Summary 1

From the dawn of the nuclear age, nuclear power has been recognized as a "dual-use" technology. The same nuclear reactions that give bombs the destructive force of many thousands of tons of high explosive can, when harnessed in a controlled fashion, produce energy for peaceful purposes. The challenge for the international nuclear nonproliferation regime—the collection of policies, treaties, and institutions intended to stem the spread of nuclear weapons—is to prevent nuclear proliferation while at the same time permitting nuclear energy's peaceful applications to be realized. One of the key institutions involved in meeting these two objectives is the International Atomic Energy Agency (IAEA), an international organization created in 1957 as a direct outgrowth of President Eisenhower's "Atoms for Peace" program.

The IAEA Statute, which creates the legal framework for the agency, charges it to "accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world." At the same time, it gives the agency the authority to enter into so-called *safeguards agreements* with individual nations or groups of nations to ensure that nuclear materials, equipment, or facilities are not used to produce nuclear weapons. The IAEA's mission and its safeguards responsibilities were extended with the enactment in 1970 of the Treaty on the Non-Proliferation of Nuclear Weapons (also known as the Non-Proliferation Treaty, or NPT). The Treaty requires non-nuclear-weapon states that are parties to the accord to enter into safeguards agreements with the IAEA covering *all* nuclear materials on their territory (e.g., uranium and plutonium, whether in forms directly usable for weapons or forms that require additional processing before becoming usable in weapons).

Today, the IAEA has a central role in the international community's efforts to prevent the spread of nuclear weapons. It has come under increasing scrutiny since the Persian Gulf War of 1991, when it was revealed that Iraq had mounted a massive, covert nuclear weapon program in parallel with the public nuclear activities that were declared to, and inspected by, the IAEA. Discovery of Iraq's activities highlighted the need to ensure that other countries subject to IAEA safeguards were not also conducting nuclear weapon activities at facilities totally unknown to the IAEA. This assignment is considerably tougher than the one that the IAEA's member states had implicitly assigned the agency before the war: making sure that *known*, ostensibly peaceful facilities and materials were not being surreptitiously used for weapon purposes.

Over the following two years, the IAEA took a key role in exposing elements of North Korea's nuclear weapon program, and in verifying that South Africa had dismantled its own weapon program. These high-profile, high-stakes activities, in conjunction with a heightened interest in nuclear nonproliferation more generally, have focused additional attention on the IAEA and its system of nuclear safeguards. In addition to their direct contribution to nonproliferation, IAEA nuclear safeguards also affect the nuclear nonproliferation regime indirectly. For example, the confidence that parties to the Non-Proliferation Treaty have in safeguards is certainly one factor in determining their commitment to that Treaty, which is the centerpiece of the nonproliferation regime.

This report analyzes what the IAEA's system of nuclear safeguards can and cannot be expected to accomplish, identifies areas where it might be broadened and improved, and presents options for doing so. However, the focus here on nuclear safeguards should not be taken to imply that these safeguards are the only, or even the most important, nonproliferation tool. As discussed in an earlier Office of Technology Assessment (OTA) report, the nuclear nonproliferation regime also includes a host of other measures: export controls, international treaties, the extension of nuclear "umbrellas" by states having nuclear weapons to other states that might otherwise feel the need to develop their own, provision of other diplomatic and military commitments by nations to reassure their allies and warn potential foes, unilateral national polices, and so on.[1] This much wider set of issues is not addressed in this report. For further discussion, the reader is referred to that earlier report and to the other publications from OTA's assessment on the proliferation of weapons of mass destruction.

This chapter summarizes the issues and options for improving nuclear safeguards. Chapter 2 provides some background information about nuclear safeguards and the IAEA. Chapter 3 discusses various proposals for improving nuclear safeguards, or otherwise tightening control over nuclear materials, that could be implemented without making major changes to existing institutions or international agreements. These proposals generally address various changes in IAEA operations that the agency already has the authority to implement; indeed, many are already being implemented. Chapter 4 of this report addresses measures that go beyond existing institutions and agreements, whose implementation would require substantial changes or additions to the current regime (e.g., new treaties, or amendments to agreements such as the IAEA Statute or the NPT). Examples would include measures to address the actions of states not party to the NPT, or new

[1]See U.S. Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks*, OTA-ISC-559 (Washington, DC: Government Printing Office, August 1993). Other publications from this OTA assessment include *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry*, OTA-BP-ISC-106, August 1993; *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, December 1993; *Export Controls and Nonproliferation Policy*, OTA-ISS-596, May 1994; and *Proliferation and the Former Soviet Union*, OTA-ISC-605, September 1994.

agreements to place constraints on the production or use of nuclear materials that go well beyond the NPT.

OTA's major findings are presented below. Following that, this summary chapter mirrors the organization of the rest of this report: it provides some background information on IAEA safeguards, discusses various options to improve those safeguards that can be implemented largely within the existing regime, and concludes with some options to augment the regime.

FINDINGS ON IAEA SAFEGUARDS

- ***Some measure of subjectivity is inherent in any system of nuclear safeguards, and it is not possible to make an absolute determination of such a system's effectiveness.*** While *violations* of IAEA safeguards might be demonstrated unambiguously, *compliance can* never be established definitively.

  Although the purpose of IAEA safeguards—to verify that nuclear material "is not diverted to nuclear weapons or other explosive devices"[2]—may be simply stated, that goal does not automatically translate into the complex system of declarations, inspections, and evaluations that comprise the safeguards system. Assumptions must be made concerning the amount of material whose diversion should be detected (see discussion of "significant quantity" thresholds to follow), the period over which those diversions are conducted, and the statistical confidence needed to assert that a diversion might have taken place. No matter how small a diversion the IAEA intends to be able to detect in a certain period of time, for example, a state might still successfully divert the same amount of material by doing so over a longer period. Of course, even in such a case, there is value in delaying a proliferant's progress.

  Statistical methods such as those used by the IAEA to account for nuclear materials cannot give absolute answers. A measurement that a certain amount of nuclear material cannot be accounted for could mean that the material has been diverted out of a given facility—but it could also mean that the material remains within the facility but has for some reason escaped measurement, or even that all the material was in fact present and measured but that due to the inherent uncertainty in the measurement, some of the material *appeared* to be missing.

- ***The conventional "material accountancy" safeguards methods now in use by the IAEA appear unable to assure that the diversion of a bomb's worth of plutonium per year from a large plutonium reprocessing plant—e.g., one processing much over about 100 tons of spent fuel per year— would be detected with high confidence. No*** reprocessing plants this large are now under full IAEA safeguards, but one is under construction at Rokkasho-mura in Japan. (The operating reprocessing plant at Tokai in Japan has a capacity of about 90 tons spent fuel per year; whether or not it can meet this standard depends on the details of its material accountancy system and its annual throughput.)

  New techniques such as "near-real-time accountancy''-unproven at this scale by the IAEA—must be adopted for large reprocessing plants, and even these techniques may not be able to measure material flows and inventories accurately enough to detect the absence of as little as one bomb's worth of plutonium per year. In that case, if the IAEA could not demonstrate that safeguards methods *other than* the material accountancy techniques that form the core of its current safeguards approach can be relied on to detect diversion with a high degree of confidence, it would have to conclude that it could not safeguard such a plant to the same standards it applies at smaller facilities. *To date, the IAEA has not considered the possibil-*

[2]International Atomic Energy Agency, "Against the Spread of Nuclear Weapons: IAEA Safeguards in the 1990s," IAEA Division of Public Information, Vienna, Austria, December 1993, p. 11.

ity that it may be unable to safeguard large facilities such as the Rokkasho-mura reprocessing plant, but neither has it been able to demonstrate that it can.

- ***Evaluations of safeguards effectiveness that consider only the precision with which nuclear material inventories and flows can be measured underestimate the effectiveness of the overall safeguards system.*** Other techniques besides material accountancy—such as physical containment, surveillance, and review and verification of design information—can serve to prevent some diversion scenarios, and to make others less likely. These techniques make important contributions to safeguards, and the IAEA is improving its use of them. However, their contribution is very difficult to quantify, and it is hard to determine to what degree confidence in safeguards is improved through their use.
- ***IAEA safeguards alone cannot prevent states from developing nuclear weapons, but they make it much more difficult for states to use safeguarded nuclear facilities to make weapons without detection.*** IAEA safeguards are intended to detect—and therefore deter—diversion of civil nuclear materials into a weapon program. However, they cannot keep states from acquiring the technology needed to produce nuclear materials, or even from stockpiling fissionable material within civil programs and then withdrawing from safeguards to produce weapons.
- ***The most fundamental limit to improving the International Atomic Energy Agency's ability to detect nuclear proliferation is the extent to which the states that subscribe to nuclear safeguards are willing to cede additional sovereignty to the IAEA.*** Although any country subscribing to an international agreement such as the Non-Proliferation Treaty or a safeguards agreement with the IAEA is understood to have surrendered some sovereignty, states may not necessarily agree to new measures that they believe go beyond their original commitments. Therefore, the IAEA may not have the power to impose some measures it might otherwise wish to take to bolster its safeguards system. However, such measures could be voluntarily accepted by states subject to safeguards.
- ***The IAEA has no power on its own to compel states to comply with its inspection requests. However, it can refer disputes to the United Nations Security Council, which has the legal authority to enact and enforce resolutions that are binding on U.N. members.*** Thus, if the Security Council concludes that a state's refusal to cooperate with the IAEA threatens international peace and security, in principle it can demand that the state comply with IAEA requests or otherwise cease its provocative behavior, and the Security Council can ultimately back up its demands by authorizing the use of military force.

The IAEA's authority to inspect sites within a country is granted by the inspected country in the safeguards agreement that the country concludes with the IAEA. In the case of NPT parties, these agreements grant the IAEA the authority to determine that all nuclear materials in the state are exclusively in peaceful use.[3] They also give the IAEA—in consultation with the inspected state, and with its permission—the ability to inspect any site where the IAEA has reason to believe nuclear-related activities are being conducted, even if the inspected state has not admitted to conducting nuclear activities there. If the request for such a "special inspection" is refused, the IAEA can seek enforcement by the United Nations Security Council.

[3]The one exception is that nuclear materials that are in use for military, but nonexplosive, purposes such as naval propulsion are exempt from IAEA safeguards. However, a state may not create a separate fuel cycle outside of safeguards to produce nuclear materials for these purposes.

Nevertheless, safeguards agreements do not give the IAEA unlimited, "anytime-anywhere" access.

- ***Even though its access is limited, the IAEA can conduct inspections that individual states would not normally be permitted to undertake.*** For example, the IAEA took samples at North Korean nuclear facilities that the United States would almost certainly not have been able to visit. As an international organization, the IAEA is not generally thought of as pursuing the parochial interests of any single state, and strives to be seen as politically neutral.
- ***Ensuring the absence of undeclared nuclear facilities (i.e., those that a state hides from the IAEA, in violation of the requirement that all such facilities must be declared) is probably more important to the international nonproliferation regime than is incrementally improving safeguards at declared facilities*** (those that have been disclosed to and safeguarded by the IAEA). On the other hand, if safeguards at declared facilities deteriorate to the point where it becomes easy to divert materials without detection, diversion will become more attractive.
- ***The IAEA is exploring a number of means to improve its ability to determine whether states are pursuing undeclared nuclear weapon programs.*** However, it is not an intelligence organization, and its ability to discover undeclared activities that states wish to keep hidden from it will depend significantly on the willingness of other member states to share their own intelligence information with the IAEA, as well as on the ability of the IAEA to evaluate and analyze all such information.
- ***The steadily growing demands placed upon the IAEA cannot be accommodated without sacrificing effectiveness under the "no real growth" funding policy that has been imposed upon the agency since 1985. New*** responsibilities—including additional states subscribing to nuclear safeguards, expanded efforts to verify the absence of undeclared nuclear facilities in safeguarded states, and possible additional missions such as monitoring surplus nuclear weapon materials from the United States and Russia—need to be accompanied by new resources. However, *who* should pay and *how* the additional funds should be allocated remain controversial. For example, it will be politically difficult, if not impossible, to increase the safeguards budget without also increasing the funds the IAEA devotes to its technical assistance programs.

INTRODUCTION

Production of fissionable nuclear material (highly enriched uranium or plutonium) is the most difficult step in making a nuclear weapon. Consequently, constraining a would-be proliferant nation's ability to produce such materials has always been a central component of international nonproliferation efforts. One of the principal constraints is the requirement that countries joining the NPT as non-nuclear-weapon states accept international monitoring of all facilities that might produce, use, or otherwise handle nuclear materials. Such monitoring is conducted under the IAEA's system of nuclear safeguards.[4]

IAEA safeguards are intended to impede nuclear proliferation by ensuring that the diversion of nuclear materials from safeguarded nuclear facilities to weapon purposes will be caught and made known to the world community. To the extent that they can assure a country that its neighbors or adversaries are not developing nuclear weapons, safeguards lessen that country's perceived need to develop its own nuclear arsenal.

[4] IAEA safeguards can also constrain nuclear programs in non-NPT countries. Brazil, not party to the NPT, has nevertheless accepted IAEA safeguards over all its nuclear facilities. Moreover, additional states such as Israel, Pakistan, and India have placed certain nuclear facilities—usually imported ones—under safeguards as well, greatly complicating any attempt to use these facilities in their nuclear weapon programs. (India has a reprocessing plant that is under safeguards only when reprocessing safeguarded fuel; its activities at other times are not constrained by safeguards.)

In addition to imposing constraints on states' nuclear activities, the NPT also calls for the "fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of atomic energy," offering a reward to those states that subscribe to the Treaty and forego their option to produce nuclear weapons. In return for concessions by the non-nuclear-weapon states, the nuclear powers agree under the NPT to strive toward nuclear disarmament (Article VI of the Treaty), and (in conjunction with non-nuclear-weapon states who are in a position to contribute) to share information on the peaceful uses of atomic energy (Article IV). All NPT members are forbidden under Article III from exporting nuclear materials or facilities unless the recipients of those goods agree to place them under IAEA safeguards.

Origins of the IAEA Role in Nonproliferation

Pursuant to President Eisenhower's "Atoms for Peace" program, the United States in 1954 began to enter into bilateral nuclear cooperation agreements with other countries. These agreements included provisions, called safeguards, by which the United States could assure itself that its nuclear materials and technology were not being put to military use by other nations. At the same time, the United States entered into negotiations to create the International Atomic Energy Agency. These negotiations concluded in late 1956 with the drafting of the IAEA Statute. The agency itself was formed the following year as an independent intergovernmental organization affiliated with, but not a subunit of, the United Nations.

The IAEA was not given highly intrusive powers of inspection or enforcement over its member states, nor did it assert control over their nuclear activities. Rather, it was given the authority to enter into safeguards agreements with individual nations or groups of nations that would allow it to make certain inspections and measurements to ensure that nuclear activities were not being conducted for military purposes.

The first such agreement was concluded between the IAEA and Japan in 1959. By 1965, the IAEA adopted a comprehensive system of safeguards that was to be applied, upon request, to individual nuclear activities within a state, and to all activities receiving IAEA assistance. This type of safeguards, set forth in the IAEA publication known as INFCIRC/66, applies to individual plants, shipments of nuclear fuel, or supply agreements between importers and exporters of nuclear fuel or technology. It remains in use today as the basis for nearly all agreements between the IAEA and states that are not party to the Non-Proliferation Treaty.

The Non-Proliferation Treaty, which entered into force in 1970, extended the scope of the IAEA's safeguards activities. By joining the NPT, non-nuclear-weapon states—by definition, all those except the United States, the Soviet Union (now Russia), the United Kingdom, France, and China—commit themselves to refrain from manufacturing or otherwise acquiring nuclear weapons or explosive devices, and to submit to IAEA safeguards. Instead of covering only selected nuclear facilities as volunteered by the state, safeguards under the NPT—known as *full-scope* safeguards—are mandatory, and they must be applied to *all* nuclear materials in *all* peaceful nuclear activities within a country's territory or under its control.[5] To implement this charge, the IAEA developed a more comprehensive standard safeguards agreement—published in the IAEA document known as INFCIRC/153—encompassing a state's entire nuclear fuel cycle. All non-nuclear-weapon states that are parties to the NPT fall under IAEA safeguards, but the converse is not true. There are

[5]Non-Proliferation Treaty of 1970, Article III(1), with the exception noted earlier for material used for military, but nonexplosive, purposes (see footnote 3).

countries with safeguarded nuclear facilities, including a country (Brazil) about to conclude a full-scope safeguards agreement, that are not members of the NPT.

The NPT requires that any nuclear equipment exported by a member state be placed under safeguards by the recipient, even if the recipient is not an NPT member. However, the treaty does *not* oblige a member to require that countries receiving its nuclear exports adopt full-scope safeguards.

■ IAEA Safeguards

IAEA safeguards involve procedures for material accountancy, control, containment, surveillance, and verification of data, including onsite inspections, that are implemented through bilateral agreements between the IAEA and individual countries. They are designed primarily for two purposes: 1) to detect proliferation activities that involve diversion of materials from the civilian nuclear fuel cycle, and 2) to provide warning of any such occurrence to an international forum in a timely fashion. **Though they may deter proliferation by posing a risk of discovery, safeguards cannot predict a country's intent or future activity, nor can they by themselves prevent proliferation.**

The safeguards process consists of three stages:

1. *examination by the IAEA of state-provided information,* including a declaration to the IAEA of those facilities where nuclear materials will be handled, the design of those facilities, inventories of nuclear materials, and receipts formaterial transfers and shipments. States subject to safeguards must establish so-called state systems of accounting and control, or SSACs, to keep track of nuclear materials under their jurisdiction. The SSACs submit their records to the IAEA for independent verification, much like a bank auditor would be asked to provide independent confirmation of the accuracy of a bank's accounting.
2. *collection of data and independent information by IAEA inspectors* to verify material inventories, operating records, or design information, or, in special circumstances, to clarify unusual findings.
3. *evaluation by the IAEA* of this information for completeness and accuracy.

Any discrepancy of nuclear materials between the recorded (book) inventory and the physical inventory determined by measurements and inspections is called *material unaccounted for* (MUF). When MUF exceeds the amount attributable to measurement uncertainties, the possibility of diversion exists and must be resolved by the IAEA.

OPTIONS FOR ENHANCING THE SAFEGUARDS REGIME

OTA has explored a number of options for improving the nonproliferation regime, particularly regarding controls over nuclear materials. Some of these options can be implemented without making major changes to existing institutions or international agreements. Such proposals generally concern various aspects of IAEA operations and are discussed immediately below. Other options would involve making substantial changes or additions to the NPT or the IAEA Statute. These are discussed in the section titled "Beyond the Traditional NPT/IAEA Framework" that concludes this chapter.

■ Strengthening IAEA Capabilities

ISSUE: *Resources available for IAEA safeguards.*

In recent years, the demands placed upon the IAEA for safeguards services have increased substantially. For example, countries with substantial nuclear infrastructures have joined the NPT or otherwise come under safeguards, not only significantly increasing the number of facilities needing to be safeguarded but also requiring the IAEA to devote considerable resources to verify as best it can that all nuclear materials produced by the state in the past can be accounted for. Perhaps more significantly, the IAEA has significantly expanded its efforts to ensure that states under safeguards do not have secret or undeclared nuclear facilities.

Despite these growing demands, however, the IAEA's safeguards budget has essentially been

held to zero real growth since 1985. A modest increase was approved in 1992, but was never realized due to the failure of the Soviet Union to make any contribution at all that year. Even though the United States interprets "zero real growth" as permitting increases to cover additional tasks that the IAEA has no ability to refuse—such as concluding new safeguards agreements and adding new facilities to existing agreements—the United States has been unable to convince other IAEA members to agree with this view. Therefore, every new country and new facility coming under safeguards squeezes the funding available for existing IAEA safeguards activities, let alone its new thrust to detect undeclared sites. In addition, the IAEA has constantly been subjected to late payments from member states, including the United States.

Even if agreement could be reached to increase funding for the IAEA, however, issues of fairness and proportionality—both with respect to *who* should pay more and *how* the added money should be allocated between safeguards and other IAEA programs such as technical assistance—complicate the debate over overall funding levels.

OPTION: *Increase U.S. contribution to the IAEA safeguards program.*

The United States, which provides just over 25 percent of the IAEA regular budget, is the IAEA's largest contributor. Its assessed contribution in 1994 totaled $49.9 million, with another $30 million provided in extrabudgetary contributions.[6] A total of $18.9 million of the U.S. assessed contribution went to fund safeguards activities. The largest portion of the U.S. extrabudgetary contribution—$14.6 million—was allocated to the IAEA's fund for technical cooperation and assistance in nuclear technology, a program integral to the IAEA's mission of promoting nuclear technology. Politically, this program is linked very strongly to the IAEA safeguards program, and there will be great resistance within the agency to increasing safeguards expenditures without corresponding increases in technical assistance. Some $9.4 million of the U.S. extrabudgetary contribution in 1994 was devoted to improving safeguards.

Those supporting increased U.S. funding for the IAEA believe that easing the fiscal pressures on the IAEA would enable it to better fulfill its current and future safeguards tasks and would be worth the added cost. Those opposed to a U.S. increase may place higher priority on competing needs for funds within the United States, or on the desire to reduce federal spending in general or contributions to international organizations in particular. Even if the United States were to increase its contribution, other IAEA member states may object to increasing their assessments or even to allowing the U.S. increase to be spent on safeguards without a corresponding increase in the technical assistance program.

OPTION: *Pay U.S. dues on time.*

Differences between the U.S. and the IAEA budget cycles mean that the U.S. contribution is consistently late, causing cash shortages for the IAEA and evoking criticism from the agency and from other member states. The United States could consider paying its dues on time. Moving the payment up, however, would incur a one-time charge equal to a year's dues because during that one fiscal year, two years' assessments would have to be paid.

ISSUE: *Allocation of inspection effort.*

Whether or not the overall safeguards budget is increased, efficiency in the use of IAEA resources is important. One inefficiency in present operations stems from the fact that safeguards are designed around nuclear material. Thus, much of the

[6] Safeguards constitute some one-third of the IAEA's regular budget—that part of the agency's activities funded by assessment on its member states. The United States and many other states have committed to make extrabudgetary contributions in addition to their assessments. Budgetary figures for 1994 are from the U.S. Department of State, March 1995.

safeguards effort has ended up being directed toward countries with large nuclear fuel cycles—Japan, Germany, and Canada-rather than states of greater proliferation concern. Furthermore, the majority of the safeguards effort gets applied to facilities with the greatest amount of material (i.e., those associated with civilian nuclear power production), rather than to other nuclear research activities that might be more likely to benefit a weapon program.

OPTION: *Reallocate inspection effort toward problem states.*

It would be desirable for the IAEA to focus greater safeguards efforts toward states either in regions of political tension or with only marginal nonproliferation records (where, for example, some effort might be directed at environmental monitoring to look for undeclared facilities). However, the IAEA is forbidden by its statute to discriminate against member states, making such proposals difficult to implement.

The IAEA already has some authority to adjust routine inspection requirements (subject to certain limits) based on a country's overall fuel-cycle characteristics. This authority might be exploited more fully, especially for *future* safeguards agreements. (Renegotiating safeguards agreements already in force would be much more difficult.) For instance, more emphasis could be placed on a country's overall amount of direct-use fissile material (i.e., material containing plutonium or highly enriched uranium, including their chemical compounds).[7] Or, if a country possesses enrichment or especially reprocessing facilities, additional inspection efforts might be justifiable even if amounts of fuel being irradiated in various reactors were small.

ISSUE: *Expansion of IAEA safeguards via "enhanced transparency" measures.*

"Transparency measures" refer to actions taken by a state to enhance the visibility and openness of its own activities in order to reassure others that it is not threatening their security. In the area of nuclear safeguards, such measures might include providing the IAEA with information, and offering access to inspectors, that is above and beyond what is required by a state safeguards agreement. Such actions can help a state assure others that it is not conducting secret nuclear activities, and they bolster the effectiveness of IAEA safeguards.

One technique that can take advantage of such transparency is the taking and analysis of environmental samples. The IAEA is exploring the potential for such environmental monitoring to detect and/or to characterize undeclared nuclear facilities. It is also accepting invitations by states such as Iran and South Africa for the IAEA to make "visits"—rather than formal inspections—to sites where questions may have been raised. As of August 1994, 20 states had agreed to participate in field trials of environmental monitoring or other techniques to strengthen safeguards. In addition to strengthening safeguards, transparency measures might allow the more efficient application of limited safeguards resources. In exchange for allowing IAEA inspectors much freer access to their territories, countries with large civilian fuel cycles, for example, might receive lessened routine inspection effort, while overall confidence in the absence of *undeclared* facilities could be increased. If the IAEA can satisfy itself that a state neither possesses nor has access to any undeclared facilities, it will have increased confidence that nuclear material at reactors and in storage has not been di-

[7] Direct-use material includes *unirradiated* direct-use material, which can be used to make weapon components with little additional processing (e.g., highly enriched uranium or separated plutonium), as well as irradiated direct-use material, such as the plutonium contained in spent fuel, which would have to be separated from the remainder of the fuel through chemical reprocessing before it could be used in weapon components.

verted to weapon use-even if the strict statistical confidence levels now required for material accountancy are somewhat relaxed.

OPTION: *Encourage states to make, and the IAEA to accept, offers to provide information and accept inspections not specifically required by safeguards agreements.*

NPT member states with nothing to hide might be willing to accept inspections and offer information above and beyond what they are required to provide, enhancing the IAEA's ability to apply safeguards. Moreover, such actions would reinforce a norm of openness for states wishing to demonstrate their compliance with nonproliferation commitments. To formalize their commitment to the IAEA to provide this transparency, states could add protocols to their safeguards agreements with the IAEA.

One possible limitation on a state's willingness to volunteer such access might be security, proprietary, or constitutional concerns that could argue against offering unlimited access. During the negotiation of the Chemical Weapons Convention, which provides for quite intrusive "challenge" inspections of suspect sites, such concerns lead to the development of "managed access" procedures that obligate the inspected state to address the concerns that motivated the inspection request, but ultimately give it the right to limit inspector access.

By providing additional information, voluntary offers of openness will improve the IAEA's ability to do its job. However, they can also pose some risk to the IAEA. First of all, acting on them will require additional resources, exacerbating the IAEA's financial difficulties. Second, voluntary invitations to conduct such visits can be retracted at any time, as was demonstrated in North Korea. Although North Korea initially offered IAEA inspectors the ability to visit sites in addition to those that the North Koreans specifically declared to the IAEA as nuclear facilities, this openness rapidly broke down when the IAEA sought to investigate discrepancies concerning North Korean plutonium production. Finally, and perhaps most seriously, "technical visits" that do not uncover suspicious activities might be overinterpreted (by outside observers, even if not by the IAEA) to give the inspected state a "clean bill of health." All that such a visit should imply is that nothing untoward was discovered at that site at that time.

OPTION: *Encourage bilateral inspection regimes and regional arms-control and confidence-building measures.*

In addition to acting on offers made by individual states to make their nuclear activities more transparent, the IAEA can also work with groups of nations in tense regions of the world to encourage confidence-building measures and promote regional arms control agreements. The model for such regional nuclear inspection regimes has been established by Argentina and Brazil, which have implemented a quadripartite inspection regime involving the IAEA and a newly established agency called ABACC (the Argentine-Brazilian Agency for Accounting and Control of Nuclear Materials). Both countries have also completed the steps necessary to bring into force the Treaty of Tlatelolco, a regional agreement banning nuclear weapons in Latin America and imposing the same constraints on nuclear weapon ambitions as would the NPT. Arrangements involving mutual visits to military and nuclear installations have been discussed bilaterally in the Korean peninsula, but have been fraught with difficulties while North Korea continues to violate its safeguards obligations with the IAEA.

The regional inspection arrangements entered into by Brazil, Argentina, and (if their bilateral agreement comes into force) the Koreas all complement and extend these states' safeguards agreements with the IAEA. They have (or could have) some role in reducing tensions-or in ratifying the relaxation of tensions—in these regions. Similar agreements might also play a role in helping resolve tensions among key states that are not now under IAEA full-scope safeguards: Israel, India, and Pakistan. Granted, the accomplishments made so far in the in the Mideast peace process shows that inspection regimes related to weapons of mass destruction need not be among the first

items addressed in regional security negotiations. It is difficult to imagine, however, that a long-term settlement can avoid addressing the issue of weapons of mass destruction in the region.

ISSUE: *Definition of "significant quantity"*

Many analysts have stated that the IAEA "significant quantity" (SQ) thresholds-the amounts of fissile material whose diversion the IAEA safeguards system is designed to detect—me probably higher than would be needed by nations attempting to make even their first nuclear explosive. (The significant quantity of plutonium is 8 kilograms; it is 25 kilograms for uranium enriched to 20 percent or more of the uranium-235 isotope.) The U.S. Department of Energy has all but confirmed this view in its recent declaration that 4 kilograms of plutonium are sufficient to make a nuclear weapon.[8]

OPTION: *Lower significant quantity thresholds.*

Lowering the significant quantity thresholds would call for greater inspection effort on the part of the IAEA, including increased inspection frequency at several small facilities in states not yet in possession of one SQ under the present definition. It would also make it more difficult in some cases for the IAEA to achieve its inspection goals, particularly at large "bulk handling" facilities—those that handle nuclear materials in bulk form (e.g., powders or solutions), rather than in discrete units such as fuel rods (see discussion immediately below). In those cases where the IAEA is close to or beyond the limits of its ability to verify diversion of one SQ in a timely manner, such as at large plutonium reprocessing plants, reducing the SQ would require the use of new safeguards techniques such as near-real-time-accountancy, and even these might not be sufficient.

A major cause for United States reluctance to press the IAEA to lower the definition of the significant quantity has been the increased resources that lowering this threshold would require. With financial pressures on the IAEA making it difficult for the agency to fulfill its growing responsibilities under the present definition of the SQ, lowering the SQ threshold without providing the necessary additional resources would exacerbate the IAEA's financial difficulties and weaken current safeguards. **Moreover, should the IAEA receive additional resources, it is not clear that lowering the SQ-which would primarily affect inspections at declared sites in those states with the largest nuclear programs-would be the most effective use of those added resources.**

OPTION: *Lower "timeliness" goals.*

For each type of nuclear material under safeguards, the IAEA has established "timeliness goals" to represent the maximum period of time after a diversion of material might take place before the IAEA would be able to detect that diversion. These goals are based on estimates of the nominal time it would take to convert a given type of safeguarded material into a finished metal component for a weapon. However, timeliness goals are not required to be less than these conversion times for producing weapon components, and in some cases they are longer. For example, although the IAEA estimates that it might take as little as one week to transform pure plutonium oxide into a weapon component, the IAEA's timeliness goal for this material is one month. In practice, these timeliness goals are at best an approximation, both with respect to the time needed by any given state to carry out a diversion of material and develop a weapon, and to the IAEA's ability to raise a clear warning flag in a particular instance of such diversion.

[8]Unclassified excerpt from U.S. Department of Energy, Classification Bulletin WNP-86, Feb. 8, 1994. This statement is not completely equivalent to stating that the SQ should beset equal to 4 kilograms, since the SQ makes an allowance for material lost in processing and machining the plutonium for use in a weapon. However, much of these processing losses can be recovered. No such statement has been issued with respect to uranium-235.

The IAEA could change its timeliness goals for various nuclear materials so that they were less than the corresponding conversion times. Such changes, however, would require considerably greater inspection resources, which would have to be weighed into the additional assurance that lessening these goals would provide. More significantly, the IAEA does not attain all of its timeliness thresholds today, due at least in part to financial pressures. **Achieving the timeliness criteria uniformly and comprehensively for all facilities—particularly those with "direct-use" nuclear materials containing highly enriched uranium or plutonium-is probably much more important than adopting even more stringent criteria as goals.**

ISSUE: *Safeguards uncertainties at nuclear material bulk-handling facilities.*

Large facilities that handle weapon-usable nuclear materials in bulk form-for example, nuclear reprocessing plants that produce plutonium, enrichment plants that produce (or could produce) highly-enriched uranium, and fuel-fabrication plants that process plutonium into "mixed-oxide" (MOX) reactor fuel—pose the toughest safeguards challenges. **For example, due to measurement uncertainties and the amount of plutonium handled per year in a large reprocessing plant such as that being built by Japan at Rokkasho-mura, conventional material accountancy techniques as currently practiced by the IAEA are not precise enough to ensure beyond a reasonable doubt that diversion of a bomb's worth of plutonium would be detected.** Even with expected improvements, new methods—unproven at this scale by the IAEA—must be adopted if plutonium throughputs in plants of this size are to be known accurately enough to detect the absence of as little as one significant quantity of plutonium per year.

The most difficult aspect of safeguarding a large reprocessing or MOX fuel fabrication plant is meeting the one-month timeliness goal, as discussed in the preceding section, for the materials processed in such plants. **The IAEA's ability to provide warning within its timeliness criteria of small but significant diversions from a large reprocessing plant is not proven, given the difficulty in making precise inventory measurements (particularly during plant operation), the time needed to identify anomalies in safeguards data that might indicate the diversion of nuclear material, and the time needed to investigate these anomalies to see whether they have a legitimate explanation. New** techniques that are substantially more intrusive than techniques in use for smaller plants will be required to detect the diversion of significant quantities of nuclear materials in a timely manner from large reprocessing plants; these methods are being explored but have yet to be demonstrated by the IAEA at the necessary scale.

Concerns about the Rokkasho-mura reprocessing plant, which because of its scale provides one of the greatest technical challenges for IAEA safeguards, largely derive from the precedent it sets. Even if Japan is judged unlikely to attempt to divert material from this plant (when it becomes operational) to a nuclear weapon, or to abrogate safeguards once a stockpile of plutonium has been amassed, many states would likely be much less sanguine about the effectiveness of safeguards if a developing country in a politically unstable region of the world were to build a plant even a fraction its size. By its obligation to be nondiscriminatory, the IAEA cannot make politically based judgments of trustworthiness, and it would have great difficulty in justifying more stringent safeguards in one country than in another.

It has been argued, on the other hand, that a country with a large reprocessing plant that wanted nuclear weapon materials would be less likely to divert a small amount than it would be to: 1) build a small clandestine nuclear infrastructure outside of safeguards, 2) attempt to buy or steal

the nuclear material, now that there may well be an active market in it,[9] or 3) withdraw from the treaty after announcing that its vital interests were no longer served by NPT membership. In this view, the primary objective of safeguards at reprocessing plants is to deny states a quick and direct route to the production of large amounts of weapon-usable material in the course of a civil power program. **With safeguards, the risk of undetected diversion might not be eliminated entirely, but it is nevertheless greatly reduced in both the probability of undetected diversion and in the amount of material subject to diversion.**

OPTION: *Increase the use of containment and surveillance techniques.*

Containment and surveillance (C/S) techniques support the primary safeguards approach of material accountancy. After the nuclear material in an item such as a nuclear fuel assembly or a container of plutonium oxide powder has been measured, for example, verifiable, tamper-proof seals are put in place. So long as the seal is intact, the amount of nuclear material present will remain known and accounted for, avoiding the need to remeasure the item at a later date. Surveillance devices (cameras and motion detectors) are used to detect movement in facilities such as spent fuel ponds or other storage areas, indicating when nuclear materials might have been transferred in or out. C/S measures therefore can indicate how long a previous measurement or inventory should still be considered valid, and hence provide what is known as "continuity of knowledge."

New methods that can make C/S techniques even more effective, such as transmitting current surveillance data via telephone or satellite links, are technically feasible and have been demonstrated. Implementing them, however, faces significant obstacles, not the least of which is a state's willingness to be subjected to them. Surveillance techniques also suffer from the fact that their usefulness is difficult to assess quantitatively. Unambiguous evidence of nondiversion can only be obtained for the material or area within a given camera's or motion detector's line of sight, and then only in the case of uninterrupted coverage. Further, in cases where a large amount of legitimate activity is occurring, it may be difficult to detect some types of illegitimate activity. Further analysis of specific applications of enhanced containment and surveillance is therefore needed to determine whether cost-effective improvements in safeguards would result.

OPTION: *Institute near-real-time accountancy and surveillance.*

Various techniques have been proposed, and partially tested, for continuously monitoring and reporting the flow of materials through a bulk-handling plant. Such "near-real-time-accountancy" techniques permit more accurate measurement of plant inventories. They also permit alarms indicating anomalous situations or status of equipment to be sent in near-real time to the IAEA. A rapid response, including the introduction of inspectors, could be arranged, especially if there were resident inspectors near the monitored site. For example, Japan and the United States have been developing and testing a robotic system for monitoring nuclear materials. The system uses advanced sensors to monitor flows of nuclear materials at various locations and then transmit data by satellite to a remote control center.

Near-real-time accountancy techniques now under investigation, particularly at Britain's large THORP plutonium reprocessing plant, could provide inspectors with considerable information concerning actual plant operation. (However, since Britain is a nuclear-weapon state, most of the THORP plant is not under IAEA safeguards.) Such techniques, involving the provision to in-

[9]The German interception of 350 grams of apparently Russian-origin plutonium oxide in August 1994, and the Czech seizure of 3 kilograms of highly enriched uranium in December 1994, indicate that black market purchase of nuclear weapon material maybe more realistic than previously thought.

specters of *process information,* would help verify the non-diversion of nuclear material. However, some years of commercial operation—which have not yet taken place—will be required to fully prove these techniques. Moreover, plant operators might object to providing this degree of access to IAEA inspectors.

OPTION: *Declare that sufficiently large bulk-handling facilities cannot be adequately safeguarded.*

Near-real-time accountancy techniques notwithstanding, nuclear material accountancy and control might not be developed to the point where the amount of plutonium flowing through a large bulk-handling facility can be monitored accurately enough to reveal the diversion of one significant quantity per year. If material accountancy to this level of accuracy were to be the ultimate test of the adequacy of IAEA safeguards, plants above a certain size threshold (somewhere around 100 tons heavy metal capacity per year) could not be adequately safeguarded by the IAEA. In this view, the IAEA should then state that it could not apply safeguards to plants above this threshold unless states were prepared to accept declarations that the IAEA was unable to certify their compliance with their safeguards obligations.

On the other hand, many observers do not measure the adequacy of safeguards solely by their ability to achieve this level of material accountancy, and they fundamentally disagree with the premise that large reprocessing plants cannot be safeguarded adequately. Any material diverted from a plant has to be physically removed from it. Therefore, techniques such as the evaluation and verification of plant design, the adoption of containment and surveillance measures, and the monitoring of plant processes can provide additional—if not complete confidence that material is not being diverted. Moreover, the threshold of one "significant quantity" per year is a subjective one to begin with, as explained above, and it need not be taken as an absolute standard. Even if a material accountancy system does not provide high confidence that a diversion of one significant quantity per year will be detected, it nevertheless provides some probability of detecting small diversions, and it can provide high confidence that sufficiently large diversions would be caught. Therefore, the inability to meet rigorous material accountancy standards might not be considered to imply that a large bulk-handling facility could not be adequately safeguarded.

ISSUE: *Improve ability to detect undeclared facilities.*

Iraq's most serious violation of its Non-Proliferation Treaty commitment was not the diversion of safeguarded nuclear material into a weapon program (although it did reprocess a small amount of plutonium in violation of safeguards), but rather its covert development and construction of a massive *undeclared* complex of nuclear facilities to produce weapon materials. Discovery of this secret infrastructure highlighted the importance of verifying the absence of undeclared facilities—a mission that the IAEA's member states at the time had not given it the political backing or the means to conduct. **Providing the IAEA with the resources, the information, and the political support it needs to look for undeclared sites may turn out to be the most important aspect of a reinvigorated safeguards regime.**

OPTION: *Increase intelligence sharing with the IAEA.*

The IAEA has repeatedly stated that its activities will be significantly enhanced by increased access to information-both open source and national intelligence information. Such information is essential if the IAEA is to learn of undeclared facilities. Successful precedents in providing such information have now been set with respect to both Iraq and North Korea. The United States could continue and enhance its sharing of information with the IAEA, as well as encourage other nations to do so. Concomitantly, if this occurs, the IAEA will need to develop the capability to evaluate such information. Even when supplied with the best of intentions, intelligence information may be ambiguous. Moreover, the IAEA will also need to guard against the possibility that one state may

wish to discredit another by supplying disinformation to the IAEA.

OPTION: *Increase the mandate and frequency of special inspections.*

The IAEA has some authority to demand "special inspections" of sites that have not been declared to the IAEA or formally placed under safeguards. Although no inspections at undeclared facilities had ever been requested or carried out before the upgrading of IAEA inspections following the Gulf War, the agency has the authority under its safeguards agreements to request inspections of undeclared sites if such inspections are needed to obtain further information or to carry out safeguards responsibilities.[10] Such inspections could help expose clandestine weapon programs, alleviate suspicions about such programs, or even deter member states from undertaking them.

The efficacy of the IAEA special inspections provision is limited by several factors, however. One is that special inspections must be carried out "in consultation" with the inspected state, which effectively precludes short-notice inspections unless they are explicitly permitted by the state in other agreements it has entered into with the IAEA. Another limitation is that special inspections can have considerable implications for IAEA credibility. Inspections have to be justified to the country and possibly also to the Board of Governors. Inspectors coming up empty-handed too many times could erode confidence in the IAEA's ability to identify suspect activities, could call into question the reliability or appropriateness of national sources of information (if such had been used), and could hinder the agency in conducting further special inspections.

A more fundamental limitation to the use of special inspections is getting states to accept them, a problem that has been highlighted by North Korea's refusal to permit IAEA special inspections at two suspected nuclear waste sites. Although the IAEA's powers of enforcement are quite limited, the agency's General Conference (consisting of representatives of all its member states) or its Board of Governors could declare that any failure to accept a special inspection will be referred immediately to the United Nations Security Council and will result in the suspension of a state's right to receive technical assistance from the IAEA. The IAEA Statute also provides that member states that have "persistently violated" the IAEA Statute, or any agreement (such as a safeguards agreement) entered into pursuant to the Statute, may be suspended from IAEA membership.[11] The U.N. Security Council could also declare in advance that failure to comply with a special inspection request would be considered a threat to international peace and security that could lead to enforcement actions under Chapter VII of the U.N. Charter. However, the significance of such a general declaration in the absence of a particular case is questionable, particularly given the Security Council's inaction to date against North Korea.

Even with limitations, the authority to carry out special inspections, together with access to national intelligence information, constitutes a formidable tool to detect clandestine activities. The recent examples of IAEA inspections in Iran and North Korea imply that both special inspections and "technical visits' '-combined with increased sharing of intelligence by member states—may become a more important tool than

[10] The IAEA's inspections in Iraq after the Gulf War were not conducted pursuant to its "special inspection" authority but rather under the far tougher provisions of United Nations Security Council Resolution 687, which formalized the cease-fire that ended the 1991 Gulf War. This resolution provides for "anytime, anywhere, no-right-of-refusal" inspections in Iraq and requires, inter alia, that Iraq nuclear weapon program and programs to develop other weapons of mass destruction be eliminated.

[11] *IAEA Statute, Article XIX.B.* Membership priveleges may be suspended if recommended by the Board of Governors, with the concurrence of two-thirds of those members of the General Conference present and voting.

they have been in the past. Some precedent has also been set within the Chemical Weapons Convention regarding challenge inspections, using "managed access" to set the terms of resulting inspections.[12] Although much of the information upon which special inspections or technical visits might be based will inevitably have to come from national intelligence sources, some could come from environmental sampling programs carried out by the IAEA itself.

Special inspections will require advanced or new kinds of portable instruments for field inspectors (e.g., compact multichannel analyzers) and additional training for inspectors to learn what they are looking for and how to react to unusual information they might discover. Increased member state support and voluntary contributions for equipment and training along these lines would be beneficial.

ISSUE: *Verifying initial inventories of nuclear materials.*

The IAEA has a responsibility to verify the completeness of the initial declaration of nuclear material inventories made by any state coming under fill-scope safeguards. That is, it must ensure that the state is not hiding nuclear materials, particularly those capable of being used in weapons. This task is a challenging one whenever the state has a substantial nuclear infrastructure, as is the case in Kazakhstan and Ukraine. It is particularly important if the state is suspected or known to have mounted a nuclear weapon program. Indeed, several such states have either come under or are about to come under full-scope IAEA safeguards, including Argentina, Brazil, South Africa, and North Korea.

To have confidence in the safeguards regime, it is important not only to be able to verify these states' initial declarations of nuclear materials, but also to ensure that any nuclear weapon programs they may have once pursued have been dismantled. South Africa's willingness to demonstrate the rollback of its nuclear weapon program, and the unprecedented access it granted the IAEA, offers a good example of how such confidence can be built. On the other hand, North Korea's refusal, as of this writing, to provide complete information as to the extent of its earlier nuclear activities is at the root of the current controversy concerning that country's nuclear program.

OPTION: *IAEA verification of the termination of a nuclear weapon program.*

Although IAEA safeguards are focused on nuclear materials, the IAEA might be called on (as it was in Iraq and, in a very different way, in South Africa) to verify the dismantlement or the conversion to peaceful uses of other elements of a nuclear weapon program. The United States, the IAEA, or the United Nations could make it clear that the former threshold or nuclear-weapon states have a special obligation to declare prior weapon-related activities and provide assurances that they have been ceased. Such assurances might include demonstrating that scientific teams had been reassigned, that facilities had been dismantled or converted to nonweapon purposes, and that any prior manufactured components and materials had been destroyed. If agreed to by the states in question, IAEA special inspections might then be used to verify the completion of these steps. Short-notice inspections could also be used to guard against the possibility of a state's transferring former bomb materials to new facilities in order to hide them from inspection, and thus enhance the confidence in determining initial inventories of previously unsafeguarded nuclear-weapon-usable material.

In opening its entire former nuclear weapon program to the IAEA, South Africa has established a precedent in this area and has enabled the IAEA to verify that its nuclear weapon program has indeed been demolished.

[12] See U.S. Congress, Office of Technology Assessment, *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry,* OTA-BP-ISC-106 (Washington, DC: U.S. Government Printing Office, August 1993).

ISSUE: *IAEA institutional weaknesses.*

Some have argued that the IAEA has been excessively conservative and cautious, unable or unwilling to take on more vigorous safeguards activities. Part of this conservatism may be attributed to the resistance of member states represented on the Board of Governors to supporting a more aggressive IAEA agenda, and part may stem from a historically evolved institutional culture. Several options are available to the United States and other member states to try to strengthen the IAEA as an institution.

OPTION: *Encourage increased transparency on the part of the IAEA.*

Just as the IAEA requires access to facilities and information to achieve its safeguards objectives, so do those attempting to evaluate the adequacy of IAEA safeguards need detailed information about the functioning of the IAEA to determine how robust those safeguards objectives are, and how well it is implementing them. Public confidence in the IAEA's effectiveness is difficult to earn in a closed environment. Greater openness on the part of the IAEA itself might also allow outside experts to formulate more intelligent and constructive proposals for its improvement, which could ultimately serve to strengthen the overall safeguards regime.

Granted, the IAEA does deal with proliferation-sensitive and proprietary information. To its credit, the agency has earned the reputation of being able to keep this information closely held within its ranks. Nevertheless, the practice of protecting "safeguards confidential" information appears to extend into areas and types of information that may, in fact, offer benefits in increased public confidence in the safeguards system if they were to be made available. For instance, annual Safeguards Implementation Reports (SIRS) are unavailable to the public; these present both an overall assessment of how well the IAEA has met its safeguards goals for the year, including those associated with timeliness, and problems it has encountered with containment and surveillance and other equipment. Distribution of SIRS is restricted despite a substantial effort to protect the identities of any specific country or facility that is discussed.

OPTION: *Encourage states not to abuse their right to reject certain inspectors, and encourage states not to delay granting visas to inspectors.*

Under IAEA procedures, only those inspectors that have been "'designated" for a certain country can conduct inspections in that country, and states have the right to reject the designation of any inspector. In light of the IAEA's need to employ the best inspectors available, especially in less cooperative countries, this practice interferes with IAEA's ability to manage its safeguards inspections. In extreme cases, wholesale rejection of inspector designations could bring the credibility of inspections in that state into question. However, most states are reluctant to give up control over the entry of foreign nationals to their territory. The United States, for example, does not accept inspectors from states it does not have diplomatic relations with or from states that do not accept United States inspectors. Moreover, it reserves the right to deny access to inspectors found to be unacceptable, such as any that might have a serious criminal record or are otherwise not eligible to enter the United States.

The IAEA could discourage rejection of inspectors by imposing the highest allowed inspection frequencies in states that have a history of abusing inspector designations, or perhaps even by calling for a certain number of special inspections at *declared* sites while the state deliberates on accepting inspector designations. Alternatively, the IAEA might modify its guidelines to specify a maximum quota of such rejections, or a time limit upon which to respond to inspector designations.

■ Beyond the Traditional NPT/IAEA Framework

IAEA safeguards are only one element of the international nuclear nonproliferation regime. Many other policy options might be considered for strengthening nuclear nonproliferation, some

of which would involve significant changes or additions to the existing regime. Even if safeguards are not the central focus of these measures, several of them could increase demands for IAEA services or otherwise affect the way the agency administers safeguards.

ISSUE: *Expanding safeguards by reinterpreting the Non-Proliferation Treaty*

Some of the limitations on the ability of nuclear safeguards to prevent nuclear proliferation are built into the Non-Proliferation Treaty, such as the fact that production and stockpiling of nuclear-weapon-capable materials are permitted as long as they are under safeguards. Although amending the NPT is, in theory, one way to address some of these limitations, it is probably not a viable option in practice for both procedural and political reasons. As an alternative approach, it might be possible for the signatories of the NPT collectively to agree to reinterpret some of the Treaty's provisions. Even though this approach may be nearly as difficult to implement as an amendment, it might be worth considering because such a reinterpretation could give considerably greater power to the IAEA, resulting in more effective safeguards. The problem, however, is that treaties, unlike domestic laws, generally have no authority that can issue definitive and binding interpretations; they mean what the states party to them agree that they mean, subject to constraints found in their negotiating record, in presentations made to legislatures during their ratification, and on past implementation practice. Coming up with a collective reinterpretation—particularly concerning politically controversial provisions—would be no easy feat.

OPTION: *Reinterpret Article III of the Non-Proliferation Treaty to give the IAEA a greater role in monitoring equipment and facilities beyond those directly related to nuclear materials.*

Article 111 of the Non-Proliferation Treaty explicitly requires non-nuclear-weapon state parties to the NPT to accept IAEA safeguards over all nuclear materials within their territory. This provision has generally been taken to limit the IAEA's purview to nuclear materials and the facilities used to process or store them. However, an alternate interpretation of that article would place greater weight on its requirement to apply safeguards ". . for the exclusive purpose of verification of the fulfillment of [a non-nuclear-weapon member state's] obligations. . .to preventing diversion of nuclear energy from peaceful uses to nuclear weapons." In this view, IAEA safeguards can justifiably cover a broader scope than just nuclear materials; instead, they might be applied to other activities that could be associated with a nuclear weapon program. Indeed, some of the Treaty's drafters have written that this interpretation was the one they had in mind. However, it has not been the one that has been implemented for the last 25 years, and it would be difficult to gain international consensus behind this new interpretation, particularly since implementing it would require renegotiation of every safeguards agreement between the IAEA and a non-nuclear-weapon NPT party.

As an alternative, and at risk of creating a "two-tiered" inspection system, this interpretation could be adopted only for new safeguards agreements, for revisions to existing ones, or for states that voluntarily accede to this new interpretation by amending or accepting protocols to their safeguards agreement.

ISSUE: *Problem NPT states.*

"Problem NPT states" are those non-nuclear-weapon state members of the NPT that are suspected of harboring nuclear weapon ambitions despite their treaty commitments. Any measures that strengthen safeguards, particularly at undeclared sites, will bolster the IAEA's ability to deter, or detect, NPT violations. However, as stated above, the NPT does not prohibit states from developing and building facilities that could produce weapon materials, or even from using these facilities to stockpile weapon-usable materials, under the guise of a civil program. Should such a state leave the NPT, those facilities and materials would provide a substantial head start toward obtaining nuclear weapons. Measures that made it more diffi-

cult to withdraw from the NPT, or penalized a state for doing so, might therefore impede such a scenario, or at least encourage the international community to respond more forcefully to it.

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

The United Nations Security Council could goon record, for example, with a resolution declaring (well in advance of any particular case) that if a state withdrew from the NPT without surrendering all the direct-use nuclear materials it possessed under safeguards-and possibly any additional nuclear material or facilities that had originally been provided by NPT states—then that state would be considered a threat to international peace and security. Such a statement would open up 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; states maybe 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.

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 from states that are not parties to the NPT and are not otherwise subject to full-scope IAEA safeguards. The United States is seeking similar agreement to withhold nuclear technology and many categories of dual-use technology from Iran, a party to the NPT whose nonproliferation credentials the United States nonetheless judges to be dubious. This policy is quite controversial. For example, Iran and other observers argue that it violates not only the spirit but the letter of Article IV, paragraph 2 of the NPT:

> 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.

The United States response is that paragraph 1 of Article IV explicitly requires that technical cooperation be conducted "in conformity with Articles I and II," which ban the development of nuclear weapons by non-nuclear-weapon states. Although neither the United States nor the IAEA has provided evidence that Iran has violated its NPT commitments, the United States nevertheless believes Iran is seeking nuclear weapons. Therefore, the United States does not consider itself obligated to provide technical assistance.

ISSUE: *Capping nuclear weapon programs of non-NPT states.*

Some countries that are not prepared to admit to their nuclear weapon programs, or to formally reverse them by joining the NPT as non-nuclear-weapon states, may nevertheless become willing to limit or cap their unacknowledged activities. One approach to this end is the Clinton Administration's proposal, discussed below, to conclude a worldwide convention banning the production of nuclear materials for weapons or outside of safeguards. Other approaches are also presented below.

OPTION: *Expand the United Nations Security Council's ability to expose and even to render harmless clandestine nuclear weapon facilities worldwide.*

The IAEA has no authority to take coercive measures to expose or reverse nuclear proliferation. However, in their January 1992 declaration that proliferation of weapons of mass destruction constitutes a "threat to international peace and security," the heads of state of all the members of the U.N. Security Council raised the possibility that the Council might take forceful measures against proliferation under Chapter VII of the U.N. Char-

ter. The IAEA could contribute inspectors and expertise to such an effort, as it did in the case of the U.N. Special Commission on Iraq. That commission's role might be extended, or a similar body created, to receive and evaluate national intelligence information concerning possible clandestine nuclear programs in other countries, and to interact with the IAEA. Such an organization would be in a position to bring matters directly to the Security Council, eliminating the time that the IAEA might require to evaluate evidence of a clandestine nuclear site or other safeguards violation, ask for a special inspection to resolve its concerns, bring allegations of noncompliance to its Board of Governors (which might direct it to repeat its request to the state), and only then forward its concerns to the Security Council.

Establishing such an organization would have far-reaching implications. Only in the case of Iraq, whose invasion of Kuwait unambiguously branded it a threat to international peace and security, has the Security Council asserted the power to forcibly disarm a state of its capability to produce weapons of mass destruction. It is extremely unlikely that the Security Council would (or even could) delegate this power to any other organization, even one subordinate to it. Therefore, any such situation in the future would almost certainly require a case-by-case determination by the Security Council. In the absence of a grievous violation of international norms, Security Council members might be very reluctant to impose such a sanction again, fearing that they themselves might some day face similar action. (Such an argument could also be made with respect to members of the IAEA's Board of Governors, although the powers of that body are far more limited.) The Security Council's five permanent members could protect themselves with their vetoes, but they might be very reluctant to take action that would be perceived as being so self-serving, and that would call attention to the Council's discriminatory structure.

This option might also be opposed from two different directions: because it goes too far, or because it doesn't go far enough. Some would object that the IAEA already has the authority to conduct special inspections, and that creating a new organization for the same mission invites duplication, if not confusion. On the other hand, the United Nations' and the IAEA's memberships are largely overlapping. **If the IAEA is deemed institutionally incapable of taking forceful action against one of its members, the United Nations may not be much more successful.**

ISSUE: *Continued global production of materials usable for nuclear weapons.*

As long as stocks of materials usable in nuclear weapons are maintained and grow, the potential for nuclear weapon proliferation remains. Even nations that have agreed to the NPT may later decide to withdraw and use their formerly safeguarded fuels in weapons.

OPTION: *Push for multilateral agreements to end the production of nuclear materials for weapons or outside IAEA safeguards.*

The Clinton Administration has proposed such a ban in the hopes of at least capping, if not reversing, the production of nuclear materials for weapon purposes, especially among states not party to the NPT. Such states, including India, Israel, and Pakistan, might agree to join a global convention banning the production of any additional nuclear weapon materials provided that they were not required to admit to any previous production of such materials. (Making such a ban universal, binding nuclear-weapon states and non-nuclear-weapon states alike, would cap the arsenals of the acknowledged nuclear-weapon states as well as the

threshold states, and it would also avoid the explictly discriminatory aspects of the NPT.[13]) Such a ban would not directly affect the U.S. nuclear weapon program, since the United States has already declared a moratorium on further production of weapon materials. A formal ban would make such a decision by the United States more difficult to reverse in the unlikely occurrence that the nation would not only seek to build new nuclear weapons in the future but would also require more than the tons of weapon material being made available by ongoing weapon dismantlements.

A critical issue, however, is whether such an agreement would have the effect of legitimizing any nuclear arsenal such states may have. For example, any verification regime for such an agreement would implicitly or explicitly have to exclude stockpiles of weapon materials, since the convention would only address future production. Critics of this proposal believe that such an arrangement would damage more than help the nonproliferation regime. They also won-y that any proposal that permitted the continued production of weapon-capable material under safeguards would enable states to amass a stockpile of such material and then to withdraw from the convention, converting the material into weapons. Worse still, they fear that the United States will aggravate this possibility by assuring states that the convention indeed would permit the production of such material under safeguards-in effect, creating an "entitlement" to pursue activities that the United States would be better off opposing.

If such a fissile material production limitation agreement were enacted, a mechanism for verifying compliance would have to be instituted. Under the Clinton Adminstration proposal, this mission would be given to the IAEA, which has longstanding experience monitoring the production of nuclear materials. However, this additional mission would require significantly greater resources for IAEA safeguards. It would also have to be implemented in such a way that whatever special verification procedures were adopted for the nuclear weapon and the nuclear threshold states did not set precedents that would weaken current IAEA safeguards in non-nuclear-weapon NPT states.

OPTION: *Discourage or ban the production worldwide of all material usable in nuclear weapons, even for civil applications.*

Such an agreement would close the loophole in existing safeguards, and in the cutoff convention discussed immediately above, that would permit states to develop production facilities and even to stockpile weapon-usable materials under safeguards. Since the United States has long renounced pursuit of a plutonium fuel-cycle for its commercial nuclear powerplants, a ban on producing plutonium for civil purposes (one component of a ban on the production of weapon-usable material) would not affect U.S. plans for nuclear power. However, under such a ban, the United States would not be able to develop new research reactors fueled with highly enriched uranium. (Banning the production of weapon materials entirely would have no more effect on the U.S. nuclear weapon program than banning their production outside safeguards, since both would prohibit the production of nuclear material explicitly for weapon purposes.)

Although this measure would not directly affect the United States, states with substantial investment in plutonium fuel cycles, including Russia, Japan, France, and the United Kingdom, would strenuously object to it. Despite the lack of any economic incentives to do so for the foreseeable future, Japan and Russia, in particular, still have active plans to pursue a plutonium fuel cycle

[13] Such a cutoff would not discriminate among states in terms of their future activities, but by not addressing their past activities would leave the discriminatory structure of the regime intact. Under such a cutoff, neither the declared nuclear states nor the undeclared threshold states (India, Israel, or Pakistan) would be forced to reveal the existence of any already produced weapons or weapon materials, nor would they have to place existing materials under safeguards.

for their nuclear industry. This measure would prevent them from doing so.

OPTION: *Explore the feasibility of internationalizing certain aspects of the nuclear fuel cycle.*

Some nonproliferation analysts maintain that no system of international inspection of nuclear production facilities can provide sufficient protection against or warning of a state's decision to use those facilities to produce nuclear weapons. Preventing nuclear proliferation in the long run, they argue, requires broad international operation of such facilities. Under such a proposal, individual states or small groups of states would be prohibited entirely from constructing or operating such facilities, and the many billions of dollars worth of such facilities would be internationalized or closed. Given the massive institutional changes from the existing status quo, such a policy decision would have far-reaching implications and would face tremendous resistance.