

NUCLEAR NONPROLIFERATION: THE SPENT FUEL PROBLEM. Edited by Frederick C. Williams and David A. Deese. New York: Pergamon Press. 1979. Pp. xi, 221. \$30.00.

Complex problems are never easy to solve, and when the benefits and risks are as great as they are with respect to the problem of nuclear energy, the usual differences of opinion tend to magnify into full-fledged controversy. The controversies surrounding nuclear energy include debate over the desirability of having any nuclear program at all, as well as how nuclear programs, if they are going to exist, should be regulated and managed. Most prominent among the managerial aspects of the debate is the issue of "spent fuel"—how to store and eventually dispose of the radioactive waste products generated by the nuclear process.

During the normal commercial operation of a nuclear power reactor, fuel rods containing a mixture of two isotopes of uranium (U-238 and U-235) are gradually exhausted in a process that yields significant quantities of plutonium, another radioactive element. These spent fuel rods generated in the reactor's fission process pose two very serious dangers. First, the spent fuel is radioactive enough to cause potential harm to human health for thousands of years into the future. Second, the plutonium present in this waste material can be reprocessed and used to manufacture atomic weapons. Decisions have to be made concerning how to dispose of this radioactive material; how to store it in the meantime; whether reprocessing is worthwhile, and if so, when; and how to impede the utilization of the plutonium for military purposes.

So far, each nation that produces nuclear fuel has dealt with the spent fuel problem on an individual basis, using some form of temporary storage or reprocessing or both. But *NUCLEAR NONPROLIFERATION: THE SPENT FUEL PROBLEM*, a collection of essays by experts on nuclear energy and policies, explores a different approach: spent fuel management at the multi-national and international level. This series of eleven papers, written as part of a study conducted under the aegis of the Center for Science and International Affairs at Harvard University, examines the technical, economic, political and legal aspects of waste storage and disposal on a

multi-nation basis. It focuses, in particular, on regional means of attacking the problem.

The opening chapter, prepared by the editors, seeks to construct a general framework for evaluating the effectiveness of present and future plans for evaluating waste management. Dr. Williams, an attorney with U.S. Arms Control and Disarmament Agency, and Dr. Deese, a research fellow at the Center for Science and International Affairs (and author of the recently published *Nuclear Power and Radioactive Waste*¹), highlight four principal issues that generally arise in determining feasibility of spent fuel programs: (1) economic feasibility; (2) the availability of storage facilities to accomplish the objectives of the proposed plan; (3) whether proliferation of nuclear arms would be retarded; and (4) whether arrangements for final disposition of spent fuel are clearly established beforehand.

Using this framework as a springboard, Williams and Deese then set forth their proposal for an international spent fuel management program. It essentially calls for the use of regional storage centers that would house spent fuel generated by many nations. The operation and regulation of this system would be the responsibility of an international commission. The authors premise their proposal on the belief that individual nations have been unable to solve their own disposal problems, and they conclude that international cooperation can achieve that which nations cannot in their individual capacities.

The premise is clearly correct, but the conclusion may not be. Their idea for internationally-managed storage facilities simply does not seem to be politically acceptable. While the chapter details at length how the system would be arranged geographically, i.e., which nations would participate and where the storage center would be located, it is much less explicit on just how the general consensus vital to this type of operation can be achieved. Indeed, the lack of success of prior attempts at international economic cooperation along the lines proposed by Williams and Deese suggest that any such effort directed at spent fuel management may be ill-fated from the start. The authors themselves cite the failings of two similar organizations, INTELSAT and Eurochemic—the former designed to regulate international satellite communications and the

1. DAVID A. DEESE, *NUCLEAR POWER AND RADIOACTIVE WASTE* (1978).

latter developed as a regional commercial nuclear fuel reprocessor—and make no attempt to show why their proposal would avoid those failings.

Still, apart from the questionable prospects for the type of joint program envisioned here based on past track records, the authors somehow manage *not* to confront directly the most difficult obstacles facing implementation. For example, will countries want to host the spent fuel facilities? *Of course*, say Deese and Williams: “Countries may vie for the prestige of hosting a sophisticated international facility.” (pp. 25-26.)

But will they? In the United States, the public is reasonably well-informed and generally well-adapted to modern technology, yet there has been strong local protest against the construction of waste facilities. True enough, in many third-world countries the public is largely unaware of the dangers involved, and this ignorance may pave the way for some storage centers at least on a temporary basis. Yet it seems more likely that the spent nuclear fuel (whether or not it is perceived as life-threatening) will be perceived as *trash*, and therefore just another example of the way in which developed nations continue to “dump” all their problems on often unsuspecting undeveloped countries.

The authors propose that the spent fuel storage facility should be located in a “stable” country. South Africa, for instance, would not be considered as a possible host. But almost anywhere the facility is located, there will be a risk of political upheaval. The apparent “stability” of a nation may in fact be nothing more than a thin coating of control over layers of unrest. Citing an example that may be by now trite as well as tragic, what if Iran had been selected? Under the Shah, Iran no doubt would have been considered stable enough to receive nuclear materials and technology. Yet within a period of months, a radical regime had taken power and wreaked havoc with sophisticated surveillance stations, not to mention diplomatic personnel; surely a spent fuel storage center would not have been immune. The delicate controls and safeguards that would be required to keep the radioactivity within the facility could easily be disturbed not only by sabotage or incompetence, but even by mere neglect.

But the even greater danger is that of nuclear proliferation. A typical commercial nuclear power reactor carries with it an inherent danger of such proliferation, because the spent fuel that results

from normal use contains a significant concentration of plutonium. Through reprocessing, this plutonium can serve as the critical ingredient of an atomic weapon. The fact that so many nations have used their commercial reactors as part of military programs underscores the potential for misuse. While the Nuclear Nonproliferation Treaty (NPT) has been signed by most, but not all, of the world's nations, the treaty has not been able to stymie all further proliferation since nuclear material is so readily available and secrecy of research so easily attainable.

The United States requires by law that supplies of uranium be cut off to any nation that is seeking to use the reactor for military purposes. But the Soviet Union has a much stricter and more effective policy, described in the essay, "Eastern Europe and the Soviet Union," by Melvyn Nathanson, of the University of Southern Illinois. The Soviet Union requires customers to return *all* spent fuel to the Soviet Union; in effect the fuel is *leased* to the client rather than sold. This strict policy greatly reduces both the danger of nuclear proliferation and the environmental issues which the client nation must face. So far, most Soviet nuclear sales have been within the East European bloc, making compliance with the Russian policy a foregone conclusion. But when Soviet nuclear projects are expanded in third-world nations, it is doubtful that this high level of compliance will persist.

Still, the Soviet approach has its obvious advantages. Could it be adopted by Western nations? The editors, commenting on Nathanson's essay, believe that it could not, for two reasons. First, there is already too large a supply of nuclear materials in circulation that have been sold outright. Second, previous exports of nuclear technology and the steady increase of West European and Japanese technological strength has generated a diversified nuclear export market which cannot easily be restricted.

Nonetheless, it would not be wise to rule out the Soviet method so quickly, unless one is supremely confident that the international spent fuel system idea will be workable. In order to induce the world's nations to put aside their disparate interests and to abide by a uniform nuclear policy, one would need either very strong incentives or very strong disincentives. Clearly, such constraints are best enforced by an organization with power. But it is difficult to imagine an international nuclear commission with the power to

compel nations to abide by policy decisions that may not be directly in their national interests.

Perhaps the most realistic plan would be for the world's suppliers of nuclear technology and the world's suppliers of uranium ore to agree to certain principles and regulations, and then specify these terms in their contracts with client states. These rules could be enforced by the power of the United States and the Soviet Union, who, obviously, would have to reach some accord. But an accord between the two superpowers would not be farfetched at all. The Soviet Union is sincerely concerned about the dangers of nuclear proliferation. Soviet "adventurism" may lead to the destabilization of third-world regimes, but when it comes to nuclear weapons, the Soviets are very much a conservative and status quo nation.

The problems inherent in the idea of a regional spent fuel storage facility are difficult and numerous. Part II of the book catalogs, on a region-by-region basis, these very problems. In "Indian Ocean Basin," Onkar Marwah, of Harvard University, contends that of the three major nations in the area—Iran, India and Pakistan—no one nation would be acceptable to each of the other two as a home for a spent fuel storage facility. Marwah suggests that only a small island site in the South Indian Ocean would be acceptable. Yet, such a remote facility would diverge dramatically from the Williams-Deese idea of a "sophisticated international facility" characterized by a level of technological development almost impossible to create in a nation with no nuclear power capability.

In "Latin America," Victoria Johnson and Carlos Astiz, professors at Northwestern University and the State University of New York at Albany, respectively, conclude that a spent fuel site in Latin America could succeed only if located in territory considered neutral by Brazil and Argentina. Those two nations are critical, according to the authors, because they are the countries of that region most capable of developing nuclear weapons if provided with the necessary plutonium. Also, not surprisingly, they are the only two Latin American countries that refused to sign a 1967 treaty that prohibited possession or production of nuclear weapons.

In "Asia and the Middle East," Richard Broinowski, of the Australian Department of Foreign Affairs, is pessimistic about the chances of any regional solutions to the problem. In the Far East,

Broinowski believes that Japan, by far the major source of nuclear waste in that region, would discourage a unified spent fuel storage program because of the advanced nature of its own reprocessing capacities; in the Middle East, the general political instability of the area apparently precludes any unified approach.

In Chapter 6, "Western Europe," Robert Gallucci, of the U.S. Department of State, finds that regional storage would not be politically practicable there either because the major West European commercial energy nations—Great Britain, France and West Germany—would be reluctant to jeopardize their successful status by subsidizing out-of-country storage for smaller nations.

The editors acknowledge the generally bleak outlook adopted by those authors reviewing the prospects for regional cooperation. Yet they seem unperturbed, insisting that a multinational solution is feasible. Still, after reading these various regional essays, the reader is left with the strong impression that for every hypothetical problem anticipated, there are sure to be several more difficulties encountered when efforts actually begin.

The book, in its later stages, shifts its focus to a discussion review of the technical, economic and political factors bearing on the feasibility of international spent fuel management. In Chapter 7, "Technical Consideration," Marvin Miller, of the Massachusetts Institute of Technology, describes the various modes of spent fuel storage, and the technology available for each. "At-reactor storage" involves the suspension of sealed containers of spent fuel under pools of water. The fuel can easily be removed or replaced. This same technique may be applied to central storage facilities, or "away-from-reactor pools." A less transitory mode is "retrievable surface storage in a passive dry mode," or "dry storage," which involves above-ground storage in carefully sealed but retrievable containers. And finally, permanent disposal involves the depositing of spent fuel in an irretrievable mode that will, theoretically, remain safe indefinitely.

Miller explains that existing technologies are adequate for interim storage of spent fuel, either at the reactor, or in away-from-reactor pools. The general consensus of opinion is that spent fuel can be stored in this way for at least twenty years. Miller, however, suggests that much longer storage may be possible, with forty years storage a reasonable expectation.

Efforts are under way to develop dry storage technology which would enable storage of spent fuel in a mode more readily accessible than permanent disposal, but still less transitory than at-reactor wet storage. Canadian researchers lead the field in dry storage advances, but the extension of current engineering knowledge is sufficient for most aspects of the technique. The conclusion that Miller seems to draw us to is that permanent solution to the waste disposal problem is not yet clear, but at the same time, we should at least realize that the temporary measures now in use are safer than generally imagined.

The following essay, "Economic Analysis," presents a convincing argument that the technical advantages of temporary spent fuel storage in regional facilities are complemented by some healthy economic advantages as well, particularly for nations with small nuclear programs. Centralized spent fuel storage fosters economies of scale that would not otherwise be available for storage in at-reactor basins. Still, in countries such as the United States, which have very large individual reactor operations, the advantages are less clear, since it is generally not difficult to build extra capacity for storage in at-reactor sites.

The final three papers address the political forces that work both to encourage and to discourage participation in a multi-nation storage operation. In "Incentives and Disincentives," by Daniel Poneman, of Oxford University, the author feels that definite incentives do exist for nations to participate, including assurances of future fuel supplies and avoidance of domestic political opposition to waste disposal. On the other hand, Poneman notes, participants will have to sacrifice their individual autonomy on the matter. In "Public Response to Nuclear Energy," Dorothy Zinerg, of Harvard University, finds a general skepticism among the public on the nuclear waste issue, and a need for scientists to join with politicians in order to dispel the public's cynicism. Finally, in "Impact of North-South Politics," a member of Pakistan's Ministry of Foreign Affairs comments on the difficulty in reaching a common solution because of the continuing conflicts between the nuclear "powerhouses" and the lesser developed nations who resent what they feel is discriminatory treatment on the part of the developed countries.

The sum total of this collection of essays appears to be this: if nuclear fuel cycle choices were made strictly on the basis of eco-

conomic and technical considerations, an international spent fuel storage facility would be sensible. But political considerations make it unlikely that such a facility will come into being unless some event or development stimulates a worldwide consensus greater than that which now exists. Unfortunately, this reader does not see any such development likely to occur in the near or even distant future. May time prove him wrong.

Bret Davis

WILDERNESS ECONOMICS AND POLICY. By Lloyd C. Irland. Lexington, Mass.: D.C. Heath & Co. 1979. Pp. xviii, 225. \$18.95.

*For we invade them impiously for gain;
We devastate them unreligiously,
And coldly ask their pottage, not their love.*

From *Blight* by Ralph Waldo Emerson

Like Emerson, many generations of Americans have turned to the wilderness for spiritual sustenance and have denounced those who perceive the land and woodlands merely as a source of commodities to be economically exploited. While Lloyd C. Irland, in *WILDERNESS ECONOMICS AND POLICY*, clearly sympathizes with Emerson's lament, he just as clearly prefers to view the wilderness through the eyes not of a poet but of a rational policy maker faced with major wilderness allocation decisions. Irland, a former professor at the Yale School of Forestry and Environmental Studies, and presently associated with the Maine Forest Service, surveys the major issues surrounding the future management of our forests and wildlands. In the process, he suggests some intriguing means of confronting these often difficult questions.

Irland's analysis takes nothing for granted. He begins by reviewing the variety of public policy objectives usually cited as justifications for wilderness preservation. He classifies those justifications into two broad categories: "utilitarian" and "non-utilitarian." The former category encompasses those scientific and economic benefits furthered by conservation. They include, for instance, the ability of research stations to operate without interference from other land uses, and the creation of mountain watersheds that can protect the quality of water supplies for both fishing and consumption purposes.

The non-utilitarian considerations, on the other hand, represent the more historical, cultural and ethical foundations in support of conservation. They reflect a growing aesthetic appreciation of our natural surroundings, a heightened concern for the preservation of endangered species and a more acute perception of man's often deleterious impact on his environment. Yet, Irland hints that a

general consensus on the true value of these non-utilitarian concerns may be impossible. Traditionally, there have been divergent views in America regarding the appeal of the wilderness. If James Fenimore Cooper represented the forest as full of charm and grandeur, a suitable refuge for virtuous white men like Hawkeye/Leatherstocking and noble Indians like Uncas, early settlers were often terrified by the unknown wilderness. As Irland remarks, "Attainment of an economic and geographic distance from wilderness by most citizens has no doubt facilitated the emergence of a more favorable aesthetic view of wildlands." (p. 4.) Indeed, Irland notes that today, "In a modern market economy, the social significance of land is no longer as the natural basis of community life: it simply is a source of crops and raw materials. The value of land is only instrumental—the discounted net return derived from using it to produce commodities. Intrinsic values are not prized." (p. 6.)

Still, he concludes that a mandate for preservation does exist based on a combination of the scientific, economic, cultural and ethical values. "The fact that only a minority of the population is currently aware of these values," Irland maintains, "makes them no less real." (pp. 12-13.)

But that mandate, he contends, has only been imperfectly fulfilled: "The great question of wilderness allocation will within a decade or two be settled—either by explicit decisions to reserve remaining lands or by the roadbuilders, miners and loggers." (pp. 181-82.) In fact, some explicit decisions have already been made in favor of preservation: the 1964 Wilderness Act, the 1968 Wild and Scenic Rivers Act, and the 1974 Eastern Wilderness Areas Act achieved immediate preservation of some areas and established procedures for setting aside more land in the future. In Irland's view, these three pieces of legislation have, "played a key role in America's progress toward fulfilling the mandate for preservation." (p. 42.) (A documentary appendix includes the text from each of these statutes.)

Yet, Irland is concerned primarily with how *future*, rather than past, decisions to preserve remaining lands should be made. His approach is a systematic one, heavily grounded in economic theory and analysis: "Economic reasoning, thoughtful assessment of goals and options, and carefully examined empirical data can illuminate the path of the ultimate actor facing a preservation decision." (p. 69.) The policy maker must first identify the major objectives

of preservation in each case and assess the various options for achieving those objectives. Then he should compare the economic costs of each option, including lost opportunities (such as foregone timber production), with the expected benefits of each. The costs and benefits should, so far as feasible, be expressed in dollar and cents terms. For example, monetary values per user-day can be assigned to various recreational uses.

This type of analysis apparently has already been used to some extent in previous allocation decisions. For example, Irland describes one study examining whether Hells Canyon, part of the Snake River along the Idaho-Oregon border, should be dammed. The study found the potential benefits, in terms of the power expected to be generated by the proposed dam, to be far exceeded by the quantifiable losses that would have arisen, including lost water recreation, visitor days and hunting fees. Congress subsequently established a wilderness and recreation area complex that halted any attempt to dam the river there, although Irland does not make it clear whether Congress was at all influenced by this study.

Irland readily concedes that it is futile to try to convert all costs and benefits into quantifiable terms: "At some point, the apples differ too much from the oranges for them to belong in the same grocery basket." (p. 62.) He contends, though, that comparisons between very different things are necessary and valuable as long as such comparisons are "recognized for what they are and not concealed by technical procedures, no matter how reasonable such procedures may seem to some." (p. 62.) Some benefits, such as opportunities for solitude, simply cannot be given a dollar value. Within limits, however, his approach appears to be helpful in assisting policy makers achieve rational decisions.

A consistent strain running through *WILDERNESS ECONOMICS AND POLICY* is the need to consider conflicting values that typically arise in the debate over preservation, and to adopt policies that can reconcile those seemingly incompatible considerations. This theme permeates Irland's evaluation of the potential effect of wilderness allocation decisions on related industries and local communities. In examining the impact of such decisions on United States timber supplies, for instance, he concludes that large allocations of woodland can be made without significantly affecting total supplies of wood products because: (1) more intensive wood growing is possi-

ble on the most productive land; (2) wood can be used more efficiently; and (3) much of the land that is potentially available for wilderness designation is already part of national forests that are not part of the commercial timber supply. According to Irland, intermediate land use—a compromise of sorts between wholesale preservation of wilderness areas, on the one hand, and full-scale use, on the other—is a possibility in some regions. By careful management of such designated intermediate areas, certain goals, such as wildlife protection and recreation, can be achieved even while timber production, albeit on a more limited basis, continues. The proposal of an intermediate category, based on the notion that the “alternative to full wilderness designation need not be hydro dams, pine plantations, and copper mines,” is one that Irland offers in a number of contexts besides timber production.

Irland's sensitivity to contrasting societal concerns affected by preservation decisions is most striking in his discussion of the impact of such decisions on local economies: “One of the major challenges of land-use policy in the future will be to provide for preservation of viable rural community economies based on wildland, while protecting environmentally significant resources.” (p. 130.) He warns that when land is withdrawn from full use, there often is an adverse effect on that area's economic well-being, as measured by the availability of jobs and the level of income of local residents. Of course, this impact will vary in each instance, depending upon the reliance of the individual communities on affected—primarily forest related—industries. A community may be hurt even further if development opportunities, such as a planned ski resort, have to be scrapped. Although not proposing that such considerations automatically be accorded priority, Irland feels they must be considered.

Irland identifies several means of alleviating the impact on local communities, including federal revenue sharing to replace some lost taxes and the creation of manpower development and training programs. During the expansion of the Redwood National Park in 1978, other mitigating measures, such as job preferences for workers laid off by affected companies as well as compensatory payments to local governments, were provided. Irland acknowledges that such measures can become political tools to buy local acquiescence to proposals for preservation, but he believes they more properly can place some of the costs of any local impact on those

who actually benefit from expansion of wildlands areas, the federal taxpayers.

Irland's analysis indicates that the advice and consent of local residents actively should be sought as part of the decision-making process. It is easier, perhaps, to dismiss local criticisms of preservation proposals as short-sighted and irresponsible than to incorporate such criticism into the policy-making process. Not only is Irland's approach less blatantly elitist but it is more likely to generate broad-based support for specific proposals and meet some of the criticisms coming from local groups.

Once an area is set aside as wilderness, a number of basic management and administrative decisions will remain to be made. At this stage, there are at least two concerns: (1) protecting the ecology of the area, and (2) enhancing the enjoyment of all wilderness users. To some extent, this requires limiting the impact of visitors. Irland, again relying on his economic model, suggests that this can be treated in "demand-supply" terms. On the supply side, use of less congested areas and lightly used non-wilderness should be encouraged. On the demand side, programs to restrict uses by barring camping in certain areas or to ration access by some kind of reservation system can be implemented.

Another complex issue is that of management of adjacent non-wilderness lands. The areas surrounding land designated as wilderness can significantly detract from or enhance a visitor's visual appreciation of the preserved sections. In addition, nearby conditions can adversely affect the physical environment of preserved land. Often, adjacent land is privately owned and thus out of the control of the agency responsible for administering the wilderness area. Irland suggests that lightly-used and carefully developed back-country (intermediate-use land) can be of some aid in this regard.

Americans inclined to be sympathetic to the concept of wilderness preservation will welcome most of Irland's ideas. Some may protest the application of economic analyses to issues for which costs and benefits cannot always be adequately expressed in monetary terms. However, since the results of this method of analysis, at least as used by Irland himself, demonstrate that broad preservation of wilderness areas is economically practicable, such protest should be muted. Irland's recommendations are more suggestions for *where* and *how* preservation decisions should be made

rather than *whether* broad areas should be preserved.

Irland's logical approach, and his concern for competing interests and values, is both refreshing and helpful. But while such analysis can be useful in deciding how to preserve, the underlying question of whether we *should* have a strong policy favoring preservation must be based on a choice between, rather than an accommodation of, competing values. He is acutely aware of the limitations of his mode of analysis: "Out of wilderness, Leopold says, man has hammered his civilization. In preserving wilderness, a civilization in turn expresses its values." (p. 188.)

Irland is obviously deeply concerned about his subject and he manages to convey this enthusiasm to his reader. He is not going to convert every reader into a life-time Sierra Club member—that is not his purpose. But for anyone who has an interest in preserving some areas of America in their natural state, his book has much to offer.

Arnold Rosenblatt