Beyond the Traditional NPT/IAEA Framework

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The preceding chapters presented several options to bolster controls over nuclear weapon material production that can be implemented within the context of existing institutions and agreements. However, that discussion also noted that some issues simply cannot be addressed within the present regime. Put another way, even if safeguards worked perfectly in those states agreeing to them, there would still be issues of concern for nonproliferation. For example, although the Non-Proliferation Treaty is the world's most widely subscribed-to arms control agreement—with 178 members as of May 25, 1995 (see appendix B)—it does not have universal adherence. While only three holdouts—India, Pakistan, and Israel—are of any real proliferation concern, that concern is genuine, given that these states almost certainly possess nuclear weapons or the capability to make them on very short notice. Furthermore, while the Treaty prohibits the use of nuclear technology for weapon purposes, it also requires that states promote the transfer of peaceful applications of such technology. Under International Atomic Energy Agency full-scope safeguards agreements, NPT parties are also permitted to acquire and stockpile nuclear-weapon-usable material. Finally, even if the IAEA is able to detect violations of safeguards, it and the rest of the world community may be unable to compel compliance, especially within the time necessary to forestall serious consequences.

From the perspective of nuclear nonproliferation, the current regime to control nuclear weapon materials contains certain inherent contradictions and limitations. This chapter presents a number of distinct policy options that might be pursued to miti-

gate or eliminate some of these limitations.[1] The various options are not meant to comprise a mutually consistent package, nor does discussion by the Office of Technology Assessment necessarily imply its support or opposition to any of them.

AMENDING THE NON-PROLIFERATION TREATY

Despite the NPT's limitations, amending it is probably not a viable option for both procedural and political reasons. Procedurally, the amendment process specified by Article VIII of the NPT makes the Treaty extremely difficult to strengthen in any significant way. Each proposed amendment must be circulated by the Depository Governments (the United States, the United Kingdom, and Russia) to all NPT members, and at least one-third of the members (59 out of 177) must request a conference be convened to discuss the amendment. Before entering into force, the amendment must be approved and ratified by a majority of all parties to the Treaty (89 out of 177), including all the nuclear weapon states (now that all are parties to the NPT) as well as all NPT parties that are represented on the IAEA's Board of Governors at the time the amendment is circulated. Even then, an amendment only binds those states that approve it. Thus, it is possible through such amendments that different versions of the NPT could be in force at the same time. Moreover, some states not approving the amendment might use the opportunity to withdraw from the Treaty altogether.

Politically, the problems may be even worse. The NPT would never have been concluded if a number of compromises had not been struck. For example, non-nuclear-weapon states agree to forego nuclear weapons, and in return nuclear-weapon states agree to work toward nuclear disarmament. States agree to forego weapon applications of nuclear technology in return for access to its peaceful applications. Re-opening any of these debates—and possibly, re-opening any portion of the Treaty—could rend these compromises asunder. Not only might a proposed amendment fail to win widespread support, but a divisive debate could ensue that would seriously damage support for the rest of the Treaty as well. Many of these issues were raised at the Treaty's 25th anniversary review and extension conference in April and May 1995, but that conference only had the authority to decide on the Treaty's extension and was not empowered to amend it (see box 4-1).

In lieu of amending the NPT, other approaches might be considered that could be less contentious, easier to arrange, and ultimately just as effective politically, although perhaps not legally binding. Such alternatives could have included making statements in the final consensus document of the 1995 NPT extension conference, although in fact no such document was issued by the conference. They could also include adding protocols to the IAEA Statute; strengthening other institutions related to the nonproliferation regime, such as Nuclear Suppliers Group dual-use export controls; implementing G-7 policies on foreign aid and trade[2]; passing resolutions in the United Nations Security Council; or enacting new multilateral agreements such as a fissionable material production cutoff or a comprehensive test ban treaty. Negotiation of a complete alternative or successor to the NPT, however, would be a diffi-

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[1]For a discussion of nonproliferation policy options in areas other than control of nuclear materials or IAEA activities, see U.S. Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks*, OTA-ISC-559 (Washington, DC: U.S. Government Printing Office, August 1993). Specific nonproliferation policies are also discussed in two other publications from this OTA assessment: U.S. Congress, Office of Technology Assessment, *Export Controls and Nonproliferation Policy*, OTA-ISS-596 (Washington, DC: U.S. Government Printing Office, May 1994) and U.S. Congress, Office of Technology Assessment, *Proliferation and the Former Soviet Union*, OTA-ISC-605 (Washington, DC: U.S. Government Printing Office, September 1994).

[2]The G-7 countries are the major industrial economies of the world: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

BOX 4-1: The 1995 NPT Extension and Review Conference

Unlike other major arms control treaties, the Non-Proliferation Treaty did not have unlimited duration. At the time the Treaty was drafted in the late 1960s, it was not clear how successful the Treaty would be at simultaneously arresting the spread of nuclear weapons among nonweapon states, reversing the nuclear arms race among the weapon states, and fostering the spread of peaceful nuclear technology. Its negotiators did not want to assume that it would be desirable to maintain the situation that evolved under the NPT indefinitely. Therefore, Article X, paragraph 2 of the NPT states that:

> Twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional period or periods. This decision shall be taken by a majority of the Parties to the Treaty.

The conference specified in Article X, held in New York in April and May 1995, resulted in the indefinite extension of the NPT by consensus. This decision does not require ratification by the NPT parties, which in ratifying the original Treaty (including Article X) have already agreed to delegate to the extension conference the power to extend the Treaty. However, **the** extension conference **was not empowered to make any changes to the Treaty's text.** Revisiting any of the provisions of the NPT would require amending the Treaty, a complicated procedure that most experts believe to be virtually impossible in practice. (See discussion on "Amending the Non-Proliferation Treaty" in the main text.)

The United States and many other NPT parties strongly supported indefinite extension of the NPT, arguing that it is in every nation's interest to prevent the spread of nuclear weapons, and that the NPT represents the only international arms control agreement binding all the nuclear weapon states to make progress toward nuclear disarmament. However, these sentiments are by no means unanimous. Other nations came into the extension conference opposed to indefinite extension, at least in the absence of significant additional measures toward nuclear disarmament by the nuclear weapon states. In fact, some argued that the Non-Proliferation Treaty should be superseded by a "Nuclear Weapons Convention" that would ban nuclear weapons entirely, just as the Chemical and Biological Weapons Conventions ban all parties from maintaining those types of weapon. In addition, some states also argued that the industrialized NPT parties have not complied with their obligation to "participate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of atomic energy. "

Factors that were raised during the extension conference, many of which are beyond the scope of this study, include:

- the pace of superpower nuclear arms reductions, and progress toward a global comprehensive test-ban treaty[1] or fissionable material cutoff;
- U.S. or other nuclear-weapon state pledges of "no first-use" of nuclear weapons or other security guarantees made to non-nuclear-weapon states;
- the West's position on targeting NPT members such as Iran with export controls on nuclear-unique and nuclear-related technologies;
- progress in removing former Soviet nuclear weapons from Belarus, Ukraine, and Kazakhstan—all now non-nuclear-weapon state parties to the NPT—to Russia;
- the behavior of North Korea in resolving its conflicts with the NPT and IAEA over safeguards inspections and once-threatened Treaty withdrawal;

(continued)

[1]Although nuclear test bans by themselves cannot prevent proliferation of fission weapons and are therefore not essential *technical* ingredients to preventing proliferation, they have played an important political role in the proliferation debate, especially over the NPT extension in 1995, See U.S. Congress, Office of Technology Assessment, Technologies *Underlying Weapons of Mass Destruction,* OTA-BP-ISC-115 (Washington, DC: U.S. Government Printing Office, Decemeber 1993).

BOX 4-1 (Cont'd.): The 1995 NPT Extension and Review Conference

- the perceived effectiveness of the IAEA and the U.N. Special Commission for Iraq (UNSCOM) in enforcing the nonproliferation regime; and
- improved international relations, reducing the need for a nuclear deterrent.

The alternatives to indefinite extension, as specified in Article X, are extension "for an additional period or periods. " Extension for a fixed period would have terminated the NPT at the conclusion of that period, since the Treaty makes no provision for a future extension conference to extend the Treaty once its initial extension period has expired. By explicitly differentiating extension for additional *periods* (plural) from extension for an additional *period* (singular), the Treaty text does imply that the 1995 conference is empowered to do something other than either extend the Treaty for a single term or extend it indefinitely. One possibility in between those cases would have been to extend the Treaty for an indefinite series of fixed periods, each concluded by a conference that would determine whether the Treaty would continue through the following period.[2] This option was the principal alternative to the indefinite extension that was eventually adopted, but it was not supported by very many of the parties attending the conference.

Only a simple majority of the parties to the Treaty was needed to decide on the Treaty's extension. However, a close vote would have been undesirable since it would indicate that a substantial fraction of the Treaty's membership was opposed to extension on whatever terms had been adopted, undermining support for the Treaty. Therefore, it was important to the United States and other supporters of indefinite extension that the conference reach its final result by consensus. This consensus was made possible by creatively wording the extension resolution to read that "a majority exists among States party to the Treaty for its indefinite extension. "[3] In this way, even countries that would not have voted for indefinite extension could agree that a majority for indefinite extension existed, avoiding a recorded vote that would have been divisive to the nonproliferation regime.

[2]George Bunn, "Extending the Nonproliferation Treaty: Legal Questions Faced by the parties in 1995, " American Society Of International Law, Issue Papers on World Conferences, No. 2, October 1994.

[3]Draft extension resolution proposed by the NPT Conference President, "Extension of the Treaty on the Non-Proliferation of Nuclear Weapons, " NPT/CONF. 1995/L 6, 9 May 1995.

cult and contentious affair that would have to contend with all the political difficulties that make NPT amendment so difficult.

REINTERPRETING THE NON-PROLIFERATION TREATY

International law differs from domestic law in that under normal circumstances, there is no supranational governmental structure that can provide and enforce authoritative interpretations of a treaty's provisions. U.N.-affiliated agencies such as the IAEA can ask the International Court of Justice in the Hague for advisory opinions on treaty interpretation, but these have no binding authority.[3] The U.N. Security Council has the power to issue and enforce resolutions that are binding upon all U.N. member states, but it can do so only when acting to "maintain or restore international peace and security" under Chapter VII of the U.N. Charter. Otherwise, the Security Council does not have any binding authority to interpret treaties, although even a nonbinding resolution may carry significant weight. **In effect, therefore, a treaty**

[3]Many treaties—not including the NPT—specify that disputes between parties over treaty provisions are to be referred to the International Court of Justice.

means what its members agree that it means, providing at least the possibility that the members might collectively agree on a new interpretation of a treaty without formally amending it.

In practice, however, NPT reinterpretation may not be much easier to accomplish than a formal amendment. Should some member states disagree with the consensus arrived at by the others, those states may decide they are not bound by the reinterpretation. In case of dispute, treaty interpretation is based upon the treaty's negotiating record, upon presentations made to various legislatures when their consent to the treaty's ratification was sought, and upon the record the parties have accumulated in implementing the treaty—none of which will be very amenable to reinterpretation after the fact.[4]

Treaty reinterpretation may be contentious within governments as well as between them. In countries such as the United States and Russia that have legislatures that are independent of their executive branches, those legislatures may object to reinterpretations that are inconsistent with the record that was submitted by the executive branch when legislative consent to treaty ratification was granted.

However, if the Non-Proliferation Treaty were to be reinterpreted, an alternate reading of Article III could require the application of tighter safeguards to non-nuclear-weapon states, as suggested in the following two options.[5]

OPTION: *Combine INFCIRC/153 safeguards required of all non-nuclear-weapon NPT members with INFCIRC/66 safeguards that can provide greater coverage of selected plants, equipment, and facilities.*

OPTION: *Apply safeguards to materials other than fissionable or fissile materials that nevertheless have relevance for nuclear weapons, such as tritium, lithium-6, and beryllium.*

Article 111.1 of the NPT requires non-nuclear-weapon states to accept IAEA safeguards over "all source or special fissionable material [e.g., highly enriched uranium, plutonium, or the materials from which these materials are produced] in all peaceful nuclear activities" within its territory. No provision explicitly requires safeguards to be placed on facilities independent of the nuclear materials they may contain, nor over any other type of material relevant to nuclear weapon manufacture. Consequently, the IAEA's INFCIRC/153 safeguards, developed to implement the safeguards mandated by the NPT, center on nuclear materials. For any specific facility, INFCIRC/153 safeguards are not as stringent as the INFCIRC/66 safeguards that predated the NPT, which can cover plant and equipment independent of any nuclear materials they may contain, and can also encompass materials such as tritium, lithium-6, and beryllium that have relevance to nuclear weapons but are not considered "special nuclear materials."

An alternate interpretation of Article 111 of the NPT would place greater weight on the requirement that safeguards be applied "... for the exclusive purpose of verification of the fulfillment of [a non-nuclear-member state's] obligations . . . to preventing diversion of nuclear energy from peaceful uses to nuclear weapons ..." In this view, IAEA safeguards exist to prevent the manufacture of nuclear weapons, and they can justifiably cover a broader scope than just the nuclear materials that might be diverted to those weapons. **However, IAEA safeguards under the NPT have until**

[4]Treaty interpretation is addressed in the Vienna convention on the Law of Treaties, which is in force and reflects customary practice accepted by the United States, even though the United States has not ratified it. See discussion in footnote 19, p. 7 of George Bunn, "Extending the Non-Proliferation Treaty: Legal Questions Faced by the Parties in 1995," American Society of International Law, Issue Papers on World Conferences, No. 2, October 1994.

5 See, e.g., Leonard Weiss, "The NPT: Strengths and Gaps," published paper distributed by the Senate Governmental Affairs Committee, NOV. 18, 1994, p. 14.

now not been taken to be this encompassing, and it would be difficult to gain international consensus behind this new interpretation. Moreover, implementing such an interpretation would require renegotiation of every safeguards agreement between the IAEA and a non-nuclear-weapon NPT party.

PROBLEM NPT STATES

"Problem NPT states" are those states that are members of the NPT but have obstructed the implementation of safeguards**,** have shown clear signs of insincerity in fulfilling their nonproliferation commitments, or have pursued the development or acquisition of delivery vehicles for weapons of mass destruction. North Korea is a prime example. **The NPT, along with the IAEA as its verification instrument, is fundamentally limited in its ability to deal effectively with such states.** First, safeguards can only detect—and not prevent (except by deterring)—the diversion of nuclear materials to weapon use. In addition, safeguards cannot *prevent* NPT states from building clandestine facilities outside of safeguards (although doing so would be a violation of the safeguards agreement), nor do they *prohibit* any of the following activities:

- developing technologies related to non-nuclear components of nuclear weapons,[6]
- building reprocessing and enrichment facilities (thus providing a potential cover for weapon-related material-production capability),
- stockpiling direct-use weapon material (e.g., material containing plutonium or highly enriched uranium) from such facilities, and
- withdrawing from the treaty if the state determines it is in its vital interest to do so, while retaining facilities and materials that were acquired while under the treaty.

Through the pursuit of such activities, a state could position itself to manufacture nuclear weapons on relatively short notice. Therefore, the United States has judged that countries such as Iran, Iraq, and Libya should be discouraged from acquiring civil nuclear technology of any kind, whether or not full-scope safeguards are in place.[7] This position does not necessarily imply a lack of confidence in safeguards themselves, but rather in the commitment of these states to remain under them. **Even a perfect safeguards system—one that was certain to detect whether a state were pursuing a nuclear weapon program—cannot stop a country that wants nuclear weapons more than it fears disclosure.**

As a result, a former Department of Defense official offered the skeptical viewpoint that:

> ...[reprocessing and enrichment activities] bring nations so close to having a bomb—within days or weeks—that no amount of inspections provide enough warning to prevent it. To assure such warning we must limit the activities of inspected nations to those that are clearly 'safe,' that is, so distant from bomb making that inspections would afford years of warning.... We should use this occasion [North Korea's threat-

[6]Although technically not a safeguards violation, non-nuclear development that was weapon-related would probably violate the NPT's prohibition against "manufacture" of nuclear weapons. See footnote 9, and the related chapter text, for discussion of this point.

[7]Except in the case of a clear-cut safeguards violation or some other objective test, the IAEA is forbidden by its Statute from discriminating against member states. It therefore cannot withhold nuclear technology from—or refuse to apply safeguards in—certain NPT parties thought by some to be "problems." A policy that drew such distinctions among NPT states could appear to conflict with those provisions of the NPT that require the "fullest possible exchange" in the peaceful uses of nuclear technology. (See the section later in this chapter on implementing general embargoes of nuclear technology to problem NPT states.) Iraq is a special case, given that U.N. Security Council resolutions 687 and 707 prohibit Iraq from conducting nuclear activities "of any kind" (except for use of radioactive isotopes for medical, agricultural, or industrial purposes). These constraints go far beyond the NPT.

ened withdrawal from the NPT] to dispel our long-time fantasy that we can take assurances from secretive, militant nations like North Korea and safeguard dangerous activities merely by inspecting them.[8]

For clear historical reasons, the NPT does not prohibit these so-called dangerous activities. They were part of the bargain to induce states with nuclear power or research programs to accept inspections and other infringements on their sovereignty by the IAEA; **if they had been banned, there never would have been a Non-Proliferation Treaty. The NPT** does, however, require states to refrain from "manufacturing" nuclear weapons, which, under the so-called Foster interpretation, has come to mean engaging in any of the activities directly associated with developing, testing, or producing nuclear *or non-nuclear* components for nuclear weapons.[9] Since nuclear weapons ultimately require nuclear materials, any evidence of research or production efforts relating to nuclear weapons—including their non-nuclear components— would indicate the strong possibility that preparations are being made to produce, divert, or otherwise acquire nuclear materials for weapon purposes. Therefore, the IAEA's current position is that even though nuclear safeguards agreements with states deal specifically with nuclear materials, any evidence of a nuclear weapon program—even non-nuclear aspects of one—would trigger requests for additional information or special inspections to verify the absence of undeclared activities or materials, or of any preparations for such diversions.

Such a scenario is not without precedent. In South Africa, both the admission by the government of having actually assembled six nuclear devices, as well as information obtained from technical visits to various types of facilities, led to a very thorough and aggressive program of inspections by the IAEA. Nevertheless, these inspections were only made possible by the cooperation of the South African government and its desire to dispel any remaining doubts about the reversal of its weapon program. They were also facilitated by South Africa allowing outside nuclear weapon experts to accompany an IAEA inspection team.

To deal with problem NPT states, therefore, the IAEA can encourage such cooperation and insist that nuclear weapon experts be allowed to join inspection teams (if they are not already incorporated among the inspectorate), whether for technical visits, or routine, ad hoc, or special inspections. If such cooperation is not forthcoming, the IAEA could also make maximum use of the provision for special inspections under the rationale that "completeness" of the inventory or of all declared activities cannot otherwise be assured.

OPTION: *Support placing additional constraints on the ability of states to withdraw from the NPT on 90 days' notice.*

Article X of the NPT states that:

> Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that *extraordinary events,* related to the subject matter of this Treaty, *have jeopardized the supreme interests of its country.* It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests. [emphasis added]

Such withdrawal clauses have now become common in arms control treaties. Although the NPT does not specify what would constitute "extraordinary events" or "supreme interests," it is clear that withdrawal is a very serious matter that would not be taken lightly by the Security Coun-

[8] Henry Sokolski, U.S. Defense Department deputy for nonproliferation from 1989 until February 1993, "Non-Proliferation Fantasy: NPT Will Not Quell N. Korean Nuclear Ambitions," *Defense News,* vol. 8, No. 14, April 12-18, 1993, p. 20.

[9] See discussion in George Bunn and Roland Timerbaev, "Avoiding the 'Definition' Pitfall to a Comprehensive Test Ban," *Arms Control Today, vol. 23, No. 4,* May 1993, pp. 16-17.

cil. (The first country ever to have begun the formal process of withdrawal from the NPT was North Korea in 1993.[10])

One option for dealing with this contingency is to clarify-perhaps via resolution of the U.N. Security Council—what it would take to constitute legitimate grounds for treaty withdrawal: for example, a clear, newly emerging nuclear threat from another country, imminent risk of invasion by an overpowering military force, or some other direct threat such as threatened or actual use of other weapons of mass destruction. On the other hand, clarifying reasons for withdrawal in this reamer might make it easier for parties to leave the Treaty. It could also damage the nonproliferation regime by implicitly assuming that the actual possession of nuclear weapons might be needed to deter aggression, and by diminishing the role of other responses, such as looking to the international community for support or becoming allied to an established nuclear weapon state. Moreover, states may be reluctant to take actions or set precedents that may limit their own freedom of action with respect to other treaties, even if they support the objective of making it more difficult to leave the NPT. One international legal expert, for example, suggests that the United States chose not to seek a U.N. Security Council resolution challenging North Korea's announced decision to withdraw from the NPT because it did not want to limit its own freedom of action in the future.

This option could also encompass the formulation of policies for determining ownership and setting forth the ultimate fate of the withdrawing country's safeguarded nuclear material. One option—admittedly unlikely to be enacted and difficult to enforce—would be for the withdrawing state to forfeit any such materials immediately to an international body for safekeeping. The U.N. Security Council could goon record with a resolution declaring (well in advance of any particular case) that if a state withdrew from the NPT without surrendering all the weapon-usable nuclear materials it possessed—and possibly any additional nuclear materials and facilities that had originally been provided by NPT states—then that state would be considered a threat to international peace and security. Although such a resolution would not prevent withdrawal, it could clarify that any state that amassed a stockpile of nuclear weapon material under the cover of safeguards, only to renounce its obligations and claim possession of that material, could open itself up to the possibility that the Security Council would authorize coercive means-perhaps including military force—to remove that state's weapon potential.

Such an approach could encounter difficulties, however, in its execution or its acceptance to states already party to the NPT. The United Nations would have to decide what measures it would consider appropriate to enforce such a take-back policy. Seizing material produced with little or no foreign assistance would certainly meet with considerable opposition. The use of military force would quite possibly be required. Thus, such a policy might have to be limited to fuel and other nuclear materials produced or obtained with the help of direct assistance from other NPT states—and possibly only to fuel supplied after the Security Council resolution had been made. The Nuclear Suppliers Group (NSG) might be a useful forum from which to stipulate such a condition of supply, further bolstering its recent decision to require full-scope safeguards as a condition of any significant new supply of dual-use nuclear technologies.

OPTION: *Attempt to implement general embargoes of nuclear technology for problem NPT states.*

Members of the Nuclear Suppliers Group have agreed to withhold nuclear technology not only from states that are *not* subject to full-scope IAEA safeguards agreements, but also from those states that *are* but whose commitment to comply with them is considered questionable. In addition, the guidelines adopted by the NSG in April 1992 ex-

[10] North Korea suspended its withdrawal just before the 90-day period ended.

plicitly state that a country's eligibility to import certain dual-use items (i.e., those having both weapon applications and legitimate civil uses) from an NSG member depends on factors such as the recipient country's statements and behaviors regarding its nonproliferation commitments.

However, withholding assistance from NPT parties poses a number of dilemmas. For instance, which criteria should be used to determine the nations to be embargoed, or even to determine what might constitute a given country's "legitimate" nuclear fuel-cycle requirements? So far, the United States has been most interested in isolating Iran, but has had little success in convincing its European allies to join in an embargo of general high-technology trade. (In part, this difficulty is because Iran has thus far apparently abided by its IAEA safeguards agreements.) In the case of Iran, government officials had made alarming statements (later contradicted) indicating their desire to develop nuclear weapons.

Many observers argue that this approach violates not only the spirit but the letter of the NPT, since Article IV, section 2 states that:

> All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also co-operate in contributing . . . to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of the non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

In response, the United States argues that section 1 of Article IV, while acknowledging the "inalienable right" of NPT parties to pursue nuclear energy for peaceful purposes, explicitly makes such activity contingent upon its being conducted "in conformity with Articles I and II," which ban the development of nuclear weapons by non-nuclear-weapon states. Analysts also note that there should be some latitude for "consideration for the needs" of countries seeking nuclear assistance. For example, oil-rich states might be seen as having lesser needs for nuclear power, and states that have not even built or operated nuclear power reactors might be legitimately denied technology for developing enrichment or spent-fuel reprocessing capabilities. Since the Nuclear Suppliers Group puts restrictions on dual-use export controls, for instance, that go well beyond what is required by the NPT (which does not address export controls on dual-use items), it would appear that it (or a subset of its members) could certainly apply these kinds of considerations as well.

OPTION: *Argue for an expanded United Nations Special Commission (UNSCOM) mandate to include exposing, and possibly even rendering harmless,* any *clandestine nuclear facilities in* any *non-nuclear-weapon NPT states worldwide, not just Iraq.*

In the aftermath of the Gulf War, the U.N. Security Council created a Special Commission and gave it extraordinary powers to ensure the "destruction, removal, or rendering harmless" of Iraq's weapons of mass destruction and its capability to produce more.[11] In the case of Iraq's nuclear weapon program, the U.N. Special Commission shares these powers with the IAEA.

UNSCOM is unique; only in Iraq, a militarily defeated power, has the world community exercised the ability to reverse forcibly the development of weapons of mass destruction. Some have argued that since the heads of state of the nations comprising the U.N. Security Council have declared the proliferation of weapons of mass destruction to be a "threat to international peace and security," the Security Council should take similar measures against other proliferant states, or at least against those states that have committed not to develop nuclear weapons but do so anyway.

One way to *expose* nuclear weapon facilities in such countries might be through the creation of a special organization like UNSCOM, under the

[11] U.N. Security Council Resolution 687, S/RES/687 (1991), Apr. 8, 1991.

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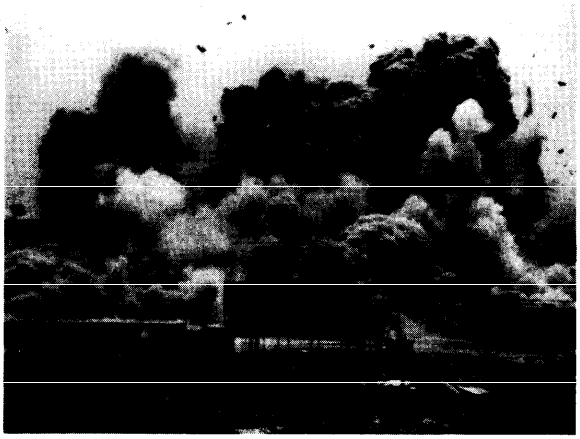


Destruction of an Iraqi nuclear facility at direction of the United Nations Security Council.

direction of the U.N. Security Council, to receive and evaluate national intelligence information on possible clandestine nuclear programs. This organization, with explicit *prior* U.N. backing, would then direct the IAEA to conduct special inspections, possibly assisting in the inspections.

This new agency would deal with cases wherein intelligence information strongly indicated the presence of a clandestine nuclear fuel-cycle facility, and the matter were serious, sensitive, and urgent enough to demand rapid and vigorous action. The advantage of such an organization would lie not in replacing the function of the IAEA, but in pre-establishing the Security Council's interest in ensuring the investigation of clandestine nuclear facilities in states that have foresworn them. Establishing such an organization and granting it the needed authority might be extremely hard, however, since it would require U.N. Security Council action and would be subject to a veto. Implementing missions to render any such discovered facilities harmless would be even more difficult, and would almost certainly require explicit Security Council action on a case-by-case basis. It is extremely unlikely that the Security Council would (or even could) delegate to this new organization the authority to force a state to accept an inspection or destroy a facility.

Since the IAEA already can request special inspections of locations that it has reason to believe would reveal violations of a state's safeguards agreement, this approach is not necessary to obtain the authority to ask for access to such facilities. Where it would go beyond existing IAEA authority would be in short-circuiting the safeguards process—which is primarily focused on declared facilities anyway—and in demonstrating prior Security Council backing for inspections. That is, under the present situation, before the IAEA can report a matter to the Security Council, it has to: 1) find an anomaly through routine safeguards activities or through other information made available to it, 2) bring the problem to the attention of the government involved, 3) attempt to resolve the problem, and 4) request a special inspection if the matter cannot be resolved. There are no preordained timelines within which special inspections must be completed. Establishing a U.N. organization to deal directly with possible clandestine activities in NPT states would allow this procedure to be streamlined in egregious cases, thus possibly saving many months or more of time that might otherwise be required by the standard escalating sequences of IAEA procedures.

This option might be opposed from two different directions: because it goes too far, or because it does not go far enough. In the first camp, some would object that the IAEA already has the authority to conduct special inspections, and the creation of a new organization for the same mission invites duplication, if not confusion. At the least, relations between this organization and the IAEA would have to be managed very carefully.

Those who argue that this proposal does not go far enough, on the other hand, might prefer to see the United Nations establish a body that would replace the IAEA—rather than work with it—for this mission. They might, for instance, believe that with its dual mission of safeguarding nuclear facilities and promoting nuclear power, the IAEA is not able to confront possible nuclear proliferation as vigorously as would anew United Nations organization. However, this argument faces serious difficulties. First, replacing the IAEA's authority to conduct special inspections would probably have a detrimental effect on the rest of the IAEA's safeguards activities, and it might entail the costly duplication of existing IAEA functions.

Second, since it is doubtful that the Security Council would delegate the authority to force a state to accept an inspection or destroy a facility, having a standing UNSCOM-like organization may not help much. Should the Security Council decide to take such action in the future, it could reconstitute such an organization.

Finally, and most significantly, **if the desire to substitute a U.N. organization for the IAEA is motivated by doubts that the IAEA would be willing to take forceful action against one of its own members, much the same doubts could also surround any new U.N.-related organization.** It might be added that in the case of North Korea, it was the IAEA that uncovered discrepancies in the North Korean declaration, confronted the North Koreans with its findings, and pressed for special inspections. When the matter was referred to the U.N. Security Council, the Council declined to take enforcement action. The United Nations and the IAEA are each governed by their respective memberships, which are largely the same. In the current international system, states may be quite reluctant to encourage the Security Council to exercise its full powers, fearing that these powers may someday be turned against themselves.

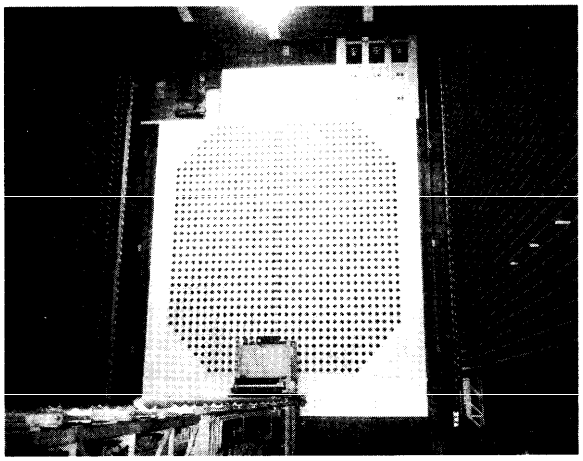
NON-NPT "THRESHOLD" STATES

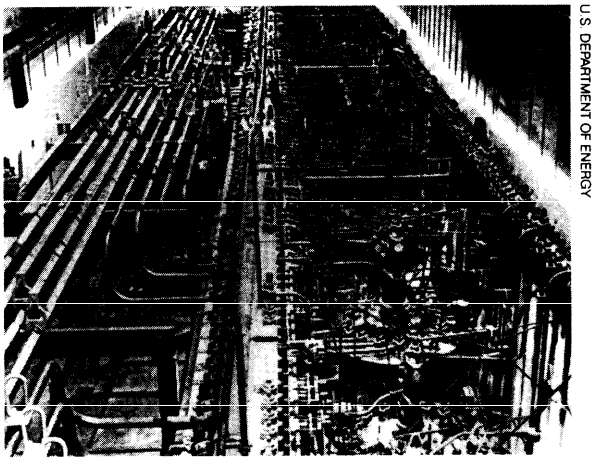
OPTION: *Bring threshold nuclear states at least partty into the nonproliferation regime by capping their production of weapon materials.*

"Threshold states" are those, most notably India, Israel, and Pakistan, that are widely believed to have a nuclear weapon capability or the ability to deploy nuclear weapons on short notice, but have never officially acknowledged it. Although it is unlikely that these states would be willing to accept full-scope (INFCIRC/153-like) safeguards under present circumstances, they might be willing to participate in greatly increased safeguards coverage by joining a proposed universal (or nearly so) international convention to ban the production of fissile materials for nuclear weapons or outside safeguards. Such a convention, as supported by the Clinton Administration, would allow threshold states that may already have an overt or latent nuclear weapon capability to place all their current and future nuclear material production facilities under safeguards without having to declare or acknowledge past material production or weapon development activities. **The essential difference between this arrangement and full-scope safeguards is that a verified fissionable cutoff would only look forward; it would not seek to verify the absolute size or whereabouts of current stockpiles of nuclear material and would not address the issue of weapon possession or past development.** It would be full-scope only with regards to facilities and *future* production of materials, all of which would have to be declared, safeguarded, and constrained to peaceful applications. It would therefore offer at least the benefit of assuring others that no participating country was producing any *additional* materials that could be used in a weapon program. It would also include identical provisions for the nuclear-weapon states, thereby avoiding the discriminatory aspect of the NPT.

Such a convention would have no effect on the non-nuclear-weapon states party to the NPT, which are already forbidden from producing nuclear materials for use in weapons or outside safeguards. It would, however, place additional constraints upon the NPT nuclear-weapon states, which are now free to produce nuclear weapon materials without limit and are not even required to place their peaceful nuclear programs under safeguards. In so doing, it would be consistent with the nuclear disarmament provisions of Article VI of the NPT.

A fissile-material production cutoff would not, however, impose any significantly new burdens on the United States, since the United States announced in June 1992 that it would not produce any more highly enriched uranium or plutonium. Existing stockpiles of nuclear material were assumed to suffice for whatever might be done with the U.S. nuclear arsenal. Where this convention would affect the United States is in its verification provisions. The U.S. government has not yet





Former U.S. nuclear material production facilities would probably become subject to international monitoring—possibly by the International Atomic Energy Agency—if a convention banning the production of nuclear materials for weapons were to come into force. ***Left:*** *the N-reactor, a former plutonium production reactor at the Hanford site in Washington state.* ***Right:*** *the interior of a plutonium reprocessing facility at the Savannah River facility in South Carolina.*

agreed either on what provisions the United States would wish to see applied to other nations in order to have confidence that they were complying with the cutoff, or on what provisions the United States could live with if applied to U.S. facilities.

Such a convention also for the first time would place limits on any non-NPT states that chose to join it. The inducement for countries such as Israel, India, and Pakistan to do so would involve self-interest in advancing regional peace processes, as well as obtaining concessions from the nuclear-weapon states by accepting binding constraints on their own programs.

If such a convention could be implemented, it could go a long way toward capping a nuclear arms race in South Asia and contributing to the Middle East peace process. However, even though the convention itself would be silent as to any existing stockpiles of nuclear weapons or weapon materials among the threshold states, it **might harm the nonproliferation regime because it may be viewed as legitimizing the existing nuclear capabilities of the threshold states.** Any verification regime for the convention, for example, would have to exempt (implicitly or explicitly) existing stockpiles of weapon materials, since past production would not be covered. Such an exemption might be construed as lending legitimacy to the excluded stocks.

A cutoff convention would also lock in perceived nuclear disparities among both threshold and acknowledged nuclear weapon states, without providing a clear recipe for further confidence-building measures or disarmament. It also would tacitly legitimize the production of *safeguarded* weapon-usable material, regardless of a country's fuel-cycle needs. (In this, though, it is no more permissive than the NPT, which also allows such production.) Indeed, some critics of a cutoff convention fear that in lining up international support for the convention, the United States would promise other states freedom to pursue activities that are not explicitly prohibited by the convention (e.g., producing weapon-capable materials under safeguards). In so doing, they argue, the United States would have the effect of creating an "entitlement" for states to conduct activities that the United States would otherwise oppose.

Cutoff proponents, in turn, counter that the United States does not *have* to promise its negotiating partners that it would support their decision to conduct such activities. The United States could make clear that it opposed such activities

even while acknowledging that it was not yet able to get international consensus on banning them.

OPTION: *Allow a one-time-only extension of the "nuclear club" while universalizing the NPZ 12*

The concept of a one-time extension of the declared nuclear states would involve setting up a time period in which *de facto* nuclear powers would be encouraged to declare their nuclear weapon status one way or the other, followed by the U.N. Security Council issuing a *binding resolution* that any *future* acquisition of weapons of mass destruction by any state (whether or not a member of the NPT) would constitute a threat to international peace and security that the Security Council would be required to halt.[13] The deadline for self-declaration of nuclear status would allow states such as Israel, India, and Pakistan a chance to establish themselves as nuclear-weapon states, if they chose to do so, and thus avoid coming under the provisions of this declaration. Once declared as nuclear-weapon states, they would have no political reason to stay outside a suitably broadened NPT, which could then become universal. At the cost of expanding the nuclear club, therefore, a universal (albeit still two-tiered) NPT might be created that would be stronger than one having several significant holdout states. Without these holdouts, there would be great pressure on the remaining states still outside the NPT to join, making the NPT truly universal. If enforced by the Security Council, such a treaty would probably be more effective than the existing NPT at preventing still further proliferation. There would be the problem, however, of verifying that a claimant actually had a nuclear weapon. Otherwise, a state could, in effect, reserve itself a slot in the nuclear club in advance.

The main problem with this proposal is that it would require an amendment of the NPT, which is crafted to make amendments virtually impossible (see discussion earlier in this chapter). Moreover, the admission of three more powers into the nuclear club might weaken international resolve against proliferation if no untoward consequences were to result for them. Other disadvantages of this would be that it would force the hand of Israel, India, and Pakistan, which already face serious security dilemmas. Each of these states has its own reasons for keeping the status of its nuclear program secret, and these reasons are probably tied primarily to regional security concerns. Such a one-time extension approach also fails to explain how regional or international security would be enhanced by threshold countries declaring their nuclear weapon capabilities openly, rather than harboring them implicitly. The decision to announce a nuclear weapon program publicly would be a provocative political act that might stimulate a response. In addition, neighbors of the new nuclear states, who would now confront a newly overt (if not new) nuclear threat, may in return withdraw from the Non-Proliferation Treaty on the grounds that it does not address their security needs. They may even conclude that they need at least to explore a nuclear weapon option.

Possibly, states making such declarations could then begin to work toward transparency (in an attempt to limit possibly destabilizing worst-case analysis by their adversaries) and toward arms control measures, such as were pursued by the United States and the former Soviet Union/Russia since the 1960s. But given the track record of superpower transparency and arms reductions, it could be years, if not decades, before tangible benefits could be derived from such an approach.

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[12] See David Kay, "The IAEA—How Can It Be Strengthened?", paper presented at the conference *Nuclear Proliferation in the 1990s: Challenges and Opportunities*, Woodrow Wilson Center, Washington, DC, Dec. 1-2, 1992 (footnote 23 of Kay's paper).

[13] The heads of the Security Council members, meeting in January 1992 at U.N. Headquarters in New York, declared in a statement that proliferation of weapons of mass destruction "constitutes a threat to international peace and security." However, this statement did not have the force of a binding Security Council resolution.

It might also be difficult to convince other states that the Security Council was serious about this extension of the nuclear club being indeed "one-time," never to be repeated if world circumstances were to change drastically.

IMPROVEMENTS IN THE INTERNATIONAL NUCLEAR FUEL CYCLE

OPTION: *Work to achieve a worldwide cutoff-either voluntary or negotiated with verification provisions—on production of* all *weapon-usable materials (highly enriched uranium and separated plutonium).* [14]

One of the most serious weaknesses of the current regime of controls over nuclear materials is that states are permitted to produce and stockpile weapon-usable materials—highly enriched uranium or separated plutonium—as long as they are placed under safeguards. After amassing a stockpile, a state would be free to withdraw from NPT and use its materials in weapons. One way to close this loophole is to eliminate the production of highly enriched uranium or separated plutonium entirely. Such a policy goes beyond the fissionable material cutoff described earlier, which permits the continued production of these materials under safeguards for nonweapon purposes.

■ Highly Enriched Uranium

Highly enriched uranium (HEU) has little use in the civil sector. Although a number of research reactors were originally designed to use HEU, the RERTR (Reduced Enrichment for Research and Test Reactor) program has developed high-density, low-enriched uranium (LEU) fuels that can be substituted for HEU fuel in a number of reactor types. Many such reactors have been converted. (See discussion below on the RERTR program.) Some reactors, however, have yet to be converted, and suitable fuels for others do not yet exist.

For example, Germany is considering construction of a new HEU-fueled research reactor to produce intense beams of neutrons for materials studies. (The United States has just cancelled its plans for a similar reactor.) Conversion of this reactor to run on LEU fuel would introduce cost, performance, and schedule penalties that the project's supporters view to be unacceptable. Another civil use for HEU is for the initial fuel loading for breeder reactors, which are reactors designed to produce plutonium fuel. Under such a cutoff proposal, such reactors would not be allowed, so HEU would not be needed to develop them. (See discussion of banning plutonium, immediately below.)

Cutting off the production of HEU is more problematic for military purposes, since naval nuclear reactors run on HEU. Nuclear-weapon powers with surplus stocks of HEU may be able to draw on those stocks to fuel their nuclear-powered naval vessels for many years; otherwise, states would need to consider conversion to LEU (if possible) or abandonment of those vessels.

Monitoring a ban on the production of HEU is complicated by the fact that many enrichment technologies can be rather easily converted from LEU production to HEU production. Therefore, special means might have to be found to assure those participating in a fissionable production ban that LEU production facilities were not being converted in this way. Such means of verification might have to be more intrusive than the Hexapartite safeguards agreement already in place for centrifuge facilities (which allows only limited access to the cascade area), and might have to extend to all enrichment technologies. In many cases, these means would have to involve very short-notice inspections, such as provided for under the Hexapartite agreement. Such short notice is possible in Europe and Japan, because the IAEA has resident inspectors either in-country or able to travel there

[14] A brief but useful summary of the history and ramifications of various fissile cutoff proposals is contained in the National Resources Defense Council report "Non-Proliferation and Arms Control: Issues and Options for the Clinton Administration," January 1993, pp. 20-22.

without lengthy border-crossing procedures. This approach may not be so easily extended to enrichment facilities elsewhere in the world, were they to be established there.

Plutonium

Eliminating the production of separated plutonium would terminate exploration and exploitation of one fuel cycle that had been envisaged since the dawn of nuclear power: the recovery of plutonium from spent reactor fuel and the exploitation of that plutonium in either the current generation or a future generation of reactors (see box 4-2). Because of its adverse implications for proliferation, the United States actively tried to discourage the use of plutonium in civil reactor programs overseas under the Carter Administration in the late 1970s. In 1984, the United States terminated the Clinch River breeder reactor program in Tennessee, and as of this writing the United States no longer operates any experimental or prototype breeder reactors.[15] However, several countries around the world still use, or say they intend to use, plutonium-based fuel cycles.

Banning the separation of plutonium would eventually foreclose the exploitation (and even the study) of the breeder reaction option. For many nuclear power proponents, such a step is unthinkable. It would be strenuously opposed, for example, by Russia, Japan, France, and possibly India, Kazakhstan, and the United Kingdom, as well as by some nuclear power proponents in the United States, which would see such a move as putting the most attractive feature of nuclear power forever out of reach. Russia has more practical reasons to oppose a ban on plutonium production: the three plutonium production reactors remaining in operation in Russia are producing steam heat and electricity for nearby towns, and are the only source of employment for skilled nuclear scientists and engineers in the area.[16] At present, the spent fuel from these production reactors must be reprocessed within about two years to avoid corrosion and radioactive leakage into the spent fuel pond. At least as of now, Japan still plans to make extensive use of plutonium, having broken ground in 1994 for its large reprocessing facility at Rokkasho-mura, now envisioned to attain full operation in the middle of the next decade.

Even so, interest in breeder reactors is declining around the world, making it easier to consider banning the use of plutonium than it would have been 10 years ago (see box 4-3). A ban on the production of weapon-usable materials would be supported by those who are unwilling to allow nations to stockpile such materials under safeguards, by those who do not believe that safeguards on plutonium handling plants are adequate to ensure that plutonium is not diverted, and by those who believe that shipping significant amounts of plutonium between nuclear facilities poses unacceptable safety and security risks even if diversions

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[15]For discussion of the advanced liquid metal reactor, an advanced reactor capable of being configured as a breeder, see U.S. Congress, Office of Technology Assessment, *Technical Options for the Advanced Liquid Metal Reactor*, OTA-BP-ENV-126 (Washington, DC: U.S. Government Printing Office, May 1994). The reactor was terminated by Congress and the Clinton Administration in 1994.

[16]These reactors also have characteristics that give them inherent needs for reprocessing, despite the fact that the resulting plutonium, with less than 1,000 MW-days/ton burnup, is necessarily of excellent weapon grade. The reactors at Tomsk, like those at Hanford, cycle through roughly 1,200 ton of natural uranium fuel per year (as opposed to 35 tons of low-enriched uranium/year for a light-water reactor); storage facilities at the reactor are adequate for only 6 to 12 months of spent fuel (which cannot be stored for longer than two years in any case; see main text). While options for conversion to coal- or gas-fired generators are being studied, there is no infrastructure to bring in these fuels, and most such options appear to run up against budgets on the order of at least a billion dollars. Laurin Dodd, Pacific Northwest Laboratory, presentation at NRDC/FAS meeting, Washington, DC, Dec. 16-17, 1993. U.S. Vice President Gore and Russian Premier Chernomyrdin agreed in December 1993 to shut down these reactors by the year 2000 while taking steps to provide alternative energy supplies, with U.S. assistance.

BOX 4-2: The Allure of the Plutonium Fuel Cycle

Nuclear reactors today generate their energy from the uranium-235 form of uranium, which comprises only 0.7 percent of natural uranium, The remaining portion of natural uranium, almost entirely the uranium-238 form, does not directly produce energy in civil reactors. Some small fraction of this uranium-238 is, however, converted to plutonium—which can generate energy-during the course of reactor operation, such that by the time a load of fuel in one type of civil reactor requires replacement, some 25 percent of the energy being produced by that fuel is actually generated by the plutonium that has previously been created within it.

Plutonium and unused uranium can be recovered from spent reactor fuel in a procedure called chemical reprocessing, with the plutonium subsequently being used in one of two ways: in present-generation "light-water" nuclear reactors in the form of "mixed-oxide" (MOX) fuel, or in next-generation "breeder" reactors. MOX, which has been used in a number of reactors around the world, typically consists of a few percent plutonium oxide mixed with natural or depleted uranium oxide and formed into fuel rods, (Depleted uranium is the byproduct of producing enriched uranium. It has a smaller fraction of uranium-235 than natural uranium has.) Although MOX eliminates the need to enrich uranium, the extraordinary expense of processing plutonium into MOX makes MOX fuel more expensive than enriched uranium fuel with the same energy content, In fact, processing costs are so high that MOX would be more expensive than uranium even if the plutonium used to make it were free. (Even if uneconomic in terms of fuel costs, reprocessing might still be done for waste management purposes. It separates the most intensely radioactive, shorter-lived reactor byproducts from less radioactive, although longer-lived, components of the spent fuel,)

In a breeder reactor, a "blanket" containing natural uranium surrounds the reactor core, which is fueled initially either with highly enriched uranium or plutonium. Uranium-238 in the blanket turns to plutonium when irradiated, and a breeder reactor can generate more plutonium than it consumes. In so doing, it can extend uranium reserves by as much as a factor of 1,000, compared with what would be available if low-enriched uranium fuel were stored as waste after being used in a nuclear reactor.[1] When the availability of uranium was thought to be the limiting factor to the spread of nuclear power, it was assumed that the nuclear fuel cycle would eventually be based on the generation, recovery, and re-use of plutonium. However, for both economic and nonproliferation reasons, plutonium reprocessing has lost much of its initial allure, and interest in breeder reactors has similarly declined (see box 4-3).

[1] A factor of 100 comes from the relative abundance of uranium-238 compared with uranium-235; another factor of 10 represents the additional low-grade uranium resources that might make sense to recover if the uranium-238 content were to be exploited to make plutonium, but that would not be economic to mine if only the uranium-235 were used. See National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium* (Washington, DC: National Academy Press, 1994), p. 53, (footnote 29 of the Academy report).

were certain to be detected. In this view, foregoing the civil use of plutonium would be the lesser of two evils.[17]

Policies governing the production or use of new plutonium will influence, if not determine, the methods chosen to dispose of existing stock-

[17] As an alternative to recycling, while retaining some of the energy value of the plutonium, there has been some interest in a fuel cycle called "DUPIC" or Direct Use of Spent Power Reactor Fuel in Candu reactors. This approach envisions using spent LEU fuel directly in Candu natural-uranium reactors. Canada has been pushing this as a long-term approach, and there is the possibility that countries such as South Korea might be interested in the future. The 0.9 percent Pu contained in the spent LWR fuel going in is reduced to 0.2 percent Pu. The advantages of such an approach are that it gets rid of much Pu, and what Pu is left has a smaller proportion than does the original spent fuel of the Pu-239 isotope that is desirable for weapons. One disadvantage is that radioactive fuel must be loaded into the Candu. More seriously, by institutionalizing the processing of spent fuel into new fuel to obtain additional energy, such a fuel cycle might still awaken interest in chemical reprocessing of full-circle spent fuel and the development of a plutonium fuel cycle.

BOX 4-3: The Declining Interest in Breeder Reactors

Breeder technology—which poses proliferation concerns since it requires separating and recycling plutonium—is no longer being vigorously pursued outside of Russia, India, and Japan. France's 1,200-MW Superphénix fast-breeder reactor (FBR) has been shut down for extended periods. It was connected to the French electrical grid for two days in December 1994, reaching 20 percent power, but has not operated since then. Despite the investment of more than DM4 billion (more than $2.5 billion) between 1974 and 1991, Germany's controversial 300-MW FBR at Kalkar had never opened. In March 1991, German officials declared that the project had no hope of being licensed and was being abandoned. ' In August 1992, Britain confirmed its decision to shut down by 1994 the Dounreay 250-MWt (megawatts of thermal power) Prototype Fast Reactor in Scotland on the grounds that commercial deployment of fast reactors in the United Kingdom would not be required for 30 to 40 years. The United Kingdom is also pulling out of a joint European project in fast reactors.

Breeder programs are making better headway in Japan, although they still face obstacles. Japan's Monju prototype FBR, with a generating capacity of 280 MWe (megawatts of electrical power), reached criticality in April 1994, a year and a half later than had been originally planned, using the plutonium shipped back from France at the end of 1992. Completion of Japan's larger scale demonstration fast-breeder reactor, which in 1991 was scheduled for the year 2000, has been delayed by at least a decade until 2010. Startup of the large commercial reprocessing plant at Rokkasho-mura has likewise slipped to about 2005, and a second proposed reprocessing plant has also been delayed.[2]

Only in India, Russia, and possibly Kazakhstan does there appear to be a strong ambition in the near term to pursue plutonium-based or plutonium-breeding fuel cycles. In the latter two countries, much of this ambition is driven by a desire to derive energy, if not economic benefit, from the scores of tonnes of plutonium that are expected to be obtained from dismantled warheads. It is also part of an ambitious overall plan Russia has put forth in an attempt to double its nuclear-generating capacity by 2010, including building 20 new reactors to produce an additional 20 GWe (gigawatts electrical power) of generating capacity.[3] The initial stage of the plan calls for constructing a 630-MWe FBR reactor at Sosnovy Bor, to be followed by three FBRs.[4] There is already a 600-MWt breeder reactor (BN-600) in operation at Beloyarsk. Kazakhstan has plans to build a second 350-MWt FBR at Aqtau (formerly Shevchenko), where it already had a BN-350 (350 MWt; 60 MWe) reactor inherited from the U.S.S.R. However, given the economic situation in these two countries, such optimistic plans for expansion may be unrealistic,

In India, the new, unsafeguarded breeder reactor and reprocessing facilities at Kalpakkam emphasize that country's continuing interest in the plutonium cycle.

Finally, in the United States, breeder reactors seemed to have reached a dead end with the termination of the Clinch River breeder reactor at an early stage of construction in 1984. Recently, there has been a small revival of interest in the nuclear industry and some national laboratories in developing the so-called ALMR—the advanced liquid metal reactor (formerly called the integral fast reactor) —which would be collocated with reprocessing and plutonium fuel fabrication facilities. There would be minimal access to plutonium-bearing fuel, whether fresh or spent, and the collocation of the elements of the fuel cycle would add significantly to proliferation resistance. In 1994, however, the U.S. administration recommended terminating work in this area as well. Despite some efforts in Congress to restore minimal levels of funding to pursue this option, the program was killed. Even if demonstrated to be feasible, which would necessitate the investment of several billion dollars, the prospects for market acceptance of such a reactor within the next decade or two are highly questionable.

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[1] *Arms Control Reporter,* 1992, p. 602. B.234.

[2] The latest Long-Term Nuclear Energy Development and Utilization Program, published in November 1994 by Japan's Atomic Energy Commission, states that the Rokkasho reprocessing plant "Is scheduled to be commissioned shortly after the year 2000" (p. 50 of unofficial English translation by the Atomic Energy Commission), but press sources indicate that the plant "won't begin operating until 2004 or so. " See, e.g., N. Usui and A. MacLachlan, "Japan AEC Looking at Delay in Startup of Reprocessing Plants, " *Nuclear Fuel,* Feb. 14, 1994, pp. 10-11.

[3] Russia also has a small (11-MWt) breeder at Dimitrovgrad and a 800-MW breeder 10 percent complete at Yuzhnouval'skaya, whose construction has been suspended.

[4] *Arms Control Reporter, 1992, p. 602. B.236.*

piles of separated plutonium, including that recovered from dismantled nuclear weapons. Some who advocate that surplus weapon plutonium be "burned" in nuclear reactors-either as mixed-oxide fuel in existing light-water reactors, or more directly in future breeders—do so in large part to maintain interest in plutonium fuel cycles.[18] Conversely, it will be difficult to pursue options for burning weapon plutonium in nuclear reactors—even in government reactors not connected with civil power production—in an environment where separation of plutonium for use in civil nuclear reactors is banned.

A variation on the option to ban the production of weapon-usable nuclear materials would be a ban on separating and stockpiling excess plutonium—any plutonium that would not be used immediately to fuel a nuclear reactor. Since the rate at which plutonium is being loaded into Japanese nuclear reactors has not kept up with the rate at which Japan now plans to import plutonium separated from the spent fuel that it had earlier shipped to European reprocessing plants, tons of separated plutonium will begin to be stockpiled on Japanese territory. Even if Japan does not give up the plutonium option, some observers have urged it to delay its own reprocessing, and to stop accepting shipments of separated plutonium from Europe, until its plans to consume plutonium catch up to its ability to produce it.

OPTION: *Reinvigorate the Reduced Enrichment for Research and Test Reactors program, combined with an expanded U.S. take-back policy for U.S.-supplied HEU reactor fuel.*

Research reactors are proliferation risks in two ways: all of them are capable of producing plutonium, and in addition, many are fueled with highly enriched uranium. The quantities both of fuel and of potential plutonium produced are roughly proportional to the power of the reactor, and the proliferation risks are small for reactors below about 10 MW thermal power (MWt). These would normally be fueled by considerably less than a "significant quantity" (SQ) of HEU and could produce only similar fractions of an SQ of plutonium per year, even if optimized for maximum production. The risks become more significant, however, for reactors of 30 to 50 MWt power levels. The issue of plutonium production is related to the effectiveness of safeguards (see box 4-4). The discussion here addresses the HEU aspect, which can be affected by unilateral actions on the part of the small number of suppliers of this specialized fuel (the United States being one of the largest).

In the United States, Argonne National Laboratory has been addressing the issue of finding alternative (LEU) fuels for such reactors for over a decade, though its funding was scaled back

[18] For extensive discussion of options for destroying weapon-grade plutonium in the United States and the Soviet Union, see U.S. Congress, Office of Technology Assessment, *Dismantling the Bomb and Managing the Nuclear Materials, OTA-O-572* (Washington, DC: U.S. Government Printing Office, September 1993) and Committee on International Security and Arms Control, National Academy of Sciences, *Management and Disposition of Excess Weapons Pluutonium* (Washington, DC: National Academy Press, 1994). A major recommendation of the latter study is that disposition of weapon plutonium be treated as an independent issue and not be subsumed under decisions concerning the future of nuclear power and the adoption or rejection of plutonium fuel cycles. The report urges that separated plutonium from weapons rapidly be put into a form where it would take at least as much effort to recover the plutonium as it would to reprocess plutonium from the much larger stocks of spent fuel already existing worldwide. The report also concludes that once weapon plutonium has been converted to such a form— for example by mixing it with radioactive waste to create "artificial spent fuel," or by converting it to mixed-oxide fuel and partially burning it in a light-water reactor—there is little point to proceeding to eliminate it entirely before addressing those stocks of spent fuel as well.

BOX 4-4: IAEA Safeguards on Research Reactors

At present, safeguards requirements do not provide for full-time camera surveillance of nuclear material at small research reactors. This leads to the theoretical possibility of diverting reactor fuel and clandestinely reprocessing it to obtain small amounts of plutonium. Iraq, for instance, reprocessed several fuel rods from its IRT-5000 reactor before the Persian Gulf war in lab-facilities ("hot cells") it was known to have, separating just over 2 g of plutonium. On that scale, this action—if done for civil, experimental purposes---did not need to be reported to the IAEA, and did not technically constitute a safeguards violation. However, Iraq also clandestinely irradiated its own, undeclared uranium fuel in this reactor, separating 3 additional grams of plutonium. The undeclared production and separation of plutonium violated Iraq's safeguards agreement. ' Nevertheless, small research reactors produce plutonium so slowly that reprocessing their fuel to obtain material for a weapon would be impractical.[2] If extra precautions are desired, however, camera surveillance at such reactors would help detect diversion of significant quantities.[3]

The main difficulties in attaining safeguards inspection goals at research reactors and critical assemblies (RRCAs) tend to involve verifying both the irradiated fuel and the fact that there was no diversion of 1 SQ or more of direct-use material if such material was produced through unrecorded irradiation. For example, inspection goals are sometimes not attained at RRCAs because of a lack of a full set of containment and surveillance or other safeguards measures for confirming the absence of unrecorded irradiation of nuclear material. (Containment and surveillance measures are difficult to apply, or draw conclusions from, because material and equipment in the reactor vault is frequently moved even during normal operation.) Certain reactor design aspects can also make it difficult to access for verification purposes the irradiated fuel located in the reactor core.

[1]Programme for promoting Nuclear Non-proliferation, *Newsbrief,* No. 15, Autumn 1991, p. 10, citing IAEA Press releases and other sources.

[2]Reactors containing mostly uranium-238 in their fuel (natural uranium or a few percent enriched LEU) produce plutonium at low burnups at a rate of roughly 1 g per MWt per day, such that a 30-MWt reactor would produce just over 8 kg of Pu per year if it were operated 75 percent of the time. Reactors running on HEU are able to produce smaller amounts in uranium-238 targets placed in and around their core; in practice only 0.5 to 0.65 g of plutonium per MWt per day is produced, due to neutron losses in control rods and out of the reactor, and absorption by fission products such as xenon-1 35. See Marvin M. Miller, MIT, "The Potential for Upgrading Safeguards Procedures at Research Reactors Fueled with Highly Enriched Uranium: Part 11," report prepared for the U.S. Arms Control and Disarmament Agency, July 1984.

[3]Statement of Hans Mayer, IAEA spokesperson, September 16-20, 1991 at the regular session of the IAEA General Conference in Vienna, as cited in the *Arms Control Reporter,* 1991, p. 602. B.200.

significantly in the 1990s.[19] Such fuels have been developed for a number of reactor types and have been substituted into many U.S. and foreign reactors.[20] In 1992, the Schumer amendment to the Energy Policy Act (Public Law 102-486) prohibited the export of directly weapon-usable HEU reactor fuel from the United States unless the United States was developing suitable alternate

[19]Some believe that the suspension of the RERTR program may have been a political decision to delay the conversion of foreign research reactors so as to avoid the pressure that would inevitably then be placed on the U.S. Department of Energy to convert its own HEU-fueled research reactors.

[20]As of 1990, the IAEA was safeguarding 42 research reactors or critical assemblies handling more than 1 SQ each of nuclear material, of which 37 handled more than 1 SQ of direct-use material outside the reactor core.

fuels, and no HEU exports were made in 1993 or 1994.[21]

The RERTR program has made significant progress in the past at finding alternate fuels. Continued funding would permit it to see its goals through to the implementation stage for additional types of reactors. Cooperative work with other countries—particularly Russia—can further reduce the use of HEU in research reactors through the development of alternative fuels for reactors that were not originally fueled with U.S.-origin HEU.

HEU Fuel Take-Back Policy

Since the 1950s, the United States has supplied HEU fuel for a number of foreign research reactors, and since about 1960 it has had a policy to take back spent HEU fuel of U.S. origin.[22] During the Carter Administration, the United States instituted a policy to develop the alternative LEU fuels mentioned above while taking back HEU fuels from reactors converted to the new fuels.

The take-back policy was suspended in 1988 because of the need to conduct an environmental review, given the lack of any permanent repository for storage of radioactive used fuel in the United States. Under pressure from the State Department and the IAEA, however, the U.S. Department of Energy (DOE) agreed on July 13, 1993 to prepare an environmental impact statement, as required by the National Environmental Policy Act, for resuming shipments of HEU fuel elements to DOE's facility at Savannah River, South Carolina. The environmental impact statement assesses the environmental consequences of taking back the fuel and compares them to those of alternate policies.

Of the some 22,700 fuel elements slated for return to the United States, 409 presented an immediate problem because they were stored at reactors that needed to discharge spent fuel but had no remaining onsite storage capacity. If these elements could not be returned to the United States, those reactors would be forced either to shut down or to have the fuel elements reprocessed in conflict with U.S. policy. After completing an environmental assessment in April 1994, DOE concluded that the return of these elements was urgently needed, and that it posed no significant environmental impact. The federal government then began accepting the fuel at Savannah River.

South Carolina challenged the return of this fuel in court and obtained an injunction preventing DOE from accepting it. However, DOE won a reversal of the injunction on appeal,[23] and it has received some 100 of the fuel elements at Savannah River pending resolution of the court challenge. Should the federal government prevail, the remainder of the 409 elements will be returned to the United States. Return of the full 22,700 fuel elements awaits completion of the environmental review process specified in the National Environmental Policy Act.

To further the goals of the RERTR program, the United States can continue its development of alternate fuels, and it can continue efforts to encourage foreign reactor operators—including operators of reactors not originally fueled with U.S.-supplied HEU—to convert to them. More-

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[21]The amendment (now section 903 of the law) prohibits export of U.S.-origin HEU fuel to foreign research reactors unless three conditions are met: 1) there is no alternative [LEU] fuel or target that can be used in that reactor; 2) the proposed recipient of the uranium has provided assurances that whenever an alternative [LEU] fuel or target can be used in that reactor, it will use that alternative in lieu of HEU; and 3) the U.S. government is actively developing an alternative nuclear reactor fuel or target that can be used in that reactor.

[22]According to a report prepared by the Nuclear Regulatory Commission, the United States has exported a total of 25,875 kg of HEU, of which 8,394 kg have been returned, leaving 17,489 kg of HEU in 51 countries that could be returned. (As cited in Michael Knapik, "DOE Drafting Policy on Taking Back HEU Fuel from Non-U.S. Reactors," *Nuclear Fuel*, Apr. 12, 1993, p. 14.) This breaks down into the following (in kilograms): 13,677 in EURATOM, 1,184 in Canada, and 1.973 in Japan. Other countries include Argentina, 58; Australia, 146; Austria, 39; Brazil, 9; Chile, 12; Columbia, 3; Iran, 6; Israel, 34; Jamaica, 1; Mexico, 12; Norway, 4; Pakistan, 16; Philippines, 3; Romania, 39; Slovenia, 5; South Africa, 10; South Korea, 25; Sweden, 127; Switzerland, 82; Taiwan, 10; Thailand, 5; and Turkey, 8. (Due to roundoff errors, individual entries may not add to totals.)

[23]Department of Energy press release, "Court Blocks Shipment of Foreign Spent Fuel," DOE News, September 13, 1994.

over, **U.S.** nonproliferation objectives will be harmed if the inability to take back spent HEU fuel forces foreign reactor operators to reprocess **U. S.**-origin fuel.

In a case that is not part of the RERTR program but also involved the shipment of highly enriched uranium to the United States, the Department of Energy successfully brought some 600 kg of HEU originating in Kazakhstan to its facility in Oak Ridge, Tennessee. This transfer, known as Project Sapphire, was undertaken to eliminate the possibility that the material might end up in unauthorized hands. Although it was conducted under cover of secrecy, state and local officials received classified briefings in advance. No court challenges were brought.

OPTION: *Undertake studies to look seriously at the feasibility and desirability of internationalizing various aspects of the nuclear fuel cycle.*

A "mild" form of internationalization would be to place stockpiles of separated plutonium under international control or management at perhaps one or a small number of agreed sites. **The IAEA** Statute envisions such a role for the IAEA, with Article XX.A.5 authorizing the IAEA to require the deposit of surplus plutonium to prevent stockpiling. Such an international plutonium storage system has been under study within the IAEA, at varying levels of attention, since at least the late 1970s.[24] More recently, the IAEA revisited the idea and held a series of meetings beginning in 1992 and 1993 in Vienna. In 1995, the United States placed highly enriched uranium and plutonium declared excess to its weapon program under IAEA safeguards (see discussion in chapter 3 of the United States' "voluntary offer" to accept safeguards.) However, this arrangement is strictly a bilateral one. It does not involve international ownership or control.

Difficulties in implementing international storage include issues of ownership of the contributed material, the conditions under which a state would be able to access and utilize plutonium that it had contributed, and fears by some that creating such a system would legitimize the production of plutonium. A more fundamental problem would be gaining the participation of states that had rejected the NPT and would not likely place their own plutonium under international control.

A more far-reaching change to the existing nuclear regime than any option so far discussed would be to revisit some of the major assumptions underlying the current regime, such as the assumption that nuclear weapon-usable materials should be permitted to remain under the control of individual states. One mechanism for keeping weapon-usable nuclear materials out of national control is to ban their production, as discussed above. However, since individual nations or (in the case of enrichment consortia) groups of nations would retain uranium enrichment capability under such an approach, they would inherently retain the capability to produce weapon-usable material by converting from LEU to HEU production. A stronger mechanism for ensuring that countries do not develop nuclear weapon-usable materials would be to place those portions of the nuclear fuel cycle that are of greatest proliferation concern under direct international control. With the Acheson-Lilienthal report and the Baruch plan, such an approach was discussed at the beginning of the nuclear era; the events of the 1990s have created fresh interest in the idea.

Instituting an international nuclear material control regime would involve the internationalization of enrichment, reprocessing, and, possibly, fuel fabrication facilities. Such a regime would be based on the assumption that existing safeguards on such facilities will not be sufficient to meet nonproliferation goals, but that banning these facilities entirely is neither desirable nor politically achievable. As such, an international control regime would involve drastic changes to the way the uranium and plutonium markets now operate, affecting the ownership and

[24] David A.V. Fischer and Paul Szasz, *Safeguarding the Atom: A Critical Appraisal* (London: SIPRI, Taylor and Francis, 1985), pp. 115-116.

operation of many billions of dollars worth of existing facilities. Dramatic changes would be required to the international legal regime, along with extensive treaty negotiations.

It would be very difficult to create such a regime. Non-nuclear-weapon states would likely object strongly to a regime that reinforced the discriminatory aspects of the NPT by denying them the ability to operate nuclear fuel-cycle facilities by themselves, while permitting the nuclear weapon states to do so in their military programs. Given the magnitude of the changes such a policy would require, it would likely be possible only with sustained effort over many years, if at all. More detailed analysis of this issue is beyond the scope of this report.