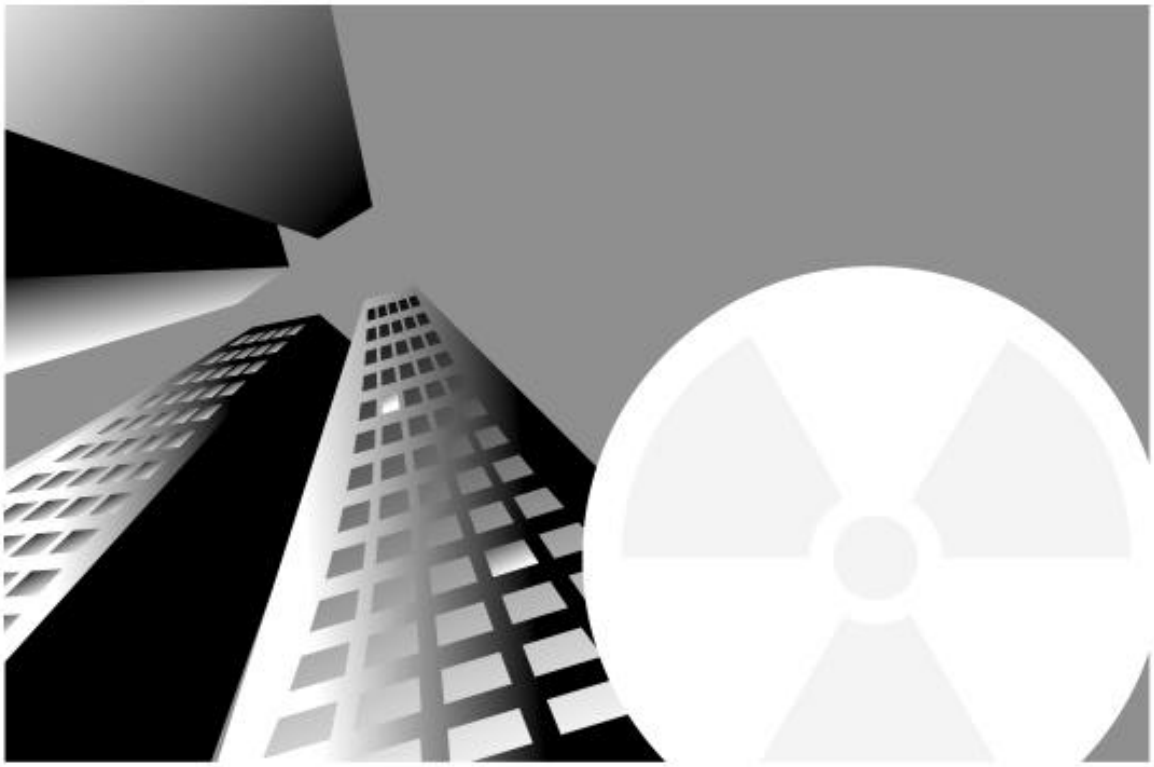

NUCLEAR WEAPONS-GRADE FISSILE MATERIALS

THE MOST SERIOUS THREAT TO US NATIONAL SECURITY TODAY?

COL GUY B. ROBERTS, USMC

The breakup of the Soviet Union left nuclear material scattered throughout the Newly Independent States and increased the potential for the theft of those materials, and for organized criminals to enter the nuclear smuggling business. As horrible as the tragedies in Oklahoma City and the World Trade Center were, imagine the destruction that could have resulted had there been a small-scale nuclear device exploded there.

—President Bill Clinton
US Air Force Academy, 31 May 1995

THE AMERICAN public has generally recognized the dangers of weapons of mass destruction.[1] Less understood or well known is the fact that the most important threat to US national security may be the growing stockpiles of nuclear weapons-grade fissile materials (plutonium and highly enriched uranium [HEU]),[2] much of which is uncontrolled and unsecured in the former Soviet Union. Fissile materials[3] are the essential elements for nuclear bomb making. Access to these materials is the primary technical barrier to a nuclear weapons capability since the technological know-how for bomb making is publicly available. Given the already prevalent availability of technology and information associated with building nuclear weapons, the greatest threat and challenge to the nuclear nonproliferation regime, recently reaffirmed by the international community with the approval in May of 1995 of the indefinite extension of the Nuclear Nonproliferation Treaty (NPT), is controlling and limiting the spread of nuclear weapons-usable fissile materials.

Controlling fissile materials is important because once these materials are acquired, construction of nuclear weapons is a relatively straightforward proposition for sophisticated terrorists or proliferant states. Even relatively unsophisticated terrorist groups could make a crude-but-workable nuclear bomb in the 10- to 100-kiloton range.[4] One physicist involved in the Manhattan Project noted:

> With modern weapons-grade uranium, the background neutron rate is so low that terrorists, if they had such material, would have a good chance of setting off a high-yield explosion simply by dropping one half of the material onto the other half. Most people seem unaware that if separated U-235 is at hand it's a trivial job to set off a nuclear explosion. . . . Even a high school kid could make a bomb in short order.[5]

Terrorists do not need the power or precision of a high-yield weapon. A low-yield "dirty" device made from reactor-grade plutonium in a truck could easily serve a terrorist's purposes, demolishing a small city and spreading radioactive fallout far and wide. At least one "terrorist" group has openly sought to acquire this capability.[6] And a recent news account reported that Iraq, in addition to developing a nuclear bomb, had worked on a "radiological" weapon, one that would scatter deadly radioactive material without a nuclear explosion.[7] Spreading radioactive materials over a battlefield or logistics supply points would obviously have a major impact on the ability of any country to conduct combat operations.

Today there are four distinct proliferation threats with reference to fissile materials. First and foremost are the difficulties arising from the dissolution of the Soviet Union. Significant aspects of this problem are the trafficking in nuclear materials acquired from the former Soviet Union and the concomitant lack of adequate controls and accounting of fissile materials. Second is the growing stockpile of plutonium resulting from both the dismantlement of nuclear weapons and the production of plutonium from reprocessed civilian reactor fuel. Third, the inadequacies of safeguards over nuclear technologies and materials have created unacceptable proliferation risks. Finally, strategies will have to be developed to address both those states not members of the NPT with unsafeguarded nuclear facilities and those with clandestine nuclear weapons programs.

The Former Soviet Union and the Problem of Fissile Material Theft or Diversion

> *Potatoes [are] guarded better than radioactive materials. . . .*
>
> —Russian special investigator

The divisive political and deteriorating economic conditions in the Russian Federation and the newly formed Commonwealth of Independent States (CIS) of the former Soviet Union have created a dangerous recipe for the diversion of fissile materials to clandestine nuclear weapons programs.[8] Given the deteriorating economic situation in the former Soviet Union, scientists and engineers working on nuclear weapons programs, once the elite of Soviet society, have steadily seen their privileges erode. As a result of the loss of in-

centives, decline in prestige, and the lack of funds for research and simple living expenses, nuclear weapons specialists began to leave the former Soviet Union in search of employment opportunities in other countries.[9] It is the scientists, technicians, and managers, in addition to security personnel, who are best placed to take fissile materials with them when they leave for work at hard-currency-paying nuclear programs in states that cause concern on the matter of proliferation.

Nuclear facility scientists, engineers, and other workers not only have a motive for nuclear trafficking— they also have the opportunity. Security is more lax at most Russian nuclear facilities than at many ordinary office buildings in the US. The chairman of a National Academy of Sciences panel that recently studied the problem of plutonium disposition observed firsthand the continuing deterioration of basic custodial and control arrangements over fissile materials, commenting that "any day now we could wake up and read [in]the newspaper that enough material for a dozen bombs really has been stolen. . . ."[10]

While security is incredibly lax, accountability is nonexistent. The facts about the magnitude of this problem are sobering: There is no national fissile material control and accounting in Russia. No one knows exactly how much plutonium or HEU they have, and at most sites they do not even know if any plutonium or HEU is missing.[11] The deputy chairman of the nuclear oversight agency Gosatomnadzor (GAN), Yuri Zubkov, said that "Russia is facing a critical problem of establishing strict control and accounting for nuclear materials. We are just at the beginning."[12] Creating such a system will be a gigantic task. And while the system is slowly being built by a government beset with financial difficulties and rampant graft and corruption, struggling in an insecure world, it will be increasingly difficult for unpaid, desperate employees to resist the fortunes offered for an unaccounted fistful of radioactive doom.

While nuclear materials trafficking is not a new phenomenon, the scale of activity has increased dramatically since the breakup of the Soviet Union. The potential exists for trafficking in nuclear materials to "totally overwhelm the current nuclear non-proliferation regime."[13] Since 1991, the number of cases reported by Western European authorities has increased steadily. In 1994, for example, a report submitted to President Boris Yeltsin by the Russian Counterintelligence Service (the FSK) estimated that in the second half of 1993 there were 900 thefts from military and nuclear plants.[14] The director of the Federal Bureau of Investigation (FBI), Louis Freeh, has called nuclear smuggling "the greatest long-term threat to the security of the United States."[15]

"If separated U-235 is at hand it's a trivial job to set off a nuclear explosion. . . . A high school kid could make a bomb in short order."

There have been a number of sensational news accounts about the growing number of trafficking incidents.[16] The US Department of Energy (DOE) has concluded, however, that most of the nuclear smuggling cases have been "nothing more than profit motivated scams involving bogus material, which were perpetrated by opportunists and con-artists."[17] Government and police authorities in Western Europe have also claimed that they are succeeding in their efforts to stop, catch, and deter nuclear materials traffickers. It is fatuous to assume, however, that law enforcement activities in this area can be any more successful than they have been against drugs or other forms of illegal trafficking or smuggling.

> Even if intelligence agencies and law enforcement are remarkably more successful in interdicting nuclear material than in interdicting other illicit products, it would be presumptuous to assume that they are able to seize more than sixty to seventy percent. The implication is that at least one-third of the nuclear material that is stolen and traded illegally escapes detection and seizure.[18]

Security is more lax at most Russian nuclear facilities than at many ordinary office buildings in the US.

Western assistance will, nevertheless, help stem and may reduce or eliminate some of these proliferation risks. Of course, the consequences of failure are incentive enough to undertake proscriptive measures to assist these states. Numerous and diverse actions have been taken by the US and others to counter this grave proliferation threat.

Western Support to the Former Soviet Union

The most significant US initiative is in allocating funds under the cooperative threat-reduction program, first authorized by Congress in November 1991 (also referred to as the Nunn-Lugar program),[19] for the physical protection, control, and accountancy of fissile materials. Under the cooperative threat-reduction initiative and a laboratory-to-laboratory program, the US has been able to make some progress towards establishing a national material control and accounting system and in helping individual facilities with their physical protection programs. As explained by one DOE official, the US strategy is to improve facility infrastructure and control over fissile materials, deploy technology to assist in bringing Russian facilities up to minimal IAEA standards, and institute national standards and systems for control and accounting of all fissile materials.[20]

Internationally, one of the ongoing efforts by the International Atomic Energy Agency (IAEA) and the Western powers is to assist the newly independent states of the former Soviet Union[21] in improving their systems for control of nuclear materials and relevant nonnuclear materials and equipment. The purpose of these "donor" programs is to substantially upgrade material control, accounting, and physical protection systems at high-risk facilities and to engage responsible government authorities and facility personnel in a cooperative effort to achieve national systems of materials accountancy and physical protection.

Since 1991, the US and the member states of the European Union (EU) have also undertaken a variety of new measures to respond to the clear and present danger of nuclear materials trafficking.[22] In addition to assisting the states of the former Soviet Union in establishing effective material control, accounting, and physical protection systems, a number of cooperative and information-sharing arrangements have been undertaken to stop and deter the growing trade in nuclear materials. The European Union has now recognized the need for greater cooperation, and has already embarked on programs of information sharing, scientific analysis, and customs cooperation with the newly independent states.

The Proliferation of Civilian Stockpiles of Fissile Materials

The production and stockpiling of plutonium from civilian reactors is also one of the world's sleeping disasters. While amounts depend on reactor types and sizes, all nuclear reactors produce plutonium.[23] As one expert warned:

> The greatest long-term threat to. . . the world may yet lie in the production and use of nuclear explosive materials in civilian commerce. If . . . civilian plutonium programs proceed as planned around the world, more than 500 metric tons of plutonium will be separated from the spent fuel of nuclear power reactors by the year 2010, of which at least 300 tons will be stockpiled as surplus.[24]

Growing stockpiles of civilian or reactor-grade plutonium in Western Europe and Japan alone will be sufficient for 47,000 bombs. According to one reliable source, most of the world's 1,000 tons of plutonium are in civilian hands and yet only 30 percent (Britain, France, and the nonnuclear weapon states) is under international safeguards.[25] And while plutonium use

will be uneconomical for the next 30 to 50 years,[26] billion-dollar reprocessing plants in Britain and France continue to reprocess and separate an average of 21 tons of plutonium a year.[27] By 2010 a total of 545 tons will have been separated,[28] mostly from Britain and France, with Russia, China, and possibly Japan also contributing.[29]

There are several approaches being proposed to address this problem, none of which are cheap or definitive. All solutions proposed so far ultimately involve disposing of plutonium in geologic repositories. Cost figures vary,[30] but they are hardly exorbitant sums in relation to the security benefits. There is no way to avoid paying a price for the processing and eventual elimination of plutonium since to do nothing would have potentially catastrophic consequences both in terms of environmental contamination and proliferation risk. Absent concerted political efforts to resolve this problem now, however, the world will face not only an increasing proliferation risk but the potential for an environmental or terrorist-initiated catastrophe as a result of mismanagement, theft, or accident.

Unabated Demand: Threshold, Pariah States, and Fissile Materials

Don't fight the Americans without nuclear weapons.

—Indian chief of staff in response to a question about the lesson of the Persian Gulf War

There are a number of reasons why the fears and ambitions of less developed nations lead them down the nuclear weapon acquisition path. It is interesting to note that the industrialized West has rarely addressed the "demand side" of nuclear proliferation. US and international attention needs to move beyond the symptoms of proliferation to its causes. It may seem easier to control supply, yet it is demand that raises the tide of proliferation. Supply-side controls are small steps; they may be easy to implement but in the end can only retard nuclear weapon proliferation—not prevent it. The most obvious and recent example of this is South Africa. The South African nuclear weapons program was carried out under strong United Nations sanctions and an international embargo. And yet, in about 10 years, involving roughly 400 scientists and technicians, it was able to develop and produce six nuclear weapons at a cost of about $900 million.[31]

The demand-side approach addresses the needs and motives of nations that seek fissile materials and nuclear technology for their nuclear weapons programs.[32] Clearly, there is no single motive that explains the proliferation decisions of every country. Likewise, no single policy prescription will address every motive. Nevertheless, once one understands the reasons and motives of a particular country as it pursues a nuclear weapons acquisition capability, strategies can be crafted to attenuate or roll back the demand for nuclear weapons. In this regard, it is worth considering what one expert wrote in 1990:

> The nuclear states should attempt to understand the motivation for some developing countries to retain their theoretical nuclear option. . . . The basic driving forces behind a nation's quest for nuclear weapons are its perceptions of security and national interests, as well as a sense of national pride, and we must appreciate that nation's own point of view if we are to take any effective steps to mitigate its concerns. Clearly, the smaller states of the world, particularly in regions where they are overshadowed by one or two regional powers, would have the greatest reason to feel insecure. Unless these legitimate security concerns of threshold states are met and dealt with effectively, the political and psychological incentives for them to retain a nuclear option will remain.[33]

While rollback remains possible and efforts should continue, it is highly unlikely that the efforts of the US or other nations can succeed in the short term. Consequently, we must continue to pursue a combination of strengthened and expanding nonproliferation norms along with enhanced supply-side initiatives to keep the political and economic costs of proliferation high.

The Inadequacy of IAEA Safeguards

The International Atomic Energy Agency was originally established in 1956 to "foster the exchange of scientific and technical information on peaceful uses of atomic energy" and to establish a "safeguards" system to ensure that fissile materials "are not used in such a way as to further any military purpose."[34] Unfortunately, for a number of technical and political reasons, the IAEA has not been able to meet the aspirations of its members concerned with the illicit diversion of fissile materials. A low point for the agency was the post-Gulf War revelations of Iraq's nuclear weapons program, in contrast to the IAEA's finding in August 1990 (the month that Iraq invaded Kuwait) that Iraq was in complete compliance with its treaty obligations.[35] For years, doubts have been expressed about the IAEA's ability to detect illicit diversions of nuclear materials and the effectiveness of safeguards where substantial amounts of HEU or plutonium are involved.[36] Today not much has changed as numerous experts have questioned the ability of the IAEA to safeguard existing reprocessing facilities.[37]

There are a number of technical problems with instituting verification systems that are 100 percent effective. As much as 3 percent of plutonium at reprocessing facilities is unaccounted for and subject to illicit diversion. As one expert has noted, in some facilities 3 percent is more than enough to make several nuclear weapons per year.[38] The IAEA also cannot detect the diversion of significant quantities of fissile material in a timely manner through its safeguard methods of containment, surveillance, and material control and accountability. The IAEA has acknowledged that, due to measurement uncertainties, its material-accounting system cannot with confidence detect the diversion of bomb quantities of nuclear material.[39]

The IAEA has recognized that gaps exist in the current safeguards system. Accordingly, it has undertaken a number of reform measures to strengthen the safeguards/verification regime since the disclosure of the Iraqi nuclear weapons program. Probably the most significant is the IAEA Board of Governors' decision in February 1992 to approve conducting "special" inspections on short notice at suspected sites of diversion or other illicit, unsafeguarded nuclear activities.[40] Also decided and reaffirmed were members' authority and responsibility to share information on suspect activities that are in violation of a member's obligations either under the NPT or a safeguards agreement.

Nevertheless, the IAEA will need a budget increase if it is to implement the proposed measures to strengthen safeguards. It has been operating for over 10 years on a "zero-growth," fiscally constrained, budget while the amount of fissile material under IAEA safeguards has been increasing at the rate of 10 percent per year. Consequently, the IAEA's full-scope safeguards regime is overburdened and understaffed. IAEA safeguards arrangements in non-NPT nations are under even greater pressure because the agency's inspectors, whose role is limited to verification of inventories that are declared for inspection, cannot seek out clandestine activities or stockpiles. The Clinton administration has committed to providing fund increases, a necessary requirement if the IAEA is to ever have a chance at achieving its stated goals. Only the IAEA has the international mandate to oversee nuclear programs like those in North Korea and Iraq, which provide to the world a window on nuclear programs we would not otherwise have.

The Nonproliferation Regime as a Framework for Controlling Fissile Materials

The Nuclear Nonproliferation Treaty is the centerpiece of the nonproliferation framework. The recent agreement by the state parties to indefinitely extend the NPT[41] signifies, in part, the recognition by the nonnuclear, nonaligned states that the NPT is not just a lever for moving the nuclear weapons states towards disarmament. It is, rather, a protective shield to ward off regional arms races and nuclear dangers. Nuclear weapon states and nonnuclear weapon states alike have concluded that their own security interests are

better served by an international regime in which it is preferable to have regional adversaries agree to not develop or acquire a nuclear weapons capability rather than one in which states retain the option of developing such weapons themselves. The greatest benefit in being a part of this important international norm is that derived from normal political and economic relations. As former Defense Secretary James Schlesinger has pointed out, the distinction between nuclear and nonnuclear weapons states "is not going to be eliminated. . . . It is in the interest of all the nations that desire stability for the United States to continue to have a deterrent sufficiently impressive to deter weapons use by other states."[42]

There have been a number of positive initiatives and measures proposed to build on this global norm. These have included negotiating a fissile material cutoff regime, establishing regional nuclear weapons-free zones, strengthening security assurances from nuclear weapon states, and harmonizing and expanding export controls.

A Fissile Materials Cutoff Regime

The purpose of a fissile materials production cutoff treaty would be to strengthen nuclear nonproliferation norms by adding a binding international commitment to existing constraints on nuclear weapons-usable fissile material. The proposed treaty would ban the production of fissile materials for nuclear weapons or other nuclear explosive devices. It would not address stockpiles. The convention would prevent the introduction of new fissionable materials to replace those removed from the US and Russian military weapons programs as warheads are destroyed.

US and international attention needs to move beyond the symptoms of proliferation to its causes.

The primary goal of the cutoff treaty is to obtain the participation of those states that have unsafeguarded enrichment and reprocessing facilities (for example, India, Pakistan, and Israel). In sum, the proposed convention is addressed to nuclear powers and "threshold" nuclear states alike. Unfortunately, some threshold states, such as Pakistan, and others[43] have insisted that any fissile materials control regime include banning all existing stockpiles and not just capping fissile materials production.[44] This proposal will almost certainly delay, and possibly doom, the negotiations for a cutoff treaty. All of the nuclear weapons states will oppose it, and India has already stated it will not accept expanding the scope to include stockpiles.[45]

That does not mean, however, that the US should give up in its efforts. Like other nonproliferation initiatives, the best opportunity for a cutoff treaty will come in the context of progress in other initiatives. Forward movement in a multilateral framework on issues like a comprehensive test ban will perhaps create a climate that will sooner rather than later result in the successful negotiation of a cutoff treaty. While that day may only be realized after progress in resolving regional security issues, that does not lessen the need to continue multilateral efforts such as the cutoff treaty proposal that could be part of a regional solution to rolling back a nuclear weapons program.

Nuclear Weapons-Free Zones

Nuclear weapons-free zones (NWFZ) have been proposed for various geographical areas since the mid-1950s. Yet to date the Treaty of Tlatelolco and the Treaty of Rarotonga (South Pacific nuclear-free zone)[46] are the only ones establishing nuclear-free zones in populated areas.[47] Although there is some disagreement over the essential elements of NWFZs, such zones usually combine (1) commitments by the parties not to acquire, develop, or possess nuclear explosive devices; (2) undertakings by nuclear weapons states (NWS) not to use or threaten to use nuclear weapons against states in the zone; and (3) agree-

ment by both the parties and the NWS not to station nuclear weapons in the zone.[48]

The US has supported efforts to establish effective NWFZs in regions of real nonproliferation concern, such as the South Asian subcontinent, the Korean Peninsula, Africa, and the Middle East.[49] NWFZs are an effective supplement to international efforts to prevent the spread of fissile materials for nuclear weapons programs, and they can help roll back proliferation where it has already occurred. The US should continue to encourage the inclusion of provisions banning the production or stockpiling of fissile materials in the proposed NWFZs.

Positive and Negative Security Assurances

Positive security assurances are enshrined in UN Security Council Resolution 255:

> Aggression with nuclear weapons or the threat of such aggression against a non-nuclear-weapon State, would create a situation in which the Security Council and above all its nuclear-weapon State permanent members would have to act immediately in accordance with their obligations under the United Nations Charter.[50]

Negative security assurances are simply promises not to use or threaten to use nuclear weapons. All five nuclear weapons states have made such assurances. There are two aspects to these declarations. First, they are unilateral and can be revoked at any time. Second, with the exception of China,[51] they are conditional. The US declaration of 1978 is representative:

> The United States will not use nuclear weapons against any non-nuclear weapon State Party to the NPT or any comparable internationally binding commitment not to acquire nuclear explosive devices, except in the case of an attack on the United States, its territories or armed forces, or its allies, by such a State allied to a nuclear-weapon State or associated with a nuclear-weapon State in carrying out or sustaining the attack.[52]

Security assurances have been a significant dissuasive factor to some states' nuclear ambitions[53] and should not therefore be wholly discounted. A number of possibilities exist to strengthen those assurances and, in turn, steadily enhance nonproliferation norms that will reinforce procedural, economic, and political constraints placed around nuclear weapon aspirants.

One possibility would be for the NWS to agree not to "escalate any conflict to the nuclear level without first consulting with the UN Security Council. . . . All nations [would] be asked to declare their support for such an agreement."[54] Frankly, it is hard to conceptualize a circumstance in which the US or other NWS would use nuclear weapons without at least "consulting" with other allies or the Security Council.[55] Creating a legally binding agreement would also attenuate some—but not all—of the criticisms regarding the "discrimination" created by the NPT. Also worth pursuing is the creation of a legally binding, universal convention in which all parties agree to provide assistance, within national resources, if any other party is subjected to nuclear attack.[56]

Export Control Regimes and the Harmonization of Export Control Law

One way the US and its Western allies have attempted to limit the spread of fissile materials is through multilateral export control arrangements. These multilateral arrangements do keep the costs of acquiring a nuclear weapons capability high. Although the supply-side barriers imposed on the spread of fissile materials can be overcome, they add a substantial economic price, and also a penalty, because states suspected of embarking on nuclear weapons programs are denied the technology that might otherwise have been used quite legitimately for civilian purposes.

The primary multilateral arrangement for coordination of efforts in controlling the supply of nuclear materials, equipment, and technology is the Nuclear Suppliers Group (NSG).[57] The NSG has adopted a set of supplier guidelines[58] that now include requiring IAEA inspections and accounting of all fissile materials in the recipient country, and the recipient country agreeing not to

transfer such materials without the permission of the exporting country. These guidelines are more stringent than that required by NPT membership and are a key part of ensuring that fissile materials are not diverted from those states that legitimately possess them for peaceful purposes to those that do not.

. . . US success in the Persian Gulf War certainly sowed the seeds of future proliferation even as it uprooted one of the more dangerous threats.

Another possible mechanism to coordinate efforts against smuggling of these materials is to negotiate an international convention or treaty making the smuggling of fissile materials a crime against international law.[59] Such a treaty regime would, at a minimum, open up additional avenues for cooperation and information sharing among states to interdict and stop smuggling, and would possibly inhibit their clients from choosing this method of acquiring fissile materials.

No Easy Solutions or Quick Fixes

A number of experts in this area have confided that it may require some catastrophic event, similar to the Oklahoma City bombing disaster, in order to energize the international community to work in concert to eliminate this problem. It is an unfortunate fact that the US and other governments, and the American people, tend to react to situations rather than anticipate them. Clearly, the danger is so great and the threat so immediate that US policymakers and the public need to recognize the illicit diversion of fissile materials as a critical and urgent national security priority, one that will require top-level attention, public education, and sufficient resource allocation if we are to eventually prevail over this new security challenge. One can only hope that a tragedy will not be necessary for galvanizing the world to action and that we will achieve progress toward an international consensus that it is in nobody's interest to acquire these materials for illicit purposes.

In examining current efforts and an exhaustive list of "new ideas" on how to stop the proliferation of fissile materials, it is hard to see how any strategy, no matter how clever the conception or assiduous the implementation, could do more than meliorate the fundamental problem. The problems of the former Soviet Union are too diverse and complex to solve overnight. Nor can the US buy up all the fissile materials that are of proliferation concern, although it would be wiser and, in the long run, cheaper to try rather than to spend trillions of dollars later to defend against the future use of these materials in weapons. And, since no country can hope to match the US in conventional arms, US success in the Persian Gulf War certainly sowed the seeds of future proliferation even as it uprooted one of the more dangerous threats.

Of course, our nonproliferation efforts have not been fruitless. In many respects, the nonproliferation regime has been successful, particularly when one evaluates it against the likely result of its absence. A number of countries have given up their nuclear ambitions (Argentina, Brazil, and South Africa are the most recent). There is no denying, however, that a number of states are actively, if covertly, seeking the wherewithal to manufacture nuclear weapons. A combination of regional factors, gaps in the nonproliferation regime, and, at times, indifference to the problem by Western states have all contributed to the likelihood that within the near future there will be a political crisis involving a newly armed nuclear state or terrorist group.

While unprecedented progress has been made in global and regional nonproliferation measures, we must not allow that progress to blind us to the fact that in an imperfect world no amount of effort will stop a determined proliferator. Consequently, the US—because it and no other state can—must be prepared to respond effectively when those proliferation threats do occur. Ultimately, there will be no "silver bullet" to stop the spread of fissile materials. No system is foolproof. Recent experi-

ences with Iraq and North Korea demonstrate the necessity of being adequately prepared to respond to proliferation threats. However, those that believe the effort is not worth it, that the continuing spread of fissile materials is inevitable, are wrong. Tough supply-side controls can tighten the spigot to a slow drip while time and commonality of interests in nonproliferation can change the political motivation to acquire nuclear weapons. One hopes that there will eventually be a seamless web of measures in the international community as a whole exercising the political will to ultimately end the threat of a nuclear catastrophe. □

Notes

1. The term ***mass destruction*** traditionally refers to nuclear, chemical, and biological weapons and the means to deliver them.

2. Highly enriched uranium (HEU)-235 is for use in bombs and some research and submarine reactors. U-235 is an isotope of uranium that is easiest to split in a reactor or bomb. It comprises only about 0.7 percent of natural uranium, but isotope separation via gaseous diffusion or centrifugation commonly "enriches" it to more than 90 percent, thereby creating "weapons-grade" concentrates. Plutonium, an element that exists in only trace amounts in nature, is manufactured in reactors by bombarding atoms of uranium isotope U-238 until they absorb a neutron and become plutonium 239 (PU-239). PU-239 is the best isotope for making bombs, but any isotope of plutonium, while less efficient, can be used for bombs.

3. Unless otherwise indicated, the terms ***fissile materials*** or ***weapons-usable fissile materials*** refer to weapons-grade HEU or plutonium. The term ***nuclear materials*** includes all materials, including fissile materials, associated with the production (to include by-products) of nuclear programs for energy and/or weapons.

4. See J. Carson Mark et al., "Can Terrorists Build Nuclear Weapons?" in Paul Leventhal and Yonah Alexander, eds., Preventing *Nuclear Terrorism* ***(Lexington, Mass.: Lexington Books,*** 1987), 60–62.

5. Luis Alvarez, ***Alvarez: Adventures of a Physicist*** (New York: Basic Books, 1987), 125.

6. Marilyn Greene, "Japan Cult Shopped for Nuclear Weapons," ***USA Today,*** 1 November 1995, 1.

7. "U.N. Official: Iraq Worked on Radiological Arms," ***Washington Post,*** 8 November 1995, 25.

8. For an excellent analysis of the conditions resulting from the breakup of the Soviet Union, see Susan B. Chodakewitz and Jill L. Jermano***, Regional Instability, Proliferation and the Former Soviet Union,*** Technical Report DNA-TR-92-199 (Washington, D.C.: Defense Nuclear Agency, December 1992).

9. One report noted that in 1992 alone 9,200 Russian scientists found employment abroad. "President Report Views Brain Problem," ITAR-TASS broadcast, 9 April 1993***, FBIS*** (Foreign Broadcast Information Service) ***Daily Report,*** FBIS- SOV-93-067, 39.

10. Bette Hileman, "U.S. and Russia Face Urgent Decisions on Weapons Plutonium," ***Chemical and Engineering News,*** 13 June 1994, 14.

11. This assessment is based on the author's numerous interviews and discussions with numerous DOD, Department of State, Arms Control and Disarmament Agency, and Department of Energy officials.

12. "A Look at Russia Nuke Watchdog on NEXIS Library," Associated Press; on-line, Nexis, 26 March 1995.

13. House, Leonard S. Spector's testimony to the Subcommittee on International Security, *International Organizations and Human Rights of the Committee on Foreign Affairs: Hearings on Russian Organized Crime and Nuclear Security,* 102d Cong., 2d sess., 27 June 1994.

14. *FBIS JPRS* (Joint Publications Research Service) *Report: Proliferation Issues*, "`Secret Report' on Nuclear Proliferation," JPRS-TNT-94-003-L (4 May 1994), 20. The report also details the sorry state of Russian security and control measures to safeguard nuclear materials.

15. Charles J. Hanley, "World Fears Spread of Nukes," Associated Press; on-line, Nexis, 28 March 1995.

16. For a detailed listing and assessment of these news accounts, see Phil Williams and Paul N. Woessner, "Nuclear Material Trafficking: An Interim Assessment," *Ridgeway Viewpoints*, 95-1, 1995.

17. US Department of Energy, *Black Market Trafficking in Nuclear Material: 1993 & 1994 Transactions* (Office of Nonproliferation and National Security, Threat Assessment Division, March 1995).

18. Williams and Woessner.

19. Public Law 102-228. An excellent summary of the legislative history and its implementation of this law may be found in Theodore Galdi, "The Nunn-Lugar Cooperative Threat Reduction Program for Soviet Weapons Dismantlement: Background and Implementation," Congressional Research Service 93-1057F (Washington, D.C.: Library of Congress, 29 December 1993). In fiscal year 1994, the Nunn-Lugar funding became an additional line item in the DOD budget.

20. Author's interviews with DOE officials, 13 March 1995; *DOE Fact Sheet on Nuclear Material Protection: Control and Accounting Cooperation with the Russian Federation* (Washington, D.C.: Department of Energy, undated).

21. Newly independent states do not include, by definition, the Russian Federation. As a nuclear weapon state, Russia has been resistant to IAEA assistance in developing a national material accounting and physical protection system.

22. Despite the fact that most trafficking in nuclear materials so far has been of a type and in amounts that are generally of no interest from a weapons perspective, the dangers inherent in this trade are considerable, and the risk of nuclear proliferation through the trafficking of all types of nuclear materials is real.

23. For an explanation of the characteristics of nuclear reactors, see appendix 5, "Technical Description of Fuel Cycle Facilities and Evaluation of Diversion Potential in Nuclear Proliferation and Safeguards," of US Congress, Office of Technology Assessment,

Nuclear Proliferation and Safeguards, vol. 2, pt. 1 (Washington, D.C.: Government Printing Office, June 1977).

24. Paul Leventhal and Daniel Horner, "NPT Extension Should Not Ignore the Dangers of Plutonium," *Disarmament Times*, 22 November 1994, 1.

25. David Albright, Frans Berkhout, and William Walker, *World Inventory of Plutonium and Highly Enriched Uranium* (New York: Oxford University Press, 1993).

26. See Brian G. Chow and Kenneth A. Solomon, *Limiting the Spread of Weapon-Usable Fissile Materials* (Santa Monica, Calif.: RAND , 1993), 44–60.

27. There is currently about 800 metric tons of civilian plutonium in spent metric tons per fuel stored around the world, and the total is growing at about 70 metric tons per year. See John P. Holdren, "Dangerous Surplus," *Bulletin of Atomic Scientists* (May/June 1994): 39–40.

28. Pat Coyne, "Do We Need a Nuclear Interpol to Police the World's Growing Stocks of Plutonium?" *New Statesman & Society*, 23 April 1993, 25.

29. Great Britain stopped producing fissile materials for explosive purposes in April 1995 but it continues to produce plutonium "fuel" at its plutonium reprocessing plant at Sella Field in Cumbria. See Barbara Crossette, "China Breaks Ranks with Other Nuclear Nations on Treaty," *New York Times*, 19 April 1995, A16.

30. For example, the National Academy of Sciences estimates it will cost from $1 to 5 billion for processing 50 tons of weapons-grade plutonium. House Armed Services Committee, *Hearings on National Defense Authorization Act for Fiscal Year 1995*, HASC no. 103–39, 103d Cong., 2d sess., 1994, 567.

31. Roger C. Molander and Peter A. Wilson, "On Dealing with the Prospect of Nuclear Chaos," *The Washington Quarterly*, Summer 1994, 19, 30.

32. It is not the intent here to examine in detail all the motivations and reasons why states may decide it is in their national security interests to pursue a nuclear weapons program. That has already been addressed exhaustively by a number of experts. See, for example, Mitchell Reiss, *Without the Bomb: The Politics of Nuclear Nonproliferation* (New York: Columbia University Press, 1988); Mitchell Reiss and Robert S. Litwak, eds., *Nuclear Proliferation after the Cold War* (Washington, D.C.: Woodrow Wilson Center Press, 1994); Dean Wilkening and Kenneth Watman, *Nuclear Deterrence in a Regional Context* (Santa Monica, Calif.: RAND, 1995).

33. Munir Ahmad Khan, "Toward a Universal Framework of Nuclear Restraint," in Joseph F. Pilat and Robert E. Pendley, eds., *Beyond 1995: The Future of the NPT Regime* (New York: Plenum Press, 1990), 89.

34. Article III, Statute of the International Atomic Energy Agency. For an exhaustive study on the history and activities of the IAEA, see Lawrence Scheinman, *The International Atomic Energy Agency and World Nuclear Order* (Washington, D.C.: Johns Hopkins University Press, 1987).

35. Robert Rudney, "A Toothless Watchdog: The Inter- national Atomic Energy Agency," *National Security Law Report* , American Bar Association Standing Committee on Law and National Security, January 1995, 1.

36. See, for example, Albert Wohlstetter et al., "The Military Potential of Civilian Nuclear Energy: Moving toward Life in a Nuclear Armed Crowd?" *Minerva* 15, no. 3–4. (Autumn–Winter 1977): 387–538. The article was based on a study for the Arms Control and Disarmament Agency entitled *Moving toward Life in a Nuclear Armed Crowd?* ACDA/PAP-263 (Washington, D.C.: Arms Control and Disarmament Agency, 1976), 22 April 1976.

37. General Accounting Office, *Nuclear Fuel Reprocessing and the Problems of Safeguarding against the Spread of Nuclear Weapons*, EMD-80-34 (Washington, D.C.: Government Printing Office, 18 March 1980), iii–v, 30–34; Paul Leventhal, "IAEA Safeguards Shortcomings—a Critique," Nuclear Control Institute, 12 September 1994; Frank Gaffney, Jr., "The IAEA's Dirty Little Secret," *The International Economy*, September/October 1994, 52; Marvin Miller, "Are IAEA Safeguards on Plutonium Bulk-Handling Facilities Effective?" Nuclear Control Institute, August, 1990.

38. Leventhal, "IAEA Safeguards."

39. The Natural Resources Defense Council has argued that the "significant quantities" standard should be lowered to 1 kilogram for plutonium and 3 kilograms for HEU since a 1-kiloton nuclear weapon can be made from these amounts. See "Tighter Nuclear Safeguards Needed to Stop Thefts," *Chemical and Engineering News*, 12 September 1994, 17.

40. Jon B. Wolfsthal, "IAEA to Implement `Suspect Site' Inspection Powers," *Arms Control Today*, March 1992, 27. Although the IAEA statute already authorizes such inspections (Art. XII A.6), the IAEA had never undertaken a special inspection. The board's action served to validate the IAEA's powers, and this authority was soon to be sorely tested by North Korea.

41. Barbara Crossette, "U.S. Ready to Seek Worldwide Ban on Nuclear Arms Tests," *New York Times*, 15 May 1995, 7. The extension decision is reported in "Extension of the Treaty on the Non-Proliferation of Nuclear Weapons," UN Doc. NPT/ Conf.1995/L.6, 9 May 1995.

42. Quoted in Stephen S. Rosenfeld, "How the Nuclear Haves Can Discourage Proliferation," *International Herald Tribune* , 27 March 1995, 8.

43. The German ambassador to the Conference on Disarmament has proposed putting all fissile materials, civilian as well as military, under safeguards, and including undeclared stocks of the threshold states in the cutoff negotiations. Ambassador Wolfgang Hoffman, "Basic Obligations and Scope of the Cut-Off Convention" (Paper presented at the Canadian Workshop on Fissile Material Production Cut Off, Toronto, 17–18 January 1995). Canadian officials have also raised concerns about any cutoff regime that would legitimize existing stockpiles in threshold states.

44. Interview by author of first secretary of the Pakistani delegation to the Conference on Disarmament, 24 March 1995.

45. Interview by author of Indian delegate to the Con- ference on Disarmament, 24 March 1995.

46. See "South Pacific Forum: The South Pacific Nuclear Free Zone Treaty," *International Legal Materials* 24, no. 5 (September 1985): 1440. The treaty entered into force 11 December 1985. Protocols 2 and 3 were ratified by China and the USSR in 1988.

47. Two other treaties prohibit nuclear weapons within their zones of application: the Antarctic Treaty and the Seabed Arms Control Treaty. The Antarctic Treaty, banning nuclear weapons on the Antarctic Continent, entered into force on 23 June 1961. See *United States Treaties and Other International Agreements* (UST), vol. 12 (Washington, D.C.: Government Printing Office, 1961), 794 (12 UST 794); *Treaties and Other International Acts Series (TIAS)* (Washington, D.C.: US Department of State, 1961), 4780; and *United Nations Treaty Series* (UNTS), vol. 402 (New York: Secretariat of the United Nations, 1961), 71 (402 UNTS 71). The Seabed Arms Control Treaty, banning nuclear weapons on or under the seabed and the ocean floor, entered into force 18 May 1972 (23 UST 701, TIAS 7337, 955 UNTS 115).

48. See, for example, UN General Assembly Resolution 3472 B, Nuclear Weapons–Free Zones [30th Session], 11 December 1975.

49. See, for example, "Voting Chart of Conference on Disarmament Members on Disarmament Resolutions," *Disarmament Times*, 20 December 1994, 2–3.

50. The resolution was adopted by 10 votes with five abstentions (Algeria, Brazil, France, India, and Pakistan). See Senate Committee on Foreign Relations, *Hearings on the Nonproliferation Treaty before the Committee on Foreign Relations*, 90th Cong., 2d sess., 10, 11, 12, 17 July 1968, 263.

51. China has adopted a "no first use" policy regarding nuclear weapons. In 1964, after China detonated its first nuclear device, Premier Chou En-lai declared that "at no time and in no circumstances

[will] China be the first to use nuclear weapons." John W. Lewis and Xue Litai, *China Builds the Bomb* (Stanford, Calif.: Stanford University Press, 1988), 1. China has never elaborated on this blanket statement and has, to the author's knowledge, never clarified how this policy would work in practice.

52. United States Arms Control and Disarmament Agency, *Arms Control and Disarmament Agreements: Texts and Histories of* the Negotiations (Washington, D.C.: Arms Control and Disarmament Agency, 1990), 94.

53. See, for example, Sherman W. Garnett, "Ukraine's Decision to Join the NPT," *Arms Control Today*, January/February 1995, 7–12.

54. George H. Quester and Victor A. Utgoff, "Toward an International Nuclear Security Policy," *Washington Quarterly,* Autumn 1994, 13.

55. As Quester and Utgoff point out, it is hard to envision a circumstance in which the US would at least telegraph its intention to use nuclear weapons before actual use. Ibid.

56. There is precedent for such an agreement. In 1986, as a result of the Chernobyl nuclear accident, a number of states—the US included—negotiated and signed the Convention on Early Notification of a Nuclear Accident, signed 26 September 1986 (25 *International Legal Materials* 1377).

57. Established in 1975 (after the Indian nuclear test), the NSG is the outcome of an informal agreement to restrict the trade in nuclear materials and technology.

58. See IAEA Document INFCIR/254/rev. 1/part 1, July 1992; and INFCIRC/254/rev. 1/part 1/mod. 1, July 1993. The NSG guidelines are reproduced in Harald Muller, David Fischer, and Wolfgang Kotter, *Nuclear Non-Proliferation and Global Order* (New York: Oxford University Press, 1994), 238, note 188; and in Joseph Goldblat, *Twenty Years of the Non-Proliferation Treaty: Implementation and Prospects* (Oslo, Norway: Peace Research Institute, 1990), 123–31.

59. Burrus M. Carnahan and Jacqueline R. Smith, "A Treaty to Ban Nuclear Smuggling: The Next Step in Nuclear Material Control?" *Arms Control Today*, October 1994, 14–17.

He is ill cloth'd, who is bare of Virtue.

—Poor Richard (aka Ben Franklin)

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