CHAPTER 8

FALLING BEHIND: INTERNATIONAL SCRUTINY OF THE PEACEFUL ATOM*

Henry Sokolski

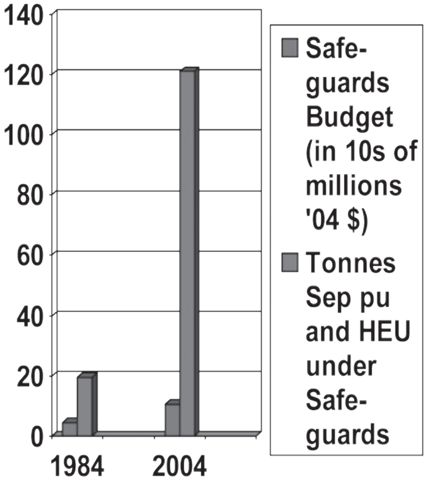
OVERVIEW

Some Negative Trends.

On a number of counts, the International Atomic Energy Agency (IAEA) safeguards system appears to be getting better. After more than a decade of no real growth, annual funding for nuclear inspections finally was increased in real terms from $89 million in 2003, to $102 million in 2004, and to $108 million in 2007. Deployment of advanced remote monitoring equipment is on the rise and implementation of new, more intrusive inspections authority under the Additional Protocol is moving forward. In the future, nuclear power might expand, but most of this expansion will take place in nuclear weapons states or countries that are so trustworthy that it could be argued that few, if any, additional nuclear inspections may be needed. As for additional safeguards requirements—e.g., inspections in India, North Korea, or Iran—they might well be met with additional contributions when and if they arise. From this perspective, current safeguards budgeting and planning could be viewed as being adequate to the task for years to come.[1]

*Originally published in Henry Sokolski, ed., *Falling Behind: International Scrutiny of the Peaceful Atom*, Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2008, pp. 3-61.

It could, that is, until other, less positive trends are considered. Of these, perhaps the most important deal with the number of significant quantities of nuclear material that the IAEA must safeguard to prevent it from being diverted and directly fashioned into bombs. This number is not only growing, but growing a rate far faster than that of the IAEA's safeguards budget. The amount of separated plutonium (Pu) and highly enriched uranium (HEU)—both nuclear fuels that can be fashioned into bombs in a matter of hours or days—that the IAEA inspects, for example, has grown more than six-fold between 1984 and 2004 while the agency's safeguards budget has barely doubled (see Figure 1). Meanwhile, the number of nuclear fuel fabrication and fuel making plants (facilities that are by far the easiest to divert nuclear material from) has grown in the last 2 decades from a mere handful to 65. Then, there is the number of other plants containing special nuclear material that the IAEA must safeguard: it has roughly tripled to more than 900 facilities today.[2]



From 1984 to 2004, IAEA safeguards spending roughly doubled $105 m in constant '04 dollars.

Amounts of HEU and separated Pu, meanwhile, grew nearly 6-fold—enough to make 12,000 to 21,000 crude nuclear weapons

Figure 1. IAEA Safeguards Spending vs. Mounting Weapons Usable Material Stockpiles.

These trends have forced the IAEA to work their inspections staff much harder. Over the last 20 years, the number of days IAEA inspectors have been in the field has nearly doubled from 60 to 70 days to 125 to 150.[3] This doubling has not only cost more money, it is one of the reasons (along with unreasonable employment and contracting rules) for a hollowing out of IAEA's experienced inspections staff. This hollowing out is expected to become acute. As noted by the U.S. Government Accountability Office, about 50 percent, or 30 out of 75, of the IAEA's senior safeguards staff are expected to retire by 2011.[4]

One way to address this inspections crunch is to have the IAEA simply inspect less. This could be done legally by implementing the Additional Protocol. In fact, limiting the number of routine safeguards inspections is one of the incentives the IAEA currently offers countries to sign up to the Additional Protocol. Once a country has ratified the Additional Protocol and the IAEA has established that there "is no indication of undeclared nuclear material activities for the state as a whole," the agency can reduce the number of routine nuclear inspections it makes of that country's nuclear materials and facilities significantly.[5]

The trouble with taking this approach, though, is that initially it actually *increases* the amount of staff time and resources that the IAEA would have to spend to safeguard a given country. It turns out that determining whether or not a country has no undeclared nuclear materials activities takes considerable safeguards staff resources.[6] Over the entire lifetime of a nuclear facility (i.e., 20 to 50 years), then, applying integrated safeguards might reduce the total amount of staff time needed to safeguard a particular set of nuclear plants slightly, but in the first few years, more, not less, staff time and safeguards resources would be consumed.[7]

Also, the Additional Protocol authorizes the IAEA to conduct wide area surveillance inspections. These would be extremely useful in the case of Iran or North Korea. They also would require significant additional safeguards staff and funding (by one estimate made for the Nonproliferation Education Center [NPEC] by a seasoned former IAEA inspector, perhaps an increase in funding constituting as much as 30 percent of the IAEA's entire current safeguards budget[8]). So far, the IAEA has done nothing to establish such an inspections capability.

Finally, relying heavily on integrated safeguards may be unsound in principle. As already noted, they require the IAEA to determine that the country in question has no undeclared nuclear material. Yet, the IAEA's safeguards staff itself has admitted that it cannot yet be relied upon to discover covert nuclear fuel-making facilities in the hardest cases (e.g., Iran). Also, reducing the frequency of on-site inspections increases the risks that a member state might divert materials to make bombs without the IAEA finding out until it is too late.

In a detailed study completed for NPEC late in 2004 on the proliferation risks associated with light water reactors, several scenarios were presented under which fresh and spent nuclear fuel rods might be diverted to make nuclear weapons fuel in covert reprocessing or enrichment plants in a matter of days or weeks without tipping off IAEA inspectors[9] These scenarios were subsequently validated independently by key officials working within the IAEA's Standing Advisory Group on Safeguards, the U.S. Department of State, and the Los Alamos National Laboratory.[10]

That a country could evade IAEA inspectors in diverting entire fuel rods is disquieting. One would assume that the current crop of IAEA remote nuclear monitoring equipment could be counted upon entirely to warn against such diversions. In fact, they cannot.[11] Most of the currently deployed remote sensors, in fact, do not allow the IAEA even to know from day to day whether these systems are activated. This is a serious shortcoming. Over the last 6 years, the agency has learned of camera "blackouts" that lasted for "more than 30 hours" on 12 separate occasions. What's worse, it only learned of these blackouts *after* inspectors went to the sites and downloaded the camera recordings as they are required to do every 90 days.[12]

Under new proposed "integrated safeguards" procedures, such "downloading," moreover, would occur as infrequently as every 12 months—a period within which a state could conceivably make a nuclear weapon unbeknownst to the IAEA.[13] The IAEA staff recently proposed to correct this inspections gap by accelerating implementation of near real-time monitoring using satellite communication connections. This effort, though, is still being implemented at an excruciatingly slow pace due to a lack of funds.[14]

Structural Problems.

The current gap in the IAEA's near-real time monitoring capabilities may be worrisome but it, at least, can be addressed if additional safeguards funding is made available. Far more intractable is the IAEA's inability to detect diversions in a timely manner from nuclear fuel-making plants. As already noted, NPEC's earlier study on the proliferation dangers associated with light water reactors highlighted the relative ease with which states might build covert reprocessing plants or divert spent civilian fuel to accelerate undeclared uranium enrichment efforts.

Additional NPEC commissioned research detailed just how poorly IAEA safeguards have performed at nuclear fuel plants in Europe and Japan. In his study, "Can Nuclear Fuel Production in Iran and Elsewhere Be Safeguarded against Diversion,"[15] Dr. Edwin Lyman highlights several examples. At a fuel fabrication plant at Tokai-mura in Japan making mixed-oxide (MOX) fuel out of powdered uranium and nuclear weapons-usable separated plutonium, the IAEA could not account for 69 kilograms of plutonium. This is enough to make at least nine nuclear weapons (assuming the IAEA's 8 kilograms per weapon estimate) or twice that figure (assuming the U.S. Department of Energy's more accurate 4 kilograms per crude nuclear weapon figure). Only after the passage of 2 years, the expenditure of $100 million, and the disassembling of the plant could the operator claim that he could account for all but 10 kilograms (i.e., one to two bombs worth).[16]

Dr. Lyman details a similarly disturbing incident involving MOX scrap in Japan where at least one bomb's worth of weapons-usable plutonium went missing and another accounting discrepancy at a Japanese reprocessing plant at which the IAEA lost track of between 59 and 206 kilograms of bomb-usable plutonium (and was able to determine this only years *after* the material initially went unaccounted for). Add to these discoveries the many bombs' worth of material unaccounted for (MUF) annually at reprocessing plants in France and the United Kingdom (UK) where the IAEA has employed its very latest near-real time monitoring techniques, and there is cause for alarm.[17]

The picture relating to safeguarding centrifuge enrichment plants is not much brighter. Even at plants where IAEA monitoring and inspectors are on site, there will be times in between inspections during which remote monitoring might be defeated. There also is the constant problem of the operator giving false design, production, or capacity figures.[18]

In any case, the times between a decision to divert and having enough material to make a crude bomb (assuming the IAEA's high estimate of 25 kilograms of highly enriched uranium being required to make one weapon) are so short, even an immediate detection of the diversion, which is by no means assured, would generally come too late to afford enough time to prevent bombs from being made. In the case of a small commercial-sized plant, a bomb's worth could be made in as little as 18 hours to 12 days (depending on whether natural or slightly enriched uranium is used as feed).[19]

SAFEGUARDS ASSUMPTIONS

Exacerbating this safeguards gap is the IAEA's overly generous view of how much material must be diverted to make a bomb (referred to by the IAEA as a "significant quantity") and how long it might take to convert this material into a nuclear weapon (known as the "conversion time"). Most of these IAEA estimates were made over 30 years ago. To reassess their accuracy, NPEC commissioned Thomas Cochran, chief nuclear scientist at the Natural Resources Defense Council (NRDC), to make new determinations. His analysis and conclusions were revealing. The IAEA estimates it would take eight kilograms of separated plutonium and 25 kilograms of highly enriched uranium to make a crude bomb. Cochran found these estimates to be too high by a minimum of 25 percent and a maximum of 800 percent, depending on the weapons expertise employed and the yield desired (see Figure 2).[20]

	WEAPON-GRADE PLUTONIUM (kg)			HIGHLY-ENRICHED URANIUM (kg)		
Yield	Technical Capability			Technical Capability		
(kt)	Low	Medium	High	Low	Medium	High
1	3	1.5	1	8	4	2.5
5	4	2.5	1.5	11	6	3.5
10	5	3	2	13	7	4
20	6	3.5	3	16	9	5

Values rounded to the nearest 0.5 kilogram.

Figure 2. NRDC Estimate of the Approximate Fissile Material Requirements for Pure Fission Nuclear Weapons.

When presented with these figures, senior IAEA safeguards staff did not dispute them. Instead they argued that the "exact" amount of diverted nuclear material needed to make a crude bomb was not important. Instead, what mattered most was the IAEA's ability to detect microscopic amounts of weapons usable materials since securing such environmental samples was the factor most likely to put an inspected party in the international spotlight.[21]

The potential downside of taking this approach, however, is significant. It is these estimates, along with the agency's projections of how long it takes a proliferator to convert uranium and plutonium materials into bombs (i.e., conversion times), that the IAEA uses to determine how often it should conduct its inspections of different nuclear facilities. If these estimates are too high, the frequency of inspections needed to detect military diversions risks being egregiously low. Certainly, what the IAEA defines as desirable "detection times"—the maximum time that may elapse between the diversion of a significant quantity of nuclear material and the likely detection of that diversion—should correspond (according to the IAEA's own guidelines) to the agency's estimated conversion times. If they do not, IAEA-inspected countries could count on being able to divert a crude weapon's worth of nuclear material and fashioning it into a bomb before the IAEA could either detect the diversion or have any chance of taking appropriate action to block bomb making.

This worry seems quite legitimate when one considers how high the IAEA's 30-year old significant quantity estimates appear to be and then looks at how generous the IAEA's estimated conversion times are (see Figure 3).

Beginning Material Form	Conversion Time
Pu, HEU, or ^{233}U metal	Order of days (7-10)
PuO_2, $Pu(NO_3)_4$ or other pure Pu compounds, HEU or ^{233}U oxide or other pure U compounds, MOX or other nonirradiated pure mixtures containing Pu, U (^{233}U + $^{235}U \geq 20\%$), Pu, HEU, and/or ^{233}U in scrap or other miscellaneous impure compounds	Order of weeks (1-3)*
Pu, HEU, or ^{233}U in irradiated fuel	Order of months (1-3)
U containing <20% ^{235}U and ^{233}U, Th	Order of months (3-12)

*This range is not determined by any single factor, but the pure Pu and U compounds will tend to be at the lower end of the range and the mixtures and scrap at the higher end.

Figure 3. Conversion Times.[22]

Using the history of the Manhattan Project as a benchmark, the IAEA's first set of estimates regarding the amount of time (7 to 10 days) needed to convert separated plutonium or HEU or U233 metal were judged by Dr. Cochran to be the correct order of time. The key reason why is that in 1945, the plutonium and enriched uranium for the first American bombs had to be shipped thousands of miles from where they were produced to where the material was fashioned into nuclear weapons. This transport took several days. If a country making nuclear weapons did not have to ship these distances, the conversion time could be much shorter. However, the conversion times could still be on the order of a day or more.

The IAEA's estimates of how long it would take (1 to 3 weeks) to convert fresh plutonium-uranium fuels (known as mixed oxide fuels or MOX) do not fare as well. Here, Dr. Cochran points out that it would take no more than a week and possibly as little as a few days to convert these materials into metal bomb components. Instead of a matter of weeks, he concludes that the correct conversion time should be measured in a matter of days.

As for the IAEA's conversion time estimates of 1 to 3 months for plutonium, HEU, or U233 contained in irradiated spent reactor fuel, these were also judged to be accurate *only* if the country possessing these materials did not have a covert or declared reprocessing or enrichment plant. If the country in question did, then it could possibly convert the spent fuel into bombs in a matter of weeks rather than months.

Finally, Dr. Cochran agreed with the IAEA's low end estimated conversion time of 3 months for low enriched uranium but, with the increased international availability of gas centrifuge uranium enrichment technology, found the IAEA's high end estimate of 12 months to be totally unwarranted. In fact, as already noted, a country might well be able to convert low enriched uranium into a bomb in a matter of weeks or less.[23]

The policy ramifications of these overly generous IAEA estimates are significant. They directly impact what the IAEA's detection goals should be. In three cases—the conversion of low enriched uranium, the conversion of plutonium, HEU, and U233 metal conversion—the order of time associated with the IAEA estimates is correct. In another three cases, however—the conversion of plutonium, HEU, and U233 in MOX (and conversion of these materials in spent fuel and of low enriched uranium if the inspected country has a covert or declared nuclear fuel-making facilities)—the IAEA's estimates are egregiously high. IAEA conversion times are measured in months when they should be measured in weeks and in weeks when they should be measured in days.

As a result, the IAEA's timeline detection goals in many cases are dangerously high. More important, the agency's current detection goals give the mistaken impression that the IAEA can detect military diversions before they result in bombs or even early enough to prevent the diversion from succeeding when this clearly is not the case. Dr. Cochran's analysis highlights that timely detection of plutonium, HEU, and U233 in metal and in fresh MOX is simply not possible. He concludes that countries that do not yet have nuclear weapons should not be allowed to stockpile or produce these materials. He reaches the same conclusion regarding the agency's ability to detect diversions of plutonium, HEU, and U233 in spent fuel in nonweapons states that may have a declared or covert enrichment or reprocessing plant. In these cases, the problem is not that the IAEA's timeliness detection goals are too liberal; it is the IAEA's claims that timely detection is possible at all (see Figure 4).

MATERIAL	IAEA Conversion Time	Cochran/NPEC Commissioned Estimate	Official IAEA Timeliness Detection Goal	Cochran Conclusions and Recommended Timeliness Detection Goals
Pu, HEU, U233 in metal form	Order of days (7-10)	Order of days (7-10)	1 month	Timely detection is not possible
In fresh MOX	Order of weeks (1-3)	Order of days (7-10)	1 month	Timely detection is not possible
In irradiated spent fuel	Order of months (1-3)	Order of months (1-3), if reprocessing - enrichment plant on tap (7-10 days	3 months	For countries with covert or declared nuclear fuel-making plants, timely detection is not possible
Low enriched uranium	Order of months (3-12)	Order of weeks to months	1 year	For countries with covert or declared enrichment plants, timely detection is not possible

Figure 4. IAEA Detection Times.

To some extent, these critical conclusions are gaining official support. As the IAEA's former director for safeguards recently explained, when it comes to nuclear fuel making, the IAEA is must rely on its limited ability to ascertain the inspected country's military intent.[24] Even the director general of the IAEA conceded that once a country acquires separated plutonium and HEU, the IAEA must start relying on these states' continued peaceful intentions, which could change rapidly. Unfortunately, the IAEA's Board of Governors and major governments, including the United States, do not yet appreciate the full implications of these points.

If the IAEA cannot provide timely detection of diversions of weapons-usable HEU and plutonium from centrifuge enrichment, spent fuel reprocessing, and other fuel-making plants, how can it claim that it is "safeguarding" such facilities in Brazil, the Netherlands, Germany, and Japan? How can it effectively safeguard an Indian reprocessing plant (as is being currently proposed by the Indian government as a way to allow for the reprocessing of foreign fuel for use in an unsafeguarded Indian breeder reactor)? What of the idea of promoting regional nuclear fuel-making centers in nonweapons states, such as Kazakhstan? How might the IAEA prevent diversions?[25]

What of other more ambitious missions for the IAEA? If one cannot keep track of many bombs' worth of nuclear weapons-usable material produced annually at declared civilian nuclear fuel-making plants, or assure that the plants themselves would not be taken over by nonconforming parties, how much sense does it make to encourage the IAEA to oversee an even more difficult to verify military fissile production cut-off treaty?[26] Finally, there is the question of large research reactors and nuclear power plants, which require lightly enriched fuel to produce significant quantities of plutonium. If the IAEA cannot reliably ferret out covert nuclear fuel-making programs, how safe is it to export the necessary machinery to new countries particularly in war-torn regions such as the Middle East?

The questions here are all intentionally rhetorical. Yet, many experts and officials within the IAEA and the U.S. and other governments actively support at least one or more of the questionable nuclear initiatives referred to. This needs to change. One of the Cochran report's key recommendations is to encourage governments and the IAEA to reassess the agency's estimates of what constitutes a significant quantity along with the conversion times for various materials and what the proper detection goals should be for the agency. The most important part of this reassessment is clarifying precisely what nuclear materials and activities—i.e., militarily significant diversions—IAEA inspections cannot be counted on to detect in a timely fashion. These activities and materials include plutonium, HEU, and U233; making MOX; enriching uranium with centrifuges; reprocessing and fabricating plutonium-based fuels; and operating large research or power reactors in nonweapons states that might have covert or declared nuclear fuel-making plants.

For these nuclear activities and materials, the IAEA would do well simply to declare that the agency can monitor, but not safeguard them—i.e., that it can surveill these facilities and materials loosely but not assure detection of their possible military diversion in a timely fashion. Such an honest announcement would be helpful. First, it would put governments on notice about how dangerous the conduct of certain nuclear activities most closely related to bomb making actually are. Second, it would encourage countries to demand more monitoring and physical security of these unsafeguardable nuclear materials and activities. The primary aim in increasing such security and monitoring would not be to block diversions so much as to increase the chance of at least detecting them after they had occurred. This would help to deter such deeds and to limit further the risks of nuclear theft or sabotage. It is difficult to determine what the optimal level of monitoring and physical security might be for this purpose. But a good place to start would be to upgrade physical security at nuclear facilities handling or producing nuclear weapons-usable materials to those standards currently employed at the most secure nuclear weapons production and storage facilities.

FUNDING

As already noted, the IAEA's inspections of safeguardable nuclear materials and activities could be enhanced in a number of ways. More near-real time monitoring could significantly enhance the agency's ability to detect the diversion of fuel rods. Retention and increasing the numbers of experienced nuclear inspectors could help assure that the IAEA actually meets its temporal detection goals and is able to analyze remote sensing information and imagery properly. Full support for the IAEA's environmental sampling activities would enable it to replace its aging Safeguards Analytical Laboratory and help the IAEA shorten the time needed to analyze samples from months to weeks or days. Much needed work to develop new safeguarding research capabilities and equipment could proceed much more quickly if more funds were made available[27] Similarly, with proper funding, the IAEA could muster reserve inspections staff and resources to meet unexpected demands and to provide the agency with deployable wide-area surveillance capabilities.

The first step to address these current gaps is simply to admit that they exist. For years, the IAEA has avoided doing this publicly. At the very outset of NPEC's investigations, early in 2005, the IAEA's safeguards planning staff briefed NPEC that it believed safeguards funding for the mid-term (i.e., the following 5 years) was sufficient. It conceded that it had given little or no thought to what funding agency safeguards might require beyond this period.

Fortunately, in the last 2 years, the agency's approach to safeguards planning has improved. Most recently the IAEA's director general highlighted the agency's lack of safeguards funding to deal with urgent inspections requirements associated with monitoring the shutdown of the reactor in North Korea. In a statement he made July 9, 2007, Dr. El Baradei explained that the IAEA was having difficulty obtaining the nearly 4 million euros needed to cover the monitoring costs. He went on to note:

> The DPRK case clearly illustrates the need for the agency to have an adequate reserve that can be drawn upon to enable it to respond promptly and effectively to unexpected crises or extraordinary requests, whether in the areas of verification, nuclear and radiological accidents, or other emergencies. The agency's financial vulnerability is also demonstrated by our current cash situation, which indicates that unless some major donors pay their outstanding contributions by the end of next month, the agency will have to draw from the Working Capital Fund in order to continue operations. *And unless contributions are received by September, that Fund would be depleted.* Finally, let me stress that the recent process of preparing and getting approval for the programme and budget for the next biennium has once again highlighted the urgent need for adequate resources to ensure effective delivery of the entire programme that you have requested. As I made clear during the last Board, even with the budget originally proposed by the Secretariat, the agency remains under-funded in many critical areas, a situation which, if it remains unaddressed, will lead to a steady erosion of our ability to perform key functions, including in the verification and safety fields.

At the conclusion of this statement, the director general then announced that he had initiated a study to examine the IAEA's "programmatic and budgetary requirements" over the "next decade or so." In addition, he announced his intention to create a high level panel to study options for financing the agency's requirements.[28]

The director general's announcement accords almost precisely with the recommendations Dr. Thomas Shea made to a select group of U.S. and European officials, including Dr. El Baradei's top scientific advisor, Andrew Graham, at an NPEC-sponsored conference held in Paris, France, on November 13, 2006.[29] In his brief, "Financing IAEA Verification of the NPT," Dr. Shea argued that North Korea "provides a clear justification" for additional safeguards funding and that to secure it the Director General "should convene a council of wise men to assist in determining how best to respond in this matter."[30]

As has been noted, the IAEA's funding is based on a United Nations (UN) formula that weights a donor country's gross domestic product and other factors. This formula may be sensible for raising general funds, but for nuclear safeguards purposes, it produces several anomalies. Countries with no large reactors (e.g., Italy) are sometimes asked to pay in more than countries that have a score or more of them (e.g., the Republic of Korea). The UN assessment method also overlooks the actual inspections requirements imposed by particular nuclear facilities that are significantly higher than the norm. Nuclear fuel-making plants of any type, reactors that are fueled on-line, and fast reactors all impose additional inspection challenges that are significantly more stringent than other types of nuclear facilities. Inspecting or monitoring these facilities costs much more than it does for other nuclear plants, yet the operator or owner pays no premium to cover these additional expenses.

Finally, because the IAEA's current approach to assessing its members for contributions fails to raise enough money for the Department of Safeguards, the agency must depend on additional voluntary contributions of cash and technical assistance. Almost all of the voluntary contributions come from the United States (amounting to roughly 35 percent of the IAEA's safeguards budget.). That so much of the safeguards budget is paid for voluntarily by the United States is politically awkward since the agency's most challenging inspections cases—e.g., India, Iran, North Korea, Taiwan, and South Korea—are all of special interest to Washington.[31]

Dr. Shea suggests several ways to increase funding for safeguards—ranging from setting up an endowment to selling bonds. All of them are worth pursuing but one of his ideas is particularly deserving: The customer (i.e., the inspected party) should pay. There already is a precedent for doing this. Taiwan, which the IAEA does not recognize as being an independent sovereign nation, does not pay as other nations do but instead pays what the IAEA estimates it costs the agency to inspect Taiwan's plants.

The Shea report recommends that the United States take the lead in getting the IAEA to help fund its safeguards activities with a user fee. The United States should continue to make its voluntary contributions but instead of making them as it currently does, Washington should justify them as representing a specific percentage cost associated with generating nuclear electricity annually in the United States. Japan, which also makes voluntary contributions, should be urged to do likewise. Agreement might subsequently be reached on an international standard, and this surcharge should be tacked on to the cost of electricity or other products these civilian plants produce. The last step would be to make the surcharge obligatory and assign all of the funds so raised to the IAEA's Department of Safeguards.

In addition to these funds, the agency should consider assessing an additional charge for the monitoring of unsafeguardable nuclear materials or facilities (e.g., nuclear fuel-making plants and nuclear weapons or near-nuclear weapons-usable fuels, etc.). Finally, an additional fee might be levied against nuclear facilities or plants that are particularly costly to the IAEA in meeting its own timeliness detection goals (e.g., for reactors fueled on-line).

RIGHTS

Some countries, of course, are likely to bridle at these proposals, arguing that imposing surcharges would interfere with their right to peaceful nuclear energy. These arguments, however, should be rejected. The exercise of one's right to develop, research, and produce peaceful nuclear energy hardly extends to not paying what it costs to safeguard these activities against military diversion. Also, the premise behind the argument for nonpaying represents a dangerously distorted view of the nuclear rules, viz., that so long as a state can claim a nuclear material or activity has some conceivable civilian application, it has a right to so engage even if they are unprofitable commercially, bring their possessor to the very brink of having bombs, or cannot be safeguarded against military diversion. The danger of this over-generous interpretation of the NPT is obvious: It risks, as UN General Secretary Koffi Anan explained to the 2005 NPT review conference, creating a dangerous world full of nuclear fuel-producing states that claim to be on the right side of the NPT, but are, in fact, only months or even days from acquiring nuclear weapons.[32]

Luckily, as research conducted for NPEC makes clear, this interpretation of the NPT is wrong.[33] The NPT makes no mention of nuclear fuel making, reprocessing, or enrichment. Spain, Romania, Brazil, and Mexico all tried in the late 1960s to get NPT negotiators to make it a duty under Article IV for the nuclear supplier states to supply "the entire fuel cycle" including fuel making, to nonweapons states. Each of their proposals was turned down.[34] At the time, the Swedish representative to the NPT negotiations even suggested that rules needed to be established to *prevent* nations from getting into such dangerous activities since there seemed to be no clear way to prevent nations from quickly fabricating bombs by diverting either the fuel or the fuel-making plants to such a purpose.[35] The Swedes were certainly were not interested in protecting uneconomical measures that are unnecessary and that could bring states to the brink of having bombs.[36]

A clear case in point was the NPT's handling of peaceful nuclear explosives, which turned out to be so dangerous and impossible to safeguard that the treaty spoke only of sharing the "potential benefits" of peaceful nuclear explosives that would be supplied by nuclear weapons states. No effort, however, was ever made to request or to offer such nuclear explosives because they were so costly to use as compared to conventional explosives and no clear economic benefit could be found in using them.[37]

Finally, in no case did the framers of the NPT believe that the "inalienable right" to develop, research, or produce peaceful nuclear energy should allow states to contravene the NPT restrictions designed to prevent the proliferation of nuclear weapons. These restrictions are contained in Articles I, II, and III of the treaty. Article I prohibits nuclear weapons states from "assist[ing], encourag[ing], or induc[ing] any nonweapons state to manufacture or otherwise acquire" nuclear weapons. Article II prohibits nonweapons states from acquiring in any way nuclear explosives or seeking "any assistance" in their manufacture. Together these two prohibitions suggest that the NPT not only bans the transfer of actual nuclear explosives, but of any nuclear technology or materials that could "assist, encourage or induce" nonweapons states to "manufacture or otherwise acquire" nuclear explosives.[38]

If there was any doubt on this point, the NPT also requires all nonweapons states to apply inspection safeguards against all of their nuclear facilities and holdings of special nuclear materials. The purpose of these nuclear inspections, according to the treaty, is "verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons."[39] It was understood at the time of the treaty's drafting that it was hoped a way could be found to assure such safeguards. It, however, was not assumed that such techniques already existed.[40]

CONCLUSION

It would be useful to remind members of the IAEA of these points. The most direct and easiest way to begin is to make clear what can and cannot be safeguarded—i.e., what can and cannot be monitored so as to detect a military diversion *before* it is completed.

Beyond this, the IAEA should requie the owner, operators, and customers of nuclear facilities to bear the costs associated with monitoring and safeguarding them. The hope here would be that the poor economics associated with large nuclear power reactors and nuclear fuel-making plants might persuade some nations to reconsider the desirability of acquiring them. Making sure that the full external costs of IAEA inspections are carried by each inspected party would be useful. The NPT, after all, is dedicated to sharing the "benefits" of peaceful nuclear energy, not conducting money-losing programs that bring countries to the brink of having bombs.[41]

ENDNOTES - CHAPTER 8

1. This line of argument was actually presented to NPEC's executive director in a private briefing by the IAEA safeguards planning staff in Vienna early in 2006.

2. For data on the IAEA's safeguards budget obligation in current—not constant—U.S. dollars, see *The Agency's Accounts for 1984*, GC(XXIX)/749, Vienna, Austria: IAEA, August 1985, p. 26; and *The Agency's Accounts for 2004*, GC(49)/7, p. 47. For data on the amount of nuclear material safeguarded by the IAEA, *see Annual Report for 1984*, GC(XXIX)/748, Vienna, Austria: IAEA, July 1985, p. 63; and *Annual Report for 2004*, GC(49)/5, Annex, Table A19.

3. Private interviews with safeguards staff and former IAEA safeguards inspectors at the Los Alamos National Laboratory, Los Alamos, New Mexico, May 12, 2005.

4. See Gene Aloise, Director, Natural Resources and Environment, U.S. Government Accountability Office, "Nuclear Nonproliferation: IAEA Safeguards and other Measures to Halt the Spread of Nuclear Weapons Materials," testimony before the Subcommittee on National Security, Emerging Threats and International Relations, Committee on Government Reform, House of Representatives, September 26, 2006.

5. For a more detailed discussion of the Additional Protocol, see Richard Hooper, "The IAEA's Additional Protocol," *Disarmament Forum* "On-site Inspections: Common Problems, Different Solutions," No. 3, 1999, pp. 7-16, available from *www.unidir.ch/bdd/fiche-article.php?ref_article=209*.

6. For example, in the case of Japan, the IAEA needed 5 years to determine that it had no undeclared nuclear material activities, and estimates that it will need about as much time to make the same determination for Canada. See *Nuclear Nonproliferation*, Washington, DC: U.S. Government Accountability Office (USGAO), pp. 12-13.

7. According to IAEA internal analyses, the average lifetime savings in safeguards resources likely from implementing integrated safeguards may be no more than 5 percent. See C. Xerri and H. Nackaerts on behalf of the ESARDA Integrated Safeguards Working Group, "Integrated Safeguards: A Case to Go Beyond the Limits: Consequences of Boundary Limits Set to the Reduction of 'Classical Safeguards Measures on Efficiency and Resources Allocation in Integrated Safeguards'" produced in 2003 for the IAEA, available from *esarda2.jrc.it/bulletin/bulletin_32/06.pdf*. For an official overview of the various safeguards resources required to implement the Additional Protocol, see Jill N. Cooley, "Current Safeguards Challenges from the IAEA View," an IAEA document produced in 2003, available from *esarda2.jrc.it/events/other_meetings/inmm/2003-esarda-inmm-Como/1-paper%20pdf/1-1-040127-cooley.pdf*.

8. See Garry Dillon, "Wide Area Environmental Sample in Iran," available from *www.npec-web.org/Essays/WideAreaEnvironmentalSampling.pdf*.

9. See Victor Gilinsky, Harmon Hubbard, and Marvin Miller, *A Fresh Examination of the Proliferation Dangers of Light Water Reactors*, Washington, DC: The Nonproliferation Policy Education Center, October 22, 2004, reprinted in Henry Sokolski, ed., *Taming the Next Set of Strategic Weapons Threats*, Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2006, available from *www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20041022-GilinskyEtAl-LWR&PDFFolder=Essays*.

10. See, e.g., Andrew Leask, Russell Leslie, and John Carlson, "Safeguards As a Design Criterion—Guidance for Regulators," Canberra, Australia: Australian Safeguards and Non-proliferation Office, September 2004, pp. 4-9, available from *www.asno.dfat.gov.au/publications/safeguards_design_criteria.pdf.*

11. For more detailed discussion of how fuel diverted from different commercial and research reactors could help accelerate a country's covert bomb program, go to Appendix II of this report.

12. See J. Whichello, J. Regula, K. Tolk, and M. Hug, "A Secure Global Communications Network for IAEA Safeguards and IEC Applications," IAEA User Requirements Document, May 6, 2005.

13. The problem of states "losing" fuel rods, it should be noted, is not limited to countries intent on diverting them to make bombs. The U.S. civilian nuclear industry, which has a clear industrial interest in keeping track of its nuclear fuel, has had difficulty keeping proper account of all of it. On this point, see *NRC Needs to Do More to Ensure Power Plants Are Effectively Controlling Spent Fuel*, GAO O5-339, Washington, DC: U.S. Government Accountability Office, April 2005, available from *www.gao.gov/new.items/d05339.pdf*.

14. Only about a third of the facilities the IAEA currently has remote sensors at have near-real-time connectivity with Vienna or other regional headquarters, and almost all of these facilities are in countries that are of minimal proliferation risk. This information was presented at a private IAEA Department of Safeguards briefing of NPEC's executive director at Vienna, Austria, at IAEA Headquarters, January 30, 2006.

15. See Edwin Lyman, "Can Nuclear Fuel Production in Iran and Elsewhere be Safeguarded Against Diversion," presented at NPEC´s Conference "After Iran: Safeguarding Peaceful Nuclear Energy" held in London, UK, October 2005, available from *www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=Paper050928LymanFuelSafeguardDiv&PDFFolder=Essays*.

16. This incident received only scant public attention. See Bayan Rahman, "Japan 'Loses' 206 kg of Plutonium," *Financial Times*, January 28, 2003, available from *news.ft.com;servlet/ContentServer?pagename=FT.com/StoryFT/FullStory&c=StoryFT&cid=1042491288304&p=10112571727095*.

17. *Ibid*. Also see "Missing Plutonium 'Just on Paper,'" *BBC News*, February 17, 2005, available from *news.bbc.co.uk/1/hi/uk/4272691.stm*; and Kenji Hall, "Missing Plutonium Probe Latest Flap for Japan's Beleaguered Nuclear Power Industry," *Associated Press* (Tokyo), January 28, 2003, available from *www.wise-paris.org/index.html?/english/othersnews/year_2003/othersnews030128b.html&/english/frame/menu.html&/english/frame/band.html*.

18. These points have been long recognized by outside experts. See Paul Leventhal, "Safeguards Shortcomings—A Critique," Washington, DC: NCI, September 12, 1994; Marvin Miller, "Are IAEA Safeguards in Plutonium Bulk-Handling Facilities Effective?" Washington, DC: NCI, August 1990; Brian G. Chow and Kenneth A. Solomon, *Limiting the Spread of Weapons-Usable Fissile Materials*, Santa Monica, CA: RAND, 1993, pp. 1-4; and Marvin Miller, "The Gas Centrifuge and Nuclear Proliferation," *A Fresh Examination of the Proliferation Dangers of Light Water Reactors*, Washington, DC: NPEC, October 22, 2004, p. 38.

19. See *ibid*.; also see the comments of the former chairman of the IAEA's Standing Advisory Group on International Safeguards, John Carlson, Australian Safeguards and Non-Proliferation Office, "Addressing Proliferation Challenges from the Spread of Uranium Enrichment Capability," Paper prepared for the Annual Meeting of the Institute for Nuclear Materials Management, Tucson, Arizona, July 8-12, 2007. Copy on file at NPEC.

20. See Thomas B. Cochran, "Adequacy of IAEA's Safeguards for Achieving Timely Warning, " paper presented before a conference cosponsored by NPEC and King's College, "After Iran: Safeguarding Peaceful Nuclear Energy," October 2-3, 2005, London, UK, available from *www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=Paper050930CochranAdequacyofTime&PDFFolder=Essays*.

21. Interview of senior advisors to the IAEA Director Gen-

eral, IAEA Headquarters, Vienna, Austria, January 17 2005, and January 30, 2006.

22. *IAEA Safeguards Glossary,* 2001 Ed., Paragraph 3.13, Vienna, Austria: IAEA. Figure 2 here is identified as Table I in the glossary.

23. Cf. the low-end conversion time estimates for low enriched uranium of John Carlson in note 19 above, which for a small commercial enrichment facility range between 18 hours and 12 days.

24. See the testimony of Pierre Goldschmidt before a hearing of the House Subcommittee on National Security and Foreign Affairs of the House Committee on Oversight and Government Reform, "International Perspectives on Strengthening the Nonproliferation Regime," June 26, 2007, Washington, DC, available from the subcommittee upon request.

25. See Ann MacLachian, Mark Hibbs, and Elaine Hiruo, "Kazakh Buy-in to Westinghouse Seen as Win-Win for Kazakhs, Toshiba," *Nucleonics Week*, July 12, 2007, p. 1; and Kenneth Silverstein, "As North Korea Gives Up Its Nukes, Kazakhstan Seeks a Nuclear Edge," *Harper's Magazine,* July 2007, available from *harpers.org/archive/2007/07/hbc-90000549*.

26. On the challenges of verifying a military fissile production cut-off treaty, see Christopher A. Ford, "The United States and the Fissile Material Cut-off Treaty," presented at the Conference on "Preparing for 2010: Getting the Process Right," Annecy, France, March 17, 2007, available from www.state.gov/t/isn/rls/other/81950.htm.

27. For a detailed discussion of what specific new safeguards capabilities the IAEA Department of Safeguards is investigating, see N. Khlebnikov, D. Parise, J. Whichello, "Novel Technology for the Detection of Undeclared Nuclear Activities," IAEA-CN148/32, presented at the IAEA Conference on Safeguards held in Vienna, Austria, October 16-20, 2006, available from *www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20070301-IAEA-NovelTechnologiesProject&PDFFolder=Essays*.

28. See IAEA Director General Dr. Mohamed El Baradei, "Introductory Statement to the Board of Governors," July 9, 2007, Vienna, Austria, available from *www.globalsecurity.org/wmd/library/news/dprk/2007/dprk-070709-iaea01.htm*.

29. See Thomas E. Shea, "Financing IAEA Verification of the NPT," paper presented at a conference sponsored by the Nonproliferation Policy Education Center and the French Foreign Ministry, "Assessing the IAEA's Ability to Verify the NPT," November 12-13, 2006, Paris, France, available from *www.npec-web.org/Essays/20061113-Shea-FinancingIAEAVerification.pdf*.

30. *Ibid*.

31. See U.S. GAO, *Nuclear Nonproliferation,* pp. 34-40.

32. See UN Secretary General Kofi Annan, Statement to the Nuclear Nonproliferation Treaty Review Conference, May 2, 2005, UN Headquarters, New York, available from *www.acronym.org.uk/docs/0505/doc11.htm*.

33. Robert Zarate, "The NPT, IAEA Safeguards and Peaceful Nuclear Energy: An ´Inalienable Right,´ But Precisely To What?" presented at "Assessing the IAEA´s Ability to Safeguard Peaceful Nuclear Energy," a conference held in Paris, France, November 12-13, 2006, available from *www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20070509-Zarate-NPT-IAEA-PeacefulNuclear&PDFFolder=Essays*.

34. See "Mexican Working Paper Submitted to the Eighteen Nation Disarmament Committee: Suggested Additions to Draft Nonproliferation Treaty," ENDC/196, September 19, 1967, U.S. Arms Control and Disarmament Agency, *Documents on Disarmament, 1967*, Publication No. 46, Washington, DC: U.S. Government Printing Office, July 1968, pp. 394-395; "Romanian Working Paper Submitted to the Eighteen Nation Disarmament Committee: Amendments and Additions to the Draft Nonproliferation Treaty," ENDC/199, October 19, 1967, in *ibid.*, pp. 525-526; "Brazilian Amendments to the Draft Nonproliferation Treaty," ENDC/201, October 31, 1967, in *Ibid.*, p. 546; and "Spanish Memorandum to the Co-Chairman of the ENDC," ENDC/210, February 8, 1968, in U.S. Arms Control and Disarmament Agency, *Documents on Disarmament, 1968*, Publication No. 52, Washington, DC: U.S. Gov-

ernment Printing Office, September 1969, pp. 39-40.

35. See "Statement by the Swedish Representative [Alva Myrdal] to the Eighteen Nation Disarmament Committee: Nonproliferation of Nuclear Weapons," ENDC/PV. 243, February 24, 1966, in U.S. Arms Control and Disarmament Agency, *Documents on Disarmament, 1966*, Publication No. 43, Washington, DC: U.S. Government Printing Office, September 1967, p. 56.

36. See Eldon V. C. Greenberg, "NPT and Plutonium: Application of NPT Prohibitions to 'Civilian' Nuclear Equipment, Technology and Materials Associated with Reprocessing and Plutonium Use," Washington, DC: Nuclear Control Institute, 1984 (Rev. May 1993).

37. See *Report of Main Committee III*, Treaty on the Nonproliferation of Nuclear Weapons Review and Extension Conference, May 5, 1995, NPT/CONF.1995/MC.III/1, Sec. I, para. 2, emphasis added, available from *www.un.org/Depts/ddar/nptconf/162.htm*, which states:

The Conference records that the potential benefits of the peaceful applications of nuclear explosions envisaged in article V of the Treaty have not materialized. In this context, the Conference notes that the potential benefits of the peaceful applications of nuclear explosions have not been demonstrated and that serious concerns have been expressed as to the environmental consequences that could result from the release of radioactivity from such applications and on the risk of possible proliferation of nuclear weapons. Furthermore, no requests for services related to the peaceful applications of nuclear explosions have been received by IAEA since the Treaty entered into force. The Conference further notes that no State party has an active programme for the peaceful application of nuclear explosions.

38. See Greenberg, "NPT and Plutonium"; and Henry D. Sokolski and George Perkovich, "It's Called *Non*proliferation," *Wall Street Journal*, April 29, 2005, p. A16.

39. NPT, Art III, para. 1.

40. For example, see "British Paper Submitted to the Eighteen

Nation Disarmament Committee: Technical Possibility of International Control of Fissile Material Production," ENDC/60, August 31, 1962, Corr. 1, November 27, 1962, U.S. Arms Control and Disarmament Agency, *Documents on Disarmament, 1962*, Publication No. 19, Vol. 2, Washington, DC: U.S. Government Printing Office, November 1963, pp. 834-852.

41. On these points, see Henry Sokolski, "Market-based Nonproliferation," testimony presented before a hearing of the House Committee on Foreign Affairs, "Every State a Superpower? Stopping the Spread of Nuclear Weapons in the 21st Century," May 10, 2007.