Nuclear Proliferation (I): Warnings from the Arms Control Community

Does the spread of nuclear power inevitably lead to the spread of nuclear weapons? This question has been worried over and debated since the early days of the atomic era. The current revival of interest dates from the Indian nuclear explosion of 18 May 1974, and the matter is rapidly becoming a focal point of concerns over U.S. energy policy, foreign policy, and national security. Nuclear proliferation has already surfaced as an issue in the presidential campaign, it is the subject of a growing number of legislative and regulatory actions (see box), and it seems certain to affect the course of the debate over the future of nuclear power in the United States.

A new element in this debate has been the emergence of the arms control community as a forceful advocate of much stricter controls over some aspects of nuclear power. A central theme in their arguments is that existing safeguards against the diversion of nuclear materials to military purposes by nations that are not members of the nuclear club are inadequate. In particular, they have directed attention to the threat posed by the spread of technologies associated with the nuclear fuel cycle.

This largely university-based group of analysts seems to have been rejuvenated by the rebirth of the nuclear proliferation issue. They have brought to it both a familiarity with its long history and a grasp of the strategic balances involved. Centered in Cambridge, Massachusetts, but with important branches elsewhere, the arms control group have not been shy about making use of their extensive contacts within the government, the press, and the foreign policy establishment to put forward their ideas in influential forums. They appear to be having an effect and, together with other critics of the nuclear fuel cycle, to be adding to the woes of the domestic nuclear industry (this will be the subject of a second article).

The fuel cycle technology that most concerns arms control analysts is reprocessing spent reactor fuel to recover the plutonium that nearly all commercial reactors produce. Once the plutonium, a fissionable material, is separated from the spent fuel, it can be used with nearly equal facility to refuel reactors (plutonium recycle) or to make nuclear weapons. Also important, however, are the techniques for enriching uranium in its fissionable isotope for use as reactor fuel, which can also be used to produce highly enriched uranium for bombs. The United States has long had an effective monopoly on the gaseous diffusion process for enriching uranium. This monopoly is now rapidly disappearing. European gaseous diffusion plants are under construction, and new centrifuge, nozzle, and laser enrichment techniques are being developed in several countries.

Sales of Reprocessing Plants

Chemical methods for recovering plutonium from spent fuel are still more readily available. At least eight countries have operated small-scale reprocessing facilities, although commercial plants have proved more difficult. Many additional nations are now showing interest in obtaining fuel reprocessing technology or in having their spent fuel reprocessed by others, despite the fact that separating and recycling plutonium as reactor fuel has not yet been shown to be economically attractive. France recently sold a reprocessing plant to Pakistan, and West Germany last year sold both reprocessing and enrichment plants to Brazil. In the latter case the fuel cycle technologies were "sweeteners" in a multibillion dollar reactor deal. A similar French sale to South Korea was canceled only after the United States used its considerable influence with the Park Chung Hee government. Iran, a nonsignatory of the Non-Proliferation Treaty, is also reported to be negotiating for a reprocessing plant.

Arms control specialists view these developments with alarm, believing that enrichment and reprocessing technologies are qualitatively different from nuclear power plants and that their spread threatens to accelerate the breakdown of the barriers to nuclear proliferation. Countries with access to reprocessing, for example, could accumulate large stockpiles of plutonium, nominally for peaceful purposes, but in a form readily adaptable for use in nuclear weapons. Such stockpiles, they charge, will render existing international safeguards irrelevant. These safeguards consist essentially of agreements between supplier countries and their clients, backed up in some but often not the most crucial cases by the Non-Proliferation Treaty, and an accounting system for nuclear materials operated by the International Atomic Energy Agency (IAEA), which in recent years has come under increasing criticism. Nonetheless, these safeguards are often cited by the nuclear industry and the governments of nuclear exporting nations as ensuring that their activities are not contributing to proliferation.

A particularly provocative analysis of these dangers is contained in a recent and lengthy report* to the Arms Control and Disarmament Agency. The principal author of the study is Albert Wohlstetter of the University of Chicago, a veteran analyst whose involvement in arms control issues spans several decades. The report asserts that many countries will legitimately come very close to making nuclear weapons. A country with access to plutonium from nuclear power could, for example, build and test the nonnuclear parts of a bomb and hold it in readiness. In the event of war or other threatening circumstances, such as internal upheaval, stockpiled plutonium could be tapped and a weapon completed within a very short time—a week or less, according to Wohlstetter. Until the decision to complete the weapon, however, the country would have conformed to the letter, if not the spirit, of its agreements with the United States or other supplier countries and the terms of the Non-Proliferation Treaty.

Thus Wohlstetter and his colleagues see developing a "Damoclean overhang" of countries increasingly near the edge of making bombs. The extent of the overhang can be judged, they say, from the fact that by 1985 nearly 40 countries will have enough plutonium in their spent reactor fuel to make at least a few bombs. Nearly half of these countries plan to build fuel reprocessing plants by 1985. When and if plutonium recycle becomes common, still more countries will have access to large quantities of plutonium in the form of shipments of fresh mixed-oxide fuel (plutonium and uranium) for their reactors. Still others will have access to plutonium from research reactors, such as the Candu reactor from which India obtained its weapons material, or from nuclear experiments aimed at the development of breeder reactors.

* A. Wohlstetter *et al.*, *Moving Toward Life in a Nuclear Armed Crowd?*, prepared by Pan Heuristics Division of Science Applications, Inc., 1801 Avenue of the Stars, Los Angeles, Calif., for the U.S. Arms Control and Disarmament Agency (ACDA/PAB-263, June 1976).

Existing safeguards will not prevent and may actually obscure this process, the analysts point out. The safeguard concept has traditionally meant provision of a warning that a country is moving toward nuclear weapons early enough to allow countermeasures to be taken. In the absence of a ready source of fissionable material, it would take most countries a year or more to build reprocessing facilities, giving time for a warning. But once a stockpile has been built up of plutonium metal, or even plutonium nitrate or oxide (the forms most commonly involved in the nuclear power fuel cycle), the critical time shrinks so dramatically that the IAEA accounting system could no longer provide any warning of diversion to military use. In fact, because the IAEA does not disclose actual quantities of nuclear ma-

Tracking the Action on Nuclear Proliferation

Concern about nuclear proliferation as a consequence of reprocessing fuel from nuclear reactors is beginning to make itself felt in a growing number of political, legislative, and regulatory forums. These have in recent weeks included:

• Jimmy Carter's speech at the United Nations on 13 May 1976. In injecting the nuclear proliferation issue into the presidential campaign, he called for a moratorium on the sale or purchase of nuclear fuel enrichment and reprocessing technology. Carter seemed to be staking out a more activist position in opposing such sales than that pursued by the Ford Administration. He also raised questions about the extent to which the United States should rely on nuclear power to meet its energy needs. Carter consulted several members of the Cambridge arms control community—Abram Chayes, Albert Carnesale, and Paul Doty, all of Harvard—in drafting portions of his remarks concerned with nuclear proliferation. But, according to these advisers, he made his own judgments. Moreover Carter is reported to have chosen nuclear energy as the subject of his first detailed policy statement in part because he could claim some expertise as a former nuclear engineer in the Navy. Thus with Carter firmly identified with the nuclear proliferation issue, it seems likely to emerge again in the course of the fall campaign.

• An amendment to the foreign aid bill voted last month by the House-Senate Conference Committee. Attached to the bill by Senator Stuart Symington (D–Mo.), the amendment would cut off U.S. economic and military aid to any country that exports or imports nuclear fuel enrichment or reprocessing technology that is not subject to international controls. The amendment is sure to provoke a strong reaction from Pakistan and Brazil, which recently bought reprocessing equipment from France and West Germany, and it was strongly opposed by the Ford Administration. As finally worded, it contains provisions for the President to override its restrictions, by certifying that he has received "reliable assurances" that the offending country will not acquire nuclear weapons.

• Pending legislation that bears on nuclear proliferation now runs to more than a dozen bills. Of these, one of the strongest being given serious consideration is an amendment to the Export Administration Act proposed by Representative Clement Zablocki (D–Wis.), chairman of the House International Relations subcommittee on security and scientific affairs, and cosponsored by Representatives Paul Findley (R–Ill.) and Pierre du Pont (R–Del.). The amendment would greatly tighten the restrictions on U.S. export of nuclear technology and fuels. In particular, it would effectively prohibit the United States from granting permission for reprocessing of nuclear fuel obtained from this country or used in a U.S.–supplied reactor. Under the agreements of cooperation signed by U.S. nuclear customers, such permission is necessary. The amendment, however, would require that it be conditional upon a determination that this country would have warning of any diversion of plutonium "not less than 90 days prior to the earliest date on which manufacture of a nuclear explosive device could be completed," a condition impossible to meet under the present safeguard system.

• A dissenting regulatory opinion in the Spanish reactor case. The Nuclear Regulatory Commission last week approved by 3 to 1 an export license for Spain's ninth reactor purchase from the United States. The dissenting opinion by Victor Gilinsky, the first in the NRC's short history, focused on his concerns about the adequacy of existing international safeguards against diversion of nuclear material to weapons. Spain has not signed the Non-Proliferation Treaty and has begun shipping spent fuel from other reactors to England for reprocessing—thus raising the question of possible military use of the recovered plutonium at some future time. The internal NRC debate—the opinion went through 11 drafts before it was released—arose from the fact that Spain is not required to use exclusively U.S.–supplied fuel in the new reactor, and other fuel (and any plutonium in it) would be subject not to U.S. controls but to those of the International Atomic Energy Agency, under present agreements.

Gilinsky did not oppose export of the reactor. But he wanted to require that it use only U.S.–supplied fuel, because he believes that present IAEA controls are inadequate to deal with plutonium and doubts that they can be made effective, for reasons similar to those cited by other arms control specialists. The commission majority, noting that the restriction would not apply to the other eight reactors already licensed, opposed it as impractical and unnecessary. Marcus Rowden, NRC chairman, told reporters that he agreed with Gilinsky that improved measures would have to be taken to safeguard plutonium, but that he believes the IAEA will be able evolve such measures.

The debate thus points to the lack of means to deal with the problem posed by reprocessing and confusion over whether the regulatory process, or some other mechanism of government, is the proper way to make such decisions. How independently of Administration policy, for example, can the NRC act? Rowden asserts that he would not hesitate to deny an export license against the advice of the State Department if he believed that it indeed would be "inimical to the common defense and security of the United States," the statutory basis. An export license to ship additional nuclear fuel to India's Tarapur reactor, now pending before the commission, may, in fact, become a test case.—A.L.H.

terials and their physical and chemical states, the present safeguard system may actually conceal the development of a stockpile of fissionable, weapons-grade material. This prospect in itself may dissolve what little support remains for the Non-Proliferation Treaty and prompt neighbors or opponents of countries† thought likely to be stockpiling to do likewise.

Contributing to the likelihood that this course of events will indeed occur is the ambivalence of U.S. policy with regard to the spread of reprocessing. The Ford Administration, for example, has refused to allow the sale of U.S. reprocessing equipment to such countries as Brazil, but did not firmly oppose the West German sale. Chancellor Schmidt, for example, is reported as saying shortly after the sale that he regretted criticism by U.S. politicians and journalists but that he "knows of no criticism by the U.S. government." Nor did the United States object during the 1960's when Japan and West Germany committed themselves to build reprocessing plants.

A recent U.S. proposal for the establishment of multinational nuclear centers that may include reprocessing and fuel fabrication facilities is also cited by arms control critics as an example of a commitment more to the rhetoric than the substance of preventing proliferation. Such centers, they point out, might simply legitimize the concept of reprocessing and would in any case make available to nonweapons states large quantities of plutonium in the form of fresh loads of mixed-oxide fuel.

Another incident that casts doubt on the strength of the U.S. commitment to preventing proliferation is the official reaction to India's nuclear explosion. Canada reacted sharply, cutting off all nuclear aid because the bomb's plutonium was produced in a Canadian-built reactor. The United States did not take similar action, despite the apparent use—according to information released by Senator Abraham Ribicoff (D–Conn.) and confirmed in its technical details by Canadian authorities—of U.S. heavy water in the reactor. (Spokesmen for the Energy Research and Development Administration have asserted that all U.S. heavy water leaked out of the reactor prior to the diversion of its plutonium, a proposition that many nuclear experts have laughed at.) Indeed, the State Department has recently recommended approval of a pending license to export additional shipments of reactor fuel to India. The lesson, for an attentive audience of other would-be nuclear powers, seems to be that international agreements can be flouted without fear of serious sanction by the United States.

The confusion over reprocessing appears to have begun much earlier, with the introduction of the artificial distinction between the peaceful atom and the military atom—a concept that is difficult to apply to plutonium. Yet the distinction appears in even the earliest post–World War II literature and was institutionalized in the 1950's Atoms for Peace program. Partly as a result, many U.S. nuclear scientists have always tended to regard reprocessing and plutonium recycle as intrinsic parts of civilian nuclear power. This tendency was undoubtedly reinforced by their familiarity with the process from the weapons program and the expectation that breeder reactors, for which reprocessing is essential, would soon be necessary. In any case, the assumption that plutonium recycle would be part of a mature nuclear industry—indeed that it was essential for the future of nuclear power—took root in both government and industry at an early stage of the nuclear program and has not been seriously questioned until recently. Technical details of several reprocessing techniques were made public at the first Atoms for Peace conference. In contrast, the United States has never released the technical details of the gaseous diffusion process for uranium enrichment.

A particular source of confusion concerns the suitability of plutonium from power reactors for making nuclear weapons. The March 1946 Acheson-Lilienthal report on the peaceful uses of nuclear power contained the concept of "denatured plutonium." Plutonium produced specially for weapons is nearly pure ^{239}Pu, but that from modern power reactors contains higher isotopes as well. These higher isotopes were thought by the authors of the 1946 report and others like it to render the material unfit for weapons because they increase the possibility of preignition of a bomb, thus reducing the size of an explosion enough to make it ineffective. This turns out to have been a false hope. Carson Mark, head of the theoretical division at the Los Alamos Scientific Laboratory for many years and one of the nation's most experienced weapons designers, is on record as saying that nuclear weapons can be made without insuperable difficulty from "essentially any grade of reactor-produced plutonium." ‡

Nonetheless, the myth of denaturing has persisted. Mark, in his 1971 comments on denaturing, felt it necessary to add that "these notions have been dangerously exaggerated." Wohlstetter, in recent testimony before the House Committee on International Relations, asserted that "the continuing (if often implicit) belief in denaturing has served to rationalize much of the carelessness about the readily fissionable material that would be generated in great quantities if plutonium recycle were to become general."

Another source of confusion and of growing debate is the economics of reprocessing and recycling plutonium. Pakistan and Brazil have both defended their planned importation of reprocessing equipment as necessary for their economic development. But there appears to be reason to doubt these claims because of rapidly escalating costs for reprocessing. Estimates of these costs for large, automated commercial plants in the United States have increased from about $30 per kilogram a few years ago to $200 to $300 per kilogram by the 1980's, and none of these plants have operated successfully yet. Costs for smaller plants of the type contemplated in less developed countries are expected to be still higher, with the result that recycled plutonium is for some years to come likely to cost these countries much more than an equivalent amount of enriched uranium fuel, and at best will be marginally cheaper. Even so, plutonium recycle can have only a minor impact on the cost of nuclear power, since fuel cycle costs constitute only about 10 percent of the costs of delivered electricity. And the use of plutonium fuel will reduce uranium needs by only 5 to 20 percent, depending on the rate of growth of nuclear capacity. Still further doubt as to the economic motivation for Pakistan's reprocessing plant arises from reports that it is to be nearly ten times larger than needed for that state's planned nuclear capacity. In many instances, in fact, nuclear power plants themselves would apparently not be economic in developing countries were it not for large subsidies, in the form of low-interest loans, from the exporting countries.

There appears to be considerable agreement in Congress and in the Administration that some of the warnings raised

† Wohlstetter and his colleagues point out that it is the smaller and less developed countries of the world that now seem most likely to follow the "peaceful nuclear power" route to nuclear weapons—not, as once expected, the major industrial powers. Their list of prime proliferation candidates, which they characterize as mostly either nonaligned by choice or isolated by fading alliances, includes South Korea, Taiwan, Pakistan, Iran, Brazil, Argentina, Spain, South Africa, and possibly Yugoslavia.

‡ B. T. Feld, T. Greenwood, G. W. Rathjens, S. Weinberg, Eds., *Impact of New Technologies in the Arms Race* (MIT Press, Cambridge, Mass., 1971), pp. 137–138.

by arms control advocates are valid. What to do about it is another matter. Even within the arms control community there are some analysts who argue that it is too late to do anything and others who believe that not too many countries will decide to build bombs anyway, regardless of their opportunities. But the debate is far from over and the political action is just beginning. Nonetheless, there seems to be considerable merit in the view advanced by many arms control analysts and articulated by Victor Gilinsky, a physicist and former analyst for the Rand Corporation who is now a member of the Nuclear Regulatory Commission, that "delay of plutonium separation is the only effective safeguard available at the moment." That is, if the spread of nuclear fuel technologies cannot be stopped or at least slowed significantly, then the path to nuclear power does appear to lead to proliferation.

—ALLEN L. HAMMOND

National Environmental Policy Act: Critics Say Promise Unfulfilled

Since the National Environmental Policy Act (NEPA) was passed 6½ years ago, it has become one of the best known of all federal laws. Thousands of "environmental impact statements," prepared pursuant to NEPA's now famous section 102, have been issued by federal agencies. And hundreds of lawsuits—a year ago the total stood at 654—have been brought, alleging violations of the act by the federal agencies responsible for building, financing, or permitting various kinds of projects, ranging from oil pipelines to dams and highways. Moreover, federal judges have ordered scores of such projects held up or stopped, although in all but a very few cases the injunctions have been lifted after the agencies involved have come back with acceptable "102 statements," which sometimes have run to thousands of pages.

In light of all the activity generated by NEPA, which attracted little notice or controversy during the period of legislative gestation that preceded its enactment, a careful evaluation of this surprising statute and its implementation obviously is in order. Over the past year, several such general evaluations have in fact been undertaken, chiefly by the Council on Environmental Quality (CEQ), by a House subcommittee on conservation and environment, and by a conference sponsored by the American Bar Association's Center for Administrative Justice and the Environmental Law Institute. The judgments have been quite mixed.

Nearly everyone agrees that NEPA has led to significant procedural reforms within the federal bureaucracy by forcing agencies to look at the environmental impact of their proposed actions and defend those actions in light of all reasonable alternatives. Furthermore, inasmuch as 102 statements are public documents and are subject to formal hearings, a vast amount of information is made public which otherwise would remain hidden in agency files.

Indeed, the Freedom of Information Act itself has not done as much as NEPA to make information publicly available in the important fields of environment protection and energy resource development. Also, if it were not for the 102 statements and their discussion of the alternatives to actions being proposed, there might be no systematic analysis of alternative "futures" whatever going on in Washington.

Indigestible Statements

But, at the same time the good news about NEPA is acknowledged, the bad news about this statute—or, more particularly, about its implementation—is also recognized. In particular, the hallmark of NEPA is the bloated and partly indigestible impact statement, from which the serious reviewer must try to dig out the relevant information from a mass of irrelevant material. Also, the analysis of alternatives is often weak and seems pro forma, indicating a failure to make the preparation of 102 statements an integral part of agency decision-making.

It is true, too, that 102 statements often do not contain the scientific information that is needed if the consequences of alternative courses of action are to be foreseen—a problem explored in some depth in a report issued last year by the Institute of Ecology. But the absence of good baseline information and the difficulty of predicting the behavior of complex ecological systems makes this failing readily explainable at least.

On 14 June, the CEQ issued a report on the first 6 years' experience with NEPA, and its conclusion was that NEPA is "working well." For instance, the report cites the findings by an interdepartmental task force that within the Department of the Interior—the agency responsible for energy resource development in the West, in Alaska, and offshore—there is "overwhelming support by nearly all bureaus for NEPA" and that the benefits of NEPA are seen to far outweigh any delays or other impacts on Interior programs.

The CEQ went to special pains in releasing the report to dispel any idea that NEPA is causing unwarranted delays in construction projects, and thus aggravating problems of unemployment and energy development. Russell W. Peterson, chairman of the council, commented that, while there were substantial problems of delay in the early years of NEPA, such problems are now diminishing as agencies improve their environmental expertise and prepare 102 statements earlier in their planning and decision-making process.

The CEQ, created under NEPA as part of the Executive Office of the President, might be suspected of self-serving motives in putting out such a report in an election year. But, actually, the report dwells at length on the need for Interior and other agencies to improve their analysis of environmental impacts and policy and program alternatives. "Agency leaders need a clearer understanding of the potential of the [102 statement] process as a management tool," the report said.

Along with holding oversight hearings on NEPA last year, Representative Robert L. Leggett (D–Calif.), chairman of the House subcommittee on conservation and environment, commissioned the Congressional Research Service of the Library of Congress to conduct a NEPA workshop. By and large the workshop participants—they included two former members of CEQ, several environmental lawyers, and some representatives of the growing body of "NEPA scholars" at the universities—agreed that NEPA's full promise will not be realized until the Ford Administration