Britain: Nuclear Power Industry Faces Critical Choice on Reactor

The British nuclear power industry is facing difficult days. For the umpteenth time in living memory, the Central Electricity Generating Board (CEGB) —the major electrical utility—is dithering over which type of power station to build next. The decision is important because it will determine the type of thermal nuclear station that will run alongside the fast breeder reactors in the last 20 years of the century. There is even a possibility, though a slim one, that the CEGB will abandon British reactors in favor of American designs.

The current state of indecision has its root in a dismal record of retarded growth and a failure to compete with other nations that has afflicted the British nuclear industry for 15 years. In the mid-1950's the government announced an ambitious program of building power reactors, but the plan quickly became mired as a sluggish economy caused electric power demand to grow more slowly than predicted. The program ran afoul as well of fears that brisk development of nuclear power might result in severe unemployment in the coal industry. Then in the mid-1960's, the Atomic Energy Authority (AEA)—the counterpart of the U.S. Atomic Energy Commission—embarked on a second and equally ambitious program which found Britain building an advanced type of gas-cooled reactor that worked well enough but that turned out to be far more expensive, and far less attractive to foreign utilities, than had been hoped.

In a short-lived boom, Britain exported two nuclear stations in the mid-1950's, one to Japan and one to Italy. Since then, there have been 12 lean years without a single foreign sale, a situation made harder to bear by the nearly total domination of the world reactor market (outside the Soviet bloc) by American light water–cooled reactors. But to bow to the inevitable and import U.S. technology (as the French are now doing) would be to throw away a massive investment in research and development. It is unlikely that anybody is ready to do this yet.

Thus, at the present juncture, the CEGB's decision promises to have a dual impact on the British nuclear industry. Its choice of reactor will not only set the pace and direction of reactor construction in Britain, but it will also bear heavily on the salability of British reactors abroad.

While the CEGB makes up its mind, everything else stops. As a monopoly purchaser, its word is law; and until the nuclear companies know what that word is, they cannot plan ahead with any conviction. Meanwhile, the CEGB has an embarrassment of choice. It could decide to stick to the Advanced Gas Cooled Reactor (AGR), a British design that first won its way to the front in 1965 in (supposedly) open competition with U.S. designs. Another contender is the Steam Generating Heavy Water Reactor (SGHWR), which has been operating successfully in prototype form for 4 years, but which has never been built on a commercial scale. The High Temperature Reactor (HTR), developed jointly with other countries in the Organization for Economic Cooperation and Development, is a third and still more remote possibility. Finally, and for reasons that nobody can quite fathom, the U.S. light water designs are being carefully assessed for the first time since 1965.

The two companies responsible for building British nuclear stations are The Nuclear Power Group (TNPG) and British Nuclear Design and Construction. They are the only two survivors of the five consortia that were set up in the 1950's, when nuclear power was the new thing. By the late 1960's, there were only three; and then in 1968 the number was reduced to two, in a badly botched reorganization by Technology Minister Anthony Wedgwood Benn.

The two consortia are in the unfortunate position of having to build power stations designed by someone else. The AEA, which designed the stations, has exerted a strong but baleful influence over the industry right from the start. Nobody denies that it is a competent outfit, but it has always had to design reactors rather than sell them, and it has done little to strengthen the consortia.

The British still have two chances of producing a reactor that will sell overseas. One is the SGHWR, a neat design using a heavy water moderator, light water coolant and enriched uranium fuel in individual pressure tubes. The design seems safe, economical, and straightforward to build, and a 100 megawatt (Mw) demonstration reactor has been operating without trouble since 1967.

Several foreign utiliites have shown interest in the SGHWR. For a while, it seemed possible that Finland would buy one, but the deal fell through. (As a measure of the state of British competition, it should be noted that Finland *did* buy a small, conventional reactor from the Soviet Union. This, so far, is the only reactor sale the U.S.S.R. has made outside Eastern Europe.) Recently TNPG submitted a tender to the Australian utilities for an SGHWR at Jervis Bay. Eventually the decision to build the plant there was deferred, but not before the CEGB had managed to upset the sales effort by saying publicly that it preferred another system, the HTR. Since then, it has changed its mind again, and now simply says that it is "undecided."

Naturally enough, foreign utilities are suspicious of a system that does not have wholehearted support in its own country. If an SGHWR is to be exported, one will have to be built at home, the argument goes. The best chance of this may come from one of Britain's smaller utilities, the North of Scotland Hydro Board, which has sought tenders for a 660 Mw station. While the CEGB deliberations go on, that proposal hangs fire.

The second British chance to export is the fast breeder reactor. An experimental fast reactor has been operating at Dounreay in Scotland since 1959, and the prototype fast reactor (PFR) on the same site should be putting 250 Mw into the national grid next year.

So far, Britain's fast reactor effort has gone well. There have been no embarrassing accidents at the 14 Mw experimental plant (unlike the troubles at the Enrico Fermi plant on Lake Michigan), and the PFR is only a year behind schedule, not too bad for a completely new design. (The delay was caused by difficulties in fabricating the roof of the pressure vessel.) The PFR uses mixed plutonium and uranium oxides as fuel and is cooled by liquid sodium. The entire reactor and primary sodium circuits are contained within a single "pot," which has no penetrations below the level of the sodium; all external connections are made through the roof of the primary vessel, from which the rest is suspended. The primary sodium circuit transfers heat to the secondary circuit through a heat exchanger, and the secondary circuit raises steam to drive the conventional turbines.

The AEA has tried hard to allay suspicions about the PFR's safety, insisting that the sodium is surprisingly easy to handle, and even has its own advantages. It does not expand on cooling, so it can, if necessary, be allowed to cool down right where it is in the pipes. Lengths of pipe can then be taken out for repair and even welded back into place with the solid sodium in situ. Any leaks that develop will be slow, because the sodium is not pressurized.

Self-Perpetuation Plus

The PFR's full fuel load is 4 tons of plutonium. Each year it will consume all of this, but at the same time will produce another 4 tons, plus a little more, in the breeder blanket around the reactor. In this region, uranium 238 is converted to plutonium by the flux of neutrons from the center of the core. Thus the PFR is a power station and a fuel manufacturing plant at the same time, and the physics is rigged so that it actually makes a little more than it consumes. At the end of 10 years or so, if the calculations are correct, this accumulated excess will be enough to start up another fast reactor.

Although the PFR is behind schedule, the AEA's confidence in it is unshaken. "We're into the finishing straight" says R. V. Moore, head of the AEA's fast reactor effort. "Testing and commissioning starts early next year and criticality is expected towards the end of 1972. We're not going to rush the start-up program."

Rush or not, the AEA is almost falling over itself in the effort to move quickly from the prototype to the first commercial fast reactor. "In the past the country hasn't done frightfully well in getting a smooth transition to the commercial phase," Moore admits. "We're determined to get over this. For the past 2 years, the electricity boards, the nuclear companies, and the AEA have been studying the problems involved in phasing in a program of fast reactor power stations. A strategic plan has been evolved and agreed which leads up to an option to build a 'lead' station, starting construction in 1974."

The crucial word is "option." This program, if it is followed, would actually involve selecting a site for the first commercial breeder next year, before the PFR is even on load, and awarding a hardware contract in 1974, after less than a year's PFR operation. For a completely new system, this might well amount to rushing the fences. "What we're saying is that we *could* order as early as 1974," a CEGB spokesman told *Science*. "That would mean we would be commissioning the first station round the turn of the decade."

While it might be in Britain's interest to get the fast reactor program going as soon as possible, this plan almost defies credibility. The first commercial station, when it is built, will be a 1300 Mw plant, with two 660 Mw turbines. Capital costs are expected to be the same as for the current generation of reactors—around $245 per kilowatt installed—but fueling costs should be halved and then reduced to a third of present levels within a decade. The AEA believes that it still has about a year's lead over the French *Phenix* and considerably more over U.S. efforts. The Soviet Union is a dark horse, but is not expected to be much commercial competition anyway.

Whether or not the planned program is followed is of rather academic interest to the two consortia. They need work much sooner than 1974 to keep their heads above water.

To confound the confusion even more, yet another reactor policy committee has been established by the Department of Trade and Industry, successor to Benn's Ministry of Technology (see *Science*, 2 July). Chairman of the committee is Peter Vinter, an official in the department, and his fellow members are CEGB Chairman Sir Stanley Brown and AEA Chairman Sir John Hill. The Vinter committee has the crucial task of injecting some sense into British reactor policy—but, as usual, it has no representative from either of the consortia.

Presumably one of the committee's purposes is to guide the CEGB's faltering hand in the choice of a thermal reactor system. In the way of these things, however, the study is being coordinated by the CEGB itself; thus the committee runs the risk of merely rubber-stamping CEGB decisions, a criticism levelled at its predecessor. An even worse danger is that of failing to agree—and there are precedents for this, too. In 1963, the Powell committee was unable to choose between the AGR and the U.S. designs.

Either way, the formation of the committee has so far done no good at all. While it deliberates, no decisions will be taken, no contracts awarded. So the consortia are even worse off—an ironic result, since one of the purposes of setting up the Vinter committee was (according to one account) to strengthen the industry.

How Firm a Foundation?

The present situation shows British administration at its very worst. The companies are being urged to sell reactors overseas, without knowing whether they have a firm home base from which to do so. The CEGB is vacillating, but is unwilling to accept direction from anybody else. The AEA, leading from the rear, is urging everybody else to build fast reactors. And the Department of Trade and Industry, dedicated as it is to keeping out of industry's hair, is busy interfering in what ought to be private decisions between the CEGB and its suppliers.

Worst of all, what is almost certain to emerge is a policy of no-change. The chances are that the CEGB will continue to build AGR's. They are more expensive than rival systems, but it would be equally costly to switch over. It is very difficult to imagine the U.S. designs getting a foothold in the British market—because of the loss of face. There is also a feeling, though nobody is rude enough to say it publicly, that PWR's and BWR's are not as intrinsically safe as the British designs.

Unless the demand for electricity picks up, however, the industry may be forced to reorganize itself once again. In the future, the CEGB is likely to be ordering about 4000 Mw of new power stations a year, not all of them nuclear. This rate of ordering is certainly not enough to keep both consortia happy, unless they can pick up some overseas orders as well. If the two consortia are forced to merge—or if one drops out of the business—the final shape of the industry would be much as a House of Commons committee recommended back in 1967. The trouble is that it might be 4 or 5 years too late.

—NIGEL HAWKES