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Cooperation to Secure Nuclear Stockpiles

A Case of Constrained Innovation

The 1991 dissolution of the Soviet Union posed an unprecedented challenge: to keep tens of thousands of nuclear weapons, and enough highly enriched uranium (HEU) and separated plutonium to make tens of thousands more, out of hostile hands. In this crisis, small groups of policy entrepreneurs launched major innovations to spur the nuclear complexes of the former rival superpowers to pursue their common interest in securing and dismantling nuclear stockpiles. Billions of dollars have now been spent pursuing these efforts, thousands of bombs' worth of nuclear materials have been permanently destroyed, and security both for thousands of nuclear weapons and for enough nuclear material for tens of thousands more has been substantially improved.

But as the Soviet collapse has receded into the past, the initial innovations have been increasingly constrained by cautious bureaucracies, continuing secrecy and mistrust, and festering political obstacles and disputes. Programs once conceived as free-wheeling, short-term crisis responses have shifted toward "business as usual" approaches—more systematized and sustainable, but far slower and less flexible.

Yet the danger remains very real.[1] Al Qaida and the jihadist network it helped to spawn have repeatedly attempted to purchase stolen nuclear material and to recruit nuclear expertise; indeed, Osama bin Laden and Ayman al-Zawahiri met at length with two senior Pakistani nuclear scientists to discuss nuclear weapons. Government studies have repeatedly concluded that a technically capable terrorist group could plausibly make at least a crude nuclear bomb if it procures HEU or separated plutonium. The essential ingredients of nuclear weapons are stored in hundreds of buildings in more than 40 countries—some very well secured, and some with little more than a night watchman and a chain-link fence. The danger of nuclear theft is

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now recognized as a global problem requiring global solutions, not just a problem of the former Soviet states.

The nuclear material for a bomb is small and easy to hide or smuggle; even an assembled bomb would fit in a passenger van or the hold of a yacht. Once nuclear material leaves the facility where it is supposed to be, it could be anywhere, and the problems of finding it and preventing its use multiply a thousand-fold; the best way to reduce the risk of nuclear terrorism is to prevent nuclear material from being stolen.

Thus, the world's security against terrorist nuclear attack requires that improved security measures reach all the potentially vulnerable caches of nuclear material around the world before terrorists and thieves do. But the lesson of past efforts is that policy entrepreneurs several tiers from the top of government establishments are unlikely to succeed in pushing these efforts forward with the needed speed and flexibility. Overcoming the substantial political and bureaucratic obstacles to progress—many of which stretch across the numerous agencies of the U.S. government and other governments working on pieces of this problem—will require sustained leadership and policy innovation by presidents, prime ministers, and their immediate staffs.

The 1991 dissolution of the Soviet Union posed an unprecedented challenge: to keep tens of thousands of nuclear weapons, and enough highly enriched uranium (HEU) and separated plutonium to make tens of thousands more, out of hostile hands.

This article will outline the initial responses to the Soviet collapse, and describe the origins and history of the cooperative programs to secure and account for nuclear stockpiles. It will examine the obstacles to progress that had to be overcome, and that still exist, and the various approaches that have been pursued to overcoming them. Finally, it will draw lessons from this experience that can strengthen and accelerate the urgent work still to be done to prevent nuclear terrorism.

RESPONDING TO THE SOVIET COLLAPSE

When the Soviet Union entered its death throes with the hard-line coup against Soviet leader Mikhail Gorbachev in August 1991, the initial focus of nuclear concern was who would control the Soviet Union's nuclear weapons. A single nuclear-armed state splintering into many states with nuclear arms would have been a nuclear proliferation disaster of unprecedented proportions. Two major top-down innovations—one from the U.S. executive branch, one from the U.S. Congress—played key roles in avoiding that outcome.

First, in September 1991, President George H.W. Bush announced a dramatic unilateral initiative to pull back and in many cases dismantle thousands of tactical nuclear weapons, and to take strategic bombers off runway alert. He and a small group of advisers short-circuited the

ponderous national-security bureaucracy to shape the new approach quickly and secretly. Gorbachev—who had been consulted before Bush's announcement—responded immediately with an equally dramatic pull-back and dismantlement plan for a large fraction of the Soviet Union's tactical nuclear weapons. Soviet nuclear weapons had already been pulled out of Eastern Europe as Soviet power there collapsed, but Bush's initiative gave Gorbachev political justification for ordering the tactical weapons all the way back to Russia, and for dismantling thousands of them. (Remarkably, this was not the primary purpose of Bush's initiative, which was focused largely on resolving the U.S.' own problems with its tactical nuclear weapons.)[2]

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Even as the Soviet Union collapsed, the Soviet military managed this pullback with remarkable professionalism, returning every single tactical nuclear weapon to Russia with no apparent losses and no major incidents. The last tactical nuclear weapon left Ukraine a few months after the Soviet collapse, in early May 1992. A potentially dramatic crisis over security and control over tactical nuclear weapons had been averted by initiatives by a small number of policy entrepreneurs at the very highest levels of the U.S. and Soviet governments, coupled with the professionalism of the Soviet military.

The Soviet Union's death throes also provoked a remarkable innovation from the Congress. In November 1991, at the initiative of Senators Sam Nunn (D-GA) and Richard Lugar (R-IN), Congress approved the "Soviet Nuclear Threat Reduction Act" as an amendment to the annual defense authorization bill, authorizing up to $400 million for a program to help the U.S.' former nuclear rival control and dismantle its massive legacy of weapons of mass destruction. (William Perry and Ashton Carter, who were then outside the government but would later play key roles in implementing the initiative, closely advised Nunn and Lugar in crafting the new approach.) Nunn and Lugar (and Representative Les Aspin [D-WI], who had first proposed assistance to the Soviet Union that summer) saw clearly that such a program would be an excellent investment in U.S. security, not a foreign aid program.

While the Constitution gives the President authority over foreign policy, Nunn-Lugar was a major foreign-policy initiative launched by Congress with little executive branch involve-

ment or support. As a result, it was slow to get moving. Under the Bush administration's approach, first an overall government-to-government agreement setting the general terms and conditions of such assistance would have to be negotiated; then specific agency-to-agency agreements covering particular projects would be negotiated; then, even more specific contracts with companies and laboratories to implement the projects would be negotiated; only then would the money flow—largely to U.S. firms (to get broad support in Congress, the original act had specified that "to the extent feasible," the program should "buy American").

The original bill did not authorize new money, but merely gave permission to divert money from other favored Defense Department projects. At the same time, an arms control bureaucracy trained to drive the toughest possible deal with Soviet officials was now called upon to find the most effective means to assist them. A defense procurement system that was ponderous buying weapons in California and Massachusetts was now called upon to move quickly to implement multi-million-dollar projects in remote parts of the chaotic former Soviet Union. It took a new administration—in which Aspin was initially Secretary of Defense, Perry his deputy (later replacing Aspin as Secretary), and Carter the assistant secretary charged with implementing Nunn-Lugar—to get the effort moving at full speed.[3] (In later years, new money was authorized and appropriated; somewhat later, the buy-American provisions were dropped.)

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A critical question was still who would control the Soviet nuclear legacy. While all the tactical nuclear weapons had been pulled back to Russia by May 1992, strategic (that is, long-range) nuclear weapons were still based in Russia, Belarus, Ukraine, and Kazakhstan. When the Soviet Union collapsed, Ukraine was the world's third largest nuclear power, and Kazakhstan the fourth (though neither had full control over the nuclear weapons on their soil). Promises of extensive Nunn-Lugar assistance, coupled with determined and coordinated U.S. and Russian diplomacy that offered both carrots and sticks, were crucial in convincing Belarus, Ukraine, and Kazakhstan to allow the nuclear weapons on their soil to be returned to Russia, and to join the nuclear Nonproliferation Treaty (NPT) as non-nuclear-weapon states—one of the great unsung nonproliferation success stories of the 1990s.

The Nunn-Lugar program grew from its initial conception as a short-term crisis response into a major cooperative enterprise that has continued for nearly fifteen years. The effort has focused on a far broader agenda than security for nuclear stockpiles, the focus of this article. Nunn-Lugar has funded the dismantlement of more than 1,000 strategic ballistic missiles, the removal of over 6,000 nuclear warheads from missiles and bombers, the destruction of scores of nuclear submarines, the construction of a major plant for chemical weapons destruction, and more. Through some of the darkest moments of U.S.-Russian relations, the Nunn-Lugar channel remained.

Over time, related efforts were established at the Departments of Energy (DOE) and State, so that the total U.S. budget for threat reduction programs is now well over $1 billion per year. In 2002, the leaders of the Group of Eight (G8) industrialized democracies launched the Global Partnership against the Spread of Weapons and Materials of Mass Destruction, under which the U.S. pledged $10 billion for Nunn-Lugar efforts over 10 years, and the other seven states pledged to match that contribution.

Yet the Nunn-Lugar program has not been immune to the deep constraints imposed by suspicion and secrecy, conflicting agendas between donor and recipients, and bureaucratic sluggishness that have hampered so many cooperative nuclear security endeavors. Prominent emblems of such problems include a massive factory to destroy heptyl fuel for ballistic missiles, built at Russian request at a price of over $100 million, which has gone unused because Russia decided to use the heptyl fuel for other purposes without informing U.S. officials; and a huge fortress capable of storing 100 tons of plutonium from dismantled weapons, whose construction was completed in 2003, after years of delays, but is still standing empty as of early 2006, because of both U.S.-Russian disagreements over what monitoring rights the U.S. will have there and an apparent Russian failure to prepare for processing the plutonium to store it there.

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Some of the seeds of delay were sown at the effort's inception. The "buy American" and money-redirection provisions of the original bill inevitably reduced the enthusiasm of the recipient states and of the Pentagon, respectively. The same congressional horse-trading to gain support that led to those provisions also led to a requirement that the president certify to Congress that any recipient country was meeting a series of congressionally imposed standards, from compliance with arms control agreements to respect for human rights, before any assistance could be provided. While President Clinton made those certifications every year, President George W. Bush has refused to certify Russia's compliance with all of its arms control commitments, due to concerns over possible secret activities at biological warfare facilities and disputes over the completeness of Russia's chemical weapons declarations; this held up crucial efforts—including warhead security upgrades—for months. As of early 2006, Senator Lugar is still seeking to eliminate this certification requirement. The act also required recipients to allow U.S. experts to inspect the use of the U.S. assistance—a daunting obstacle at some especially secret sites. With Cold War memories still fresh, the money flowing to American companies rather than Russian firms, and demands for inspection at sensitive sites, it is no wonder that hawks in Russia saw Nunn-Lugar as an American conspiracy to disarm and dominate Russia, rather than as genuine cooperation.

Perhaps the greatest obstacles to cooperative nuclear security efforts are secrecy and lingering suspicion. While the dismantlement of many missiles and submarines has been verified

over the years, the U.S. has not verified the dismantlement of a single Russian nuclear warhead, and Russia has not verified the dismantlement of a single U.S. nuclear warhead—because the two sides have never agreed on how to do so without compromising secrets they still wish to protect. The two countries have not even disclosed how many nuclear weapons and how much potential nuclear bomb material they have. As a result, Nunn-Lugar money has not financed the actual dismantlement of any nuclear warheads—such funding would require that the U.S. be allowed to verify the dismantlement it was paying for.

With all of these obstacles, the success of most Nunn-Lugar efforts is remarkable. Fortunately, in 1992 the non-Russian states of the former Soviet Union were eager for help, and the economically desperate Russia was run by reformers eager for close cooperation with the U.S.. Nunn-Lugar cooperation proved its value in this favorable soil, and has managed to survive and grow as circumstances have shifted dramatically—though the effort's long-term prospects in a changing Russia remain uncertain.

COMING TO GRIPS WITH NUCLEAR INSECURITY

In 1991-1992, concern about nuclear security in the former Soviet Union focused on who would control the warheads outside of Russia and how they could be transported back, not on the security of the nuclear warheads and materials in Russia itself. There had been no reports of major nuclear security incidents in Soviet times, and the Soviet Union, like the U.S., had provided effective safeguards technologies for the International Atomic Energy Agency (IAEA) to use in other countries; it was logical to assume that the Soviet Union had implemented similar technologies at its own facilities. Hence, while security and accounting for nuclear materials were among the U.S.' first Nunn-Lugar proposals in 1992, there was little sense of urgency on this topic.

This initial optimism was misguided. Starting in 1992–1994, U.S. laboratory experts and other visitors to Russian nuclear laboratories saw alarming nuclear security conditions: one terrifying cable on nuclear security from the U.S.-Moscow embassy was entitled "Holes in the Fences." At the same time, with the collapse of Soviet-era controls on the press, a flood of reporting—some of it nonsense, some of it distressingly accurate—described serious nuclear security problems.

The Soviet Union had, in fact, implemented a sensible nuclear security system—but the system depended on a closed society, closed borders, nuclear workers who got the best of everything Soviet society had to offer, and close surveillance of everyone by the KGB. In the new Russian state, an open society with open borders, impoverished nuclear workers were unpaid for months at a time, the KGB's successors were weak, and no money was available to fix the nuclear security systems.

In Soviet times, theft of nuclear material or a nuclear weapon by insiders at nuclear facilities was not considered a major problem: even if someone stole nuclear material, what could they do with it? They could neither leave the country nor meet with a foreigner inside the country without being watched by the KGB. Similarly, outsider theft was not a major issue; armed terrorist teams or criminal groups would be unlikely to operate in the territory of a controlled society like the Soviet Union. Indeed, the Soviet nuclear security systems were principally designed to thwart penetration by Western spies.

For these reasons, in the years after the Soviet collapse, most buildings with potential nuclear bomb material lacked sensors that would sound an alarm if someone walked out the door with plutonium or HEU, and most nuclear material areas lacked security cameras. With state funding slashed, major nuclear facilities had crumbling walls, overgrown fences with gaping holes, and broken alarm systems; weapons-usable nuclear material was often stored in lockers with padlocks that could be snapped in seconds with any bolt-cutter; the seals used to indicate whether material had been tampered with were often clay or wax with a stamp, so that any worker with an authorized stamp could break a seal, remove material, and put a new seal on. The Soviet nuclear material accounting system was designed to ensure that facilities met their production quotas, not to detect theft: indeed, at many facilities, the difference between input and output was *defined* as material "lost to waste," making it impossible to detect the theft of any material. Thousands of containers of nuclear material at scores of facilities were accounted for in paper records—but in many cases it had been decades since anyone had actually looked to see if the nuclear material was still there.[4]

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Figure 1 shows Building 116 at the Kurchatov Institute, a major nuclear institute in Moscow, in 1994. The building housed enough HEU to make a bomb. The fence was so overgrown that it is difficult to see in the photograph. Inside the building, a guard with a pistol waved in authorized personnel with few security procedures.

As a result of such conditions, numerous thefts of potential nuclear bomb material took place. In 1992, a worker at the Luch Production Association in Podolsk stole 1.5 kilograms of 90% enriched uranium without detection. 1993 saw several thefts, including at least two from naval facilities. In one of the naval cases, a naval officer walked through a gaping hole in a fence, snapped a padlock on a shed, and walked off with several kilograms of nuclear material without setting off any alarm. As the Russian military prosecutor in the case famously concluded, "potatoes were guarded better." In 1994, plutonium was found in Munich on a plane from Moscow (the result of a sting operation by German intelligence), and nearly three kilograms of HEU were found in a parked car in Prague. By late 1994, the U.S. Joint Atomic Energy Intelligence Committee (JAEIC) concluded that no nuclear facility in the former Soviet Union had adequate safeguards and security.[5]

Initial government-to-government negotiations with the non-Russian states of the former Soviet Union over cooperation to improve nuclear material protection, control, and account-

Figure 1. Moscow building with enough HEU for a bomb, 1994.

Source: U.S. Department of Energy.

ing (MPC&A) were successful. These new states realized they needed help and had little interest in protecting Soviet-era nuclear secrets. Indeed, by 1996-1998, security systems had been modernized at virtually all of the former Soviet facilities with weapons-usable nuclear material outside of Russia.

But the initial negotiations with Russia did not go well. Russian security managers had spent their careers keeping out U.S. spies; convincing them to allow Americans to work with them to find and fix the security problems at their facilities was a daunting task, particularly at a time when the consequences of being responsible for allowing Americans to visit secret locations were still unclear. The sites of early Nunn-Lugar missile dismantlement projects had been open to arms control inspections for years, but no foreigner had ever visited a Russian nuclear warhead storage facility or many of the facilities that housed plutonium and HEU.

Russian officials' sense of superpower pride, coupled with their comfort with the existing nuclear security system, which had functioned for decades with few problems, made it difficult for them to admit the need for urgent improvements in nuclear security, and U.S. assistance. Russian officials initially refused the U.S. access to any facilities with plutonium or HEU,

even civilian ones. Then in 1993, the two sides agreed to carry out cooperative security upgrades on a single fabrication line handling only low-enriched uranium (LEU) that did not pose a significant proliferation risk. (The U.S. hoped that approaches demonstrated there would be applied elsewhere.)

By early 1994, it was obvious that this approach simply did not match the urgency of the threat. A few policy entrepreneurs launched two new efforts to break the deadlock—a new lab-to-lab approach, and a revised approach to the government-to-government discussions.[6]

THE LAB-TO-LAB BREAKTHROUGH

The first and most important of these efforts was the launch of the lab-to-lab MPC&A program. Under the leadership of Siegfried Hecker, then director of the Los Alamos National Laboratory, senior experts from the U.S. and Russian nuclear weapons laboratories had pursued basic science cooperation since 1992. Like the 1991 presidential nuclear initiatives, this lab-to-lab cooperation bypassed the bureaucracies in Washington and Moscow—in this case from the bottom up. U.S. laboratory officials discussed their plans with only two executive branch officials in Washington, Victor Alessi, head of DOE's Office of Arms Control and Nonproliferation, and Robert Gallucci, the State Department's Senior Coordinator for nonproliferation and nuclear safety initiatives in the former Soviet Union, and moved forward with contracts if neither man objected. Other Washington officials frequently had no knowledge of these activities.

Similarly, the Russian Minister of Atomic Energy, Victor Mikhailov, was aware of these contacts, but it appears that few others in Moscow were. Mikhailov, who enjoyed a close relationship with Yeltsin and a reputation as a hawk, supported the initial lab-to-lab science efforts and was in a good position to defend them. He had been a leading weapons designer at Arzamas-16 (since renamed Sarov), Russia's equivalent of Los Alamos, and in the 1980s had participated in joint verification experiments with U.S. colleagues.

The personal trust created through basic science cooperation in 1992-1993 allowed the scientists to broach the sensitive subject of cooperation on nuclear security. The labs had originally been instructed to keep their cooperation to basic science, but in 1993, under President Clinton's Secretary of Energy, Hazel O'Leary, a new DOE leadership sought to pursue nonproliferation initiatives more aggressively. Kenneth N. Luongo, first as O'Leary's personal advisor on nonproliferation and then both in that role and as Alessi's successor in running the Office of Nonproliferation and Arms Control, became the driving force behind a dramatic and innovative expansion of MPC&A efforts. By early 1994, with frustrations rising over the formal government-to-government negotiations, newly arrived Undersecretary of Energy Charles Curtis gave the U.S. labs permission to pursue lab-to-lab cooperation on MPC&A.

The results were dramatic. Within months, the labs had negotiated initial MPC&A contracts with several Russian facilities, and work was well underway. By the end of the year, security for Building 116 (see Figure 1) was extensively upgraded, with fences, intrusion detectors, security cameras, special nuclear material detectors, and vault-type storage for the nuclear material. A demonstration MPC&A system was also being installed at Arzamas-16. Representatives from other facilities saw these modern security and accounting systems—and the U.S. money that had bought the equipment and paid the salaries of the people designing

and installing it—and pressured the Russian government for permission to cooperate with U.S. experts in similar ways. By 1995, the number of sites with cooperative projects was expanding dramatically. A joint U.S.-Russian team of laboratory experts had been formed to guide the effort, and the team was drafting a plan to install security and accounting upgrades throughout Russia's nuclear complex.

While a wide range of different types of upgrades were pursued in these early days, the upgrade approach has since been systematized, consisting of two principal phases. A first round of "rapid upgrades" focuses on basic measures that can make a difference quickly—bricking over windows, installing nuclear material detectors at exits, installing armored steel doors, putting nuclear material in steel cages, etc. These are usually followed by a more inclusive "comprehensive upgrade" to a complete modern security and accounting system that includes fences, barriers, intrusion detectors, accurate systems to account for nuclear material, and more. The comprehensive upgrades are typically designed to protect material from theft by one insider, a modest group of well-armed and well-trained outside attackers, or both working together.

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The lab-to-lab effort was successful because it changed the governance of the nuclear security upgrade effort. In the government-to-government approach, the U.S. sought formal agreements between interagency teams of U.S. and Russian mid-level government officials—none of whom would benefit directly from upgrades, and each of whom faced significant career risks if the work proved to compromise secrets or lead to the diversion of funds. In the lab-to-lab approach, U.S. laboratory experts worked directly with their counterparts at the Russian sites, offering them respect, money, interesting work, and a real partnership with U.S. peers. The Russian participants were highly motivated to move the cooperation forward, and pushed for approval within their own government in ways the Americans could not. As Hecker observed, "We made enormous inroads with the philosophy of 'you work your government, we'll work our government.'"[7]

Luongo and others at DOE headquarters realized that they must give the laboratories much greater latitude than was typical in most DOE projects, including the flexibility to negotiate specific nuclear security upgrade projects with their Russian counterparts (subject to approval by both governments). DOE headquarters simply did not have the technical expertise, contacts on the ground in Russia, or personnel to manage this effort in detail. In essence, headquarters set policy direction, found resources to pay for the effort, and tried to overcome bureaucratic obstacles as they arose, while the labs used their technical judgment to determine what should be done at individual sites, and their contacts in Russia and flexible contracting capabilities to move the effort forward.

DOE formed a team of senior laboratory experts to provide regular advice on policy and technical issues facing the effort, and brought individual laboratory experts to headquarters to help manage the laboratory-to-laboratory effort and the government-to-government nuclear security upgrade effort, which had also begun to heat up during 1994.

MOVEMENT ON THE GOVERNMENT-TO-GOVERNMENT TRACK

In early 1994, when DOE was launching the lab-to-lab effort, Washington officials were also seeking to kick-start the government-to-government discussions, and get beyond working on an LEU line that posed no proliferation risk. They attempted two approaches, one of which worked.

First, they proposed what came to be called the "quick fix." Russia would identify the 5 to 10 facilities with the most urgent security vulnerabilities, the U.S. would pay to fix those vulnerabilities, and the two sides would then move on to the next group of facilities. This approach seemed logical in Washington. The proud and suspicious Russian nuclear establishment, however, felt that the U.S. was saying: "Show us the worst of your dirty laundry, let U.S. experts who may be spies go to the nuclear facilities that are in the worst shape, and all of the money will go to U.S. companies."[8] Russian negotiators quickly rejected this idea.

A second initiative—reciprocity—led to more action. The U.S. offered to bring Russian experts to a civilian area of the Hanford plutonium facility, to review the security arrangements for substantial amounts of plutonium in storage in the U.S., if U.S. experts could then visit an equivalent area at the Mayak plutonium facility in Russia, where tens of tons of weapons-usable civilian plutonium was stored. Russian negotiators accepted this proposal. The Russian government appears to have taken the Hanford-Mayak exchange very seriously; for example, the Russian delegation was led by the deputy minister of atomic energy who was Russia's main negotiator for Nunn-Lugar projects with that ministry. Frank von Hippel, then a senior official in the White House Office of Science and Technology Policy (and the present author's boss) played a key role in suggesting the reciprocity initiative, and led the U.S. delegation to the Mayak plutonium storage facility—where the security chief said he had been instructed to show the U.S. team exactly as much as the Russian team had been shown at Hanford. After further negotiations, a number of additional facilities that actually had plutonium and HEU were added to the list for government-to-government cooperation, which grew to be an important complement to the lab-to-lab effort.

INNOVATION REVERSED: THE SHIFT TO HEADQUARTERS

By the winter of 1994-1995, with the lab-to-lab effort beginning to discuss nuclear security upgrades throughout the Russian complex and the government-to-government effort also moving forward, some Clinton administration officials felt that the nuclear security upgrade effort was fast reaching the limits of what Moscow officials could approve without formal authorization from the highest level. Russian President Boris Yeltsin seemed supportive, and the seizures of stolen nuclear material in Europe in 1994 and the JAEIC report had intensified the sense of urgency among the small cabal of officials in Washington who followed this issue. In spring 1995, a high-level panel secretly recommended to President Clinton a series of steps to accelerate efforts to secure nuclear stockpiles. One recommendation was that U.S. and Russian experts prepare a joint report outlining a comprehensive set of steps to improve nuclear security for the two presidents' approval.[9]

Unfortunately, the process of drafting this report made the entire Russian bureaucracy—including opponents of nuclear security cooperation—aware of the plan for nuclear security

upgrades that the joint U.S.-Russian lab-to-lab team had been developing before the Russian experts had a chance to prepare the ground for it. A wide range of agencies on both sides asserted a right to have their say on a report that was to go to the two presidents, and opponents of expanded nuclear security cooperation seized this opportunity to block progress, almost leading to the collapse of the lab-to-lab effort. By the winter of 1995-1996, while the lab-to-lab effort survived (thanks to some adroit negotiation by DOE officials and lab experts), the Russian security services had succeeded in establishing much tighter control over it. Tighter central control was inevitable as the effort expanded, but came sooner because of this episode than it might have otherwise.

During this period, another approach to gaining high-level approval—regular meetings between the U.S. vice president and the Russian prime minister, known as the Gore-Chernomyrdin process--worked well. Each meeting forced the two nuclear establishments to come up with "deliverables" that demonstrated continued progress, and the vice president and the prime minister often side-stepped the usual processes of negotiation and took decisions themselves to overcome obstacles. O'Leary and Mikhailov—who, despite being polar opposites in personality and experience, had forged an effective personal relationship—signed a number of crucial statements at Gore-Chernomyrdin meetings that provided the high-level imprimatur on nuclear security cooperation the report to the presidents had failed to provide.

In winter 1996-1997, as President Clinton's second term began, most of the high-level supporters of the lab-to-lab effort at DOE and the White House left the government. Mid-level DOE officials who had been chafing at the perceived inefficiencies of the lab-to-lab effort's loose central management merged the lab-to-lab and government-to-government programs, effectively abolishing the lab-to-lab effort. All of the governance innovations of that effort—the labs' flexibility to use their judgment in negotiating the specific upgrades to be performed at individual Russian sites, the lab experts brought to headquarters to help run the programs, the senior lab team to advise DOE policymakers, the joint U.S.-Russian lab-to-lab team that had been guiding the effort—were abolished or allowed to wither. Negotiations over next steps were once again being carried out by Russian and U.S. mid-level officials who had every incentive for caution and little personal incentive to move these efforts forward. Not surprisingly, the effort slowed at many sites.[10]

Yet the new leaders sought to organize and systematize the security upgrade effort in ways that were probably needed. They initiated a more organized process to track expenditures at each site; created a new set of standards for the kinds of security and accounting systems project teams should seek to install at each site; and established a "Technical Survey Team" to review progress at each site. Unfortunately, all these laudable initiatives were imposed unilaterally by the U.S.: standards for security at Russian sites were drawn up without consulting with Russian experts (and indeed, were kept secret from them), and the Technical Survey Team was an all-U.S. effort. Contracts were canceled when a team, with no Russian members or Russian input, determined that the projects did not meet guidelines the Russians were not allowed to see. A genuine partnership had become largely a U.S.-directed assistance program, with Russian experts often feeling like the "hired help."[11] The resulting resentments led to less enthusiasm among Russian participants in finding ways past the inevitable obstacles to cooperation, further slowing progress. While some increase in central government control was probably inevitable as the lab-to-lab effort grew into a large enterprise involving many facili-

ties, hundreds of experts on both sides, and tens of millions of dollars per year,[12] there seems little doubt that a blend of the previous innovations with a more systematic approach developed in genuine partnership with Russia would have led to faster and longer-lasting progress.

The benefits of a partnership-based approach, with more freedom for the U.S. and Russian implementers to use their technical judgment, can be seen in the one part of the program where such an approach survived—the work with Russia's nuclear navy. Because of the extreme sensitivity of many of its sites, the Russian navy had insisted from the beginning that only a small and stable group of U.S. lab experts whom they trusted should participate; this made it difficult for DOE to impose its new approaches on the navy work. The U.S. team for the nuclear navy projects worked in genuine partnership with its Russian counterpart, and the Russian naval leadership was strongly committed to the effort and willing to bend rules to move it forward. The Kurchatov Institute (which had long trained the navy's reactor operators) acted almost as an integrating contractor, organizing all the projects. This meant that, rather than relying on an occasional visit from U.S. experts to push progress forward, there were Russian experts, with Russian security clearances and personal incentives to move the effort forward, in Moscow full-time to lobby for the next steps. The two sides agreed that Russian experts would design and implement the new security and accounting systems, which relied almost entirely on Russian-made equipment.

This program moved far more rapidly and encountered far fewer obstacles than other parts of the MPC&A effort. Despite the sensitivity of the navy's sites, the U.S. team negotiated flexible access arrangements at every navy HEU site. Typically, work at a site was completed within 18 to 24 months of the first U.S. visit. Once security upgrades for all of the Russian navy's fresh HEU were well underway, the Russian navy asked DOE for help with nuclear warhead sites as well. (The U.S. Department of Defense had been attempting to provide security assistance for nuclear warhead sites for years, but Russian officials had not yet agreed to let the Pentagon teams, with their more cumbersome procedures and less partnership-based approach, have access to the warhead sites. After the 9/11 attacks, that problem was finally solved, and both DOE and the Department of Defense are now financing security upgrades at nuclear warhead sites in Russia.) Once the navy warhead sites were well underway, the Russian government asked the same teams to help upgrade other warhead sites as well.[13]

INNOVATION DENIED: SECRECY AND ACCESS

Throughout these efforts, there was a fundamental tension between the U.S.' need to ensure that taxpayers' money was not being misspent and Russia's desire to maintain its nuclear secrets. The basic U.S. approach was to demand access to the sites where U.S. money was to be spent on upgrades, to confirm that the proposed upgrades were really needed, and that the work was done as agreed. Russian security officials objected to what they saw as "nuclear tourism."

While Russia eventually granted access at some sites, Russian experts made clear from the outset that certain facilities (especially the warhead assembly-disassembly facilities) were simply too sensitive to allow foreigners to visit. The U.S. lab experts received permission from DOE to work with their Russian colleagues to find ways to ensure that tax dollars were spent appropriately without direct, on-site access. The approaches they developed included photo-

graphs and videotapes of installed equipment, detailed operational reports on the equipment in use, certifications by senior Russian officials, and more. The U.S. and Russia signed an agreement specifying that these non-access assurances would be used at especially sensitive sites.

But DOE officials felt increasing pressure to get more and more access. The Technical Survey Team objected to the assurances proposed by the labs, saying it was impossible for them to judge the progress of upgrades they could not inspect. A DOE Inspector General report questioned how much confidence DOE could have that its funds were not being misused. DOE officials expected pressure from Congress. In September 1999, DOE demanded access at any site where any new contract was to be signed. This was a betrayal of the Russian experts who had gone out on a limb within their own security system to negotiate these sensitive arrangements, arguing that the U.S. would be a reliable partner—and it confirmed the Russian security services' belief that the U.S. most wanted opportunities to collect intelligence on Russia's sensitive nuclear sites. This U.S. decision also coincided with the rise to power of Vladimir Putin, and the accompanying dramatic increase in the power and pervasiveness of the Russian security services; in recent years, they have done a great deal to slow and complicate nuclear security cooperation.

Throughout these efforts, there was a fundamental tension between the U.S.' need to ensure that taxpayers' money was not being misspent and Russia's desire to maintain its nuclear secrets.

It has taken years of patient negotiation to recover from the 1999 blunder. More than six years later, the only U.S.-funded security upgrades that have been installed at the warhead assembly-disassembly facilities (where a substantial fraction of Russia's nuclear bomb material resides), are still a set of portal monitors to detect removal of nuclear material provided without access in the lab-to-lab days—though large-scale upgrades at those sites appeared imminent before the 1999 decision. A new access agreement, signed in fall 2001, limited U.S. visitors to Russian nuclear sites to a specified list who could be vetted in advance by the Russian security services, and strictly limited the number and duration of visits. Since then, access accords have been reached, building by building, for nearly all of the major buildings with weapons-usable material in Russia other than the warhead assembly-disassembly facilities themselves (of which only two remain).

The DOD's separate efforts to upgrade security for Russian nuclear warhead sites had run into even more severe access obstacles, partly due to the Pentagon's stringent approach to access.[14] Indeed, scores of sets of DOD-provided equipment for a "quick fix" of security at Russian nuclear warhead sites, which U.S. and Russian security experts agreed were urgently needed, gathered dust in warehouses in Russia for years after they were delivered, as disagreements over access to these sites and who would pay for the equipment's installation dragged on.[15] After the 9/11 attacks, however, Russia finally granted Pentagon experts access to a limited number of warhead sites, and gave DOE experts access to an expanded range of sites. Following the Bratislava Bush-Putin summit in February 2005, Russia offered access to a still

larger number of warhead sites.

In a separate effort to finance secure transports of warheads to dismantlement facilities or central storage sites, Russian officials said that the very locations of all the facilities involved were secret, so the U.S. could not be allowed to verify them. The Pentagon and Russian negotiators devised an innovative approach based on "trusted agents"—Russians with Russian security clearances and employed by major U.S. contractors would ride the trains and certify that they started from and delivered their cargo to the correct sites. Unfortunately, that effort has now been cut off, at least for the present, in a dispute over whether the U.S. may in fact have ended up paying for operational warhead shipments, not just trips to dismantlement or storage sites.

In the past few years, some of the innovations of the 1990s have been revived. For example, U.S. and Russian experts have carried out a "pilot project" demonstrating various ways to provide assurances that U.S. taxpayer funds are being spent appropriately. And as in the Hanford-Mayak exchange of 1994, in late 2004 DOE brought the chief security officials from Russia's nuclear weapons complex to Pantex, the U.S. warhead assembly-disassembly facility, and showed them the exterior security arrangements and the security for the bunkers within the plant—everything the U.S. was arguing it should be able to see at comparable Russian facilities if it is to fund security upgrades there. In a press conference shortly after that visit, President Bush said that the U.S. should offer Russia "equal access" to U.S. nuclear facilities as part of the cooperation. The two sides are still discussing whether and how they can cooperate in upgrading security measures at Russia's last nuclear warhead assembly and disassembly facilities.

Technology offers opportunities to solve many such issues of nuclear secrecy and confidence, which should be pursued more intensively than they have been to date. Digital photographs and videotapes with an encrypted Global Positioning System (GPS) location embedded in the image could document that the images of installed equipment really came from a particular designated facility (though this is itself problematic when the very location of the facility is a secret). Technologies have already been developed and tested by U.S. and Russian experts working together that allow a monitoring system to take measurements to confirm that an object in a can matches the signatures or characteristics of a nuclear weapon, or a nuclear weapon component, without the machine revealing anything more than a "yes" or "no." To build confidence in controls over nuclear warheads, tables of the serial numbers and locations of all warheads could be exchanged, encrypted in a secure hash so that only one entry at a time could be decrypted for inspection purposes.[16] The time has come for the two sides to begin pursuing such approaches, to build confidence on both sides that nuclear stockpiles are secure and accounted for.

SUSTAINING NUCLEAR SECURITY

The billions spent on security upgrades would be wasted if the security and accounting equipment is all broken and unused five years later. The importance of "sustainability" was driven home during the 1998 Russian economic crisis, when unpaid guards left their posts to forage for food, and the alarm systems at some sites lost electrical power when utility bills were

unpaid– provoking DOE to provide emergency help ranging from warm winter uniforms for guards to backup diesel generators.

The sustainability program that grew from this stop-gap effort includes extensive training programs (to provide the human capital needed to maintain an effective MPC&A system); contracts designed to build up the infrastructure of experts and firms available for building, installing, and maintaining MPC&A equipment in Russia; helping Russia write and enforce effective nuclear security and accounting regulations; helping facilities estimate their costs to maintain good MPC&A systems and plan for paying those costs; and more.

The most fundamental sustainability problem is the widespread view—in Russia and around the world—that the threat of nuclear terrorism is minimal.

These efforts are necessary but not sufficient to achieving success; in the long run, maintaining high security in the former Soviet Union will require that senior officials believe that effective security for nuclear stockpiles is essential to their own countries' security, and that they provide a sound structure of incentives for facility managers.[17] Under current plans, U.S. assistance will phase out by 2013; Russia's cost to maintain (and ultimately replace and improve) the systems now being installed may ultimately be hundreds of millions of dollars per year.

Fortunately, Russia is now in a far better position to shoulder that burden. With a growing economy and a budget surplus, Russian nuclear workers receive a living wage, on time, and major nuclear facilities are able to pay their bills. But Russia's new-found wealth, and statements from top political leaders about the high priority of keeping potential nuclear bomb materials out of terrorist hands, have not yet translated into commitments of adequate resources to operate and maintain security systems at Russian sites. In early 2005, for example, the commander of the interior troops for the Moscow district estimated that only 7 of the critical guarded facilities in the district had adequately maintained security systems, while the systems at the other 39 facilities had "serious shortcomings." In May 2005, one leading Russian expert estimated that funding for nuclear security systems is only 30% of what is needed.[18]

Moreover, Russia's new strength has led to a tougher negotiating stance. The message now is, in effect: "We're not on our knees anymore. We're not desperate for your money, and we don't like your lectures. We can cooperate as equals or not at all." Unfortunately, this has come at a moment when the U.S. government has also hardened its attitudes, perceiving a corruption-riddled Russia slipping back toward authoritarianism.

The most fundamental sustainability problem is the widespread view—in Russia and around the world—that the threat of nuclear terrorism is minimal. Most Russian officials and facility managers appear to believe that the nuclear security measures already taken in recent years are sufficient; as one senior nuclear official put it, "the nuclear thief does not stand a chance in Russia."[19] Similarly, much of Russia's nuclear establishment remains convinced, wrongly, that, as the chief of security for Russia's nuclear agency put it, "even having any nuclear material does not mean that an explosive device can be made [by terrorists]. This is

absolutely impossible."[20] An intensive effort will be needed to build a greater sense of urgency and commitment among Russian officials and site managers if they are to provide the money and high-level attention needed to sustain effective security after international assistance comes to an end. Such a sense of urgency will also be crucial to building the effective "security culture" needed to ensure that nuclear personnel take security seriously and appropriately use the modern equipment now being installed. If guards continue to patrol without ammunition in their guns and employees continue to prop open security doors for convenience, no modern equipment can provide high security.[21]

FROM 9/11 TO TODAY

The 9/11 attacks highlighted the danger posed by sophisticated, suicidal terrorists bent on wreaking mass destruction. In response, Congress added hundreds of millions of dollars in supplemental funding for cooperative nuclear security efforts, and DOE worked intensively with its Russian counterparts to accelerate plans for securing nuclear stockpiles, establishing a new target date of 2008 for completing security and accounting upgrades for nuclear material sites throughout Russia. Slowly, similar nuclear security upgrade efforts have been established with countries beyond the former Soviet Union, and in 2004, DOE established the Global Threat Reduction Initiative (GTRI), designed to expand and accelerate efforts to remove potential bomb material from vulnerable sites around the world.

On-the-ground progress in Russia has remained slow, however, due to resistance by the Russian security services and a range of bureaucratic obstacles on both sides. In the two years after 9/11, upgrades were completed for only about as much material as had been completed in the two years before (though the pace has picked up somewhat since then). Although two successive Secretaries of Energy (Spencer Abraham and Samuel Bodman) have worked hard to accelerate these efforts, many of the obstacles stretch across agency boundaries, and must realistically be resolved by the White House and the Kremlin.

While President Bush has repeatedly warned of the danger of nuclear terrorism, and appears genuinely committed to attempting to prevent it, the White House has not paid sustained attention to finding and fixing the obstacles to progress, or building a global effort to lock down nuclear stockpiles. Vladimir Putin's Kremlin seems to have put even less emphasis on nuclear security, despite occasional indicators of attention.

Despite the public assurances that everything is secure, however, Russian officials have had their own reasons to be worried. Shortly after the 9/11 attacks, the commander of the force that guards Russia's nuclear weapons confirmed two cases of terrorist groups carrying out reconnaissance at secret nuclear weapon storage sites, and President Putin reportedly called the new Minister of Atomic Energy on the carpet and told him to beef up nuclear security after a failed security test at a major nuclear facility.[22] In October 2002, some 40 heavily armed terrorists struck a popular theater in the middle of Moscow with no warning, seizing hundreds of hostages—and the Russian state newspaper reported that they had considered seizing the Kurchatov Institute, site of Building 116, pictured above.[23] And then, in September 2004, there was the tragedy of Beslan, where again a large team of heavily armed terrorists was able to gather and strike without warning. These events presumably contributed to the Russian decisions to finally allow DOD officials access to warhead sites to perform upgrades there, and to

work with DOE officials to expand and accelerate upgrades at nuclear material sites.

Nevertheless, the immense difficulty of overcoming the obstacles to progress led U.S. officials to conclude, during 2004, that the issue had to be raised to the summit level. At the summit in Bratislava in February 2005, President Bush and President Putin identified nuclear terrorism as "one of the gravest threats our two countries face," endorsed accelerated cooperation to upgrade security at nuclear sites, and established an interagency group to follow up, co-chaired by Bodman and Rosatom chief Alexander Rumiantsev (replaced with former prime minister Sergei Kirienko as this article was going to press). While the Bratislava statement left the key issues slowing action unresolved, the presidential imprimatur and the mechanism established for regular tracking of progress led to notable improvements in results. Russia provided a substantial list of additional warhead sites to which U.S. experts would be allowed access, and, in a return of an old idea, by June the two sides had developed a report to the two presidents that included a joint plan for completing security upgrades by the end of 2008. There is now much talk of shifting from assistance to a genuine partnership, with a balanced contribution of ideas and resources from each side (another old idea).[24]

The danger of nuclear theft is not a Russia problem; it is a global problem. The essential ingredients of nuclear weapons exist in hundreds of buildings in more than 40 countries—some extremely well secured, and some with little more than a night watchman and a chain-link fence.

By the end of fiscal year 2005, U.S.-funded rapid upgrades were completed for 75% of the buildings containing potential nuclear bomb material in the former Soviet Union, holding an estimated 49% of that material; the full suite of comprehensive upgrades had been completed for only 54% of the buildings, holding some 29% of the potentially vulnerable bomb material.[25] The remaining buildings are primarily at large nuclear weapon complex sites—likely some of the more secure facilities in Russia—so these materials are probably not completely insecure; on the other hand, at each facility where U.S. experts have gained access, U.S. and Russian security experts have generally agreed on an extensive list of needed upgrades.

There is no doubt that nuclear security in Russia has improved dramatically over the past dozen years. Hundreds of Russian and U.S. experts have labored hard, under often difficult conditions, and have made an immense contribution to the security of their countries and the world. The main threat observed in the 1990s—that one insider or outsider could easily take material without detection—has largely been addressed. The key nuclear security challenges in Russia today revolve around three issues:

Is security tight enough? Both insider and outsider threats in Russia may be more capable than the threats the security systems being put in place were designed to beat. Corruption and insider theft are rampant in Russia, and the outsider terrorist threat is huge, as demonstrated by incidents like the Moscow theater attack and Beslan.

Is there a culture of security? There have been reports of guards patrolling without ammunition in their guns, and staff propping open security doors for convenience. The U.S. has had difficulty solving this problem in its own country, where it can control the facilities and set their rules, as evidenced by long-standing problems at Los Alamos and elsewhere.

Will security be sustained after U.S. assistance phases out?

Positive answers to these questions will require continued innovations in approaches to nuclear security—in Moscow, in Washington, and around the world.

LESSONS AND NEXT STEPS

The danger of nuclear theft is not a Russia problem; it is a global problem. The essential ingredients of nuclear weapons exist in hundreds of buildings in more than 40 countries—some extremely well secured, and some with little more than a night watchman and a chain-link fence. A fast-paced global partnership designed to ensure that every nuclear weapon and every kilogram of weapons-usable nuclear material worldwide is secure and accounted for is urgently needed. These stockpiles must be secured to standards sufficient to defeat the threats that terrorists and criminals have shown they can pose, in a way that will last. This must include a rapid effort to remove all potential bomb material from the world's least defensible sites, achieving more security at lower cost by defending fewer locations.[26] The U.S. and Russia, which together possess more than 95% of the world's nuclear weapons and more than 80% of the world's potential nuclear bomb material, must play leadership roles in this global effort. Four lessons from their nuclear security cooperation over the last 15 years will be crucial to success:

Top-down, bottom-up, but not middle-through. Initiatives from the presidential level can sweep aside seemingly intractable bureaucratic and political obstacles to progress when powerful and motivated actors are assigned to follow through. As the lab-to-lab experience shows, bottom-up initiatives starting with technical experts at individual sites can also be remarkably powerful, if they remain beneath the radar of officials who may be motivated to put obstacles in their path. Mid-level nuclear officials, by contrast, usually have little flexibility to introduce major changes in approaches to nuclear security, and usually resist foreign attempts to convince them to do so. The bottom-up approach, however, is more likely to work in countries undergoing revolutionary transformation, as Russia was in 1992, or in more stable countries where the necessary work is modest in scale and not especially sensitive (such as upgrading security or converting the fuel at a single HEU-fueled research reactor, the only nuclear facility of concern in many countries), or where cooperation at sensitive nuclear installations has a public imprimatur from the highest levels.

In general, the experience of the past 15 years suggest that innovations in nuclear security are most likely to be successful when they are driven forward by a small group of committed and well-connected individuals who are able to take advantage of events that create a sense of urgency (as in the cases of the collapse of the Soviet Union in 1991 and the nuclear material seizures in 1993-1994). Such small groups are able to maintain substantial creativity and flexibility in their approaches, and to build trust with foreign partners. Innovations are most likely to be blocked, slowed, or overturned when large numbers of officials and agencies become involved, many of whom may be committed to past approaches or may not see the advantages

of new ones.

Partnership works. As the lab-to-lab and navy MPC&A programs show, cooperation on nuclear security is most effective when it incorporates ideas and resources from both sides. Countries such as China, India, and Pakistan are far more likely to join an effort framed as a partnership of the leading nuclear states to ensure nuclear security worldwide than one described as assistance to countries too weak and uninformed to take care of nuclear security themselves. Building trust among the participants in such a partnership is crucial to gaining the flexibility needed to overcome the inevitable obstacles. Despite the urgency of the problem, in some cases it is necessary to start with small projects to build trust before expanding to more substantial efforts. It is also essential to follow through on what has been agreed, rather than ripping up previous agreements. Only when the people who will use and maintain an improved nuclear security system are directly involved in conceiving, designing, and implementing the new approach are they likely to work their own government to overcome obstacles, and to use and maintain the new system effectively after foreign assistance comes to an end. This lesson is not unique to nuclear security cooperation: a major World Bank study, for example, pointed out that 62% of rural water projects that promoted extensive participation by the recipients were successful, compared to only 10% that did not.[27]

[I]nnovations in nuclear security are most likely to be successful when they are driven forward by a small group of committed and well-connected individuals who are able to take advantage of events that create a sense of urgency...

Building commitment and a sense of urgency is crucial. If senior officials and facility managers are to assign sufficient resources to nuclear security and do the political work to change approaches, they must be convinced that the threat of nuclear theft and terrorism is real and urgent. Measures that might be taken include joint threat briefings by senior experts from the U.S. and the potential partner country; war games and similar simulations of nuclear terrorism scenarios, which engage hearts and minds in a way that paper reports and briefings never do; putting together teams of security experts from potential partner countries to do rapid assessments of vulnerabilities at their own nuclear facilities (as DOE did for its facilities after the 9/11 attacks); working with countries to help them identify insider and outsider threats their facilities should be defended from (as the IAEA has been working to do in recent years); and producing training videos for facility managers and staff outlining the dangers of nuclear theft and sabotage, including emotional images of Hiroshima and Chernobyl to highlight the potential consequences of nuclear terrorism.[28]

Flexible approaches on secrecy and access are needed. To be successful, security upgrade programs in many cases will have to acknowledge that countries are simply not going to reveal all of their nuclear security secrets. For example, Pakistan is very unlikely to allow U.S. or other foreign experts to visit all its nuclear weapon storage facilities and fully understand their secu-

rity vulnerabilities; Pakistan is legitimately concerned that the U.S. might at some time want to destroy or seize control of its nuclear arsenal, or might inadvertently leak secrets to India. India has similar concerns, as does China. But there is a great deal that can be done to improve security for nuclear sites without actually seeing them or learning anything very specific about them—from detailed discussions of techniques and best practices for assessing vulnerabilities to outsider and insider threats, to identifying some of the best commercially available equipment, to training and other help with writing and enforcing effective nuclear security rules. Using methods developed in the lab-to-lab program, the U.S. or other donor countries can finance security upgrades at sites their experts will never visit, while ensuring that their money is being spent appropriately.

With sufficient effort from the highest levels, there is good reason to believe that in the next few years a global effort to lock down the world's nuclear stockpiles can be forged. President Bush, working with Russian President Putin and the leaders of other key nuclear states around the world, should seek to launch a global partnership to prevent nuclear terrorism; to forge effective global nuclear security standards, and focus the partnership on helping states to meet them; and to expand and accelerate the effort to remove nuclear material from the world's most vulnerable sites. To keep the issue on the front burner every day, he should appoint a senior White House official (perhaps a Deputy National Security Adviser) with full-time responsibility for leading the entire complex of efforts focused on preventing nuclear terrorism, and the access necessary to walk in and get a presidential decision when needed—and he should encourage President Putin to do the same. Given the urgency of the threat, steps to prevent nuclear terrorism must be made a top priority of U.S. security policy—something to be addressed with every country with stockpiles to secure or resources to help, at every level, until the job is done. There remains an excellent opportunity to greatly reduce the chance that terrorists will ever obtain and use a nuclear bomb. But the hour is late. As Senator Nunn has said, the world is in a race "between catastrophe and cooperation." It is a race we cannot afford to lose.

We invite reader comments. Please send an email to <editors@innovationsjournal.net>.

1. For recent summaries of the threat and measures to address it, see Graham T. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, 1st ed. (New York: Times Books/Henry Holt, 2004); Matthew Bunn and Anthony Wier, Securing the Bomb 2005: *The New Global Imperatives* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom and Nuclear Threat Initiative, 2005; available at http://www.nti.org/e_research/report_cnwmupdate2005.pdf as of 6 July 2005); Charles D. Ferguson, William C. Potter, and Leonard S. Spector (with Amy Sands and Fred L. Wehling), *The Four Faces of Nuclear Terrorism* (Monterey, CA: Center for Nonproliferation Studies, Monterey Institute of International Studies, 2004; available at http://www.nti.org/c_press/analysis_4faces.pdf as of 5 December 2005); Christopher F. Chyba, Hal Feiveson, and Frank Von Hippel, *Preventing Nuclear Proliferation and Terrorism: Essential Steps to Reduce the Availability of Nuclear-Explosive Materials* (Palo Alto, Calif.: Center for International Security and Cooperation, Stanford Institute for International Studies, Stanford University and Program on Science and Global Security, Woodrow Wilson School of Public and International Affairs, Princeton University, 2005; available at http://iis-db.stanford.edu/pubs/20855/Prvnt_Nuc_Prlf_and_Nuc_Trror_2005-0407.pdf as of 1 November 2005).

2. The U.S. nuclear artillery shells in Europe had become useless with the reunification of Germany (on whose soil

such weapons would explode). The South Korean government had asked that the U.S. withdraw its nuclear weapons from South Korean soil; announcing a global tactical nuclear initiative made it possible to fulfill that request without appearing to cave in to North Korean pressure. The tactical weapons on Navy surface ships had become a political problem because an increasing number of countries would not allow U.S. ships to visit if they might be carrying nuclear weapons. Of the Soviet nuclear weapons in the non-Russian states, Bush and Scowcroft quote Powell, remarkably, saying: "I am comfortable where they are." Even more remarkably, Scowcroft himself reports that he was hoping at the time that control over the Soviet nuclear arsenal would be broken up among multiple states, so that the size of any attack would be smaller. See George Bush and Brent Scowcroft, *A World Transformed* (New York: Knopf, 1998), pp. 542-547. See also Colin Powell (with Joseph E. Persico), My American Journey (New York: Random House, 1995), pp. 540-541.

3. See Ashton B. Carter and William J. Perry, Preventive Defense: *A New Security Strategy for America* (Washington, D.C.: Brookings, 1999); Jason D. Ellis, *Defense by Other Means: The Politics of U.S.-NIS Threat Reduction and Nuclear Security Cooperation* (Westport, Conn.: Praeger, 2001).

4. For a discussion of security and accounting for nuclear material since the Soviet collapse, see Matthew Bunn, "The Threat in Russia and the Newly Independent States," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2005; available at http://www.nti.org/e_research/cnwm/threat/russia.asp as of 16 September 2005).

5. In unclassified 1996 testimony, then-Director of Central Intelligence John Deutch described this conclusion as the result of a "comprehensive evaluation" by the intelligence community. See Committee on Governmental Affairs, Permanent Subcommittee on Investigations, Global Proliferation of Weapons of Mass Destruction, Part II, U.S. Senate, 104th Congress, 2nd Session (13, 20, and 22 March 1996).

6. For an excellent recent review of this history, see Caitlin Talmadge, "Striking a Balance: The Lessons of U.S.-Russian Materials Security Cooperation," *Nonproliferation Review* 12, no. 1 (March 2005; available at http://cns.miis.edu/pubs/npr/vol12/121/121talmadge.pdf as of 2 November 2005). For a discussion of the successful work with the Russian Navy, see Morton Bremer Maerli, "U.S.-Russian Naval Security Upgrades: Lessons Learned and the Way Ahead," *Naval War College Review* 56, no. 4 (Autumn 2003; available at http://www.nwc.navy.mil/press/Review/2003/Autumn/pdfs/art2-a03.pdf as of 18 April 2005). See also 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, D.C.: Russian American Nuclear Security Advisory Council, 2000; available at
<http://bcsia.ksg.harvard.edu/BCSIA_content/documents/mpca2000.pdf>
as of 10 March 2005).

7. Quoted in Talmadge, "Striking a Balance," p. 10.

8. The flawed "quick fix" proposal was largely my idea.

9. I directed this study, and the problematic "report to the Presidents" approach was also largely my idea. Study chair John P. Holdren provided an unclassified summary of the study's conclusions and recommendations in Committee on Foreign Relations, Subcommittee on European Affairs and Committee on Governmental Affairs, Permanent Subcommittee on Investigations, Loose Nukes, Nuclear Smuggling, and the Fissile Material Problem in Russia and the NIS, U.S. Senate, 104th Congress, 1st Session (22-23 August 1995).

10. See, for example, discussion in Talmadge, "Striking a Balance."

11. Renewing the Partnership.

12. There is a good discussion of this point in Talmadge, "Striking a Balance."

13. For a discussion of the lessons from the naval MPC&A effort, see Bremer Maerli, "U.S.-Russian Naval Security Upgrades." See also *Renewing the Partnership*.

14. Department of Defense experts argue that their approach is only what is required by the Federal Acquisition Regulations (FAR), which require that before contracting for any project, government officials must be able to make an independent estimate of what the project should cost—and that government officials must be able to review the completed project to ensure that the agreed standards were met. It is clear, however, that the approaches taken by the DOE teams, also subject to the FAR, have been somewhat different and more flexible. This appears to be one of several cases where the amount of flexibility U.S. or Russian officials brought to interpreting their legal constraints made a significant difference in the ability to get past obstacles to progress.

15. For a discussion, see "Warhead Security: The Saga of the Slow 'Quick Fix,'" in Matthew Bunn and Anthony Wier, *Securing the Bomb: An Agenda for Action* (Cambridge, Mass., and Washington, D.C.: Project on Managing the

Atom, Harvard University, and Nuclear Threat Initiative, 2004; available at http://www.nti.org/e_research/-cnwm/overview/2004report.asp as of 1 February 2005), pp. 52-53.

16. A number of these concepts are discussed in some detail in U.S. National Academy of Sciences, Committee on International Security and Arms Control, Monitoring Nuclear Weapons and Nuclear-Explosive Materials (Washington, D.C.: National Academy Press, 2005; available at http://books.nap.edu/catalog/11265.html as of 8 August 2005).

17. Matthew Bunn, "Incentives for Nuclear Security," paper presented at the 46th Annual Meeting of the Institute for Nuclear Materials Management, Phoenix, Ariz., 10-14 July 2005.

18. The Moscow commander's remarks are quoted in "Over 4,000 Trespassers Detained at Moscow District Restricted Access Facilities," Interfax-Agentstvo Voyennykh Novostey, 18 March 2005. The 30% figure is from Nikolai N. Shemigon, director-general, Eleron (Rosatom's physical protection firm), remarks to "MPC&A 2005: Third Russian International Conference on Nuclear Material Protection, Control, and Accounting," 16-20 May 2005, Obninsk, Russia.

19. Tatiana Sinitsyna, "Does the Nuclear Thief Stand a Chance in Russia?" RIA Novosti, 30 December 2003.

20. Anatoliy Kotelnikov, quoted in "Secret Materials," Russian Central TV, 29 November 2002 (translated by BBC Monitoring Service).

21. For a good account of the security culture problem, see Igor Khripunov and James Holmes, eds., *Nuclear Security Culture: The Case of Russia* (Athens, Georgia: Center for International Trade and Security, University of Georgia, 2004; available at http://www.uga.edu/cits/documents/pdf/Security%20Culture%20Report%-2020041118.pdf as of 18 February 2005).

22. For the commander's remarks, see, for example, "Russia: Terror Groups Scoped Nuke Site," *Associated Press*, 25 October 2001, and Pavel Koryashkin, "Russian Nuclear Ammunition Depots Well Protected—Official," ITAR-TASS, 25 October 2001. For reports of the discussion between Putin and his minister, see, for example, "The Ministry of Atomic Energy in the Middle of a Scandal," Nezavizamaya Gazeta, 14 December 2001 (translated by BBC Monitoring Service).

23. Vladimir Bogdanov, "Propusk K Beogolovkam Nashli U Terrorista (A Pass to Warheads Found on a Terrorist)," Rossiskaya Gazeta, 1 November 2002.

24. For accounts of what a more genuine partnership might look like, see, for example, U.S. and Russian Committees on Strengthening U.S. and Russian Cooperative Nuclear Nonproliferation, U.S. National Academy of Sciences and Russian Academy of Sciences, *Strengthening U.S.-Russian Cooperation on Nuclear Nonproliferation: Recommendations for Action* (Washington, D.C.: National Academy Press, 2005; available at http://books.nap.edu/catalog/11302.html as of 15 November 2005); Matthew Bunn, "Building a Genuine U.S.-Russian Partnership for Nuclear Security," paper presented at the 46th Annual Meeting of the Institute for Nuclear Materials Management, Phoenix, Ariz., 10-14 July 2005 (available at http://bcsia.ksg.harvard.edu/BCSIA_content_stage/documents/inmmpartnership205.pdf as of 16 September 2005).

25. Data provided by DOE, September 2005.

26. For detailed recommendations on securing nuclear stockpiles worldwide, see Bunn and Wier, *Securing the Bomb* 2005.

27. World Bank, *Assessing Aid: What Works, What Doesn't, and Why* (Oxford, U.K.: Oxford University Press, 1998).

28. For a discussion of such measures, focused primarily on their potential use in Russia, see Bunn and Wier, *Securing the Bomb* 2005.