

NUCLEAR THEFT & SABOTAGE

PRIORITIES FOR REDUCING NEW THREATS

BY MATTHEW BUNN AND GEORGE BUNN

The appalling attacks of 11 September 2001 in the United States make clear that the threat of large, well-organized global terrorist groups bent on causing mass destruction is not hypothetical but real. The attackers achieved horrifying destruction with box-cutters. The results could have been even more horrific if the attackers would have had access to, and used, weapons of mass destruction.

Ensuring that technologies and materials for weapons of mass destruction – especially weapons-usable nuclear materials, whose acquisition is the most difficult part of making a nuclear bomb – do not fall into the hands of terrorist groups or hostile States must be a central element of the coming global effort to prevent catastrophic terrorism. At the same time, nuclear facilities and materials – along with a wide range of other especially hazardous facilities and materials – must be protected from mass-consequence sabotage. Securing these materials and facilities must be a top priority on the international agenda – pursued at every opportunity, at every level of authority, until the job is done.

At the same time, the threats against which we must defend have to be fundamentally reconsidered. On 11 September, the threat revealed itself to be

bigger, smarter, better organized, and more deadly than the threats most of the world's security systems were designed to defend against. We must ensure that our defensive response is every bit as intelligent and capable as the September attackers. And we may have to rethink some of the approaches to nuclear energy that the world has been pursuing or contemplating.

Every reasonable effort must be made to ensure that nuclear materials and facilities are effectively secured. In the past, many scenarios with enormously high consequences were dismissed as too unlikely to contribute much to overall risk – but now many of these probability estimates will have to be revised.

A far-reaching new effort is needed to strengthen security for nuclear materials and facilities worldwide, and to put stringent security standards in place. This is a global problem,

requiring a global solution – but the best global solution may be a mosaic including national, bilateral, and multilateral pieces.

INTERNATIONAL ARMS CONTROL

This article focuses on steps to strengthen security for nuclear material and facilities. But the September attacks also clearly send the message that a broad range of other efforts – from nuclear arms reductions to strengthened export controls – must be redoubled to reduce the global threats posed by nuclear, chemical, and biological weapons.

Realistically, to be truly effective, a regime to keep weapons of mass destruction out of terrorist hands must be built on a solid structure of arms control and non-proliferation measures binding States to norms and rules of behavior, and to cooperative approaches to security problems. Arms control and non-proliferation

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agreements bind bureaucracies into implementing good practices; add strength to the arguments of domestic advocates of improved controls; and give governments more authority in regulating facility operators and private enterprises.

In the case of nuclear materials, the necessary regime would include a strengthened and adequately funded IAEA safeguards system; a verified cutoff in the production of fissile material for weapons; international verification of the removal of large quantities of fissile material from military stockpiles; and other measures.

Moreover, there is the issue of building political support among the non-nuclear-weapon States on whom most of the burdens and inconveniences of the non-proliferation regime fall. Without engagement of the United States and other nuclear-weapon States (NWS) on multilateral arms control – including supporting measures that impose some constraints and inconveniences on their own forces and facilities – it is unlikely to be possible to build the needed support for an effective international regime to protect nuclear material and facilities from terrorists.

INTERNATIONAL EFFORTS: BRIDGING SECURITY GAPS

In recent years, there have been substantial international cooperative efforts both to upgrade the security of specific facilities around the world and to put more effective security recommendations and standards in place. The United States has spent hundreds of millions of dollars on cooperative efforts

SECURING THE LEGACY

Global stockpiles of nuclear material are large and widespread. A decade after the end of the Cold War, there are still some 30,000 nuclear weapons in the world (more than 95% of them in US and Russian arsenals). The world's stockpiles of separated plutonium and highly enriched uranium (HEU), the essential ingredients of



nuclear weapons, are estimated to include some 450 tons of military and civilian separated plutonium, and over 1700 tons of HEU. Most of these weapons and materials are believed to be reasonably well accounted for and secured. But this is by no means universally the case. Levels of security and accounting for both the military and civilian material vary widely, with no binding international requirements in place for military material or for a great deal of civilian material in nuclear-weapon States. The only binding international security requirements (under the Convention on the Physical Protection of Nuclear Material) for nuclear-weapon and for non-nuclear weapon States are for plutonium and HEU in international transport.

with the States of the former Soviet Union to modernize material protection, control, and accounting (MPC&A) systems at dozens of sites throughout the former Soviet States, and expects to spend more than a billion and a half more by the time the programme is completed.

Other States have contributed to this effort as well. Substantial international cooperation has also focused on improving capabilities to monitor, analyze, and interdict nuclear smuggling.

The IAEA has established a physical protection advisory service, which offers international expert peer reviews for its Member States and coordinates donor State assistance for upgrading physical protection. Through that mechanism and others, significant physical protection upgrades have been accomplished in several States outside the former Soviet Union as well.

In the area of standards and recommendations, a substantial revision of the IAEA's recommendations on physical protection was completed in 1999 (INFCIRC/225/Rev.4). New initiatives have been undertaken to provide assistance to States in developing design-basis threats (DBTs) for their physical protection systems, and to expand international physical protection training. In the wake of the September attacks, the IAEA General Conference unanimously endorsed physical protection principles developed by an experts' group.

Today, there is no treaty requiring countries using weapons-usable material to protect it from being stolen, or requiring that high-consequence nuclear facilities be protected from sabotage. The only treaty in this area is the Convention on the Physical Protection of Nuclear Material,

which entered into force in 1987 and calls for physical protection measures only for material in international transport (or storage incidental to such transport). Its requirements do not apply to material in domestic use, storage and transport. Furthermore, its protection requirements are against theft of nuclear material; there are no added requirements to deal with sabotage attacks on nuclear facilities.

Moreover, the Convention's requirements are very general and non-specific. No mechanisms are included for verification, or even voluntary reports on, or peer review of, physical protection practices. Such measures could build international confidence that States were adequately protecting their nuclear material and facilities.

In 1998, the United States proposed that the Convention be amended, and IAEA staff outlined additional possibilities for strengthening its requirements. The IAEA Director General subsequently convened experts to review the Convention. After some initial disagreement, they recommended drafting an amendment to the Convention extending its coverage to civilian nuclear material in domestic use, storage, and transport; adding a requirement to protect against sabotage of nuclear facilities as well as theft of nuclear material; stating twelve fundamental principles for

physical protection that parties should follow; and including some additional issues related to confidentiality and national responsibility.

The experts, however, opposed including any requirement that States prepare reports on their physical protection arrangements and regulations; any mechanism for international peer review of such arrangements; any reference to the much more detailed IAEA physical protection recommendations, even a requirement to give them "due consideration" or take them "into account"; and any extension of the convention to material in military use.

In September 2001, the experts' report and the Director General's decision to convene a group of experts* to draft the proposed amendment to the Convention were welcomed by the IAEA Board of Governors and General Conference. Importantly, the Board also endorsed the fundamental principles for physical protection recommended by the experts.

PRIORITY ONE: SECURITY UPGRADES

In response to new nuclear security threats, a range of specific actions should be considered urgently to strengthen and upgrade the physical protection of nuclear material and facilities. In our view, they can be grouped into two main categories – direct steps to implement security upgrades at specific facilities and to interdict nuclear smuggling; and steps to strengthen national and international security standards.

■ Every State with weapons-usable nuclear materials or high-consequence nuclear facilities should urgently assess its security arrangements and regulations in light of the magnitude of the threat demonstrated on September 11th, and upgrade them where necessary. Every such State should also review its organizational arrangements, to ensure that lines of authority and approaches to coordination for the different aspects of nuclear security are clear, and those in charge have adequate authority and resources.

If technical assistance is needed to perform security reviews, the State should request that the IAEA help organize such help – and if the State does not have adequate resources to carry out needed upgrades, it should request that the IAEA organize assistance. Where nuclear material cannot be effectively and sustainably secured in place, it should be consolidated at secure facilities.

■ Working with Russia, the United States should launch a new initiative to control and secure weapons of mass destruction (WMD) in both their countries and worldwide. In December 2001, the US Congress approved a first downpayment on such an accelerated WMD control effort, appropriating \$226 million for additional non-proliferation programmes as part of the emergency spending intended to respond to the September attacks.

■ In particular, as part of such an initiative, the United States and Russia should drastically accelerate their joint cooperation to improve MPC&A. Other States should

** In early December 2001, the IAEA Director General convened a group of legal and technical experts to prepare the draft amendment to the Convention.*

substantially increase their contributions to this effort as well. The scope of these efforts should be expanded to include physical protection assistance needed to prevent catastrophic sabotage, as well as theft of nuclear material.

■ As additional elements of such an initiative, the United States and Russia should also accelerate their other cooperative programmes designed to secure, monitor, and reduce stockpiles of nuclear weapons, plutonium, and HEU; downsize nuclear complexes and re-employ nuclear weapons and materials experts; interdict nuclear smuggling; and control sensitive nuclear exports.

Here, too, other States should substantially expand their contributions. This would include, for example, measures to accelerate the blend-down of HEU, and to place excess weapons plutonium under international verification (ideally designed to allow real-time monitoring of the material's status) and transform this plutonium into forms no more usable in nuclear weapons than commercial spent fuel.

Where such efforts have run into substantial obstacles from lack of funding, political leadership, or cooperation (as in the case of disposition of excess plutonium, for example) intensive efforts should be made to overcome these obstacles.

■ The United States and other major nuclear States should also provide substantial funding – at least several tens of millions of dollars for the coming year – to finance MPC&A upgrades and assistance for sustaining high levels of security in other countries around the world –

focused both on securing nuclear material and on preventing sabotage. These could be carried out both through bilateral arrangements and through the IAEA, but in any case should be coordinated, with the IAEA serving as a central clearinghouse for information.

■ States that so far have had no armed guards at their nuclear facilities should reconsider, and develop culturally appropriate approaches to deploying armed security personnel at each nuclear facility with weapons-usable nuclear material or whose sabotage could cause a major catastrophe.

■ The United States and other major nuclear States should finance a drastic increase in physical protection training around the world, as recommended in the final report of the IAEA-convened experts. This training should include not only technical training, but discussion of the crucial role of such security in preventing the spread of nuclear weapons and stopping nuclear terrorism. Effective training is crucial to improving security and assuring that improvements are sustained over time.

■ The budget and personnel available to the IAEA's physical protection programmes should be drastically increased, making it possible to carry out a much larger number of missions to help member states improve security measures, and to provide more effective follow-up to such missions. The recent \$1.2 million three-year grant from the Nuclear Threat Initiative, matched by the US Department of Energy, is a critical first step, but

substantially more funding is still needed.

■ International cooperative efforts to reduce the number of sites around the world where HEU and separated plutonium are stored should be drastically expanded. The budgets available for converting HEU-fueled research reactors to low-enriched uranium (LEU), taking back fresh and spent research reactor fuel to the country of origin, and developing new higher-density fuels should be substantially increased, so that these efforts can be accelerated – including particularly Russian take-back of Soviet-supplied HEU from vulnerable sites around the world. Efforts to reduce the size of these stockpiles – including bringing plutonium supply and demand into balance and reducing the existing stocks of civilian separated plutonium – should also be increased.

■ Every State with weapons-usable nuclear materials should review, and strengthen as necessary, the accuracy and effectiveness of its State System of Accounting and Control (SSAC) – as control and accounting systems are an important part of preventing and detecting insider theft. Non-nuclear-weapon States party to the NPT already have SSACs reviewed by the IAEA, as it implements safeguards, providing a multilateral discipline absent in most facilities in nuclear-weapon States. (Accounting and control of British and French civilian nuclear material are similarly reviewed by Euratom.) The nuclear-weapon States should each undertake a “self-audit,” identifying the quantities and locations of all of their

weapons-usable nuclear material, and matching these to historical production and use.

■ Firms in the nuclear industry should drop their opposition to more stringent security standards; this opposition is “penny wise and pound foolish.” While increased security measures will cost money, successful theft of nuclear material for a nuclear weapons programme, or successful catastrophic sabotage of a nuclear power plant, would be a gigantic disaster for the nuclear industry in all countries, wherever it occurred. For the same reason, the nuclear industry would be well-advised to add their voices and lobbying muscle to efforts to convince governments to allocate funds to upgrading security wherever needed.

■ The nuclear industry should establish a cooperative industry organization focused on improving security standards worldwide through peer review and assistance, comparable to the role the World Association of Nuclear Operators (WANO) has played in improving nuclear safety.

■ All relevant States should undertake dramatically increased efforts to interdict nuclear smuggling and control sensitive nuclear exports, including: (a) far-reaching sharing of intelligence and law-enforcement information; (b) ensuring that every relevant State has at least a small unit of the national police trained and equipped to deal with nuclear smuggling, and that other law-enforcement and border-control units are trained to contact them as appropriate; (c) ensuring that every relevant country has a unit

of its national intelligence service focused on, trained to deal with, and cooperating with other States on, the nuclear smuggling and illicit export threats;

(d) providing equipment and training for detection at key border crossings, airports, ports, and at potential key nodes within countries as well; and (e) substantially improving international nuclear forensics capabilities to examine seized samples and determine their origin.

PRIORITY TWO: STRONGER SECURITY STANDARDS

In addition to immediate upgrades, strengthened standards are needed if security is to be improved consistently worldwide and sustained over the long haul. These priorities extend to *national standards and regulations; international recommendations and agreements; and transparency.*

Concerning national standards and regulations:

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities should move urgently to put in place effective national security standards and regulation – at a minimum offering a level of security comparable to that recommended in INFCIRC/225/Rev.4, and with the physical protection principles adopted at the IAEA General Conference in September 2001.

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities should incorporate design basis threats into its regulations (while maintaining

confidentiality as necessary). These threats should take into account the global reach of terrorist organizations. At a minimum, it is difficult to argue that there is any country with major nuclear facilities where an attack by a small group of well-armed, well-trained terrorists, making use of a vehicle and explosives, and possibly with the assistance of one insider, is not a plausible threat against which security systems should be prepared to defend.

■ These national standards and regulations should include regular, realistic, independent testing of the performance of security systems in defeating intelligent, well-trained insider and outsider efforts to overcome them. The IAEA's physical protection advisory service should be expanded to include helping countries to carry out such tests and establish such domestic testing programmes.

■ Every relevant country should put in place strong legal and regulatory frameworks to deal with the problem of theft and illicit trafficking in nuclear material. In particular, given the immense potential consequences, States should modify their laws to make the penalties for theft or unauthorized possession or transfer of plutonium or HEU, or major sabotage of a high-consequence nuclear facility, comparable to those for murder or treason.

Concerning international recommendations & agreements:

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities that has not already done so

should sign and ratify the Convention on the Physical Protection of Nuclear Material (CPPNM).

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities should voluntarily commit to provide security for its facilities comparable to or better than that recommended in INFCIRC/225/Rev.4.

Major wealthy nuclear States such as the United States, France, the United Kingdom, Japan, and Germany should join in making a politically binding commitment that they will provide the levels of security recommended in INFCIRC/225/Rev.4 for all their nuclear material and facilities, military and civilian; that they will report to the IAEA on their regulations and procedures; that they will allow managed peer review of physical protection at selected facilities; and that they will encourage other States to make comparable commitments (including requiring that foreign facilities they supply or contract with to demonstrate compliance with the INFCIRC/225/Rev.4 recommendations).

■ A new review of INFCIRC/225 should be initiated, to make whatever modifications are necessary given the new understanding of the threat in the aftermath of September 11th.

■ The CPPNM should be amended as rapidly as practicable, to expand its coverage to domestic material and make the other improvements recommended by the experts convened by the IAEA.

■ At the same time, some of the conclusions the experts reached before September 11 should now be reversed.

Parties to the Convention should work to build support for an amendment that would include: (a) an obligation to provide levels of security comparable to those recommended in INFCIRC/225; (b) coverage of materials in military as well as civilian stockpiles; and (c) an obligation to report to the IAEA on the national legislation and regulations put in place to meet the amendment's requirements, and to report to the IAEA on overall physical protection arrangements within that State.

■ The effort to negotiate a nuclear terrorism convention should be revived. The previously drafted text should be reviewed and modified to ensure that it includes all the provisions that now seem most important to contribute to the international struggle to prevent nuclear terrorism.

■ Every nuclear supplier State should undertake steps to examine whether security in its recipient States is adequate, and if not, work with the recipient States to ensure that effective and sustainable security measures and regulations are put in place, including providing assistance where needed. The Nuclear Suppliers' Group (a body external to the IAEA) should adopt more stringent requirements prohibiting exports to countries that do not provide levels of security comparable to those called for in INFCIRC/225/Rev.4. Either peer reviews by the

supplier State or international peer reviews organized by the IAEA could be used to confirm that such requirements were being met.

■ Major nuclear States should adopt a policy that their governments and firms will not enter into contracts with nuclear facilities that fail to provide effective security and accounting for their nuclear material – making this part of the “price of admission” for doing business in the major nuclear markets.

■ Major nuclear States should place the issue of adequate security for nuclear materials and facilities high on the diplomatic agenda, giving it a prominence comparable to enforcing effective export controls and accepting safeguards on all civilian facilities.

Concerning transparency:

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities should take care to keep confidential details of its physical protection arrangements that would be useful to terrorists seeking to overcome them.

■ At the same time, sufficient information should be made available to enable informed public debate and build public and international confidence that sufficient steps are being taken.

■ Every State with weapons-usable nuclear material or high-consequence nuclear facilities should voluntarily report to the IAEA on the steps it has taken to strengthen security and put in place effective national regulations. Major nuclear States should take the lead in

PERCEPTIONS & LEVELS OF NUCLEAR SECURITY

The limited information available on how countries perceive nuclear threats against themselves shows variation from country to country. For example, in a 1997 survey of physical protection practices provided to a Stanford University, USA, workshop and to an IAEA conference, 12 of 19 countries said they perceived some kind of insider threat to their nuclear materials, six provided no information on insiders and one insisted that it faced no threat from insider theft. Only 11 of the 19 reported dangers of sabotage from terrorists or others.

Subsequently, a more detailed questionnaire on physical protection was circulated by Stanford, with six completed questionnaires received so far. The countries and their answers are confidential. None of them are nuclear-weapon States, but all have peaceful nuclear programmes. They are located in Asia, Eastern and Western Europe and South America.

Their answers show considerable variation. Four of the six had previously agreed with their nuclear suppliers to follow the recommendations of IAEA Information Circular INFCIRC/225 or to take those recommendations into account. However, the Nuclear Suppliers' Guidelines do not specify which version of INFCIRC/225 should be applied, the 1993 Revision 3 or the 1999 Revision 4. All of the six countries said they applied INFCIRC/225 but two reported applying Revision 3, three reported applying Revision 4 and one reported applying both. There was, of course, considerable variation in their actual practices.

Variations in the application of INFCIRC/225 were also reported by country experts who were involved in the first 10 missions of the International Physical Protection Advisory Service (IPPAS), the IAEA's advisory programme. Based on their experience in the ten countries, these experts reported that the implementation of INFCIRC/225 recommendations "will vary from State to State. Differences in culture, perceived threat, financial and technical resources, and national laws are some of the reasons for variations." This variation in practices came about even though the States involved said they had reviewed and considered either Revision 3 or Revision 4 of INFCIRC/225. Of course, the language of revisions permit considerable variation in national practices. The latest, Revision 4, was a consensus document agreed in 1998, long before the events of 11 September 2001.

All six respondents to the latest Stanford questionnaire reported they had national regulatory

systems that required licensing of facilities containing nuclear material. Four of the six reported that inspections of protected areas for nuclear materials were conducted at least once a year by authorities not under the supervision of the managers of the facilities.

Five of the six respondents said they had established a design basis threat (DBT). These five said they used their DBT either to design or to evaluate their protection facilities. However, only three of the six said that they kept their DBTs current. Moreover, two reported that they did not consider illicit trafficking in other countries in devising their own DBTs. While illicit trafficking may not suggest the dangers of terrorist sabotage, it is evidence of both the risks of poor protection and the active market for nuclear material. It should not be irrelevant to countries not yet feeling threatened by thieves or terrorists. Furthermore, two of the six respondents reported that they did not take into account any risk of an attack on a protected area by terrorists in establishing their DBTs. In addition, three did not take into account "the danger of unauthorized removal or sabotage by insiders."

These differences in threat perceptions must have helped cause some of the many differences in physical protection practices. The differences in perception also suggest risks in relying entirely on national DBTs to establish national physical protection standards. Should an attempt be made to achieve closer agreement on DBTs or on the methodology to determine them so that more consistent DBTs can be developed? Are there really as many differences in risks faced by different countries as the responses to our questionnaires might suggest? If terrorists want to steal weapons-usable material, won't they seek out the places where protection is weakest? If they wish to demonstrate their power and their contempt for all who reject their views by bombing a reactor or a spent-fuel repository, will they only attack facilities in the United States where, after the attacks of September 11, the protections are likely to be stronger? Are they not likely to seek out reactors or spent-fuel repositories in other parts of the world that are less well protected?

The answers to our questionnaire suggest that facility operators in many parts of the world worry about theft and sabotage by armed outsiders. Indeed, the greatest theft threats perceived by the four responders who answered our threat ranking questions were from a single insider acting (voluntarily or involuntarily) with an armed outsider or outsiders. Sabotage was also perceived as an outside threat by all

REFERENCES ON THE WEB

For background documents and reports on the Physical Protection of Nuclear Material and the IAEA's role, check the Web pages of the Agency's *WorldAtom* site. The section on physical protection is located at <http://www.iaea.org/worldatom/program/protection/>. Also see the Web pages of Harvard's Managing the Atom project, at <http://ksgnotes1.harvard.edu/BCSIA/MTA.nsf/www/N-Terror>



these four. All four ranked the most likely sabotage threats as “armed attack by outlaw, terrorist or military unit on the facility,” or “surreptitious entry by outsiders” in some cases assisted by insiders.

But not one of the six reported plans for dealing with protected-area sabotage from a truck bomb “which spreads radioactive material over and beyond the protected area.” None of them had developed plans “to minimize radiological impact” to the health and safety of the public beyond the protected area. Sabotage that causes radiological impact beyond that area is simply not perceived as a threat that they need to deal with. The bomb-laden truck which penetrates the protective area fencing and crashes into a reactor or spent-fuel storage facility causing dispersion of radioactivity outside the protected area is simply not a risk that they are protected against.

In response to a question whether their fenced-in protected areas had “vehicle barriers stronger than the fence at the points where vehicles such as a truck bomber might try to crash the fence” only three of the six respondents said “yes.” Similarly, when asked what level of protection best described their protected area, three responded: “Area or material can be accessed by defeating lightly reinforced barriers (e.g. crossing two or more fence lines, crashing a heavy gate, breaking a reinforced door or window, etc.).” Only one of the six reported stronger protection than this. This one’s protected area could only be accessed “by defeating heavily reinforced barriers and active measures (e.g., vehicle traps or pop-up crash barriers, man-traps, booby traps...).”

There were many other variations in the questionnaire responses. For example: Two out of the six did not provide guns for their guards for protected areas where weapons-usable material is located. Three followed the good practice of providing only one exit for inner areas within the protected area where weapons-usable material is actually stored, but three did not. All required some sort of identification for personnel entering such an inner area, but there was considerable variation in the manner of identification. Within such an inner area, most required that two persons be present (the “two-person” rule) but that requirement was administered in quite different ways and sometimes not followed.

If a country does not perceive any “insider” threat of stealing even weapons-usable material, as some of the respondents do not, is it not a threat to other countries if the material is stolen? If a country with a power reactor or spent fuel pond near its boundary with another country does not perceive any threat that a truck bomber will attack its nuclear facilities, could its failure to deal with that sort of threat become a threat to the neighboring country if truck bombers could produce a reactor melt-down or a dispersion of radioactivity from the spent fuel?

As stated in the IAEA Director General’s preface to INFCIRC/225/Rev.4, although responsibility for physical protection rests with the State having the nuclear material or facility to be protected, “it is not a matter of indifference to other States whether and to what extent that responsibility is fulfilled.”

taking particularly stringent measures and being among the first to report them to the IAEA.

■ Voluntary peer reviews of physical protection arrangements, such as those organized in recent years by the IAEA's International Physical Protection Advisory Service, should become, over time, a regular, normal part of doing business in major nuclear facilities – just as safety peer reviews have become. Toward that end, major nuclear States such as the United States, France, Japan, Britain, and Germany should not only provide greater funding for such peer reviews but should invite peer reviews at selected facilities of their own. As noted earlier, a new industry-led organization comparable to WANO could potentially also provide such peer reviews.

■ New cooperation should be established between the IAEA's safeguards inspectors and its physical protection experts. The IAEA's safeguards inspectors should be instructed to provide relevant information observed during their inspections to the physical protection office (while keeping the information safeguards-confidential). The IAEA's inspectors should be provided limited physical protection awareness training to facilitate this.

■ Using information from all available sources, the IAEA physical protection office should work to establish a confidential database on the state of physical protection for nuclear materials and high-consequence nuclear facilities

around the world, with a view toward identifying the facilities most in need of security upgrades.

RETHINKING THE NUCLEAR THREAT

The September attacks require a fundamental rethinking of the threats that nuclear security systems must be designed to address. The threat consisted of 19 well-trained attackers operating in four independent but coordinated teams; who were both suicidal and bent on causing mass destruction; who came from an organization with access to automatic weapons, explosives, and heavy weapons, and extensive combat training and experience; who attacked without warning; and who appear to have planned, trained, and collected intelligence for the attack for more than a year. Even without the addition of the use of large civilian aircraft fully loaded with jet fuel, this is a threat far larger and more capable than most nuclear security systems (at least for civilian facilities) were ever designed to cope with.

Countries around the world will now have to ask fundamental questions about what threats their nuclear facilities should be required to defend against – including how much they are willing to spend to provide security against large threats, and how much military force they are willing to put in place around civilian energy facilities. Security at US nuclear weapons facilities and nuclear power plants has been beefed up, and the Chairman of the Nuclear Regulatory Commission (NRC) has indicated that the NRC and the government are undertaking a

major review of nuclear security arrangements. Nuclear authorities in other countries around the world are doing the same. Questions that must be answered include:

■ Is this a threat only the United States must defend against? Or is it more likely (as we think) that all States that are large users of nuclear energy and holders of fissile material are also at risk?

■ What, if anything, should be done to protect nuclear facilities from attack by large, fuel laden aircraft? (In the US, the protection is supposed to withstand an accident from a small aircraft and was tested with attack by a small military jet.) The NRC in the US has indicated that the likelihood of such a crash was never considered high enough to be included in safety regulations. Regulatory authorities in France, the United Kingdom and several other countries have said the same. Can it now be assumed that large civilian airliners will become sufficiently difficult to hijack that the threat of a September-type attack on a power plant can be safely ignored? Or should we consider deploying anti-aircraft defenses at such facilities? What about small planes, operating from unregulated airports, which might be packed with explosives?

■ How many people, with what level of training and weaponry, should design basis threats now include? What would be the cost of providing effective protection against threats from ground attack on the scale of the September attacks?

■ Should facilities be protected against attackers

arriving and departing by unconventional means designed to overcome delays at the perimeter, such as helicopters?

While this reconsideration has only just begun, a few things do seem clear already. First, high-consequence nuclear facilities should be designed to survive truck bomb attacks. Second, it is unsafe to rely on the assumption that there will be prior warning before an attack.

A NEW VISION OF NUCLEAR SECURITY

The events of September 11th created a new world – a world in which we know for certain there are highly capable terrorist groups with global reach, bent on mass destruction. At the same time, the aftermath is demonstrating that we live in a world where far-reaching international cooperation toward common objectives can be a reality.

This new world calls for new approaches for securing much of the fragile infrastructure of modern industrial societies – including nuclear materials and facilities. A major new international initiative – composed of national, bilateral, and multilateral pieces – is needed, to achieve, as rapidly as possible, a world in which all weapons-usable nuclear material is secure and accounted for, and all nuclear facilities secured from sabotage, with sufficient transparency that the international community can have confidence that this is the case.

Of course, it is not possible to defend every facility against

every imaginable threat. Society has other things to secure besides nuclear material and facilities, and other things to expend its resources on besides security. The debate over “how much is enough?” is crucial, and has only just begun.

In our judgment, the stakes justify a significant investment in improving security worldwide. Given that proliferating States have been willing to spend billions of dollars on their efforts to produce fissile material – and given that a single bomb could threaten tens of thousands of lives – the level of effort devoted to securing and accounting for stocks of even a few kilograms of fissile material should be even higher than that devoted to protecting stores of millions of dollars worth of cash, gold, or diamonds. This is manifestly not the case at many facilities in many countries today.

Indeed, a strong case can be made that the essential ingredients of nuclear weapons should be protected roughly as rigorously as nuclear weapons themselves are, as a committee of the US National Academy of Sciences recommended in 1994. As the US Department of Energy regulations on physical protection put it, “use of weapons of mass destruction by a terrorist(s) could have consequences so grave as to demand the highest reasonably attainable standard of security.” Similarly, for nuclear facilities where successful sabotage could threaten tens of thousands of lives, very high levels of security are needed.

While every threat cannot be defended against, substantial security improvements could be made for costs that would be quite small when judged against what societies routinely spend for military security, or when judged as a percentage of the cost of nuclear-generated electricity. Safeguards and security today are a very small contribution to nuclear costs.

Obviously, not everything can be done with equal speed. The first priority must be to upgrade security for the least secure nuclear material and high-consequence nuclear facilities, in the former Soviet Union and worldwide. Strengthened international standards will likely take longer to achieve, though the momentum should not be lost.

These steps will cost money. Many of them have been blocked or slowed in recent years because of lack of political priority, bureaucratic obstacles, penny-pinching budgets, reluctance to make commitments that would cost money, and the like. In the aftermath of September 11th, governments and industry should work together to sweep these obstacles aside and take the steps needed to ensure that nuclear materials and facilities do not become the tools of terrorists.

For the United States, sustained Presidential engagement will be needed, working in difficult and sensitive partnerships with Russia and countries around the world – along with a new willingness to re-engage in multilateral arms control in a serious way. The costs and risks of failing to act are far higher than the costs of acting now. □