Nuclear Power and Nonproliferation

The term "fuel cycle" refers to the flow-chart we've all seen of the path that nuclear fuels follow through various facilities. For policy purposes, the fuel cycle can usefully be divided in two ways: the front vs. back end, and domestic vs. international.

Front end refers to what happens to uranium before it is placed in a reactor: the mining, milling, chemical conversion, and enrichment of uranium and its fabrication into fuel elements. Here there are no major policy problems or disagreements; worldwide, the supply of uranium and enrichment services exceeds demand, and the prices for both are much lower than was projected 20 years ago. In the United States, the most significant events are the decision to buy 500 tons of Russian highly-enriched uranium derived from dismantled Russian nuclear weapons over 20 years, and the privatization of DOE's enrichment services and the anti-dumping agreement with Russia that greatly complicated the HEU purchase. To put the HEU purchase in perspective, 500 tons of HEU could supply about one-quarter of the fuel required by all U.S. reactors over this time period.

The major disagreements revolve around the back end of the fuel cycle, or what happens to the fuel after it is discharged from the reactor. Nuclear engineers had long planned to close the fuel by reprocessing the spent fuel to separate the fission-product wastes from the valuable uranium and plutonium, which could then be recycled as fuel. In the late 1970s, however, the Carter administration decided that reprocessing and the use of plutonium presented unacceptable proliferation risks, particularly in developing countries. Bulk-handling facilities are very difficult to safeguard to ensure that divisions would be detected, and shipments of plutonium fuel could be subject to theft. Instead of a closed fuel cycle, the U.S. adopted a "once-through" cycle, in which the spent fuel discharged from a reactor is placed in a geologic depository without further processing. Carter decided to abandon civil reprocessing mostly to set a good example for other countries, and set about trying to convince its allies—particularly the major west European countries and Japan—to do the same, an effort our allies deeply resented and ultimately rejected.

The Reagan administration tried to reverse the Carter policies, but there was no strong domestic interest in reprocessing. It was then apparent that the nuclear industry would not grow nearly as fast as had been projected, and that the lower-than-expected demand for uranium would keep prices well below the level needed to justify reprocessing. Today, the economics are reprocessing and plutonium recycle are extremely unfavorable, costing perhaps five times as much as the once-through cycle.

Our European and Japanese allies, however, have stubbornly stuck with reprocessing, despite any economic or technical rationale for doing so. Government technocrats who believed in the closed fuel cycle were largely responsible for rigging the system with laws, regulations, and subsidies so that market forces could not operate. The Reagan administration removed barriers to large-scale reprocessing of Japanese fuel by waiving its right to approve the processing of U.S. origin fuels. The United Kingdom and France have made a lot of money of reprocessing Japanese spent fuel and storing the plutonium and radioactive wastes, which ultimately are to be returned to Japan. Although official Japanese plans indicate that all this plutonium will be recycled by a growing nuclear industry, reality lags behind the plans, and China has expressed concern that Japan should be accumulated so much unneeded plutonium. Although some industry analysts admit that reprocessing and recycle is uneconomic, they defend it as a waste-management technique that burns hazardous plutonium rather than burying it—a claim which has no technical merit. Perhaps most maddening, many European and Japanese nuclear officials continue to claim in public that plutonium derived from reactor fuel is extremely difficult or impossible to use in bombs—a claim that the U.S. government and nuclear weapon designers have often refuted. In fact, if reactor-grade plutonium had been used in Fat Man—the bomb dropped on Nagasaki—the yield would have been about 1 kiloton rather than 12 kilotons. More advanced designs could use reactor-grade plutonium with little degradation in yield.

When the Clinton administration came to office in 1993, the European and Japanese nuclear industries were afraid that there might be a repeat of the Carter administration's efforts to curtail foreign reprocessing. The British were especially apprehensive, since the costly Thorp reprocessing plant was about to be licensed. The administration decided to try to walk a fine line by opposing reprocessing as uneconomic and presenting proliferation risks, but deciding not to interfere in the fuel cycle decisions of countries with established reprocessing and recycle programs and comprehensive nonproliferation commitments. The administration also began to renegotiate its nuclear cooperation agreement with Euratom, proposing, as in the case of Japan, to waive its right to approve or disapprove of the reprocessing of U.S.-origin spent fuel. This discriminatory policy is working so far, but probably is not tenable over the long term; Korea, for example, resents the fact that it is not permitted to reprocess, while Japan is.

If the global nuclear industry continues to grow, uranium prices eventually will reach levels that would make reprocessing and plutonium recycle economically competitive with a once-through fuel cycle. This point is very far in the future,

however—at least 50 years, and probably 100 years. There is no need to build and operate facilities today to hedge against the distant possibility of expensive uranium. In fact, before turning to reprocessing and breeder reactors, it would be more economic to use reactors that burn much of the plutonium and uranium in-situ.