Europe's Fast Breeders Move to a Slow Track

The U.S. Clinch River reactor is not the only project faced with mounting economic and political problems

Paris. Europe's enthusiasm for fast breeder nuclear reactors is rapidly running out of steam, faced with increased costs, decreased projections of electricity needs, and across-the-board delays in the construction of conventional light water reactors on which a commercially viable fast breeder program would depend.

In both Britain and West Germany there is now serious talk, if not of abandoning fast breeder development completely, at least of putting a freeze on expansion plans until future needs can be perceived more clearly. Nigel Lawson, Britain's minister of energy, told Parliament on 29 November that the British government remains committed to the long-term development of fast breeder reactors, but that commercial orders for fast reactors are not expected until after the year 2000.

In France, President François Mitterrand has not so far invoked his preelection call for a temporary halt in the construction of France's technological jewel, the Super-Phénix fast breeder reactor at Creys-Malville in the Rhône valley. This has stimulated concern that pressure to retain the breeder may be coming from the French military, attracted by the high-grade plutonium that will become available from the reactor blanket (see box). However, the government announced earlier this year that it was reducing its future commitment from five to one more fast reactor after Super-Phénix, and there are doubts about whether it will decide to go even this far, at least without considerably more international support.

It is all very different from the heady enthusiasm that existed up to the end of the 1970's. Even 2 years ago, at the time of the International Nuclear Fuel Cycle Evaluation (INFCE) studies, the talk was of having 50 gigawatts of breeder reactor capacity worldwide by the year 2000. Today, many economists claim breeders will not be competitive with light water reactors for the next 50 years. Even the more optimistic, such as Georges Vendreyes, head of industrial applications of nuclear energy at France's Commissariat à l'Energie Atomique (CEA), admit that breeders are not likely to become commercially attractive until the beginning of the next century.

Confidence in the technical potential of fast breeders as an eventual important energy source remains high, particularly in countries that lack access to domestic energy resources and are reluctant to accept the implications of heavy dependence on foreign supplies of uranium.

Political enthusiasm, however, has cooled, for the OPEC-inspired oil price rises have provoked a steady decline in the rate of growth of electricity demand.

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This, combined with licensing restrictions imposed by public concern about safety, has caused delays in conventional nuclear programs to such an extent that the date at which they would be able to sustain a viable fast breeder program, based on reprocessed light water reactor spent fuel, is receding further and further into the distance.

Furthermore, the resultant decreased demand for natural uranium is making it increasingly difficult to argue that fast breeders are urgently needed to compensate for an imminent evaporation of uranium supplies. "There now seems to be enough uranium at least until the first decade of the next century, so that the need for the breeder from the supply side is rapidly diminishing," says one analyst with the nuclear energy agency in Paris. "The long-term need for the breeder is still there; but compared to the thinking at the time of INFCE, the prospects have been put back by 20 to 30 years."

The changed economic and political climate has affected European countries in different ways, depending on the stage of their breeder programs. France, still out at the head of the pack with the world's first commercial fast breeder, the 1200-megawatt sodium-cooled Super-Phénix, is in an easier position than some. Completion of Super-Phénix is currently scheduled for 1984, and no decisions about the next step (currently thought of as Super-Phénix II) need be made until at least 1 or 2 years later.

When it comes, however, the decision will not be easy. Until recently, the future of fast breeders in France seemed well assured. The prototype Phénix, a 250-megawatt reactor, has been providing power for the French utility Electricité de France (EDF) since 1973, and most of the technical questions about fast breeder operations seem to have been solved. Furthermore, French politicians have proudly displayed fast breeders as one technology in which the country is well ahead of its international competitors.

Various factors, however, have dampened some of the enthusiasm. After 8 years of "working like clockwork," in the words of Vendreyes, Phénix sprang a leak in April of this year in its cooling system, leading to a fire when the sodium came in contact with the air. The accident put the reactor out of operation for several weeks and stimulated a debate about fast breeder safety.

Furthermore, the cost of Super-Phénix, jointly financed with German and Italian partners, has been rising alarmingly. Estimated 5 years ago to cost 4 billion francs ($550 million at current exchange rates), the latest estimate is that it will cost about 12 billion francs ($1.7 billion). Even allowing for the first-time costs of a new engineering enterprise, this means that a commercial fast breeder based on the Super-Phénix design would cost about twice as much as a conventional light water reactor of the same size.

A third factor, perhaps even less predictable, is politics. During his election campaign in 1980, Mitterrand's apparently skeptical stance toward fast breeders helped him secure support not merely from the environmental movement—to whom the whole idea of a plutonium economy remains a can of worms—but also from members of the powerful union the Confédération Française Démocratique de Travailleurs, which has been waging various well-publicized campaigns around nuclear safety issues, such as the safety of working conditions for its members at the La Hague reprocessing plant.

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Since his election, Mitterrand has backpedaled on his previous criticisms of the nuclear industry, well aware that for other sectors of the labor movement, it represents an important source of jobs. Work on Super-Phénix has continued virtually uninterrupted; last year, for example, Prime Minister Pierre Mauroy underlined the government commitment to fast breeders by announcing plans to expand La Hague with a facility to produce plutonium for Super-Phénix.

By announcing that no political decision will be made about the future of the French fast breeder program until operating experience has been gained with the Super-Phénix, Mitterrand has been able to keep the lid on what could become a damaging political conflict between different groups of his supporters. But, fueled on the one hand by unfavorable economic conditions and on the other by concerns that breeders could become a principal source of plutonium for France's *force de frappe*, the tensions are not far beneath the surface.

The situation is more delicate in Germany, which is still struggling to complete construction of its own prototype reactor, the 300-megawatt sodium-cooled test reactor SNR-300 at Kalkar, which started in 1973. This is being built by the consortium Schnell-Brüter-Kernkraftwerksgesellschaft (SBK), headed by Germany's largest utility Rheinisch-Westfalisches-Elektrivitätswerk (RWE). Belgium and the Netherlands are each contributing 15 percent of the cost and Britain's Central Electricity Generating Board 2 percent. Of the German share, electric utilities agreed to absorb 8 percent of the construction costs, the rest being covered by the federal government.

When originally planned, Kalkar was expected to be ready by 1978. It now looks as if completion will not be until at least 1986; and if the German government is unable or unwilling to raise the necessary finance, either from its own resources or from utility and nuclear construction companies, final completion could still be postponed indefinitely.

Various factors have contributed to the delay. For example, the reactor has had to go through a lengthy and detailed series of licensing procedures, which themselves have become increasingly more strict in response to growing public concerns about the safety of nuclear power. In addition, there have been various design changes, some the result of new licensing requirements, others of miscalculations in the original plans.

Each of these factors has helped increase the costs. At the beginning of the

Breeders and Bombs

Questions were raised in the West German Federal Parliament, the Bundestag, last week about whether German funds are being used to help produce plutonium for French nuclear weapons. The questions were prompted by an article in the weekly magazine *Der Spiegel*, which claimed that the Super-Phénix sodium-cooled fast breeder reactor is intended to produce plutonium for the French military, and that customers of the German utility that is providing 16 percent of the funding for Super-Phénix were therefore unwittingly helping to finance the planned buildup of France's nuclear forces.

The questions were quickly dismissed by both the German and the French governments, which pointed out that the whole Super-Phénix project is being overseen by Euratom, and that this should be sufficient to ensure safeguards against the diversion of civilian plutonium to military purposes. But the incident reflects the type of political difficulty that could arise over multilateral cooperation in fast breeder research and development—difficulties that the United States has already encountered in its own nuclear cooperation agreements, most recently in its efforts, through the Nuclear Nonproliferation Act, to keep a handle on the plutonium contained in the light water reactor fuel sold to other nations.

The attraction of the fast breeder, from the military point of view, is the high purity of the plutonium that can be extracted from the uranium oxide blanket after it has been bombarded with fast neutrons from the reactor core. One visitor to the United Kingdom's Atomic Energy Authority's fast breeder at Dounreay was told that the purity was as high as 98 percent. There are several cheaper and more convenient ways of producing weapons-grade plutonium; but if fast breeders are built, the temptation to the military to make use of the plutonium in the blanket will be strong.

France has never admitted that it intends to do this. Indeed, at present it has plenty of plutonium from its own military reactors. However, a veil of secrecy is generally drawn over where the country will get the plutonium it needs to fulfill future commitments to building new weapons. Nuclear critics claim they can discern from a few public statements made by those close to the military program a logic that points toward the fast breeder.

In 1973, for example, a report on the military applications of nuclear energy prepared by the Commissariat à l'Energie Atomique (CEA) recommended that the production of military nuclear material should take "advantage . . . of civilian programs . . . in order to limit the costs." In 1978 General Jean Thiry, previously director of France's military centers for nuclear testing, and subsequently an adviser to the head of the CEA, wrote that France was able to make large quantities of nuclear bombs "since fast breeders will provide ample supplies of the necessary plutonium." Most recently, an article in a weekly newsletter *L'Energie* stated boldly that the future supply of weapons-grade plutonium, currently produced by the aging reactor G-3 in Marcoule, was "assured" by Super-Phénix which would produce enough high quality plutonium to fuel 60 atomic bombs a year. "Super-Phénix is obviously becoming the technical base of the French *force de frappe*," the author, L. Lammers, an economist with Electricité de France, declared. To some critics, the message is clear. Given the declining economic interest in fast breeders as a source of electric power, they ask, what is the explanation for continued political enthusiasm? "The answer is succinct: the military needs breeders," wrote Yves Lenoire and Michel Genestout in the October issue of the popular French magazine *Science et Vie*, the source of *Der Spiegel*'s broadside against West German involvement in Super-Phénix. So far, the French authorities have kept a discrete silence on the issue, other than pointing out that although it is not a signatory of the nonproliferation treaty, France is voluntarily obeying International Atomic Energy Authority safeguards on its civilian nuclear installations.

Whether the complaints are, in themselves, sufficient to deter the French, who take a strong nationalistic pride in their ability to determine their own nuclear future, from moving in this direction is open to speculation.—**D.D.**

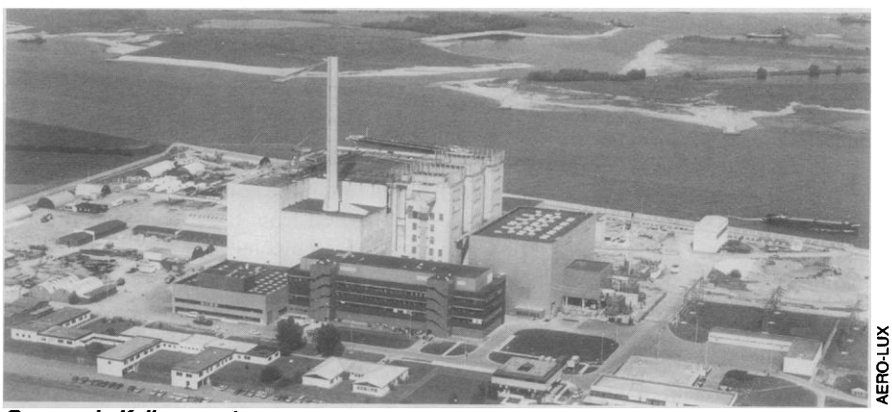
1970's, it was estimated that Kalkar would cost 1.355 billion marks ($550 million at current exchange rates), but this projection rose steadily during the decade. In February 1981 new estimates were made public that the completion of Kalkar would cost 5 billion marks. A lengthy series of negotiations followed, during which the utilities and the nuclear industry agreed to share the extra costs with the government—but only provided that the federal parliament give the full project its approval.

This goal was almost reached earlier this fall. After 3 years of discussions, a special parliamentary commission of inquiry agreed by a narrow majority to recommend to the parliament that the construction of Kalkar should be completed and the reactor be allowed to start operation. A parliamentary debate now scheduled for 3 December had been expected to endorse the commission's recommendations with little difficulty.

Since then, two separate events have raised new doubts. With the change of government in September, the Social Democrats have closed ranks with the critics. On 24 November, the party agreed to endorse the resolution being put before parliament stating that a number of important economic and safety questions still need to be answered before Kalkar is given final approval. To some observers in Bonn, the most significant aspect of this move is that it represents the breakup of the previous all-party coalition on which support for the fast breeder has depended.

Given the extent of both public and private investments, as well as the number of construction jobs at stake, parliamentary criticism in itself is unlikely to be sufficient to halt SNR-300. However, in September, it was announced that the costs had once again been recalculated and that they were now expected to be at least 6.5 billion marks ($2.6 billion). Germany's research and technology minister, Heinz Riesenhüber, was reported last week to have written to the federation of German industrialists saying that the Bonn government does not intend to increase its contributions either to Kalkar or to another controversial nuclear project, the high temperature reactor, which has also encountered major financial problems.

Industrial sponsors of the project remain, at least in public, optimistic that the money will be found somewhere. Critics of the fast breeder, however, suggest that the new cost increases may prove to be the final death blow.



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Germany's Kalkar reactor

Cost overruns and political opposition

All this casts even more doubt on what was to have been the next stage in Germany's fast breeder program, the construction of a demonstration commercial reactor known as SNR-2. Roughly comparable in size to Super-Phénix, this is officially planned to be jointly financed with French and Italian participants, and the final design has been virtually completed. Even the most optimistic supporters of fast breeders in Germany, however, accept that construction is unlikely to start before the end of the 1980's—"This time, we plan to get the construction license granted before we start building," says one official—and many will not be surprised if, even if Kalkar is completed, SNR-2 is put on the shelf for many years.

In Italy, doubts about current plans for fast breeder development have not taken such a public form. Italy has recently made a substantial increase in its support for all forms of energy research—including fast breeders, which now consume 39 percent of the nation's energy R & D budget—as part of its response to the energy crises of the late 1970's. However, most of Italy's support for fast breeders is going into Super-Phénix. It has agreed with France to shoulder 33 percent of the construction costs (and as a result has received orders for about one-third of the components, and will receive the same proportion of the electricity when it is produced).

Domestically, the delays in Italy's conventional nuclear program—only one full size nuclear reactor has so far been built with one more under construction—means that discussion about the need for commercial fast breeders is not even expected to begin until the mid-1990's. The most Italy is aiming for at present is to keep up with the state of the art through its contribution to Super-Phénix and the construction of its own 120-megawatt experimental fast reactor PEC (Prova Elementi Combustibili), designed to develop Italy's domestic nuclear capabilities and to study various aspects of fast reactor functioning.

Even this, however, is running into economic problems. Earlier this year, faced with the calculations that, rather than the 650 billion lire ($450 million at current exchange rates) estimated in 1980, PEC was now likely to cost 1400 billion lire ($950 million), the Italian government asked its Commission on Economic Planning to carry out an investigation of the project to determine whether it should still be supported. The commission appointed an advisory panel from the Comitato Nazionale per l'Energia Nucleare e Energie Alternativa (CNENEA), which gave the project a green light on technical grounds, and at the beginning of last week the commission itself approved the project. Officials from the CNENEA estimate that, once allowance is made for inflation, the real cost increase is only about 15 percent. Given a more stable political and economic environment, construction would probably proceed without interruption; but with the current political crisis in Italy, together with growing demands from the international banking community for broad cuts in public spending, the future of the project is still highly uncertain.

Similar uncertainty, though based on different reasons, exists in Britain. Up to now, the United Kingdom has been at the forefront of fast breeder research, with its 250-megawatt reactor in commercial operation at Dounreay in the north of Scotland since 1975, and a current research and development program costing about 110 million pounds ($136 million) a year. Britain is also working on a design for a 1300-megawatt commercial demonstration fast reactor.

In practical terms, the British government is now faced with the question of what to do next. Some observers feel that, faced with the recent weakening of

economic arguments in favor of fast breeders, the answer is likely to be "wait and see." The British Conservative government faces the political challenge of bringing to fruition a program to construct ten light water reactors announced by Prime Minister Margaret Thatcher, the first of which, at Sizewell in Suffolk, is due to become the subject of a public inquiry in January. In the circumstances, an earlier government promise of an inquiry into the commercial development of fast breeders now seems a distant prospect.

Certainly, the fast breeder does not lack enthusiastic supporters in Britain (or elsewhere in Europe, for that matter), such as Walter Marshall, until recently head of the United Kingdom Atomic Energy Authority. The main British utility, the Central Electricity Generating Board (which Marshall now heads), however, basing its assessment on economic rather than technical arguments, has always been less enthusiastic. For example, it turned down an invitation to contribute toward the cost of the UKAEA-financed fast breeder at Dounreay, which according to estimates by Colin Sweet of the South Bank Polytechnic in London, has a spotty operating record, reaching only 6.8 percent capacity over its first 8 years of operation.

Britain's medium-term plans for the fast breeder are currently being thrashed out in the U.K. Department of Energy. As noted earlier, substantial investment is likely to be delayed for the next 20 years.

Given the cost escalation, almost all countries agree that there is a strong case—again in principle—for the next step toward a commercial demonstration fast reactor to be taken internationally. The French, for example, have long said that they would welcome more foreign partners in the development of Super-Phénix II, a topic which is said to have been the subject of recent negotiations both with the Americans (a possible substitute for the Clinch River liquid metal fast breeder?) and with Japan.

Again, however, the hurdles to international collaboration are high, ranging from security and legal concern about the control of plutonium, to the equitable distribution of construction contracts. Furthermore, any effort to mount an international project is seen by some critics as an attempt by nuclear supporters to evade domestic criticism. "It looks as if the breeder people are going for another Concorde syndrome, so that if they get an international treaty, it will be impossible to cancel it," says Walter Patterson of Britain's Friends of the Earth.

At the time of the INFCE studies, any decision not to proceed with a commercial program of fast breeder reactors was portrayed as a major political gamble. Today the technology has lost its imperative. As a result, proceeding with the rapid development of fast breeders, given demand uncertainties and the apparent medium-term adequacy of uranium supplies, is coming to be seen in Europe as an economic and political gamble whose outcome is unpredictable—and perhaps equally risky.—**DAVID DICKSON**

Can OMB Cure Accountability Strife?

Agency seeks better way to audit university R & D fund management; Harvard's, meanwhile, faulted to tune of $1.7 million by federal auditors

The chronic tensions between universities and federal auditors flared again recently when the government released a report of an audit of the Harvard Medical School's handling of federal grant and contract funds over a 3-year period, recommending that Harvard pay back $1.7 million. The way Harvard figures, it may owe $1400, but certainly not $1.7 million. The decision is being appealed.

Underlying the dispute are deep-seated differences over the way universities use and account for federal R & D funds. The basic issues in the new case are the same that fueled a protracted wrangle over time and effort reporting under Office of Management and Budget (OMB) Circular A-21. That conflict was quieted by a compromise (*Science*, 27 August, p. 810), which, however, may prove to be a truce rather than a peace treaty.

An effort to find a broader modus vivendi is now being made under the aegis of OMB. The compromise effort is taking the form of an experiment with a so-called single audit. The "single" means mainly that an institution would be expected to have one audit of its whole research accounting system rather than audits of separate programs as is now done. An experiment funded by the Department of Health and Human Services (HHS) is also in progress under which institutions doing federal R & D work could be audited by private accounting firms under guidelines agreed to by the government, thus relieving federal auditors of a major share of their work load of auditing universities. Harvard, despite its troubles with the federal auditors or perhaps because of them, is in the forefront of the experiment.

In the new claims against Harvard, nearly $1.6 million of the disallowances involve disputed cost transfers. The federal auditors say that charges in that amount were improperly transferred to certain federal projects from other projects, federal and nonfederal, "to reduce cost overruns and/or utilize unexpended funds." The broad issue at Harvard and elsewhere remains the HHS auditors' insistence that the weakness of university accounting systems makes it impossible to relate salaries to effort expended.

Harvard denies any wrongdoing. The 3 years covered in the audit were 1975, 1976, and 1977, and Harvard's vice president for finances, Thomas O'Brien, says that the federal auditors looked at individual transactions so long after the fact that it was impossible to reconstruct the circumstances. O'Brien insists that the audit showed "no fraud, no abuse, no diversion of funds." What is involved, he says, is a disagreement over application of the accounting rules then in force.

HHS auditors conducted the audit at Harvard. HHS is not the only agency responsible for auditing R & D funds, but its auditors have acquired a reputation for being sticklers in applying the letter of regulations. University faculty and administrators saw HHS auditors as their main antagonists in the conflict over effort reporting under A-21. HHS audits about 95 percent of federal R & D projects but these involve only about 50 percent of the total funds.

Federal officials concerned about accountability are critical of university bookkeeping systems and seem to regard

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