Hard Times in Uranium Enrichment

Plummeting sales have forced a major overhaul of the enrichment program, including radical surgery in research and development

The federal government's $2-billion-a-year business enriching uranium for reactor fuel is in such dire straits that the Department of Energy (DOE) will soon be forced to drop one of two major programs aimed at developing an advanced enrichment technology. In mid-1985, it will choose between developing a new generation of gas centrifuges or a process based on lasers to replace the aging facilities that are currently in operation. The losing project will be virtually closed down.

Billions of dollars will ride on the choice. At stake is the future of a massive gas centrifuge plant under construction in Portsmouth, Ohio. Known as the Gas Centrifuge Enrichment Plant, or GCEP (pronounced gee-sep), it has already soaked up some $2 billion in construction funds. If the development of advanced centrifuges is shut off, the plant would be at best marginally economic and may have to be abandoned. On the other hand, if DOE closes out the laser enrichment program, it risks turning its back on a promising technology on which it has already spent several hundred million dollars.

The department had originally wanted to make the selection around 1988, but has decided it can no longer afford to support two $100-million-a-year R & D programs. It will thus be forced to choose before either technology is fully demonstrated.

The accelerated decision is part of a radical overhaul of the enrichment program designed to pull it back from the brink of disaster. Last year, DOE belatedly realized that its customers for enriched uranium were deserting it just as the enrichment program was committed to spending billions of dollars on construction (*Science*, 19 August 1983, p. 730). "I can't overemphasize the criticality of what we were facing in 1983. We were in a death spiral. It was a problem as big and as bad as Chrysler," says Shelby Brewer, head of nuclear programs at DOE.

At the root of the problem is the worldwide slump in the nuclear power industry. In the early 1970's, utilities had placed so many orders for future deliveries of enriched uranium that DOE—which then had a worldwide monopoly—closed its order books because it believed its production capacity would soon be exceeded. A $1.5-billion program was launched to expand output from DOE's three existing plants, and in 1977 the go-ahead was given to build GCEP. The Europeans also entered the enrichment business in the 1970's with the construction of two new plants.

Then the bottom fell out of the market for reactor fuel as utilities around the world began to scale back their nuclear construction. DOE found itself with contracts that were "just a handful of paper," as Brewer puts it. It was also locked into long-term contracts with utilities for electricity to operate its enrichment plants, and is now paying huge penalties for power it ordered but no longer needs. Next year alone, DOE will fork over $339 million in penalties to the Tennessee Valley Authority (TVA).

DOE calculates that worldwide production capacity currently exceeds demand by a factor of 2. To make matters worse, many utilities are holding a huge stockpile of enriched uranium that they have been forced to accept under strict take-or-pay contracts, and they are unloading it to other utilities at a substantial discount. There is enough material slopping around in this so-called secondary market to meet current demand for about 3 years.

Some two-thirds of this surplus is of European origin, and the devaluation of European currencies against the dollar has made this cut-price fuel doubly attractive to U.S. utilities. About 18 months ago, DOE was jolted when some of its customers started canceling contracts and going to the secondary market. It received another blow when some utilities also began negotiating contracts with European producers, which are now undercutting DOE's prices in part because of those huge penalties DOE is paying to TVA.

Suddenly, DOE was faced with the prospect of a rapidly dwindling market just when it was building all that new capacity. Brewer says he was "horrified" when he looked into the program and realized the dimensions of the problem. Some radical surgery was in order.

To try to prevent further erosion of its market share, DOE has recently dropped its prices (although they are still above those of its European competitors) and offered its customers a more flexible contract that permits them to obtain a specified fraction of their requirements from the secondary market. Existing contract-holders have until October to convert to the new contract; DOE will

A $2-billion deal

Response to DOE's new contract will determine the future of the enrichment program. Duke Power chairman Bill Lee (left) and Shelby Brewer sign the first one.

Problems at Parachute Creek

The Union Oil Company is trying to put the best face on breakdowns and accidents at its brand new shale retort near Parachute Creek, Colorado. These nuisances aren't even problems, said company spokesman Barry Lane in a telephone interview, just "routine items one would expect to encounter in a project of this magnitude."

Lane confirmed a point that Denver environmentalists have been pressing for some time—that wastewater ponds at the site have become highly acidic. Union maintains that the acid comes primarily from rainfall runoff, not from within the retort, as critics believe. The ponds aroused new controversy recently because two employees checking on acid levels on the night of 6 December slipped on a plastic liner, fell into the water, and drowned. A medical examiner reportedly found the water in the victims' bodies to show an extremely low *p*H level. The Occupational Safety and Health Administration (OSHA) has begun an inquiry, but there is no plan to release a public report.

In a sense, the Union retort in Colorado represents the brightest hope of America's synthetic fuels campaign. It certainly carries one of the biggest investments. Union already has received a government price guarantee worth $400 million and, as a result of action taken by the Synthetic Fuels Corporation (SFC) in December, is due to get a contract for federal price guarantees worth $2.7 billion, the largest pledge yet made by the SFC.

According to spokesperson Karen Hutcheson, the SFC board planned to discuss Union's contract on 16 and 24 February, but adjourned without doing so. The case will probably come up at the next meeting on 15 March. Friends of the Earth, an environmental group, has asked the SFC to make a special inquiry because, it argues, $4.9 billion is now riding on this particular retort. Another project at Cathedral Bluffs, Colorado (backed by Occidental Petroleum, Tenneco, and Peter Kiewit and Sons, Inc.), plans to use Union's technology and has already received a pledge of $2.2 billion in price guarantees from the SFC. Cathedral Bluffs is expected to sign a contract with the SFC shortly after Union does. At present, the SFC is not planning a new investigation.

Before the recent setbacks, Union had said its retort would begin running in December of 1983. But only a few days after the SFC approved the $2.7-billion commitment, the company announced that it was having trouble and would not meet its December start-up date. Lane declined to describe the troubles in any detail, for the company wants to protect proprietary information. "We don't feel it's necessary to give day-by-day, blow-by-blow reports on the plant," he said. Indeed, Union gives no forecast now on when the retort is likely to begin running.

According to Kevin Markey, who dogs the project for Friends of the Earth in Denver, "It's easier to divine events in the Kremlin than to pierce the veil of secrecy at Parachute Creek." The Environmental Protection Agency is excluded by law from involving itself in SFC-backed projects. And Union, according to its spokesman, believes that federal monitoring of environmental effects does not begin officially until the plant is running.

Based on "our admittedly inadequate information," Markey says, the main problem appears to be that mechanical parts in the retort are jamming up in the thick, asphalt-like by-product of the retorting process. (This by-product is not meant to be so sticky.) As a result, some of the equipment must be redesigned, remade, and reinstalled. Meanwhile, Markey believes, sour water or retort waste—which is supposed to be treated in the still-idle oil upgrading plant—may be making its way into the huge holding ponds. To keep the ponds within permitted acid standards, company employees have been treating them with caustics.

Markey says that many people who have been at the site claim to have detected the odor of sulfides coming from the wastewater, suggesting that something is seriously amiss in the retort, and that wastes are being dumped. This is not so, according to Lane; the company is obeying all relevant environmental laws. Reports to the contrary, in his view, are merely "rumor and speculation."—**ELIOT MARSHALL**

then have a firm estimate of its revenues over the next few years.

Initial response to the new contract has been favorable. In the first month after it was unveiled, Duke Power signed on with orders worth more than $2 billion over the next 30 years, and almost half DOE's customers expressed their intent to convert. But even so, DOE projects that its revenues will drop from $2.1 billion this year to $1.675 billion in fiscal year 1985.

Even under the most favorable assumptions, the revenues are unlikely to cover the cost of the ambitious construction and R & D program that DOE laid out in the 1970's. GCEP alone would have cost nearly $10 billion by the time it was finished in the late 1980's. DOE officials were therefore faced with two alternatives: either scale the program back drastically or try to persuade the Office of Management and Budget (OMB) and Congress to approve an operating deficit for a few years. There was little chance OMB would go along and even less that Congress would agree, so the knives were sharpened.

But more than simple cuts are being considered. When it was first approved, GCEP was envisaged as a massive complex of eight process buildings, each housing thousands of centrifuges. By the early 1980's, it was recognized that the original justification for building GCEP had vanished because DOE's three existing enrichment plants have more than enough capacity to meet projected demand until the end of the century. But construction continued because DOE changed the justification. In essence, it argued that because gas centrifuge technology is much less energy-intensive than the gaseous diffusion process employed in the existing plants, GCEP was needed to replace some of its aging facilities and hold down costs in future years.

Two of GCEP's process buildings and most of the central control and fuel-handling facilities have already been completed, and late last year the first centrifuges were installed. But DOE has now thrown the project into a lower gear. Plans for constructing the remaining six process buildings have been deferred, and DOE is committed to filling only half the first building with current-generation centrifuges. What happens next will depend to a large extent on whether DOE chooses to develop either advanced centrifuges or an entirely different technology based on lasers.

In the early 1980's, DOE began to pour money into the development of an advanced centrifuge with three times the efficiency of the machines now being

installed. It also stepped up work on a potentially more efficient process using lasers that had been under development at the Lawrence Livermore Laboratory. DOE was planning to spend about $190 million on the two programs this year, with a full-scale demonstration of both of them expected in the late 1980's.

Funding for both technologies is being reduced, however, and the projects are now being revamped so that a choice can be made in the summer of 1985. If DOE chooses to continue with the advanced centrifuge, the new machines will probably be installed in the two completed process buildings of GCEP. According to DOE estimates, a two-building GCEP equipped with advanced centrifuges would be cheaper to operate than the existing gaseous diffusion plants. But with current-generation machines, such a plant would provide little or no cost savings. Thus, if the laser process is chosen, the future of GCEP would be in doubt.

In view of the fact that some $2 billion has already been invested in GCEP, DOE's technological choice would seem to be heavily skewed toward the advanced centrifuge. "Yes, that will be a factor," says Brewer. "That's life; you have to live with past decisions." But John Longenecker, the head of the enrichment program, points out that the capital cost of building a new laser plant would be roughly equal to the additional cost of completing a two-building GCEP with advanced centrifuges. Thus the money sunk into GCEP has, in effect, put the two technologies on a roughly equal footing.

Longenecker says that the choice will be made not only on the expected capital and operating costs of the two technologies but also on their relative attractiveness to private investors. DOE is hoping to get some private capital into the enrichment program as a first step toward turning the enterprise over to private industry. Exactly how the transition would be accomplished, however, is not clear.

In any case, the real key to attracting any investment into enrichment, whether public or private, will be how successful DOE is in hanging on to its customers, and how long the depression endures in the nuclear industry. From now on, claims Brewer, investment decisions in the enrichment program will depend on the market—an elementary business strategy that, he admits, DOE has not followed in the past.—**COLIN NORMAN**

Will There Be Room on the Arc?

Third World countries are challenging the United States on use of an orbit crucial to communications satellites

International jostling for position on the radio spectrum will resume in public next year at a world meeting to plan the use of geostationary satellites. Under discussion will be access to the orbit directly over the equator and 38,500 kilometers (22,300 miles) from Earth; in that orbit it is possible for a satellite to keep a fixed relation with a particular spot on the surface and maintain communication with it continuously.

Geostationary satellites are carrying a rapidly increasing volume of voice, video, and data traffic and represent a major growth area in telecommunications. Less-developed countries (LDC's) contend that the buildup of satellites in geostationary orbit by the United States and other industrial countries will result in crowding that will exclude LDC's from access to the orbit. When the physical separation between satellites in the same geosynchronous orbit and operating on similar frequencies is insufficient, interference occurs.

The LDC's have sought to ensure their future use of the orbit by reserving space through international negotiations, acquiring what are informally termed "parking" privileges. The issue was controversial enough to cause discussion of it to be deferred during the 1979 major meeting of the World Administrative Radio Conference (WARC) which operates under the aegis of the International Telecommunications Union (ITU). The matter is scheduled to be taken up in July 1985 in Geneva at a WARC Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing it, mercifully, for short, ORB 85.

In allocating frequencies, WARC has historically run things on a first-come–first-served basis. Since only the industrial nations had highly developed telecommunications networks, the LDC's did not seriously challenge the system. However, the expanding potential of satellite use, particularly for direct television broadcasting, prompted the LDC's to stake their claim to a portion of the radio-frequency spectrum devoted to satellite communications.

The United States has opposed the LDC attempt to reserve space for future use, claiming that such a policy involved a waste of resources and would retard the development of satellite technology. U.S. policy has been to support the present flexible policy and to assume that advancing technology will make it possible to accommodate those who want to make use of the "arc" in the future.

At the 1979 WARC conference, the LDC's major immediate concern was with expanding their use of frequencies for ground-based, point-to-point broadcasting. What were probably the two most controversial issues—geostationary satellites and high-frequency (shortwave) radio—were both bypassed by relegating negotiations to later meetings.

In respect to actual decisions taken at WARC '79, the United States fared reasonably well. But many American observers saw the meeting as marking a permanent change in the U.S. position in the organization. An assessment of the meeting* by the congressional Office of Technology Assessment noted that "The long-term trends may be running against the United States in the sense that more problems without apparent solutions are foreseen. The United States finds itself increasingly in a defensive mode, trying to minimize losses rather than seeking significant changes to improve its long-term posture."

The issue of crowding remains the one likeliest to cause LDC-U.S. differences to crystallize at ORB 85. The LDC's, aware of the rapidly increasing numbers of satellites in geostationary orbit, continue to express concern that the orbit will be saturated by the time they wish to use it.

An American view that seems to domi-

**Radiofrequency Use and Management* (Office of Technology Assessment. Washington, D.C., 1982), 163 pages.