Report

Raising International Standards for Protecting Nuclear Materials from Theft and Sabotage

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The break-up of the Soviet Union resulted in conditions that focused attention on the possible risk of "loose nukes." But the risk from insecure nuclear materials is not limited to the former Soviet Union; there is a need to ensure adequate physical protection on a global basis. Weapons-usable materials—plutonium and highly enriched uranium (HEU)—are spread widely around the world. A significant portion of these materials exists in civilian rather than military inventories. For example, some 12 countries (Belgium, China, France, Germany, India, Italy, Japan, the Netherlands, Russia, Switzerland, the United Kingdom, and the United States) possess among them over 180,000 kilograms of separated, *civilian* weapons-usable plutonium—as compared with approximately 250,000 kilograms in weapons or weapons reserves.[1] It takes only a few kilograms of this material to make a nuclear weapon.[2] If any of this material were stolen or illegally removed from an existing inventory, it could be used by another country or terrorist organization to make a bomb. Without effective cooperative efforts between many countries to guard weapons-usable materials, no government can protect its people from the threat of nuclear weapons in the hands of terrorists or hostile states.

In 1997, the US Department of Energy (DOE) established a goal of guarding weapons-usable materials just as well as US nuclear weapons are guarded.[3] However, many civilian weapons-usable materials are not yet so protected even in the United States. And, even if they were, that might not reduce American risks much if other countries continued to maintain lower standards. Hostile countries or terrorist groups that want to obtain weapons-usable materials are likely to go wherever these materials can most easily be bought or stolen.

US efforts from 1997 to 1999 to press for higher international standards for protection of these materials helped strengthen *recommendations* for greater protection published by the International Atomic Energy Agency (IAEA), but they failed to create any international *requirements* for such protection. Moreover, the strengthened recommendations still fell well short of the DOE goal. This report will briefly describe the current threats to weapons-usable materials, discuss the DOE goal for protecting these materials, and outline what the recommended international standards provide. Then it will report on the results of recent US efforts to strengthen these standards and make them obligatory. It will conclude with recommendations for further steps to improve global protection of weapons-usable materials.

THE THREAT FROM "LOOSE" WEAPONS-USABLE MATERIALS

The principles of physics involved in making a simple nuclear weapon such as the one exploded over Hiroshima are widely known. The main technical barrier that today prevents non-nuclear states or terrorist organizations from making nuclear weapons is the difficulty of acquiring the necessary plutonium or highly enriched uranium, the weapons-usable materials.[4] That is one reason why the US government has spent so much money through the Nunn-Lugar and related nonproliferation assistance programs, now collectively known as the "Expanded Threat Reduction Initiative" (ETRI), to improve the security of such materials in Russia and other former Soviet republics.[5] After the Soviet Union dissolved, its protection based upon "guards, guns, gates and gulags," plus KGB monitoring of contacts with foreigners, became less effective, particularly in places where the government could no longer afford to pay a living wage to the guards or to others who had access to the material.[6] When the resulting dangers became evident from reports of illicit trafficking in nuclear materials in Russia and other former Soviet republics, the United States initiated assistance, now part of the ETRI program, to support US-Russian cooperation to protect this material.

But ETRI has been unable to deal promptly with all the many locations in the former Soviet republics where weapons-usable material exists. Adequate protection is probably still years away.[7] The current US estimate is that there are about 650,000 kilograms of civilian and military weapons-usable materials in Russia and the other former Soviet republics, not including the material in Russian weapons. Most of this is in Russia. DOE has announced adequate protection so far for only 50,000 kilograms of the material in Russia.[8]

There are, in addition, poorly guarded weapons-usable materials in many other countries. The IAEA lists 138 reported incidents of illicit trafficking in nuclear material, including some weapons-usable material, as of September 1999.[9] There have been several documented cases of theft of weapons-usable material of one or more kilograms.[10] Poorly guarded materials include plutonium separated from spent nuclear fuel from ordinary electric power reactors, and HEU for running many research reactors.[11] Both the Aum Shinrikyo cult and Osama bin Laden's terrorist group sought to obtain nuclear weapons or the materials to make them in Russia or other former Soviet republics as well as in other countries.[12] So far as we know, they have not been successful. But illicit trafficking that goes undetected may not be discovered until too late.

PAST EFFORTS TO NEGOTIATE INTERNATIONAL STANDARDS TO PREVENT THEFT

There is no treaty requiring countries that possess weapons-usable material to protect it from being stolen. When the nuclear Non-Proliferation Treaty (NPT) was drafted in the 1960s, the primary concern was that countries using nuclear energy for peaceful purposes might divert weapons-usable materials to nuclear weapons programs of their own. To make this less likely, the NPT required non-nuclear weapon states (NNWS) to accept IAEA safeguards. These obligate NNWS to establish a state system of accounting and control for their nuclear material and to allow IAEA inspectors to review this system and their nuclear operations in order "to verify, in ascertaining that there had been no diversion of nuclear material from peaceful purposes to nuclear weapons, the findings of the state system."[13] IAEA safeguards agreements with these countries sometimes refer to the need for "control" of the nuclear material so that it can be accounted for. But they do not require *physical protection* of the material from theft or sabotage.[14] "Control" includes such things as electronic monitors to detect radiation or tampering, and reactor seals that, if broken, would suggest that the reactor had been opened.[15]

These control measures, along with national accounting systems and IAEA inspections and reviews of national accounting, help to increase physical security of the material subject to IAEA safeguards even though there is no explicit physical protection requirement. But even these safeguards requirements are absent for nonparties to the NPT (Cuba, India, Israel, and Pakistan) and for the nuclear weapon states (NWS) that are NPT parties (China, France, Russia, the United Kingdom, and the United States). The NPT's safeguards requirement does not apply to them.

In 1972, when the negotiations to prescribe IAEA safeguards requirements for non-weapon NPT parties were completed, the IAEA became the locus for a new negotiation among experts to provide standards for physical protection. The result, however, was *recommended* standards; no treaty was produced that would create obligatory standards in every country that became a party. The agreed recommended standards were published in

1975 as IAEA Information Circular 225, referred to as INFCIRC/225/Corrected. This and its later revisions are not formal agreements and do not have "parties." They contain recommendations for all countries that have nuclear material to protect. However, IAEA inspectors who verify the accounting required by NPT safeguards are not directed to check on physical protection. They are thus not required to report on such matters as whether there are walls and fences to protect weapons-usable material, whether there are electronic sensors to detect its removal, whether those who have access to it have any kind of clearance, or whether guards with guns are present to protect it from attack and robbery.

Later in the 1970s, a treaty containing *required* physical protection standards was negotiated. However, some of the negotiating countries opposed its application to any nuclear materials except those that were in transit from one country to another. Hence, the treaty covers only nuclear materials for peaceful purposes that are in international transport or in temporary storage as part of international transport.[16] It therefore applies to only a small proportion of all weapons-usable material, and usually only briefly. The treaty, the Physical Protection Convention of 1980, has not been amended since then to be more broadly applicable. It also contains no provision for inspections or other verification of whether its parties have satisfied its limited requirements. Moreover, as of late 1999, it had only 64 parties.[17]

The result is that there is wide variation from state to state in the way that nuclear material is guarded. Moreover, there is no central office to collect information on physical protection practices around the world. In a survey of state practices in 19 countries (based upon accounts from experts from those countries recorded at 1997 Stanford and IAEA conferences on physical protection) two things stood out: the great variation in country practices shown by the data and the lack of information provided by some countries about specific practices.[18] The survey collected information concerning:

- the potential threats to their countries' nuclear materials as perceived by experts from each country;
- the human and technological elements of physical protection systems, ranging from how guards are selected and armed to the sensors used to monitor nuclear-material storage vaults; and
- the existing laws and national regulatory frameworks, including national management and review of physical protection practices through inspections and tests.

The survey suggested that the wide differences in practices were caused by several factors besides the absence of enforced international standards:

- differences in the perception from country to country of the threat to their nuclear materials;
- differences in the financial ability of countries to pay for strong walls, monitoring equipment, or guard forces;
- differences in the national laws and regulatory authority, including the independence of the regulators from the regulated entities and the provisions (if any) for national inspection or testing of physical security installations; and
- differences in cultural attitudes toward such things as arming guards, requiring background investigations of personnel with access to weapons-usable material, and structuring national regulatory systems.[19]

Since the end of the Cold War, major efforts to improve international cooperation on physical protection have taken place. But, in the former Soviet Union, much weapons-usable material is still in buildings where the security has not been substantially upgraded. For example, one expert believes that most of these buildings do not yet have portal monitoring equipment that would detect the removal of weapons-usable material if guards did not detect it or were not on duty at the time it was taken.[20]

Some countries, including Russia and the United States, have agreed to "take into account" the INFCIRC/225 recommendations published by the IAEA.[21] These agreements do not usually provide for inspections or other verification, though visits to some protected sites are sometimes possible. In a variety of agreements authorizing export of nuclear materials and equipment, many recipient countries have agreed to give weight to these IAEA recommended standards. Eight countries with major activities involving plutonium (Belgium, China, France, Germany, Japan, Russia, the United Kingdom, and the United States—but not India or Israel) have agreed to consider these recommendations in their practices, as appropriate.[22]

Several countries have adopted national legislation or regulations providing standards like those in the IAEA-published recommendations. The Russian Federation has adopted obligatory standards that are higher in some

respects than Revision 3 of INFCIRC/225 and that, like US regulations, require periodic inspections or testing by national authorities. However, as in the United States, if the material is held by either the defense or atomic energy ministry, the inspections or tests are often conducted by that agency, not an independent one.[23] The IAEA has provided "peer reviews" of physical protection at nuclear facilities in some smaller countries, and those countries have usually been rewarded by financial assistance from European Union (EU) members, Japan, or the United States to help pay for any improvements in physical protection they have been willing to make.[24]

Except for the few agreements in which states have agreed to provide protections at least as high as those of INFCIRC/225, these standards are not mandatory. However, they represent the current global standards for physical protection.[25]

RECENT EFFORTS TO RAISE INTERNATIONAL STANDARDS

The American "Stored Weapons Standard"

In 1994, research by a committee of the US National Academy of Sciences made clear the need for a major improvement in physical protection standards. At the end of the Bush administration, the Academy had been asked by National Security Advisor Brent Scowcroft to consider how to dispose of the plutonium that would be made excess by US-Soviet dismantlement of thousands of nuclear weapons due to arms reduction agreements and reciprocal withdrawals of these weapons from Western Europe, from non-Russian Soviet republics, and from naval vessels of the Soviet Union and the United States.[26]

The Academy committee became concerned about protecting the vast quantities of material from these dismantled weapons. Among other things, it recommended that "to the extent possible, the high standards of security and accounting applied to storage of intact nuclear weapons should be maintained for [weapons-usable nuclear] materials…."[27] The Academy called this the "stored weapons standard" and recommended that inspectors visit sites where weapons-usable material was stored to judge how good the protection was. In 1997, the DOE accepted the Academy's "stored weapons" goal not just for the plutonium from the dismantled weapons but, in general, for plutonium and HEU under its jurisdiction. In a major study that was reviewed by other agencies and the White House, the DOE concluded that "the most attractive types of material in the [DOE] graded safeguards system—material that could be used directly in nuclear weapons or could be readily converted to such use—will, to the extent practicable, be protected and accounted for just as nuclear weapons themselves are."[28] So far, however, no major changes in physical protection of weapons-usable material held by DOE have been announced except that DOE is using the same "safe, secure transports" for carrying such materials from place to place as it uses for weapons.[29]

While the DOE report did not describe in any detail what the "stored weapons standard" means in practice, DOE's regulations and those of the Department of Defense do so. For example, under that standard, two and a half kilograms or more of plutonium in storage would have to be secure against a violent, external assault by a hostile group using guns and vehicles (including possibly a helicopter), in which the group was assisted by an insider who knew where and how the stored material was protected. This is one of the "design basis threats" for the stored weapons standard, i.e., the realistically possible threats considered when designing a facility and planning the personnel and equipment needed for its protection.[30]

Specific US requirements for protecting stored nuclear weapons against such a threat include, for example, a strong, secure storage vault with a single entry surrounded by two layers of strong fences and an open, lighted area where no one can hide. Access to the vault is supposed to be limited to those with a need for access, who are cleared through full-field background investigations, and who are accompanied by another such person (the "two-person" rule). These access limitations are to be enforced by electronic monitoring devices and armed guards at the site—supported in case of need by nearby armed backup forces. All these personnel are supposed to be trained to deal with a threat such as that described above, and their competence tested periodically in exercises like war games.[31]

Strengthened IAEA Recommendations

A comparison of this stored weapons standard with the IAEA recommendations in effect until 1999 (INFCIRC/225, Revision 3) showed that the US standard was much higher.[32] In 1999, as a result of IAEA-sponsored negotiations among experts from interested countries, strengthened IAEA recommendations were issued: INFCIRC/225, Revision 4. They still fail to live

up to the stored weapons standard in significant respects. For example, as discussed above, one of the threats against which the standard requires protection is an armed attack using a vehicle. Establishing "design basis threats" like this is critical to making sure that physical protection requirements are adequate. Revision 4 for the first time refers to the *idea* of a design basis threat, saying it "is an essential element of a State's system of physical protection."[33] But Revision 4 does not define even a minimum recommended global design basis threat for the most attractive weapons-usable material it describes: two or more kilograms of unirradiated plutonium. Instead, it says that a state's physical protection system "should be based upon the *State's* evaluation of the threat."[34]

If some countries decide for themselves that no threats to their material exist, how will other countries be protected? If Aum Shinrikyo or Osama bin Laden had acquired sufficient plutonium or HEU in Russia, the bomb made from it could well have been used in another country. As the IAEA's director general states in the preface to Revision 4, while responsibility for physical protection rests with each state that has weapons-usable material, "it is not a matter of indifference to other States whether and to what extent that responsibility is fulfilled."[35]

In the reports made by experts at the 1997 Stanford and IAEA conferences to compare physical protection practices, there was great variety in the threat perceptions from country to country. Among the 19 countries for which experts' reports were compared, 10 reported that they perceived possible threats from terrorists' attempts to acquire material, five from ordinary theft, and five from sabotage. Only Russia and the United States reported that they perceived threats from all three. And seven countries did not provide information on any perceived threat.[36]

One important scenario where there is variation in national protection practices is the threat of insider thefts or insider cooperation with outsider groups. Among the countries that reported on their practices, only Japan, through its expert at the Stanford conference, said explicitly that it had adopted "no specific measures… against the 'insider' problem."[37] A reason for this difference in threat perception was suggested by another Japanese expert at the IAEA conference:

> Because of the homogeneity of the racial composition of the Japanese population, the society is relatively secure and safe; the stability of the society, which is due to economic development, and the high standard of the police force have contributed to minimizing crime…. The 'family register' system [and residence registration systems]…make it easier to confirm personnel identity, thereby providing a deterrent to crime….[38]

Unlike Japan, both Russia and the United States take measures to deal with insider threats. In 1995, Russia's nuclear regulatory agency, Gosatomnadzor, surveyed the known thefts of materials in the nuclear facilities that had come under its jurisdiction after its creation in the early 1990s. As described at a 1999 Institute of Nuclear Materials Management (INMM) meeting, *every* such theft involved insiders and *none* of the thefts had been detected by the physical protection or material accounting and control systems then in place. The stolen nuclear materials included thefts of kilogram amounts of enriched uranium. At the time of the study, there were no regular assessments of the effectiveness of these systems against insider threats, which is one of the functions that Gosatomnadzor is to perform. The Russian expert who described the thefts said that, despite efforts at change, Russian nuclear facilities had inadequate protection programs against theft by insiders.[39]

At the 1999 INMM meeting, the Japanese expert who had participated in the Stanford conference suggested Revision 4 could have a positive impact. He specifically cited the IAEA's recommendation that each country establish and periodically re-evaluate "design basis threats" for its facilities, as well as conduct exercises to test whether the guards, sensors, and other protections were adequate. He said these new recommendations could lead to changes in Japan's current physical protection standards.[40]

However, the new IAEA recommendations still do not specify the threats countries must try to address, meaning national variations in perceived threat may persist. What these differences in threat perception might mean in practical terms is evident from the design basis threat given in the US regulations summarized above. If, for example, the designers of protection measures assume that they must defend against the possibility of trucks crashing through the fences guarding the outer perimeter of an area where material is stored, they will require strong vehicle barriers wherever vehicles might attempt to penetrate. However, of the 19 countries in the

sample that provided information, only the Czech Republic, Germany, Japan, and the United States reported that they require such barriers for weapons-usable-material protection.[41]

It is impossible to prescribe by rule or recommendation all the detailed requirements for plausible threats. But some consensus on the major threats that weapons-usable materials face around the world would certainly help designers and contribute to more effective protection.

Not only does Revision 4 fail to state any minimum design basis threat, its other recommendations are less strict than the US stored weapons standard. It does not, for example, require two surrounding fences and outdoor lighting to protect a vault with weapons-usable material, as the stored weapons standard does. Instead, it says that the highest category of weapons-usable material (e.g., two kilograms or more of plutonium) should be used or stored within an "inner area located in a protected area."[42]

Unlike the stored weapons standard, Revision 4 contains no requirement that access limitations be enforced both by armed guards and by electronic monitoring devices. Indeed, it no longer even "encourages" the use of *armed* guards, as Revision 3 did. However, it says: "When guards are not armed, compensating measures should be applied. The objective should be the arrival of adequately armed response forces in time to counter armed attacks and prevent unauthorized removal of nuclear material."[43] Thus, response forces on call near the site where the material is kept are to be armed to deal with the problem. The British and the Japanese both have an aversion to armed guards at the site even for weapons-usable material, but the British now provide nearby armed response forces of the kind recommended by Revision 4.[44]

If one assumes that a storage site for plutonium might be attacked by vehicles containing armed men—as the stored weapons standard assumes—is this adequate? New provisions of Revision 4 to deal with sabotage now recommend that vehicle barriers be built to protect storage sites or reactors from attacking vehicles.[45] While this does not meet the stored weapons standard, it demonstrates an appreciation of the problem.

Unlike the stored weapons standard, monitoring devices in addition to guards are not recommended by Revision 4 for the initial access point to a site. But it now recommends them for emergency exits.[46] This is part of a provision recommending that "entries and exits be minimized (ideally only one)."[47] The assumption appears to be that entries to "inner areas" where material is stored can be adequately guarded by personnel, but that unguarded emergency exits such as fire escapes should at least be protected by electronic sensors so that nuclear material cannot be taken through them undetected.

Also unlike the stored weapons standard, Revision 4 does not recommend that personnel with access to weapons-usable material have full-field background investigations before they are hired. Instead, it says that access should be "limited to persons whose trustworthiness has been determined"—except for temporary workers, who must be accompanied by regular personnel whose trustworthiness has been determined.[48] In actual practice, there are wide variations in the ways that trustworthiness is checked. The Japanese, consistent with their view of the close-knit nature of their society, do not seek background investigations of their guards or other personnel with access to weapons-usable material. Instead:

> Personnel checks, normally made at the place of employment are deemed to be sufficient. Business people or workers are generally stationed together with many others in a large room rather than working in individual offices. Implicit mutual surveillance, in effect, exists in this system.[49]

Germany checks criminal and other records on prospective employees but does not question neighbors and associates. Few countries reported an American-style "full-field background investigation" in which neighbors, associates, and banks are questioned. And, many countries simply did not report what they did to check prospective employees.[50]

Revision 4 also does not follow the stored weapons standard in recommending that access to storage rooms for weapons-usable material be limited to two cleared personnel going in together—the "two-person rule." Two persons are recommended only when one of them is a visiting construction worker or some other temporary worker.[51]

The stored weapons standard requires periodic unannounced inspections or tests by outsiders of the protection capacity of the facilities that store weapons-usable

material. Of the sample of 19 countries taken from the Stanford and IAEA conferences, only two, France and the United States, reported that they required such inspections. But 10 countries reported periodic routine inspections, and four reported that they had had "peer reviews" by experts from other countries. No information was available on tests or inspections by seven of the 19 countries.[52] Revision 4 recommends evaluations of physical protection measures by operators of particular facilities. These are to include tests of equipment, communications, guards, and response forces, and they are to be reviewed by the government agency with authority over the facility.

Revision 4 reflects greater concern about nuclear terrorism than did Revision 3. Revision 3 had a few provisions designed to prevent sabotage to nuclear material and facilities. But Revision 4 contains a new chapter on "nuclear sabotage," which it defines as an attack that could "endanger the health and safety of personnel, the public and the environment by exposure to radiation or release of radioactive substances."[53] There are now detailed provisions on protecting nuclear power reactors as well as stored nuclear materials from such sabotage.[54]

Attempts to Strengthen the Physical Protection Convention

Numerous proposals to strengthen the Physical Protection Convention have been made over the years.[55] In 1998, US Secretary of State Albright wrote to other foreign ministers making such a recommendation, and a US draft revision of the Convention was sent to foreign offices.[56] This draft would make the Convention's standards applicable to domestic use, storage, and transport of civilian nuclear material, not just to material in international transport. It proposed that physical protection measures adopted by each Convention party "shall at a minimum provide protection comparable to the recommendations set forth in the current version of IAEA Document INFCIRC/225." At the time, Revision 4 had been negotiated but not yet issued. The Convention amendment draft provided that revisions of INFCIRC/225 adopted *after* the amendment went into effect would be applicable to each party only if and when the party accepted that revision.[57] The US draft would also require each party to report to the IAEA on its physical protection measures at least every five years, and it would provide for review conferences of the parties every five years at which these reports could be discussed.[58] It would not require IAEA inspections or "peer review" visits to physical protection sites, and it suggested that requests from the IAEA or parties for specific information could be overridden by national laws protecting confidential information about nuclear matters.[59] Moreover, it did not propose to change the Convention's exception for military nuclear materials and would thus apply only to materials for civilian purposes.

These proposed amendments produced both discussion and opposition. A committee of experts from some 40 countries met in Vienna in late 1999 and early 2000 to consider whether there was a need to amend the Convention. For these meetings, the IAEA Secretariat provided a list of additional options for amendment beyond those in the US draft. To show the need for change, the Secretariat's paper referred to:

- the cases of illicit trafficking in weapons-usable nuclear material that have been reported in recent years;
- the increased privatization of the nuclear electric energy industries in several countries, a change that suggested a possibly greater need for national and international standards for domestic protection of nuclear material; and
- the increasing quantities of nuclear material available and expected to become available for peaceful uses as a result of the dismantlement of nuclear weapons.[60]

The IAEA Secretariat listed three areas in which revision had been proposed in the past and suggested several possible amendments covering these and other areas. The three areas of principal concern were:

- the absence of any obligation in the Convention to protect material in domestic use, storage, and transport;
- the absence of provisions requiring protection of nuclear facilities such as reactors from sabotage; and
- the absence of any obligation with respect to nuclear material still under military jurisdiction.[61]

In a note to the experts' meeting, however, five EU countries with major nuclear activities stated that they believed it "inopportune" to "consider the case for revision of the Convention at this point." These five were Belgium, France, Germany, Sweden, and the United Kingdom, all possessors of significant amounts of civilian plutonium to which the standards would apply if they became a requirement. Before considering whether the Convention should be revised, these five countries

suggested that studies be made of the actual likelihood of illicit trafficking and of the results already achieved from the assistance and training on physical protection provided to a few Eastern European and Latin American countries by the IAEA and by some advanced nuclear countries, including several of these five.[62]

After discussion, the other experts accepted this proposal for further study rather than the US proposal to revise the Convention. They also agreed that a smaller group of experts would meet periodically with the hope of reporting to the larger group by May 2001 on the results of the studies.[63] Clearly the United States failed to persuade even its EU allies that strengthening the Convention was urgent. After the meeting, it gave the participants a statement that it still supported revising the Convention to make it applicable to domestic nuclear material that is not in international transport, but would not seek mandatory acceptance of the standards of INFCIRC/225, Revision 4. Instead it would ask for language such as "giving due consideration" to INFCIRC/225. Moreover, it would no longer seek a requirement for periodic national reports on physical protection, to be discussed periodically at review conferences. It would seek instead some other mechanism through which parties could demonstrate that they were observing the Convention.[64] These were major concessions in an attempt to achieve consensus on at least some revisions of the Convention. More expert group discussions of possible revisions will continue until at least June 2001.

The Proposed Convention on Nuclear Terrorism

A working group of the legal subcommittee of the UN General Assembly has been drafting an International Convention for the Suppression of Acts of Nuclear Terrorism based upon draft language submitted by Russia in 1996.[65] One provision would have required that parties adopt legislation and regulations "to ensure physical protection of nuclear material, nuclear fuel,…radioactive substances, nuclear installations…as well as protection against illegal or unauthorized access to them by third parties."[66] As revised by a working group, the draft treaty would suggest that parties follow the IAEA recommendations in INFCIRC/225: "For the purpose of preventing offences under this Convention, States Parties shall make every effort to adopt appropriate measures to ensure the protection of radioactive materials [including nuclear material] taking into account relevant recommendations and functions of the International Atomic Energy Agency."[67] Thus, if this new draft treaty were to go into force, its parties would be expected to make good faith efforts to protect their materials taking the then current revision of INFCIRC/225 into account.

Some developing countries, however, have objected to a convention to prohibit nuclear terrorism that does not also prohibit any use of nuclear weapons by nuclear weapon states.[68] A coordinator selected to seek resolution of this issue reported in late 1999 that the task appeared to be "enormous."[69] No estimate of when or whether the task would be completed was given.

RECOMMENDATIONS

The INFCIRC/225 suggestions for physical protection published by the IAEA have become a worldwide standard for protecting weapons-usable materials in military as well as civilian hands, and in domestic storage and use as well as in international transport. But, unless the Physical Protection Convention is amended to refer to these recommended standards, or some other such requirement is adopted, there will be no global obligation to apply them. Neither the consensus necessary to amend the Physical Protection Convention to do this nor that needed to complete the draft convention on nuclear terrorism appears to be present at the moment.

Moreover, while the level of protection of INFCIRC/225's Revision 4 for weapons-usable material is higher than before, it is not as high as the DOE's stored weapons standard. However, the consensus of country experts needed to raise the standards again in the near future does not exist.

What can be done? There are at least four steps that could be taken now without waiting for the international consensus needed to change international legal obligations.

1. **Maintain Efforts to Improve Physical Protection in the United States and the Newly Independent States (NIS).** The ETRI program to improve physical protection standards for weapons-usable material in Russia and other former Soviet republics should be continued and strengthened.[70] Moreover, the United States should take steps to strengthen its own national standards if it expects Russia and other countries to strengthen theirs. The "stored weapons standard" is an

admirable goal, but it appears to have been ignored in practice.

2. **Announce Unilateral Adherence to IAEA Standards.** The United States should announce that it now accepts INFCIRC/225, Revision 4 as a minimum standard for physical protection of its weapons-usable material, and that it will promptly bring any non-conforming sites into compliance.[71] As indicated above, it agreed with some countries to make good faith efforts to achieve INFCIRC/225 standards, and it urged parties to the Physical Protection Convention to revise that Convention to make Revision 4 an obligatory minimum. Just as the United States stopped nuclear weapon testing in 1992 and helped initiate the current moratorium on testing pending entry into force of the Comprehensive Test Ban Treaty, so, pending entry into force of Physical Protection Convention amendments, it should implement what it has asked other countries to accept.[72]

3. **Expand Peer Reviews.** The IAEA's peer review program should be expanded to include countries beyond the smaller and less affluent states that have been the prime objects of peer review so far. Could it include the United States? This form of peer review involves actual visits to sites to observe physical protection. To protect the confidentiality of some aspects of such visits, the "managed access" procedures used in some arms control agreements might be used. The United States could set a good example by accepting peer review of facilities that would be covered by the US-proposed amendments to the Physical Protection Convention. This would not, of course, include weapons sites, but only those for non-military purposes under the US proposal.

In 1967, when a US- and Soviet-proposed NPT article calling for IAEA safeguards on the peaceful nuclear activities of non-nuclear weapon countries was sharply criticized by many potential parties (including important US allies), the United States volunteered one of its nuclear power plants for inspection by the IAEA to show that such inspections need not interfere with operations. As one of those involved in the negotiation of this proposed NPT article, I believe that the US offer to accept inspections made a difference in gaining ultimate acceptance of it, particularly by US allies.[73]

4. **Begin Voluntary Information Collection.** The IAEA Board of Governors should direct the Secretariat to develop a questionnaire on physical protection that would ask states to provide answers voluntarily to questions about their physical protection practices. The Board could also consider asking IAEA inspectors to begin collecting data on physical protection when they visit sites subject to safeguards inspections. The Center for Nonproliferation Studies (CNS) 1999 assessment of US nonproliferation assistance to the NIS provides considerable information on Russia's physical protection practices as well as those of other former Soviet republics.[74] The 1997 IAEA and Stanford conferences and recent annual meetings of the Institute for Nuclear Materials Management have collected data piecemeal from participants from Russia and some other countries. However, these sources do not cover all countries, are mostly more than two years old, and do not always cover the same subjects because there is no standard questionnaire. A questionnaire to be completed by each country each year for its nuclear materials could be a first step toward producing comparable information from a broader group of participants. It would be especially helpful if such a questionnaire were based upon the standards of INFCIRC/225, Revision 4.

Some states insist that much of the information about physical protection must be classified; otherwise, they say, terrorists or others would use it to penetrate their physical protection systems. But a great deal of information has been provided by some states to CNS, to the IAEA and Stanford conferences, and to recent INMM meetings. What is proposed here is to standardize voluntary submissions by providing reasonably precise questions to be answered so that better comparisons can be made. Again, the United States might set a good example by preparing such a questionnaire for facilities to be covered by its proposed amendments to the Physical Protection Convention and providing the information for itself to the IAEA.[75]

CONCLUSION

Efforts to protect weapons-usable nuclear materials from theft and sabotage will not be effective against terrorists and aspiring nuclear weapon states unless adequate standards are applied to all potential sources of such materials worldwide. Several valuable recommendations for improved standards have been made recently, but the international consensus to make them obligatory is lacking. Unilateral announcements of adherence to recommended standards and voluntary provision of information by states about their physical protection practices could increase the momentum behind raising international standards for protecting nuclear materials.

[1] David Albright and Lauren Barbour, "Separated Inventories of Civil Plutonium Continue to Grow," *ISIS Plutonium Watch* (Washington, DC: Institute for Science and International Security, 1999), pp. 2-3. These estimates were for the end of 1997, and the amount of civil plutonium continues to grow.

[2] See, e.g., J. Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman, and Jacob Wechsler, "Can Terrorists Build Nuclear Weapons?" in Paul Leventhal and Yonah Alexander, eds., *Preventing Nuclear Terrorism* (Lexington, MA: Lexington Books, 1987), pp. 55-65; US Department of Energy, *Nonproliferation and Arms Control Assessment of Weapons-Usable Material Storage and Excess Plutonium Alternatives* (Washington, DC: US DOE, 1997), pp. 35-39.

[3] US Department of Energy, *Nonproliferation and Arms Control Assessment*, pp. 35-39.

[4] Ibid., p. 1; Matthew Bunn and John Holdren, "Managing Military Uranium and Plutonium in the United States and the Former Soviet Union," *Annual Review of Energy and Environment* 22 (1997), pp. 403-486; Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Materials* (Washington, DC: Carnegie Endowment for International Peace and Harvard Project on Managing the Atom, 2000), pp. 1, 6. In this report, "weapons-usable" material means separated plutonium or uranium enriched to 20 percent or more uranium-235.

[5] See John W.R. Lepingwell and Nikolai Sokov, "Strategic Offensive Arms Elimination and Weapons Protection, Control, and Accounting," *The Nonproliferation Review* 7 (Spring 2000), p. 59; Russian American Nuclear Advisory Council, *Russian Nuclear Security and the Clinton Administration's Fiscal Year 2000 Expanded Threat Reduction Initiative: A Summary of Congressional Action* (Princeton, NJ: RANSAC, Feb. 2000), available at <http://www.princeton.edu/~ransac/congress/fy00/etri-1.html>; Jessica Eve Stern, "Cooperative Activities to Improve Fissile Material Protection, Control and Accounting," in John M. Shields and William C. Potter, eds., *Dismantling the Cold War: US and NIS Perspectives on the Nunn-Lugar Cooperative Threat Reduction Program* (Cambridge, MA: Center for Science and International Affairs, 1997), pp. 317-324. (The Defense Department part of this combined program is called Cooperative Threat Reduction or CTR).

[6] Statement of Amb. Eileen Malloy, US Department of Energy, to conference on Assessing US Dismantlement and Nonproliferation Assistance Programs in the Newly Independent States, sponsored by the Center for Nonproliferation Studies, Monterery, CA, December 12, 1999; James Clay Moltz, "Russian Nuclear Submarine Dismantlement and the Naval Fuel Cycle," *The Nonproliferation Review* 7 (Spring 2000), pp. 76-77.

[7] Emily E. Daughtry and Fred Wehling, "Cooperative Efforts to Secure Fissile Material in the NIS," *The Nonproliferation Review* 7 (Spring 2000); Moltz, " Russian Nuclear Submarine Dismantlement," pp. 85-86; M. Bunn, *The Next Wave*, pp. 75-106.

[8] Malloy, Statement; Daughtry and Wehling, "Cooperative Efforts," p. 104; William C. Potter and Fred L. Wehling, "Sustainability: A Vital Component of Nuclear Material Security in Russia," *The Nonproliferation Review* 7 (Spring 2000), p. 180.

[9] Statement of IAEA Director General Mohamed ElBaradei to the General Conference, September 1999, Programme for Promoting Nuclear Non-Proliferation, *Newsbrief* 47 (3rd Quarter, 1999), p. 29.

[10] See Matthew Bunn, "A Detailed Analysis of the Urgently Needed New Steps to Control Warheads and Fissile Material," in Joseph Cirincione, ed., *Repairing the Regime: Preventing the Spread of Weapons of Mass Destruction* (New York: Routledge, 2000), p. 78.

[11] Both civilian reactor-grade plutonium and HEU from research reactors can be used to make unsophisticated nuclear weapons. See Mark et al., "Can Terrorists Build Nuclear Weapons?"; US Department of Energy, *Nonproliferation and Arms Control Assessment*, pp. 35-39.

[12] Gavin Cameron, "Multi-Track Micro-Proliferation: Lessons from Aum Shinrikyo and Al Qaida," *Studies in Conflict and Terrorism* 22 (October-December 1999). See also testimony of Central Intelligence Agency Director George Tenet to the Senate Armed Services Committee on February 2, 2000, as reported by Associated Press, February 2, 2000; "US Indictment: 'Detonated an Explosive Device,'" *New York Times*, November 5, 1998 (national ed.— the US indictment of Osama bin Laden alleging efforts by his group to obtain nuclear weapon components); Sean D. Murphy, "Contemporary Practice of the United States Relating to International Law," *American Journal of International Law* 94 (April 2000), pp. 365-66. (Osama bin Laden's organization was recently designated by the Secretary of State pursuant to statute as a "foreign terrorist organization" meaning that it "engages in terrorist activity that threatens US nationals or national security.")

[13] International Atomic Energy Agency, *The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, Information Circular (INFCIRC)/153, par. 7.

[14] Ibid., pars. 31, 43, 49, 74.

[15] See, e.g., Model Protocol Additional to Agreements Between States and the IAEA for the Application of Safeguards, INFCIRC/540 (IAEA 1997), Art. 6. In nuclear weapon countries like Russia and the United States that were not required by the NPT to accept *IAEA* safeguards on their nuclear activities, the precise line between safeguards and physical protection may sometimes not be as clear as it is to the IAEA. In US-Russian discussions, a term frequently used to include both is "Materials Protection, Control and Accounting" or MPC&A. In Russia, control and accounting include computerized accounting, physical inventory (including bar code technology), scale and weight measurement control, and tamper-indicating devices. But at some Russian facilities, portal monitors for detecting nuclear material and hand-held nuclear-material detectors are counted as physical protection and at some they are counted as control and accounting. Emily Ewell Daughtry, Monterey Institute of International Studies expert on Russian MPC&A practices, e-mail to author of January 11, 2000. In the United States, there are sometimes ambiguities as to whether "control" is part of safeguards (accounting and control to the IAEA) or physical protection. Matthew Bunn, Harvard University expert on physical protection, e-mail to the author of January 17, 2000.

[16] See George Bunn, "International Arrangements against Nuclear Terrorism," in Paul Leventhal and Yonah Alexander, eds., *Preventing Nuclear Terrorism* (Lexington, MA: Lexington Books, 1987), pp. 343-44; George Bunn, "Physical Protection of Nuclear Materials: Strengthening Global Norms," *IAEA Bulletin*, 39, No. 4 (1997).

[17] According to the IAEA Secretariat, there were 64 parties to the Convention on Physical Protection of Nuclear Material as of November 5, 1999. See IAEA, *Secretariat Note, Possible Issues for Consideration by the Informal Open-Ended Expert Meeting to Discuss Whether there is a Need to Review the Convention on the Physical Protection of Nuclear Material*, 15-19 November 1999. The IAEA is the official depositary for the treaty, the place where states deposit their instruments of ratification for the treaty when they become parties.

[18] Kevin J. Harrington, *Physical Protection of Civilian Fissile Material: National Comparisons* (Livermore, CA: Sandia National Laboratories, 1999). The proceedings of the IAEA conference appear in *Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations* (Vienna, Austria: IAEA, 1998). The Stanford conference papers appear in *A Comparative Analysis of Approaches to the Protection of Fissile Material: Proceedings of the Workshop at Stanford University* (Livermore, CA: Lawrence Livermore Laboratory, 1998). The Stanford conference was a cooperative venture by Stanford University's Center for International Security and Cooperation, Monterey Institute's Center for Nonproliferation Studies, and Lawrence Livermore National Laboratory's Center for Global Security Research.

[19] See Harrington, *Physical Protection*, pp. 64-66 and tables 1-6.

[20] Matthew Bunn, "Ensuring Security for Weapons-Usable Nuclear Material Worldwide: Expanding International Cooperation, Strengthening Global Standards," *Proceedings of the International Conference on Future Nuclear Systems, Global 99* (LaGrange Park, IL: American Nuclear Society, 1999, CD-ROM). For many other deficiencies in Russian physical protection practices, see also Daughtry and Wehling, "Cooperative Efforts," pp. 104-107; and Potter and Wehling, "Sustainability: A Vital Component," pp. 180-183.

[21] E.g., Agreement between the Governments of the US and the Russian Federation regarding Cooperation in the area of Nuclear Material Physical Protection, Control and Accounting, October 2, 1999. This calls for "Taking into account the recommendations of the IAEA in the area of physical protection of nuclear materials." This refers to INFCIRC/225, Revision 4. See Laura Holgate, in "14th Annual INMM Safeguards Roundtable," *Journal of Nuclear Materials Management* 28 (Fall 1999), p.18. An earlier agreement adopted INCIRC/225, Revision 3 as a minimum standard. The parties to the African nuclear-weapon-free zone have a similar obligation. Bonnie D. Jenkins, "Establishing International Standards for Physical Protection of Nuclear Material," *The Nonproliferation Review* 5 (Spring-Summer 1998), p.102.

[22] Jenkins, "Establishing International Standards," p.102.

[23] Russian Federation Ordinance 264, March 7, 1997, "Physical Protection of Nuclear Materials, Nuclear Installations, and Nuclear Materials Storage Sites," Russian Federation Federal Law on Use of Nuclear Energy, October 20, 1995, chap. XI. Recent Lithuanian "Regulations on Physical Protection of Nuclear Facilities" say they are based upon the Physical Protection Convention and INFCIRC/225, Revision 3. See par.3.1. Some DOE facilities are now subject to inspection by the US Nuclear Regulatory Commission. See, for additional examples, Jenkins, "Establishing International Standards," p. 102.

[24] See Anita B. Nilsson and Bernard Weiss, "International Standards and Guides for Physical Protection," *Proceedings of the 40th Annual Meeting of the Institute of Nuclear Materials Management* (Northbrook, IL: INMM, 1999, CD-ROM) and Jenkins, "Establishing International Standards," p. 102.

[25] Jenkins, "Establishing International Standards," pp. 102-103; Denis Flory, Jean Jalounieux, and Jean-Claude Drevillon, "The Evolution of Physical Protection Recommendations: A French Reading," *Proceedings of the 40th Annual Meeting of the Institute of Nuclear Materials Management.*

[26] National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington, DC: National Academy Press, 1994), p. v; George Bunn, *Arms Control by Committee: Managing Negotiations with the Russians* (Stanford, CA: Stanford University Press, 1992), pp. 251-53.

[27] National Academy of Sciences, *Management and Disposition*, p. 31. See also George Bunn, "US Standards for Protecting Weapons-Usable Fissile Material Compared to International Standards," *The Nonproliferation Review* 6 (Fall 1998), p. 141.

[28] Department of Energy, *Nonproliferation and Arms Control Assessment*, pp. v, 35-39.

[29] Ibid., p. 36

[30] G. Bunn, "US Standards," p. 142.

[31] Ibid.

[32] Ibid.

[33] INFCIRC/225/Rev.4, par.4.1.4.

[34] INFCIRC/225/Rev. 4, pars. 4.1.3 and 4.1.4 (emphasis added).

[35] Ibid., preface.

[36] Harrington, *Physical Protection*, p. 18.

[37] Hiroshi Kurihara, "The Protection of Fissile Materials in Japan," *A Comparative Analysis of Approaches*, p. 104.

[38] K. Moriya, "Physical Protection at Nuclear Power Stations in Japan," *Physical Protection of Nuclear Materials*, pp. 212-13.

[39] Irina Koupriyanova, "Russian Perspectives on Insider Threats," *Proceedings of the 40th Annual Meeting.* For a description at the same meeting of the DOE insider threat protection policy, see David D. Wilkey, Steven T. Kroney, Pamela G. Dawson, and Don L. Jewell, "An Interpretation of Insider Protection Policy."

[40] H. Kurihara, "Implications of INFCIRC/225/Rev.4 to Japan's Nuclear Security," *Proceedings of the 40th Annual Meeting.*

[41] Harrington, *Physical Protection*, p. 31.

[42] INFCIRC/225, Rev.4, par.6.2.1.

[43] Ibid., par. 6.2.14

[44] Roger Howsley, "The Physical Protection of Fissile Nuclear Material in the UK—A BNFL Perspective," *A Comparative Analysis*, pp. 68-69. The Japanese expert who described the Revision 4 changes that could produce changes in Japan's physical protection did not mention possible changes in Japan's policy of not arming guards and not providing nearby armed response forces. See Kurihara, "Implications of INFCIRC/225/Rev.4 to Japan's Nuclear Security."

[45] INFCIRC/225, Rev.4, part 7; Hageman, "Implications of Revision 4 for Germany's Nuclear Security System," *Proceedings of the 40th Annual Meeting*.

[46] INFCIRC/225, Rev.4, par. 6.2.11.

[47] Ibid.

[48] Ibid., par. 6.2.2.

[49] Kurihara, "The Protection of Fissile Materials in Japan," p. 104. In his 1999 statement to the International Nuclear Materials Management meeting, Kurihara did not refer to personnel clearances. See "Implications of INFCIRC/225/Rev.4 to Japan's Nuclear Security."

[50] Harrington, *Physical Protection*, Table 3 and pp. 25-26.

[51] INFCIRC/225, Rev. 4, par.6.2.2.

[52] Harrington, *Physical Protection*, p. 36.

[53] INFCIRC/225/Rev.4, par.2.1.2.

[54] Ibid., par. 7.2.

[55] See, e.g., G. Bunn, "International Arrangements against Nuclear Terrorism"; G. Bunn, "Physical Protection of Nuclear Materials"; and Jenkins, "Establishing International Standards."

[56] Statement by Secretary of State Madeline Albright, US Department of State, Press Release, June 10, 1998; Memorandum dated November 4, 1998, from the US Embassy to Norway addressed to Sverre Hornkjol, an official of the Norwegian Radiation Protection Authority, attaching text of "Physical Protection Convention Draft."

[57] "Physical Protection Convention Draft," Art. 3.

[58] Ibid., Arts. 17-20.

[59] Ibid., Art. 23.

[60] IAEA, *Secretariat Note*.

[61] Ibid.

[62] *Note from the United Kingdom, France, Germany, Belgium, and Sweden to Open-Ended Expert Meeting to Discuss the Need for Revision of the Convention on Physical Protection*, October 22, 1999.

[63] *Chairman's Report to Informal Open-Ended Meeting of Experts to Discuss Whether there is a Need to Revise the Convention on Physical Protection*, November 19, 1999.

[64] *Additional Views of the United States of America on Amending the Convention on the Physical Protection of Nuclear Materials*, November 1999.

[65] *Measures to Eliminate International Terrorism, Report of the Working Group*, UN General Assembly document A/C.6/54/L.2, October 26, 1999, p. 2.

[66] *Convention on the Suppression of Acts of Nuclear Terrorism, Draft Submitted by the Russian Federation*, UN General Assembly document A/AC.252/L.3, January 28, 1997, Art. 4.3.

[67] *Report of the Working Group of the Sixth Committee*, UN General Assembly document A/C.6/53/L.4, Annex I, October 8, 1998, Arts. 1.1, 1.2 and 8.

[68] See Virginia Morris and M.-Christiane Bourloyannis-Vrailas, "The Work of the Sixth Committee at the Fifty-Third Session of the UN," *American Journal of International Law* 93, No. 3 (1999), pp. 727-28.

[69] *Measures to Eliminate International Terrorism*, p. 3.

[70] See, e.g., Potter and Wehling, "Sustainability: A Vital Component," pp. 181-187; M. Bunn, "The Next Wave," pp. 29-106.

[71] Some DOE insiders estimate that this could be costly, but no thorough survey of DOE nuclear materials has been made yet to find out.

[72] See also M. Bunn, "Ensuring Security for Weapons-Usable Nuclear Material Worldwide."

[73] G. Bunn, *Arms Control by Committee*, p. 101.

[74] See "Special Report: Assessing US Nonproliferation Assistance to the NIS," *The Nonproliferation Review* 7 (Spring 2000), pp. 55-124.

[75] For this recommendation, I am indebted to Matthew Bunn, "Security for Weapons-Usable Nuclear Materials: Expanding International Cooperation, Strengthening International Standards," in *A Comparative Analysis*, p. 23; see also M. Bunn, "Ensuring Security for Weapons-Usable Nuclear Material Worldwide."