

PREVENTING NUCLEAR TERRORISM

TESTIMONY OF MATTHEW BUNN FOR THE SUBCOMMITTEE ON NATIONAL SECURITY COMMITTEE ON GOVERNMENT REFORM UNITED STATES HOUSE OF REPRESENTATIVES

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MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE: My name is Matthew Bunn. I have been directly involved in the spectrum of efforts to secure, monitor, and reduce nuclear stockpiles and prevent nuclear terrorism, both in and out of government, for a decade, and I am currently a senior researcher at Harvard University. A more extensive biographical sketch is attached to my testimony. I ask that the full text of my testimony, which I will summarize, be included in the record, along with some additional materials on nuclear terrorism which I am providing.¹

It is an honor to be here today to discuss what we can and should do to reduce what I believe is among the most urgent threats to America's homeland security – the threat of nuclear terrorism. My message to you today is simple: the danger is real, but there are specific steps we can take that would greatly reduce the threat. It is time for our nation to take those steps. The costs and dangers of failure to act are far, far higher than the costs and dangers of timely preventive action.

Potential terrorist use of an actual nuclear bomb, and potential terrorist use of a radiological “dirty bomb,” the two main concerns of today's hearing, are very different in their probabilities, in their consequences, and in how the threats can best be reduced. I will address the less likely but dramatically more devastating nuclear bomb threat first, and then turn briefly to the issue of radiological dirty bombs, as well as to potential sabotage of nuclear facilities.

The Nuclear Explosive Terror Threat

Mr. Chairman, Mother Nature has been both kind and cruel in setting the laws of physics that frame the predicament we face. Kind, in that the essential ingredients of nuclear weapons, highly enriched uranium (HEU) and plutonium, do not occur in significant quantities in nature, and are quite difficult to produce. Making them is well beyond the plausible capabilities of terrorist groups. Hence, if we can effectively guard all of the existing stockpiles we can prevent nuclear weapons terrorism from ever occurring: no material, no bomb. (This makes nuclear weapons quite different from chemical and biological weapons, for which the essential ingredients can be found in nature.) Cruel, in that, while it is not easy to make a nuclear bomb, it is not as difficult as we would like, once the needed materials are in hand: most states and even some particularly well-organized terrorist groups could do it. And cruel, in that HEU and plutonium, while radioactive, are not radioactive enough to make them difficult to steal and carry

away, or to make them easy to detect when being smuggled across borders. Hence our best defense is keeping these items from being stolen in the first place.

Since September 11, we have often heard that while there were warnings, there was no intelligence specific enough to tell us what actions to take. Here, that is not the case: the warnings are clear. The facts are stark:

- We know that Osama bin Laden and his Al Qaida terrorist network are seeking nuclear weapons to use against us. Bin Laden has called the acquisition of weapons of mass destruction (WMD) a “religious duty.”² Al Qaida operatives have made repeated attempts to buy stolen nuclear material from which to make a nuclear bomb. They have tried to recruit nuclear weapon scientists to help them. The extensive downloaded materials on nuclear weapons (and crude bomb design drawings) found in Al Qaida camps in Afghanistan make clear the group’s continuing desire for a nuclear capability.³
- We know that if they got the materials, making a bomb is at least potentially within the capability of a large and well-organized terrorist group. With HEU, terrorists could potentially make a simple “gun-type” bomb, little more than firing two pieces of HEU into each other to form a critical mass, with a device to generate a shower of neutrons to start the chain reaction when they come together. Making a bomb from plutonium would be more difficult, because it would have to be an “implosion” bomb, in which explosives are set off all around a plutonium core, crushing it down to a smaller, denser configuration where the nuclear chain reaction will begin. While getting these explosives right was a difficult challenge in the Manhattan Project, today the relevant explosive technology is in wide use in conventional military and even commercial applications. Detailed examinations by U.S. nuclear weapons experts have concluded again and again that with enough nuclear material in hand, it is plausible that a sophisticated terrorist group could build at least a crude nuclear explosive. These conclusions were drawn *before* September 11 demonstrated the sophistication and careful planning and intelligence gathering of which Al Qaida is capable.⁴ Indeed, DOE internal security regulations envision the possibility of an “improvised nuclear device” – a nuclear bomb the terrorists might be able to put together while they were still inside the facility where they stole the HEU.⁵
- We know that the amounts needed to build a bomb are small. With an efficient implosion design, a baseball-sized lump of plutonium weighing 4 kilograms (about 10 pounds), or a softball-sized lump of HEU weighing perhaps 3 times as much, is enough.⁶ For a simpler but less-efficient gun-type design, 4-5 times more HEU would be needed. Unless proper security and accounting systems are in place, a worker at a nuclear facility could put enough material for a bomb in a briefcase or under an overcoat and walk out.
- We know, at the same time, that enough HEU and separated plutonium to make nearly a *quarter million* nuclear weapons exists in the world today, in hundreds of buildings, in scores of countries, with security conditions that range from excellent to appalling.⁷ The collapse of the former Soviet Union, an empire with some 30,000 nuclear weapons and enough nuclear material or many tens of thousands more, created a unique security crisis, for the Soviet nuclear security system was based on a closed society with closed borders, pampered nuclear workers, and everyone under close surveillance by the KGB – a world that no longer exists. But this is a global problem as well, extending far beyond the former Soviet Union. For example, there are well over 100 civilian research reactors operating with HEU in more than 40 countries (as well as a substantial number of shut-down research reactors with HEU fuel

still on-site), most of which have very modest security arrangements. At some facilities where the essential ingredients of nuclear weapons reside, there are literally no armed guards on duty; at some, there is no security camera in the area where the material is stored, and no detector at the door to sound an alarm if some one was carrying out nuclear material in their briefcase; a few of these facilities are so impoverished that they have dead rats floating in the spent fuel pool; at some facilities, for some of the 1990s, scientists and workers were receiving pay of less than \$100 per month, which sometimes was delayed for months at a time. During the Russian financial crisis of 1998, guards at some nuclear facilities were leaving their posts to forage for food.⁸ There are also some 30,000 assembled nuclear weapons that remain in the world, and while security for these is generally better, here, too, there are some grounds for concern -- particularly with respect to tactical weapons, which are often more portable and in some cases are not equipped with modern electronic locks to prevent unauthorized use -- and there is a need for immediate steps to improve security.

- We know that as a result of such conditions, there have been multiple documented cases of real theft of kilogram quantities of real weapons-usable nuclear material. The International Atomic Energy Agency has a database that includes 18 incidents involving seizure of stolen HEU or plutonium that have been confirmed by the relevant states. To cite just one example, in 1998 there was a conspiracy by insiders at one of Russia's largest nuclear weapons facilities to steal 18.5 kilograms of HEU -- potentially enough for a nuclear bomb at a single stroke. Fortunately, Russian officials report that the conspirators were caught before the material left the facility.⁹ Theft of the essential ingredients of nuclear weapons is not a hypothetical worry -- it is an ongoing reality. What we do *not* know is how many of these thefts have *not* been detected -- how many horses have already left the barn.
- We know that nuclear materials, or even nuclear weapons, could readily be smuggled across our borders, or other nations' borders. If stolen or built abroad, a nuclear bomb might be delivered to the United States, intact or in pieces, by ship or aircraft or truck, or the materials could be smuggled in and the bomb constructed at the site of its intended use. The length of the border, the diversity of means of transport, and the ease of shielding the radiation from plutonium or highly enriched uranium all operate in favor of the terrorists. Building the overall system of legal infrastructure, intelligence, law enforcement, border and customs forces, and nuclear detectors needed to find and recover stolen nuclear weapons or materials, or to interdict these as they cross national borders, is an extraordinarily difficult challenge.
- We know that the detonation of such a bomb in a U.S. (or any other) city would be a catastrophe almost beyond imagination. A 10-kiloton nuclear explosion (from a "small" tactical nuclear weapon from an existing arsenal or a well-executed terrorist design) would create a circle of near-total destruction perhaps 2 miles in diameter. Even a 1-kiloton "fizzle" from a badly executed terrorist bomb would have a diameter of destruction nearly half as big. If parked at the site of the World Trade Center, even a 1-kiloton truck-bomb would level every building in the Wall Street financial area and destroy much of lower Manhattan. If carried out on a typical business day, some 200,000 people might be killed in a flash.¹⁰ America and its way of life would be transformed forever.

These facts lead immediately to an inescapable conclusion: we must do everything within our power to ensure that every nuclear weapon, and every kilogram of HEU and plutonium, wherever it may be in the world, is secure and accounted for, to stringent standards. In short, we have the warning we need to know what needs to be done. Failing to act on this clear warning

would simply be irresponsible. We must not allow this effort to be slowed by penny pinching, bureaucratic wrangling, or lack of sustained, high-level focus. Our response must be every bit as focused, intelligent, and sustained as the adversaries arrayed against us. The terrorists who have sworn to destroy us have demonstrated global reach, and – with attacks such as those on the U.S. embassies in Africa in 1998 – an ability to identify weak points and strike at them on a global basis. The procurement agents for hostile states such as Iraq, Iran, and North Korea have demonstrated similar capabilities. Those seeking material for a nuclear bomb will go wherever it is easiest to steal, or buy it from anyone willing to sell. Thus insecure nuclear bomb material anywhere is a threat to everyone, everywhere.

By contrast, the probability that a hostile state such as Iraq would intentionally provide a nuclear weapon or the materials to make one to a terrorist group – one often-cited rationale for a near-term U.S.-led attack on Iraq – appears small. Saddam Hussein is a fanatical dictator, which means that he wants to control everything himself; that is the nature of such leaders. He has spent billions of dollars in his effort to build a nuclear bomb, and has endured a decade of international sanctions to protect his nuclear, chemical, and biological programs. There is no evidence – none – that he has a nuclear weapon or the materials to make one today, despite a decade of effort. If he managed to get the materials for a bomb quickly, as the administration has warned he might, it would almost certainly be by getting stolen materials from abroad – that is, because of a failure of our efforts to secure “loose nukes.” The notion that if he got a nuclear bomb or the materials to make one, he would hand these hard-won items over to a terrorist group whose actions he could not absolutely control, knowing that the result could be a U.S. retaliation that would result in the utter destruction of his regime and everything associated with it, strains credulity. The Defense Department’s own most recent assessment of the proliferation threat concludes that “the likelihood of a state sponsor providing such a weapon to a terrorist group is believed to be low.”¹¹

Whatever marriage of convenience at the margins Saddam’s security services may or may not be engaging in with Al Qaida operatives, Al Qaida would seem to be a highly unlikely group for Saddam to choose to give the potentially regime-destroying power of a nuclear weapon; a central avowed purpose of Al Qaida is to destroy the secular regimes of the Arab world and replace them with fundamentalist Islamic governments, and Saddam Hussein is the leader of just such a secular, socialist regime. Indeed, the only circumstance in which I can imagine him considering supplying such arms to terrorists is exactly the situation we seem bent on creating – one in which Saddam becomes convinced that he has nothing left to lose, because the United States is going to destroy him and his regime in any case. Whatever the other arguments may be for invading Iraq, it is difficult to take the Bush administration’s assertion that we must do so to keep weapons of mass destruction out of the hands of terrorists seriously when the Bush administration itself is putting such a modest effort into blocking the much easier routes by which terrorists (and states like Iraq) might acquire such weapons.

There are crucial pieces of good news in this story as well. First, we have *no* evidence that either nuclear weapons or the materials needed to make them have fallen into the hands of terrorists or hostile states, or that Al Qaida has yet put together the expertise that would be needed to turn such materials into a bomb – though again, we cannot know what we have not detected. Second, the evidence from the materials seized in Afghanistan suggests that Al

Qaida's overall focus remains overwhelmingly on the conventional tools of terror: nuclear, chemical, and biological weapons appear to be a small part of their overall level of effort, though a dangerous one. Third, we have the technology to secure and account for the world's nuclear stockpiles, and reduce the risk that they could be stolen and fall into the hands of terrorists or hostile states almost to zero. This is a big job, and a complex job, but it is a doable one. It is a matter of putting the resources and the political will behind getting the job done – the subject to which I now turn.

The U.S. Response

The U.S. government has a patchwork quilt of dozens of programs in several Cabinet departments designed to address pieces of this threat. These efforts cover nearly the entire continuum of steps a terrorist group would have to take to acquire a nuclear bomb or the materials to make one, and deliver it against the United States. There are programs focused on securing and accounting for nuclear weapons and materials; interdicting nuclear smuggling; stabilizing the custodians of nuclear weapons and materials, to limit incentives for both theft and sale of nuclear weapons or materials or sale of nuclear knowledge; monitoring nuclear stockpiles; ending further production of weapons materials; and destroying the vast stockpiles of bomb materials wherever possible. At the same time, the war on terrorism itself is a crucial factor: by depriving Al Qaida of its Afghanistan sanctuary, disrupting its operations, interfering with its finances, and making it more difficult for it to carry out sustained activities with substantial numbers of people in a single place, the war has clearly reduced Al Qaida's potential to put together a nuclear explosive – though there remains a significant risk.

Many of these nuclear threat reduction efforts are making substantial progress, and deserve strong support. As a result of cooperative programs already underway, hundreds of tons of nuclear material and thousands of nuclear weapons are demonstrably more secure; enough nuclear material for thousands of nuclear weapons has been permanently destroyed; and thousands of under-employed nuclear weapons experts have received support for redirecting their talents to civilian work. These efforts have represented an extremely cost-effective investment in the security of the United States, Russia, and the world.

Much has been accomplished – but much, much more remains to be done than has been done so far. To date, U.S.-Russian cooperative programs have accomplished even initial “rapid upgrades” – such as bricking over windows or piling heavy blocks on top of material – on only 40% of the weapons-usable nuclear material in Russia, and comprehensive security and accounting upgrades on only half of that.¹² Less than one-seventh of Russia's stockpile of HEU (and still less of the U.S. stockpile) has been destroyed, and virtually none of the weapons plutonium in either country has yet been eliminated. While salaries and conditions for nuclear workers and guards in the former Soviet Union have notably improved, Russia plans to lay off tens of thousands of nuclear weapons scientists and workers in the next few years, and the infrastructure to create jobs for these people has not yet been built. HEU-fueled research reactors in countries around the world remain dangerously insecure.

A program to do a better job need not be unduly expensive. Elsewhere, I have estimated that these threats could be drastically reduced with the expenditure of \$5-\$8 billion over 5-8

years.¹³ The Baker-Cutler report called for a more thorough-going effort that would cost \$30 billion over 10 years – still roughly 1% of the U.S. defense budget, to drastically reduce one of the most urgent national security threats our nation faces.¹⁴

Since September 11, President Bush has described the effort to keep weapons of mass destruction (including not only nuclear but also chemical and biological weapons) out of terrorist hands as “our highest priority.” While a number of key officials of the Bush administration have worked hard in the last year to accelerate efforts to secure stockpiles of nuclear weapons and their essential ingredients around the world, the reality is that the President’s program does not yet match his rhetoric. To do an important job, you need three things: some one in charge; a plan; and the resources to get the job done. Of course, the plan and its execution also have to be designed in a way that gets the job done effectively, quickly, and at reasonable cost.

Unfortunately, for this mission, few of these essential ingredients are in place. For most of these programs, budget resources are no longer the principal limiting factor – thanks to Congress adding substantial sums in the emergency supplementals for fiscal 2002, and the Bush administration reversing course to support, in essence, a “steady as you go” threat reduction budget (similar in size and scope to the last threat reduction budget President Clinton proposed, long before September 11).¹⁵ Nevertheless, the crude measure of resources does tell the story of priorities: the roughly \$1 billion allocated for all threat reduction efforts combined represents less than one-third of one percent of the U.S. defense budget. The threat reduction budget for the whole year is what the Defense Department spends in a single day. More important, there is still no senior official anywhere in the government with full-time responsibility for leading the myriad efforts to keep nuclear weapons out of the hands of terrorists; there is still no integrated strategic plan for these efforts; and there is still very little sustained, high-level attention to getting this job done. The fact is that the President and his most senior officials spend only a tiny fraction of their time on this subject. And as a result, it remains true that bureaucratic wrangling, lack of coordination, failure to conceive and pursue new approaches, unimaginative program execution, limited planning, and low priority are slowing many of these programs and limiting their success.

Consider, as just one example, the Department of Defense’s efforts to improve security for nuclear weapons in Russia – surely one of the highest national security priorities we face. While better protected than some nuclear material sites, these are sites that have urgent vulnerabilities, from overgrown fences to guards without equipment to communicate with each other. Because of disputes between the U.S. Department of Defense and the Russian Ministry of Defense over exactly how much access U.S. experts would be given to these sensitive sites, there is today urgently needed security upgrade equipment that was purchased *five years ago* that is still sitting in warehouses, uninstalled, while the vulnerabilities it was intended to fix go unaddressed.¹⁶ Yet during this same period, the Department of Energy had resolved similar issues with the Russian Navy and was moving rapidly to upgrade security at the sites where Russian naval warheads are stored and handled – demonstrating that there was a different approach available that could work. After September 11, there was a breakthrough, and the Russian Ministry of Defense got permission from the highest levels of the Russian government to offer the access the Department of Defense had been demanding. Department of Defense officials were just about to travel to Russia to sign the papers to get the security upgrades

moving, when the Bush administration decided not to certify Russia's eligibility for Nunn-Lugar assistance, thereby creating many more months of delay (a problem that is resolved for the moment, but House and Senate conferees are still wrangling over a permanent resolution).¹⁷ What will we say to the families of the victims if this kind of bureaucratization of the effort leads to a nuclear weapon or the materials needed to make it falling into terrorist hands?

This is not primarily a critique of President Bush and his administration. There are many capable officials in the administration who are doing their best in these areas under difficult circumstances. They are to be commended for some of the important progress that has been made since President Bush came to office. I could have – and did – make many of the same criticisms of the Clinton administration's approach. The warhead security story, along with many others like it, extends across both the Clinton and Bush administrations. Rather, this is a critique of a system and a structure, a structure that lacks any overall leader for these efforts, and any institutional focal point for moving them forward. As long as that structural problem remains, the forces of inertia and business as usual will be extraordinarily difficult to overcome, and yawning gaps in our response will likely remain.

In short, the U.S. response is still not remotely commensurate with the magnitude of the threat – or the opportunities available to address it.

Recommendations for Congress

Congress has an opportunity and an obligation to help chart a new course that will make our nation more secure against these deadly threats. Congress should continue its strong record of bipartisan support for the budgets required; should avoid undue restrictions on the President's flexibility to seize opportunities as they arise and pursue new priorities as they are identified; should vigorously exercise its oversight responsibilities through hearings such as this one; should hold the administration accountable for making demonstrable progress in reducing the threat with the funds provided; and, at the same time, should understand – and communicate its understanding to the administration – that much of the future of threat reduction is in the difficult-to-measure intangibles of changing the way thousands of people do their jobs every day, securing and accounting for nuclear material, enforcing export controls, and controlling borders. I want to emphasize particularly the need for consistent, in-depth congressional oversight, including hearings with independent witnesses: as the warhead security example mentioned above suggests, there are key issues facing these programs of which most members of Congress are completely unaware – and Congress will remain unaware of these problems if only administration witnesses are heard from.

There is also an unfulfilled agenda of specific steps that would greatly reduce the nuclear terrorism threat, which Congress can and should take a leading role in initiating. I respectfully recommend the following actions:

- (1) **A single leader.** As just noted, today there is no senior official anywhere in the U.S. government with full-time responsibility for leading and coordinating the entire panoply of efforts related to securing nuclear weapons and materials – setting priorities, eliminating overlaps, seizing opportunities for synergy – and keeping the

mission of moving these programs forward on the front burner at the senior levels of the White House every day, as Governor Ridge does for homeland security.¹⁸ The lack of such a senior leader is leading inevitably to an uncoordinated and increasingly bureaucratized effort.¹⁹ I recommend that Congress mandate that President Bush appoint someone in the White House, who reports directly to him, who has no other mission but this – someone tasked to wake up every morning thinking: “what can I do today to keep nuclear weapons out of the hands of terrorists?” Congress should mandate that this official be given the authority and the staff resources needed to do such a job effectively. Congress is normally reluctant to tell the President how to organize his government, but is being asked to weigh in on government reorganization to address the homeland security problem today. Surely, if we are going to have an entire Department of Homeland Security, we should have at least one senior person in charge of keeping the most devastating weapons out of terrorist hands in the first place.

- (2) **A global coalition.** Stockpiles of weapons of mass destruction (WMD) – not just nuclear weapons but chemical and biological ones as well – and their essential ingredients exist in dozens of countries throughout the world, in both the military and civilian sectors. Hence this is a problem that can only be solved through cooperation on a global scale. Congress should commend President Bush for his success in establishing, at the G-8 summit in June 2002, a “Global Partnership Against the Spread of Weapons and Materials of Mass Destruction,” and should direct him to pursue urgent negotiations to build from that an effective global cooperative effort to secure stockpiles of WMD and their essential ingredients everywhere.²⁰ Participants would pledge to secure and account for their own stockpiles to stringent standards, provide assistance in meeting these standards to states willing to commit to them, cooperate to interdict WMD theft and smuggling, share critical intelligence on these threats, and prepare to respond to WMD threats and attacks. The United States and Russia, with the world’s largest WMD stockpiles, bear a special responsibility to lead such an effort.
- (3) **An accelerated, partnership-based approach in Russia.** Every effort should be made to ensure that all nuclear warheads and materials in the United States and Russia are secured and accounted for to standards adequate to meet the likely threats as rapidly as possible – and that they are secured in a way that will last for the long haul. Congress should direct the administration to work with Russia to develop and implement a fully *joint* strategic plan to complete “rapid upgrades” of security and accounting for all stockpiles of nuclear warheads and weapons-usable nuclear materials within two years and comprehensive upgrades within four. Congress should require an annual report on progress toward this objective, problems that are arising, and steps that could be taken to overcome the obstacles and further accelerate the effort. At the same time, Congress should direct the administration to focus this plan on upgrades that will be sustained over time, and to identify an “exit strategy” that includes a target date by which the states of the former Soviet Union will take over primarily responsibility for continuing efforts to ensure high standards of security and accounting for their weapons and materials. While holding the

administration accountable for making real progress with appropriated funds, Congress at the same time should understand the crucial importance of the intangible elements of sustainability. Finally, Congress should direct the administration to focus on a partnership-based approach to these efforts, integrating Russian experts into every aspect of their planning, design, and implementation. Only then will we achieve the Russian buy-in that will be crucial to sustaining security for the long haul.²¹

As part of such an accelerated, partnership-based approach, Congress should give the President the permanent authority to waive the Nunn-Lugar certification conditions he has requested, to ensure that these crucial investments in U.S. homeland security are not held up again over political issues related to arms control compliance. After all, though Iraq has long been in flagrant violation of its arms control obligations, does anyone seriously believe that it would not be worthwhile to spend U.S. funds to destroy as much as we could of Iraq's weapons of mass destruction and related infrastructure?

- (4) **“Global Cleanout and Secure.”** The success of Project Vinca in removing roughly 3 bombs' worth of HEU from a vulnerable facility in Yugoslavia is a demonstration of what needs to be done for many more facilities throughout the world. But this was a success that almost wasn't: pulling it off required well over a year of secret interagency negotiations – and ultimately going to the private sector for a \$5 million handout when the U.S. government did not have the authorities to carry out one crucial part of the deal. After September 11, we no longer have time for such delays. I recommend that a flexible new program be established, funded at approximately \$50 million per year for several years, which would (a) provide a range of targeted incentives to facilities around the world to give up their highly enriched uranium or plutonium, and (b) implement rapid security upgrades at facilities where these materials would remain. In combination with the ongoing effort in the former Soviet Union, such an effort could eliminate the most urgent risks worldwide within a few years. Building the necessary sensitive security partnerships with countries around the world will be a difficult but essential task (as I believe other panelists will discuss). The Senate's version of the defense authorization bill includes language that would go most of the way toward providing the authorities and direction needed. I ask that my memo to the defense conferees recommending modifications to the Senate language to ensure that such an effort is fully authorized be attached for the record. At the same time, the Senate's defense bill also authorizes the President to expend Nunn-Lugar funds not just in the former Soviet Union, but wherever threats to the United States may arise: House negotiators should agree with their Senate colleagues on giving the President this important flexibility for preventive action to address threats to U.S. security.
- (5) **Stringent global nuclear security standards.** Although nuclear security is only as strong as its weakest link, there are today no binding international standards for how well nuclear weapons and materials should be secured. Current efforts to amend the Physical Protection Convention are important and should be continued – but it is

clear that they will not lead to putting stringent international standards in place. I recommend that Congress direct the administration to pursue arrangements to flesh out the Global Partnership reached at the G-8 summit with commitments by the participating states to protect their own nuclear materials to at least an agreed minimum standard, and to provide assistance as needed to any state willing to commit to achieving the same standard. This would provide an incentive for a large number of states to make at least a political commitment to stringent standards of security for their nuclear materials. Over time, we should move to ensure that states and facilities we supply and contract with in nuclear areas also meet high security standards. Ultimately, effective security and accounting for weapons-usable nuclear material should become part of the “price of admission” for doing business in the international nuclear market.

- (6) **A beefed-up second line of defense.** While the greatest leverage is in programs to prevent nuclear material from being stolen in the first place, we also need to do what we can to provide a second line of defense should those efforts fail -- to find and recover stolen nuclear weapons or materials, and to interdict nuclear smuggling. Congress should require the administration to integrate its several anti-nuclear smuggling efforts into an overall plan to ensure, by a date certain, that each relevant country has at least one unit of its national police force assigned, trained, and equipped to deal with nuclear smuggling; that border control and customs officials at key crossing points are similarly trained and equipped; and that adequate forensic capabilities to help determine the origin of seized nuclear materials are provided on a regional basis. Substantially expanded intelligence cooperation focused on this threat, difficult though it may be, is urgently needed: as the suppliers, smugglers, and buyers may be operating in several different countries, international cooperation is the only way to beat them. Finally, as I believe others will address in more detail, we need to focus more of our own intelligence effort – including operations – on identifying and smashing nuclear smuggling rings.
- (7) **Reformed U.S. nuclear intelligence.** The resources the intelligence community devotes to nuclear issues have been substantially reduced since the end of the Cold War. And for reasons ranging from inertia to congressional mandates (which require, among other things, detailed reporting on states’ compliance with their arms control obligations), U.S. nuclear intelligence still focuses much more on detailed assessment of the nuclear forces of states that already have nuclear weapons than it does on the possibility that “loose nukes” might lead some unexpected party to get a nuclear bomb overnight. Currently there does not exist, for example, a unified database of where all the plutonium and HEU is in the world, and how well secured each of those facilities is believed to be – a crucial starting point for prioritizing corrective actions. Whether the bombs’ worth of HEU sitting at a research reactor in an obscure country is adequately secured or not, and how much the people there are paid, has not been a major focus of U.S. intelligence – yet that matters much more for U.S. security, and carries much more potential for devastating strategic surprise, than whether or not there are a few pounds of nuclear yield resulting from a Russian experiment at the Novaya Zemlya test range (a subject to which far more intelligence

resources are devoted). Congress should mandate the intelligence community to devote substantial resources to the multifaceted aspects of the nuclear terrorism problem. In particular, Congress should require that the administration prepare a classified annual report detailing what is known about which facilities in the world hold warheads, plutonium, or HEU, in what quantities and forms, how well secured and accounted for the materials are at these facilities, and what other information is available about the general level of threat at each facility. Such a legislative reporting requirement would begin to put such issues on a priority level comparable to arms control compliance and other nuclear intelligence priorities.

- (8) **Agreements to secure, monitor, and dismantle dangerous excess warheads.** The Strategic Offensive Reductions Treaty signed by President Bush and President Putin in May, while valuable, represents a missed opportunity to reduce threats of nuclear terrorism. It does not require that the reduced warheads be dismantled, or their security improved, and it does not address tactical nuclear warheads at all. It is a remarkable fact that neither the United States nor Russia has ever verified the dismantlement of a single nuclear warhead by the other country, and that not a penny of Nunn-Lugar assistance has gone directly for Russian warhead dismantlement. I recommend that Congress call on the administration to pursue a next-phase accord under which: (a) thousands of U.S. and Russian excess warheads (both strategic and tactical), including specifically all warheads not equipped with modern electronic locks to prevent unauthorized use, would be placed in secure storage facilities open to monitoring by the other side; (b) both sides would commit that these warheads would be verifiably dismantled as soon as appropriate procedures to do so while protecting classified information were agreed; (c) both sides would commit to place the plutonium and HEU from dismantling these warheads in secure, monitored storage, pending efforts to eliminate these materials; and (d) the United States would offer to provide Nunn-Lugar assistance in implementing these agreed steps, giving Russia an incentive to agree. With such an accord, in a matter of months thousands of the most dangerous warheads could be under jointly monitored lock and key, and committed to eventual dismantlement – a substantial step forward for U.S. security.
- (9) **Data exchange and monitoring – sizing the problem.** If we want to solve the problem of insecure nuclear weapons and materials, it would help a lot to know how big the problem is. It is much more important for *Russia* to know exactly how much material it has (and where) than for the United States to know this. Nevertheless, undue secrecy and limited access to sensitive facilities remain some of the biggest factors slowing progress in cooperative efforts to secure and account for warheads and materials – obstacles that could be substantially overcome if reciprocal arrangements for data exchange and monitoring of key facilities could be agreed. I recommend that Congress direct the administration to seek formal or informal arrangements with Russia to exchange information on how many warheads, how much plutonium, and how much HEU each side has, along with reciprocal monitoring of excess fissile material stockpiles and of warhead dismantlement.

- (10) **Accelerated HEU blend-down.** The surest means to prevent highly enriched uranium (HEU) from being stolen and used in a nuclear bomb is to destroy it -- by blending it with natural uranium until the content of the nuclear-explosive isotope, U-235, is below the level required to create a nuclear explosion, transforming it into proliferation-resistant low-enriched uranium (LEU). Thirty tons of HEU is currently being blended down each year under the U.S.-Russian HEU Purchase Agreement, for use as LEU fuel for nuclear power reactors. By paying Russia a fee for service to blend additional HEU to LEU and then hold it in storage in Russia (rather than flooding the market with it), the national security objective of destroying HEU could be decoupled from market constraints.²² The Senate, in its version of the defense authorization bill, has authorized such an effort, and the working group on the subject that President Bush and President Putin established at their May, 2002 summit has completed its first report. I recommend that the Congress approve the Senate authorization, and provide a provisional appropriation of perhaps \$50 million to fund the first year's accelerated blending -- probably sufficient to blend 20-30 tons of additional HEU. If the blending rate were doubled, more than a thousand bomb's worth of additional HEU would be destroyed every year -- clear, measurable threat reduction for each dollar invested.
- (11) **Expanded disposition of excess plutonium, and ending production.** The effort to transform stockpiles of excess weapons plutonium into forms that are no more usable in nuclear weapons than plutonium in spent reactor fuel is a long-term proposition -- it will not address the immediate threat of theft we face today. Nevertheless, we do not want to be guarding these excess materials forever, and fulfilling our public commitments to reduce them will send a powerful signal to the world that we intend our arms reductions to be permanent and transparent, not temporary. For those reasons, we should move forward with disposition of U.S. and Russian excess weapons plutonium, and we should move with all deliberate speed to go well beyond the 34 tons of plutonium on each side covered by the initial U.S.-Russian disposition agreement -- which represents roughly one-fifth of Russia's stockpile of separated plutonium. At the same time, as we expand efforts to get rid of excess stockpiles of plutonium and HEU, we should turn off the tap -- verifiably shutting down Russia's plutonium production reactors, and putting in place measures to confirm that neither Russia or the United States are any longer producing HEU.
- (12) **A refocused effort to stabilize and shrink Russia's nuclear complex.** Efforts to secure and account for nuclear materials in the former Soviet Union, in a sense, are treating the symptom; we need, at the same time, to treat the underlying cause, which is a vastly oversized and underfunded nuclear complex, and the resulting human desperation that creates temptations to sell materials or knowledge. While the situation in Russia's nuclear complex is nothing like as desperate as it was in 1998, the fact remains that there are tens of thousands of nuclear weapons scientists and workers (many of whom have access to either critical nuclear secrets or weapons-usable nuclear materials) who are no longer needed and will be laid off over the next few years, and the infrastructure to provide jobs for these people has not yet been built. So far, U.S. programs to help Russia reduce the size of its nuclear complex

and reemploy its nuclear scientists and workers – particularly the Nuclear Cities Initiative – have suffered from a range of problems, from lack of resources to lack of appropriate focus to lack of high-level leadership, that have greatly hindered their effectiveness. This mission remains critical to long-term success in preventing nuclear terrorism, however. I recommend that Congress direct the administration to restructure these efforts, basing them not on the expertise of nonproliferation experts and weapons designers, but rather on the economic lessons learned in other efforts at regional economic redevelopment throughout the world, adapted to the unique circumstances of the Russian economy and of its nuclear cities. Such a refocused effort would likely focus much less on subsidizing Western investment in particular production projects and much more on fostering broad regional economic growth. But it will still require more resources than have been provided to date.

- (13) **Support for the International Atomic Energy Agency (IAEA).** The IAEA is the only global organization with responsibility for safeguarding stockpiles of plutonium and HEU worldwide. We need to give it the resources to do its job. For a decade and a half, the IAEA has been kept to a zero-real-growth safeguards budget, while the amount of material under safeguards increased more than three-fold, and the number of countries and facilities where safeguards are being implemented also increased dramatically. The budget crisis is now seriously weakening the effectiveness of the safeguards system.²³ Yet the amounts involved are almost pathetically small by comparison to the security stakes; the entire global safeguards budget is in the range of \$85 million a year (of which the United States pays only a fraction).²⁴ While safeguards are designed to detect diversion by a state, not to prevent theft by a subnational group, they nonetheless impose a multilateral discipline in ensuring effective accounting and control for nuclear materials, which contributes significantly to preventing theft. Moreover, in the aftermath of September 11, the IAEA put together an action plan to prevent nuclear terrorism, which would cost \$12 million per year for the agency, and an additional \$20 million per year from donor states to implement the security upgrades identified as needed in reviews the agency would carry out. Unfortunately, the IAEA has been forced to rely on voluntary contributions rather than regular budget financing for this effort, and as of August, less than \$8 million had been pledged from all sources²⁵ – much of it in multi-year pledges, so that this total should not be compared to \$12 million but to a substantial multiple of that figure. In short, the IAEA simply does not have the money to carry out many of the actions needed to prevent nuclear terrorism. Congress should commend and support the Bush administration's decision to press for increases in the IAEA's safeguards budget, and should authorize increased funding for both the regular IAEA budget and the U.S. voluntary contribution.
- (14) **New revenue streams for nuclear security.** All of these efforts are going to cost money – though lack of money alone is not the primary limiting factor on their success today. The Bush administration should be commended for achieving the “10 plus 10 over 10” commitment – that is, the commitment at the G-8 summit that the United States and the combination of its other G-8 partners would each provide roughly \$1 billion a year for threat reduction over the next decade. Much remains to

be done, however, to transform this statement from promises to action. Given the scale of the activities that need to be funded, and the need for a strapped Russian budget ultimately to provide full funding for securing Russia's huge stockpiles of nuclear weapons and materials, it makes sense to develop new revenue streams that can supplement on-budget government expenditures. I recommend that Congress support two particular approaches: (a) a "debt for nonproliferation" swap, modeled on past debt-for-environment swaps, in which a portion of Russia's debts would be canceled in return for Russia making payments into an auditable fund to finance agreed arms reduction and nonproliferation projects (as called for in the Biden-Lugar legislation);²⁶ and (b) *if* arrangements for commercial Russian spent fuel imports can be developed that meet stringent criteria for U.S. support, using the leverage provided by U.S. veto rights over U.S.-obligated spent fuel to seek Russian commitments to devote a portion of the proceeds to a similar auditable fund to finance agreed nuclear security efforts.²⁷

- (15) **Independent analysis and advice.** It is extraordinarily difficult, in the course of the day-to-day fights involved in running a program in the administration, or the day-to-day struggles on Capitol Hill, to draw back and think strategically about how best to address these kinds of threats. There is an urgent need, therefore, to create increased capabilities for in-depth, independent analysis of these threats and the programs to address them, from outside government. In their recent report on the role of science and technology in defending the nation from terrorism, a committee of the national academies recommended the establishment of an Institute for Homeland Security, modeled roughly on the role the RAND Corporation played for the Air Force in the 1950s.²⁸ I believe such an independent think-tank, with a portion of its effort devoted to nuclear security, could make an enormous contribution to shaping a more effective U.S. response. In addition, I believe that each of the largest programs should have an independent advisory group to provide regular oversight and advice, composed of individuals with the time and expertise to provide both strategic vision and mid-course corrections on the specifics of program implementation. I recommend that Congress direct the administration to establish both types of capabilities.

The Nuclear Sabotage and Dirty Bomb Threats

In addition to attempting to acquire or build an actual nuclear bomb, terrorists might seek to disperse radioactive material over an area, by sabotaging a nuclear power plant or other sensitive nuclear facility, or by spreading such material with a "dirty bomb."

Like the use of a nuclear explosive, a truly successful sabotage of a major nuclear facility, causing a Chernobyl-scale release of radiation, would be quite difficult for terrorists to pull off, but would be quite devastating. If the linear no-threshold theory of radiation effects is correct, a worst-case sabotage might lead to tens of thousands of long-term deaths.²⁹ The best available response to this threat is also the same as for the nuclear explosive threat: we need to make sure that every major nuclear facility in the United States – as well as other particularly dangerous industrial facilities – are protected against the scale of terrorist threats we now face.

As with security for nuclear weapons and materials, there are a large but limited number of facilities to protect, and therefore if we take the actions that we know how to take, we can reduce the probability of successful terrorist action against nuclear facilities to a very, very low level.

Today, however, few nuclear security systems in the world were designed to deal with a threat as severe as was revealed on September 11 – four independent but coordinated groups of four or five well-trained and suicidal terrorists each, from a group with extensive experience with explosives and infantry combat weaponry, collecting intelligence and planning for more than a year before the attack, striking without warning. It is appropriate for Congress to insist, as legislation now under consideration does, on a broad review of the threat against which our nuclear facilities should be protected, and the adequacy of current security arrangements.³⁰ A key question, if it is determined (as I believe it should be) that additional security measures are needed, is who should pay – the industry that profits by the operation of these facilities, or the government that is responsible for the defense of the nation against enemy attack.

Congress should also authorize support for improved security against sabotage in other countries: while a Chernobyl-scale accident caused by terrorists on the other side of the world would not have a direct effect on the U.S. homeland in the way that terrorist acquisition of a nuclear weapon or nuclear material would, it would be a terrible humanitarian disaster, and would seriously undermine the entire global nuclear industry – an industry on which the United States depends for 20% of its electricity.

Potential terrorist use of a radioactive “dirty bomb” poses a very different problem. A dirty bomb is really a weapon of mass disruption, not a weapon of mass destruction. A well-executed dirty bomb attack could force the evacuation of a substantial area and impose billions of dollars in cleanup costs and billions more in economic disruption. But it would not obliterate the center of a major city or kill tens of thousands of people in a flash as a nuclear explosive could. In most cases that have been examined, there would be no immediate casualties from the dispersed radiation; while there might be hundreds or even thousands of long-term cancer deaths in some cases, these would be very difficult to notice against the much larger background of cancer deaths from other causes. As we sit in this room, each of us has roughly a 20% chance of dying of cancer, on average; if we were so unfortunate as to be outdoors and breathe in material from the dispersal plume of a dirty bomb attack, that probability might be increased by a few percent (depending, of course, on the details of the material dispersed, how it was dispersed, and so on).

A dirty bomb is certainly the most likely form of nuclear terrorist attack – though the least devastating. Radiological materials are very widely available, and making a dirty bomb would be a much easier task for terrorists than making an actual nuclear bomb or successfully sabotaging a major nuclear facility (though not quite as simple as is sometimes suggested). Indeed, I believe it is more likely than not that a dirty bomb attack will be carried out in the United States within the next decade. To reduce this threat, we should:

- Strengthen regulatory controls over radiological sources within the United States, and develop an improved national capability to recover lost or “orphan” sources;
- Develop an appropriate categorization of the risk posed by different types of sources, and strengthen security requirements for those that pose the greatest danger;

- Consider economic alternatives to the use of radiological sources in some applications;
- Develop an improved strategy and improved capabilities for responding to a radiological attack, including (a) training and equipment for first responders, (b) better capabilities for large-scale decontamination in an urban environment, and (c) a credible communication plan for providing information to the public in such an event.
- Put in place improved nuclear detection systems around the country, particularly at key economic or governmental nodes and key transportation points;
- Undertake a targeted public education effort, to increase understanding of the real magnitude of the threat and thereby reduce panic should such an attack occur; and
- Work with other countries (particularly the states of the former Soviet Union, where nuclear enthusiasm has led to the presence of a large number of particularly dangerous sources) and international organizations to improve controls over radiological sources around the world.³¹

Currently pending legislation, both the “Dirty Bomb Prevention Act” and the provisions related to international control over radiological materials in the Senate version of the defense authorization bill, represent very important first steps in these directions, and deserve Congressional support. Realistically, however, we should understand the limits of what can be done. In the case of securing warheads, plutonium, HEU, and major nuclear facilities, if we take appropriate actions today, within a few years it might be possible for some one to come to this committee and honestly testify that all the known stockpiles and facilities in the world had been effectively secured. Radiological sources suitable for use in a “dirty bomb,” by contrast, are so widely dispersed throughout this country and the world that no one will ever be able to make such a claim with a straight face. Moreover, given the serious but relatively limited consequences of the use of a dirty bomb, we should not allow our efforts to reduce the dirty bomb threat to distract our attention from the urgent steps needed to deal with the far more devastating danger of terrorist acquisition of an actual nuclear bomb.

A Time to Act

The time for action is now. Immediate further steps are needed to ensure that all of the tens of thousands of nuclear weapons and hundreds of tons of weapons-usable nuclear materials around the world are secure and accounted for. Accomplishing this as rapidly as possible must be a top U.S. homeland security objective. After September 11, “business as usual” is simply not good enough.

Mr. Chairman and members of the committee, you need to ask yourselves: “On the day after a terrorist nuclear attack, what actions would we wish we had taken to prevent it?” – and then begin taking those steps before disaster strikes.³² How will any leader explain it to his country – or his children – if the next terrorist attack uses a nuclear weapon and the terrorists got the material they needed for this because the world’s leaders failed to take the obvious and practical actions to secure it?

Matthew Bunn

Matthew Bunn is a Senior Research Associate in the Project on Managing the Atom in the Belfer Center for Science and International Affairs at Harvard University's John F. Kennedy School of Government. His current research interests include nuclear theft and terrorism; security for weapons-usable nuclear material in the former Soviet Union and worldwide; verification of nuclear stockpiles and of nuclear warhead dismantlement; disposition of excess plutonium; conversion in Russia's nuclear cities; and nuclear waste storage, disposal, and reprocessing.

Before joining the Kennedy School in January 1997, he served for three years as an adviser to the Office of Science and Technology Policy, where he played a major role in U.S. policies related to the control and disposition of weapons-usable nuclear materials in the U.S. and the former Soviet Union, and directed a secret study for President Clinton on security for nuclear materials in Russia. Previously, Bunn was at the National Academy of Sciences, where he directed the two-volume study *Management and Disposition of Excess Weapons Plutonium*. He is a consultant to the Nuclear Threat Initiative, a member of the Russian-American Nuclear Security Advisory Council, an organization devoted to promoting nuclear security cooperation between the United States and Russia, and a member of the Board of Directors of the Arms Control Association.

Bunn is the author or co-author of several books and book-length technical reports, and dozens of articles in magazines and newspapers including *Foreign Policy*, *Scientific American*, *Science*, *Technology Review*, *Annual Review of Energy and the Environment*, *Arms Control Today*, *The Bulletin of the Atomic Scientists*, and *The Washington Post*, and appears regularly on television and radio. Bunn received his bachelors' and masters' degrees in political science, specializing in defense and arms control, from the Massachusetts Institute of Technology in 1985. He is married to Jennifer Weeks, and lives in Watertown, Massachusetts. They have two daughters, Claire and Nina.

ENDNOTES

¹ These include the Executive Summary of Matthew Bunn, John P. Holdren, and Anthony Wier, *Securing Nuclear Weapons and Materials: Seven Steps for Immediate Action* (Cambridge, MA: Harvard University Managing the Atom Project and Nuclear Threat Initiative, May 2002, available as of September 19, 2002 at http://www.nti.org/e_research/securing_nuclear_weapons_and_materials_May2002.pdf); Matthew Bunn and George Bunn, "Strengthening Nuclear Security Against Post-September 11 Threats of Theft and Sabotage," *Journal of Nuclear Materials Management*, Spring 2002 (available as of September 19, 2002 at <http://www.inmm.org/topics/contents/strengthening.pdf>); and a memorandum to the defense authorization conferees. This testimony draws heavily from the Bunn, Holdren, Wier report, and I thank my co-authors for permission to use this material. Other recent sources from which I have benefited immensely, and which I commend to the committee's attention, include: Committee on Science and Technology for Countering Terrorism, National Research Council, *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism* (Washington DC: National Academy Press, 2002, available as of September 19, 2002, at <http://books.nap.edu/html/stct/index.html>), especially Chapter 2, "Nuclear and Radiological Threats"; Siegfried Hecker, testimony to the Senate Foreign Relations Committee, April 23, 2002; Frank von Hippel, "Recommendations for Preventing Nuclear Terrorism," *F.A.S. Public Interest Report*, November/December 2001 (available as of September 19, 2002, at <http://www.fas.org/faspir/2001/v54n6/prevent.htm>); Richard L. Garwin, "Nuclear and Biological Megaterrorism," August 21, 2002, available as of September 19, 2002, at <http://www.fas.org/rlg/020821-terror.htm>; Sam Nunn, "Reducing the Threats From Weapons of Mass Destruction and Building a Global Coalition Against Catastrophic Terrorism," May 27, 2002, available as of September 19, 2002, at http://www.nti.org/c_press/c_index.html; and Michael Barletta, ed., *After 9/11: Preventing Mass Destruction Terrorism and Weapons Proliferation* (Monterey, CA: Monterey Institute for International Studies, Center for Nonproliferation Studies, May 2002, available as of September 19, 2002, at <http://cns.miis.edu/pubs/opapers/op8/op8.pdf>). For a more complete set of resources on nuclear terrorism, see <http://ksgnotes1.harvard.edu/BCSIA/MTA.nsf/www/N-Terror>.

² "Interview with Bin Laden: 'World's Most Wanted Terrorist'," *ABCNews.com* (available as of September 19, 2002 at http://more.abcnews.go.com/sections/world/DailyNews/transcript_binladen1_990110.html).

³ See, for example, David Albright, Kathryn Buehler, and Holly Higgins, "Bin Laden and the Bomb," *Bulletin of Atomic Scientists*, Jan.-Feb. 2002 (available as of September 19, 2002 at <http://www.isis-online.org/publications/terrorism/binladenandbomb.pdf>); Mike Boetcher and Ingrid Arnesen, "Al Qaeda Documents Outline Serious Weapons Program," *CNN*, January 25, 2002 (available as of September 19, 2002 at <http://www.isis-online.org/publications/terrorism/cnnstory.html>); Gavin Cameron, "Multi-Track Microproliferation: Lessons from Aum Shinrikyo and Al Qaeda," *Studies in Conflict and Terrorism*, Vol. 22, No. 4, 1999; and Kimberly McCloud and Matthew Osborne, "WMD Terrorism and Usama bin Laden," Monterey Institute for International Studies, Center for Nonproliferation Studies (available as of September 19, 2002 at <http://cns.miis.edu/pubs/reports/binladen.htm>).

⁴ See J. Carson Mark et al., "Can Terrorists Build Nuclear Weapons?" in Paul Leventhal, and Yonah Alexander, *Preventing Nuclear Terrorism* (Lexington, MA: Lexington Books, 1987, available as of September 19, 2002 at <http://www.nci.org/k-m/makeab.htm>). This remains the most authoritative unclassified treatment of the subject – in part because it represents something of a negotiated statement by experts with a range of views on the matter.

⁵ U.S. Department of Energy, Office of Security Affairs, Office of Safeguards and Security, *Manual for Protection and Control of Safeguards and Security Interests, Chapter I, Protection and Control Planning* (Washington, DC: DOE, July 15, 1994, available as of September 19, 2002 at http://www.fas.org/irp/doddir/doe/m5632_1c-1/m5632_1c-1_c1.htm).

⁶ The Department of Energy has officially declassified the fact that 4 kilograms of plutonium is in principle sufficient to make a nuclear weapon. See *Drawing Back the Curtain of Secrecy: Restricted Data Declassification Decisions 1946 to the Present*, RDD-5 (Washington DC: U.S. Department of Energy, January 1, 1999).

⁷ The total world stockpile of HEU is estimated to be some 1600 tons (potentially enough to fabricate 130,000 nuclear weapons), while the world stockpile of plutonium separated from spent fuel is estimated to be over 450 tons (enough to fabricate an additional 110,000 nuclear weapons). See David Albright and Mark Gorwicz, "Tracking Civil Plutonium Inventories: End of 1999," October 2000, available as of September 19, 2002, at <http://www.isis->

online.org/publications/puwatch/puwatch2000.html; the figures presented there have been updated to reflect continuing blend-down of HEU and continuing accumulation of civil separated plutonium. The weapons equivalent calculation assumes 4 kilograms of plutonium per weapon and three times that for HEU.

⁸ For a recent unclassified summary of the situation in Russia, see National Intelligence Council, *Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces* (Langley, VA: Central Intelligence Agency, February 2002, available as of September 19, 2002 at http://www.cia.gov/nic/pubs/other_products/icarusiansecurity.htm); for earlier accounts of the state of security and accounting for nuclear weapons and materials in the former Soviet Union, see Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Material* (Washington, DC: Carnegie Endowment for International Peace and Harvard Project on Managing the Atom, April 2000, available as of September 19, 2002 at <http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/pubs/Nextwave>), and sources cited therein. For a discussion of the global threat outside the former Soviet Union, see Bunn, Holdren, and Wier, *Securing Nuclear Warheads and Materials*, op. cit.

⁹ For discussions, with references, of many of the major theft cases, including this one, see Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Materials* (Washington, DC: Carnegie Endowment for International Peace, Nonproliferation Project, and Harvard University Managing the Atom Project, 2000, available as of September 19, 2002, at <http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/pubs/Nextwave>).

¹⁰ For some useful calculations on effects in Manhattan, see Garwin, "Nuclear and Biological Megaterrorism," op. cit.

¹¹ U.S. Department of Defense, *Proliferation: Threat and Response* (Washington DC: U.S. Department of Defense, January 2001, available as of September 19, 2002 at <http://www.defenselink.mil/pubs/ptr20010110.pdf>), p. 61.

¹² DOE estimates that 42% of the weapons-usable nuclear material will have rapid upgrades installed by the end of FY 2002, with 18% having comprehensive upgrades installed by that time. See U.S. Department of Energy, *FY 2003 Budget Request: Detailed Budget Justifications—Defense Nuclear Nonproliferation* (Washington, DC: DOE, February 2002, available as of September 19, 2002, at <http://www.cfo.doe.gov/budget/03budget/content/defnn/nuclnonp.pdf>), p. 24.

¹³ Bunn, *The Next Wave*, op. cit.

¹⁴ Howard Baker and Lloyd Cutler, co-chairs, *A Report Card on the Department of Energy's Nonproliferation Programs with Russia* (Washington DC: Secretary of Energy Advisory Board, January 2001, available as of September 19, 2002 at <http://www.hr.doe.gov/seab/rusrpt.pdf>).

¹⁵ For an analysis of the FY 2003 threat reduction budget proposal, see Bunn, Holdren, and Wier, *Securing Nuclear Warheads and Materials*, op. cit.

¹⁶ See, for example, Charles L. Thornton, "The Nunn-Lugar Weapons Protection, Control, and Accounting Program: Securing Russia's Nuclear Warheads," in *Proceedings of the 43rd Annual Meeting of the Institute for Nuclear Materials Management*, Orlando, Florida, June 23-27, 2002 (Northbrook, IL: INMM, 2002).

¹⁷ Interviews with Department of Defense personnel, April and May, 2002.

¹⁸ While there is a highly capable individual several tiers down on National Security Council staff tasked with coordinating most of these efforts, that does not remotely compare to some one on the model of Governor Ridge, which I believe is roughly what is required.

¹⁹ For a useful (though depressing) recent account of one element of this picture (in this case programs intended to prevent nuclear smuggling), see U.S. General Accounting Office, *Nuclear Nonproliferation: U.S. Assistance Efforts to Help Other Countries Combat Nuclear Smuggling Need Strengthened Coordination and Planning*, GAO-02-426 (Washington, DC: General Accounting Office, May 2002, available as of September 19, 2002 at <http://www.gao.gov/new.items/d02426.pdf>).

²⁰ For a description of this initiative, see Cristina Chuen, Michael Jasinski, and Tim Meyer, "The 10 Plus 10 Over 10 Initiative: A Promising Start, But Little Substance So Far," (no date), available as of September 19, 2002, at <http://cns.miis.edu/pubs/week/020812.htm>. The text of the G-8 commitment was available as of September 19, 2002, at http://www.g8.gc.ca/kan_docs/globpart-e.asp. Former Senator Sam Nunn and Senator Richard Lugar have taken the lead in making the case for such a global coalition; see, for example, their statement from the Moscow conference on the topic sponsored by the Nuclear Threat Initiative in May, 2002, available as of September 19, 2002 at http://www.nti.org/c_press/c_index.html.

²¹ For more detailed recommendations on these points, see Bunn, Holdren, and Weir, *Securing Nuclear Weapons and Materials*, op. cit.; Hecker, testimony to the Senate Foreign Relations Committee, op. cit.; and Oleg Bukharin, Matthew Bunn, and Kenneth N. Luongo, *Renewing the Partnership: Recommendations for Accelerated Action to*

Secure Nuclear Material in the Former Soviet Union (Washington DC: Russian American Nuclear Security Advisory Council, 2000, available as of September 19, 2000 at <http://ksgnotes1.harvard.edu/BCSIA/Library.nsf/pubs/ransacreport>).

²² For more on this recommendation, in addition to *Securing Nuclear Warheads and Materials*, and *The Next Wave*, see Robert L. Civiak, *Closing the Gaps: Securing High Enriched Uranium in the Former Soviet Union and Eastern Europe* (Washington DC: Federation of American Scientists, May 2002, available as of September 19, 2002, at <http://www.fas.org/ssp/docs/020500-heu/full.pdf>),

²³ For an eloquent statement on this point, see Charles Curtis, “Reducing the Nuclear Threat in the 21st Century,” address to the IAEA Safeguards Symposium, October 29, 2001, available at http://www.nti.org/c_press/c_index.html.

²⁴ See for example, IAEA, *Annual Report 2001* (Vienna, Austria: 2002, available as of September 19, 2002 at <http://www.iaea.org/worldatom/Documents/Anrep/Anrep2001>), p. 95.

²⁵ See “Nuclear Security: Progress on Measures to Protect Against Nuclear Terrorism,” GOV/INF/2002/11-GC(46)/14 (Vienna, Austria: IAEA, August 12, 2002, available as of September 19, 2002, at <http://www.iaea.org/worldatom/About/Policy/GC/GC46/Documents/gc46-14.pdf>). At the IAEA General Conference in early September, Secretary of Energy Spencer Abraham pledged an additional U.S. contribution of \$3 million.

²⁶ For more on this concept, see, for example, James Fuller, “Debt for Nonproliferation: The Next Step in Threat Reduction,” *Arms Control Today*, January/February 2002, available as of September 19, 2002 at http://www.armscontrol.org/act/2002_01-02/fullerjanfeb02.asp.

²⁷ For a discussion of appropriate conditions that would have to be met, see Bunn, Holdren, and Wier, *Securing Nuclear Warheads and Materials*, op. cit..

²⁸ Committee on Science and Technology for Countering Terrorism, *Making the Nation Safer*, op. cit.

²⁹ For discussion, see Bunn and Bunn, “Strengthening Nuclear Security Against Post-September 11 Threats of Theft and Sabotage,” op. cit., and sources cited therein; for a more detailed discussion, drawing on the effects of the Chernobyl accident (which the authors conclude probably will cause 24,000 long-term cancer deaths), see Richard L. Garwin and Georges Charpak, *Megawatts and Megatons: A Turning Point in the Nuclear Age* (New York, NY: Knopf, 2001). A recent article in *Science* argues that sabotage of reactors is not a major concern (Douglas M. Chapin et al., “Nuclear Power Plants and Their Fuel as Terrorist Targets,” *Science*, September 20, 2002) – but the National Research Council report was much less sanguine, warning that “studies suggest that a terrorist attack on an NPP could have potentially severe consequences if the attack were large enough. The severity is highly dependent on the specific design configuration of the NPP including details such as the location of specific safety equipment.” (*Making the Nation Safer*, op. cit.). Moreover, the performance of U.S. reactors in NRC security exercises – in which, 46% of the time, the reactor security forces fail to protect vital areas whose destruction could lead to core damage and possible radioactive release – suggests that additional work to secure U.S. facilities is required. See statement of David N. Orrick to the House Committee on Energy and Commerce, April 11, 2002, available as of September 19, 2002 at <http://energycommerce.house.gov/107/hearings/04112002Hearing532/Orrick908.htm>.

³⁰ See discussion in Bunn and Bunn, “Strengthening Nuclear Security Against Post-September 11 Threats of Theft and Sabotage,” op. cit. Relevant pending legislation on this topic includes, for example, the “Nuclear Security Act,” reported favorably by the Senate Committee on Environment and Public Works on July 25, 2002.

³¹ I am grateful to Michael Levi and his colleagues at the Federation of American Scientists (FAS) for recommendations in this area. For more details, see the testimony of Henry Kelly, president of FAS, before the Senate Foreign Relations Committee, March 6, 2002, available as of September 19, 2002, at http://www.fas.org/ssp/docs/kelly_testimony_030602.pdf. For discussion of international efforts to control radiological materials, see the links provided at <http://ksgnotes1.harvard.edu/BCSIA/MTA.nsf/www/N-Terror>.

³² This way of posing the question was first proposed by Graham T. Allison, Owen R. Coté, Richard A. Falkenrath, and Steven E. Miller, *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge, MA: MIT Press, 1995), p. 17.