsisted largely on a $500,000-a-month allowance from Penthouse magazine publisher Robert Guccione.

But with conceptual designs now nearly complete, INESCO is trying to scrape up more cash — at least $100 million — to pay for the engineering and construction of five Riggatron prototypes by 1989. The company recently filed with the Securities and Exchange Commission a proposal to raise $6 million through the sale of common stock and warrants, and it is rumored to be negotiating with wealthy American, European and Israeli investors. Because INESCO is in registration, company executives will not discuss their plans publicly.

Meanwhile, scientists at rival GA Technologies are close to finishing work on a prototype scaled-down fusion reactor. GA's design — called OHTE, for ohmically heated terroidal experiment — is not technically a Tokamak, although it is based on many of the same principles as the Riggatron. Patented by GA Vice President Tihiro Ohkawa in 1979, it also consists of a disposable metal doughnut wrapped with copper magnets. But it is designed to operate at much lower pressures and temperatures than the Riggatron, which Ohkawa believes will make for a simpler and more reliable system in the long run. "Our philosophy," he says, " is to make things tougher on the physicists but easier on the engineers."

The first OHTE prototype, financed jointly by GA and Phillips Petroleum, is scheduled to begin operating sometime next year. Primarily a research device, the machine will test whether the copper magnets can properly confine the hydrogen gas. If that experiment is successful, Ohkawa expects GA and Phillips to cough up $100 million to proceed with Phase Two, which calls for the completion of a full-scale working reactor by 1990.

Whether it will work is, of course, the big unanswered question. Indeed, while many nuclear scientists are fascinated by the disposable-reactor concept, most consider both the Riggatron and OHTE to be long shots at best. Pointing to the failure of government researchers to produce a sustained reaction after thirty years of trying, they note that there is actually no firm evidence that such a reaction is even possible. "I'm not saying the compact approach won't work," says President Stephen Dean of Fusion Power Associates, which lobbies for the government's mainstream program, "but a lot more basic research needs to be done on the concept."

But both GA's Ohkawa and INESCO's Bussard dismiss such skepticism. Bussard, in particular, contends that after three decades of theoretical research by the government, it is time to take a practical approach to the problem. In his view, the most significant inventions have resulted largely from trial and error, rather than theoretical reasoning, and there is no reason to think that fusion will be any different. "If we had to understand on the basis of fundamental theory the flow of water in pipes," he notes, "we would not have flush toilets."