The Breeder: French Prototype Shut Down for Repairs

While this country is reanalyzing the desirability of proceeding with its program to develop a breeder reactor to supply future electrical energy needs, other countries are testing experimental prototypes for such advanced reactors and finding that they are not without problems.

Last fall, plumbing leaks similar to those that have crippled the British and Soviet breeders for several years struck the French breeder on the Rhone River near Avignon. Because of the leaks, the 250-megawatt Phenix reactor was shut down in October for repairs and is not expected to be started again before late spring. Thus breeders seem to be showing that—like the present reactor generation—they may work well for some years and then be shut down for minor but disabling failures.

Engineers familiar with the latest problems in the French reactor emphasize, however, that the difficulties should not be taken as any indication of generic problems with the basic concept of the reactor. In order to stretch the world's uranium supply beyond the limits that will be imposed by the present-day reactor technology, virtually all of the countries with well-developed nuclear industries have opted for uranium-fed, advanced reactors that are cooled with liquid sodium and produce more than enough plutonium to refuel themselves. The United States once led in the development of this concept, the so-called liquid metal fast breeder reactor, but it is now far behind. Construction has not yet begun for the American demonstration breeder plant, a 350-megawatt unit planned for installation along the Clinch River near Oak Ridge, Tennessee. It is specifically the plan to build the Clinch River breeder that is now undergoing intensive review by the Carter Administration.

During its first 2 years of operation, the French breeder reactor operated with 80 percent reliability and converted heat to electrical energy with an efficiency of 43 percent—figures of merit clearly superior to the performance of the typical light water reactor today. The French breeder was not only the smoothest running national program, it was also a symbol of the feasibility of the breeder concept which was eagerly embraced by many participants in the American program, which has been troubled with managerial problems, cost overruns, and political opposition in recent years. "Every morning I wake up thankful for the success of the Phenix," said one American reactor engineer at a nuclear conference 18 months ago.

The first sign of trouble with the symbol of success appeared last summer. On 1 July, one of the three large intermediate heat exchangers, used to transfer heat out of the reactor, while keeping the radioactivity inside, sprang a sodium leak. It was detected by some gas-sniffing equipment that checked for traces of sodium vapor mixed with argon in an annular space inside the 1-meter-diameter, 5-meter-high stainless steel heat exchanger. In the French reactor design, the cigar-shaped structures are installed through the top of the reactor and lowered into the 850-ton pool of liquid sodium that floods the reactor tank (Fig. 1). Sodium in a secondary circuit is pumped into the tubular structure through the top and carries heat out of the reactor tank in order to produce steam in an adjacent room and subsequently produce electricity with turbogenerators by utilizing the steam.

A second heat exchanger developed a leak last 5 October and, with two-thirds of its power capacity thus disabled, the reactor was shut down in order to disassemble the troublesome units and find the source of the leaks. By mid-February, both of the units had been removed, cleaned of radioactive sodium, and partly dismantled for repairs. The leak was found deep inside the heat exchanger, where an annular pipe designed to shield people on the reactor floor from radiation had buckled an adjacent pipe. The leak was the result of "a small detail that was not properly designed," said Louis Vautrey, the father of the Phenix reactor design, from his office at the French atomic energy commission laboratory at Saclay outside Paris. But the repair will require a considerable amount of cutting and rewelding of seams under strict measures of quality control.

Ironically, operating experience at the Phenix had shown that the pump body would have been a more than sufficient shield by itself, and so the troublesome extra shield was not needed in the first place. It was not included in the design of the larger, 1200-megawatt breeder Superphenix that the French, Italians, and West Germans plan to build at Creys-Malville near Geneva, and it now will probably be removed from the Phenix as well, according to Vautrey. "There was absolutely no concern with the reactor or with the intermediate heat exchanger itself," said Vautrey. "We are just now beginning to repair it, but perhaps by late spring the plant could be back in operation" with two heat exchangers he said. After the plant is restarted, the remaining two heat exchangers will be fixed one at a time until the design defect is corrected in all units.

In other respects, the French breeder continues to function well. The fuel has exceeded the performance it was designed for by more than 30 percent with only one failure among more than 20,000 fuel pins. The steam generators, after some small problems with erosion at an inlet manifold, are also performing well.

The recent problem is no doubt an embarrassment to the French program, but American engineers agree with the French that it does not indicate a serious flaw. Some opponents of the breeder have hoped that it would prove too difficult to implement in a commercial power station. But the French experience indicates that the wisdom of the breeder must be argued over greater issues that its technical workability.

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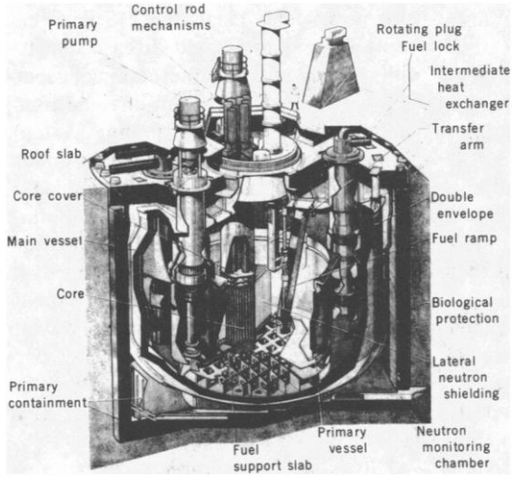

Fig. 1. The design of the French 250-megawatt fast breeder reactor. Two of the three intermediate heat exchangers have been removed for repairs.