lish a base for epidemiological analysis." The printed version of the statement omits the adverb "strongly" and the reference to establishing an epidemiological base. The NIH guidelines say that the principal investigator is responsible for determining whether serological monitoring is appropriate, and make no provision for establishing the epidemiological base whereby the efficacy of the proposed containment measures could be established one way or the other.

A point that semantic quibblers and possibly others might raise concerns the definition upon which the NIH guidelines are based. The aspect on which the whole concern about recombinant DNA has been focused is that of joining the DNA from different organisms to create recombinants that may not have occurred before in nature. Such molecules have been called chimeras, after the mythological beast that was part lion, part goat, and part snake. The definition in the NIH guidelines is innocent of reference to this central issue. Instead, it defines recombinant DNA's by their mode of manufacture: as "molecules that consist of different segments of DNA which have been joined together in cell-free systems, and which have the capacity to replicate in some host cell. . . ." There is, perhaps, something intellectually unsatisfying in a definition that describes an object by the way it is made rather than by its essential properties.

The question of public participation in the guidelines is a matter of some relevance. The minutes of the NIH recombinant DNA committee record that at its first meeting, on 28 February 1975, the committee "specifically recommended that one lay representative be appointed." The recommendation was reaffirmed in May. Two new members joined the committee shortly thereafter, but both were scientists. Not until December was a lay member produced, and in public sessions, at least, he has contributed little. Representatives of public interest groups were invited to the hearing convened by Fredrickson in February. Some attended, but the serious criticisms of the guidelines continued to come from scientists rather than the lay public. The guidelines have not been significantly changed as a result of the February hearing, so that the public's effective input into the decision-making process cannot be described as substantial.

Public participation or not, the important fact is probably the guideline's relation to the Asilomar agreement. The Asilomar conference has been widely extolled as a responsible and disinterested act of self-regulation by the scientific community. It was also a hard act to follow, but the NIH guidelines will probably be judged to have succeeded in doing so, in as far as they stipulate safety precautions that are at least as strict as those envisaged at Asilomar.

Yet the immediate purpose of the NIH guidelines, to allow research to proceed under appropriate safeguards, is transcended by their probable historical role, that they sanction the use of a powerful heuristic technique likely to engender a quite new technology as well as a cornucopia of new knowledge. Even the nuclear era, despite the magnitude of its attendant benefits and risks, can be seen as just a continuation of man's development of his physical powers over nature. In making possible the creation of new forms of life, a prerogative hitherto reserved for evolution, the recombinant DNA technique may open the door to a technology of a different order. Considered in this context, the process being initiated may be one that is easiest to control at its outset and progressively harder thereafter. Nevertheless, the NIH guidelines probably represent as circumspect a beginning as could be hoped for.

—NICHOLAS WADE

Nuclear Proliferation (II): Will Fallout Kill Domestic Recycle?

The nuclear power referendum in California has come and gone, leaving in its wake some new legislation and a heightened sensitivity to nuclear issues. A little-noted aspect of that California legislation, however, is the requirement that commercial facilities to reprocess spent nuclear fuel be available before more power plants are built. Ironically, reprocessing to separate plutonium from the spent fuel and recycling that plutonium as fresh reactor fuel is emerging as the next major battleground in the war over nuclear power.

Opposition to domestic plutonium recycle has been led by environmentalists concerned about safety, environmental contamination, and nuclear terrorism. Now, it appears, arms control analysts concerned with nuclear proliferation and the international implications of domestic reprocessing of nuclear fuel are entering the fray, and there are signs that environmentalists are also beginning to raise this issue. Both groups are preparing to argue, in effect, that proceeding with domestic plutonium recycle will make it difficult, if not impossible, to persuade other, especially developing countries to forgo this step. Before proceeding, they contend, the United States should weigh the consequences of seeming to endorse a technology, the possession of which offers few if any economic benefits but lowers the price of entry into the nuclear weapons club.

The Ford Administration is coming under increasing pressure to adopt an uncompromising policy of opposing the spread of reprocessing technology abroad, but it has so far hesitated to do so. One source of this reluctance is almost certainly the awkwardness that would then attach to a decision in favor of reprocessing and plutonium recycle at home—to which both the government and the nuclear industry are at least officially committed. But the growing vigor of the debate over nuclear proliferation and the role of reprocessed plutonium (*Science*, 9 July, p. 126) is making it increasingly uncertain whether that commitment can be maintained.

The emerging concerns of the environmentalists and arms control analysts will find a forum in hearings scheduled later this year on the final environmental impact statement for domestic plutonium recycle, now in preparation by the Nuclear Regulatory Commission (NRC). The Commission is then scheduled to take up the question of licensing plutonium recycle sometime in 1977. Just how the decision will go and whether the licensing action will be superseded by a policy decision at a higher level of government is uncertain. But there are grounds for speculating that the nuclear proliferation issue and the incipient alliance of environmentalists and arms control analysts

may prove to be a winning combination.

The combination is certainly an unlikely one. The environmentalists tend to be young, activist in style, and antiestablishment in outlook. Their opposition extends beyond the nuclear fuel cycle to nuclear power itself and is rooted in what they see as ethical reasons. The arms control analysts, on the other hand, are for the most part of an older generation and their style runs more to analytical reports and consultative relationships than lawsuits. Many do not oppose nuclear power itself; rather they are concerned about "managing" its growth by restricting the spread of the nuclear fuel technologies and plutonium recycle.

Ironically, the course of events has already led to environmentalists filing a lawsuit over plutonium recycle in which one of the defendants, as a member of the NRC, is Victor Gilinsky. Gilinsky, however, is a former arms control analyst and, to judge from his recent testimony before Congress and his dissenting opinion from the NRC majority on nuclear proliferation matters, holds views on the dangers of plutonium recycle not unlike those of many environmentalists. The incident illustrates the differing approaches—working from within versus confrontation from without—of the two groups.

Ruling Has Symbolic Importance

The lawsuit in question arose over the issue of interim licenses for plutonium recycle before the final decision on widescale use. On 26 May 1976, the U.S. Court of Appeals in New York ruled that such interim licenses are not permitted by the National Environmental Protection Act. The practical effect of the ruling may well have been nil, since all commercial attempts to proceed with plutonium recycle appear to have been at least temporarily abandoned because of technical or economic problems, but it had considerable symbolic importance as the final loophole for the nuclear industry. Indeed, environmentalists claim with considerable justification and some bitterness that, but for their vigilance and opposition, plutonium recycle in the United States might well by now have been a fait accompli. The landmarks include a 1973 suit that halted the first commercial attempt to use mixed-oxide fuel—so-called because it contains recycled plutonium oxide as well as uranium oxide—in the Big Rock Point nuclear power station in Michigan, and a later commitment extracted from the Atomic Energy Commission staff not to proceed with interim licenses except those already in process.

Had these lawsuits not been filed and won, environmental attorneys point out, there might by this time have been several reactors with full loads of plutonium, several reprocessing plants under construction, and the momentum toward a "plutonium economy" might have seemed nearly unstoppable. As it was, says J. Gustave Speth of the Natural Resources Defense Council, a principal in much of the legal action, the matter came "dangerously close" to being a foregone conclusion.

To the environmental challenge must now be added the growing number of arms control analysts who oppose going ahead with domestic plutonium recycle because of its impact on the spread of reprocessing technology abroad. Although not all analysts see a close connection, many do. Albert Wohlstetter of the University of Chicago, for example, says, "We should not license domestic reprocessing now and we need make no decision on it for 10 years." Wohlstetter, often a lone wolf among the arms control crowd, seems to have plenty of company on this issue. George Questor of Cornell also favors a "no-go" decision for the time being, although he believes it would be advantageous for our relationships with other countries to deemphasize proliferation as a stated reason. George Rathjens of the Massachusetts Institute of Technology believes that a U.S. decision to forgo recycling would convey two important messages to the rest of the world: that the economic arguments for recycling plutonium are not persuasive (he believes they are not); and that storing nuclear wastes in the form of spent fuel, without reprocessing, is an acceptable temporary solution to this problem. (The *present* U.S. program on nuclear wastes, in contrast, assumes that reprocessing will occur and is directed toward finding permanent storage for the residual wastes as soon as possible.)

Although a few members of the arms control community, such as Wohlstetter, have been concerned with the spread of nuclear power technology for a long time, most have adopted the nuclear proliferation issue only within the last year and a half. A summer study held in Aspen, Colorado, in 1975 is cited by some as a turning point away from the earlier predominant focus on the U.S.-Soviet strategic balance. The growing availability of contract money for studies of nuclear proliferation—from the Arms Control Agency, the Ford Foundation's nuclear power project, and others—has also clearly been a factor in the enthusiasm. Many of these studies, some of which are still in progress, focus attention on the economic and technical problems associated with reprocessing and plutonium recycle both in this country and in the context of the multinational nuclear centers proposed by Secretary of State Kissinger last year.

The concept of multinational reprocessing illustrates the degree to which positions on nuclear proliferation are still in flux. A recent letter from Speth to the NRC urging that it consider the international implications of licensing plutonium recycle, which the Commission has not yet agreed are germane to its decision, cites the development of a worldwide plutonium economy as perhaps "the single most important result" of deciding to go ahead. The letter goes on, however, to state that it is imperative to consider fully the alternative of multinational reprocessing and not to preclude this option by unilaterally launching a domestic industry. At the same time, however, arms control analysts appear to be coming to a consensus that the multinational reprocessing idea should be quietly buried as unworkable and more likely to spread the disease than to cure it. That at least seems to be the result of a recent conference on the topic held in Wisconsin under Pugwash auspices with support from the Johnson Foundation.

The debate over nuclear proliferation seems unlikely to make life easier for proponents of plutonium recycle in government and industry. Indeed, some observers believe that were it not for the nuclear industry's embattled mentality, it might well hesitate to embrace the technology. "Why take on proliferation, the worst environmental problems associated with nuclear power, and the only real terrorist problem, just to lose money?" as one analyst who doubts the industry's claims of economic feasibility put it. There is in fact some evidence of second thoughts in industry. Allied-General Nuclear Services has proposed converting its half-finished reprocessing plant in Barnwell, South Carolina, planned as the first large commercial processing venture, to a demonstration facility—in effect, asking for federal aid to complete it.

If the environmentalists and arms control analysts now marshaling their arguments against plutonium recycle have their way, neither the aid nor a domestic reprocessing industry will be forthcoming anytime soon. At the very least, these unusual allies seem likely to effectively link the domestic and international debate over the use of plutonium in the nuclear fuel cycle.

—ALLEN L. HAMMOND