Securing the Bomb 2005: The New Global Imperatives

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The New Global Imperatives

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EXECUTIVE SUMMARY

Evidence that terrorists are actively seeking nuclear weapons and the materials needed to make them, and that some nuclear stockpiles around the world remain dangerously vulnerable to potential theft and transfer to terrorist groups, continued to accumulate in the past year. A comprehensive strategy for preventing nuclear terrorism would include many strands, from offensive action against terrorists with global reach to measures to stop nuclear smuggling. But the most crucial element of such a strategy is to lock down every nuclear weapon and every kilogram of potential nuclear bomb material everywhere. Because nuclear weapons and their essential ingredients do not occur in nature and are too difficult for terrorists to plausibly produce on their own, if these stockpiles can be kept out of terrorist hands, nuclear terrorism can be reliably prevented.

Foundations for Accelerated Action—New Imperatives

Over the past year, the United States and other countries laid three critical foundations for an accelerated and expanded effort to prevent nuclear terrorism.

- The UN Security Council unanimously passed Resolution (UNSCR) 1540 in April 2004, legally obligating every country in the world to put in place effective security and accounting for nuclear stockpiles, and thus providing the base for an accelerated nuclear security upgrade effort worldwide, not just in the former Soviet Union.

- In May 2004, the U.S. Department of Energy launched the Global Threat Reduction Initiative (GTRI), offering the potential to accelerate and expand efforts to remove and secure potential nuclear bomb material from insecure sites around the world.

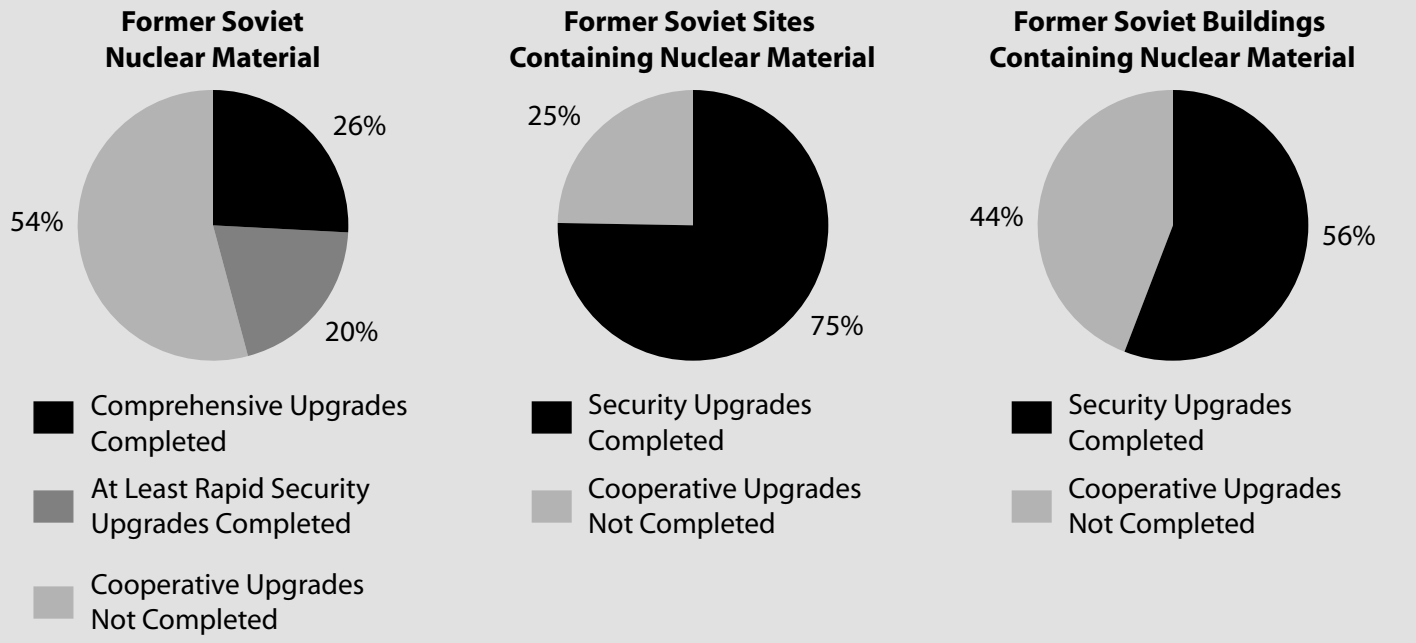
- At their February 2005 summit in Bratislava, Slovakia, U.S. President George W. Bush and Russian President Vladimir Putin issued a summit statement calling for intensified cooperation to secure nuclear stockpiles in Russia, and for joint U.S.-Russian leadership of nuclear security upgrade efforts elsewhere around the world.

Translating last year's pledges into the needed rapid action will require sustained leadership from both President Bush and President Putin—and from the leaders of other key nuclear states. Action from the highest levels is needed because difficult bureaucratic and political impediments persist that cut across agencies and departments and cannot be resolved by officials within any one agency. Success will require not just occasional encouraging statements, but in-depth, day-to-day engagement. As the leaders of the two countries that own the vast majority of the world's nuclear weapons and weapons-usable nuclear material, President Bush and President Putin have an historic opportunity to leave behind, as a lasting legacy, a world in which the danger that terrorists could get hold of a nuclear weapon or the materials needed to make it has been dramatically reduced.

On-the-Ground Progress Still Slow—But Hope for Acceleration

Unfortunately, the on-the-ground progress in securing, consolidating, and eliminating nuclear stockpiles in the last year remained slow, when compared to the urgency of the threat. During fiscal year (FY) 2004, U.S.-funded comprehensive security and accounting upgrades were completed on only 4% of the weapons-usable nuclear material in the former Soviet Union, bringing the total fraction with such upgrades completed by the end of the fiscal year to 26%. Initial rapid upgrades were completed for 3% of the potentially vulnerable weapons-usable nuclear material, so that by the end of the fiscal year, these first steps had been taken for an additional 20% of the former Soviet stockpile. Because huge quantities of material are located at a small number of highly sensitive sites, the

Figure ES-1
Status of Security Upgrades on Sites and Buildings in the Former Soviet Union Containing Former Soviet Weapons-Usable Nuclear Material

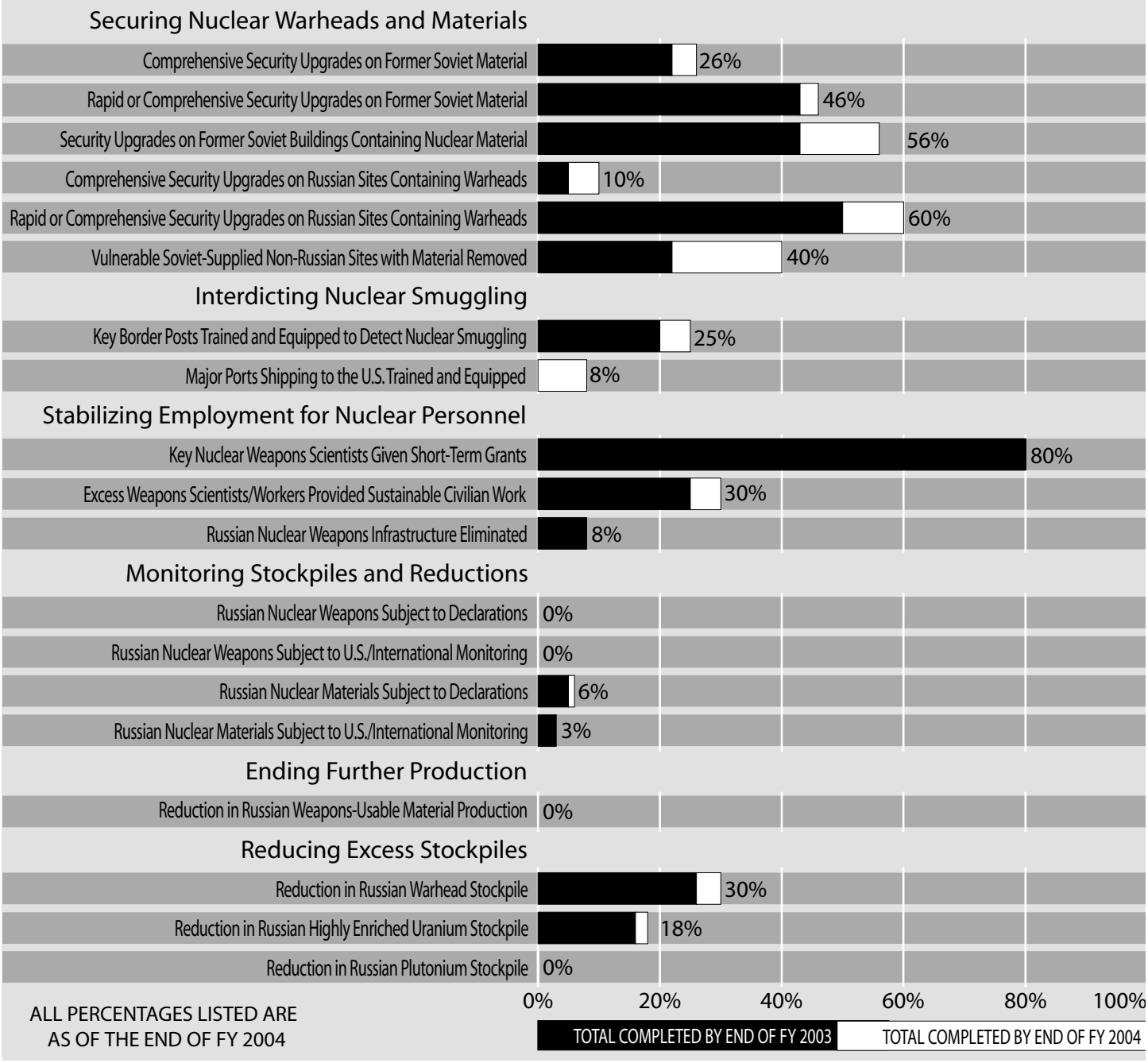


Note: The percentages for buildings and sites completed differ somewhat from DOE's official estimate because we include only those buildings and sites containing nuclear material, treating nuclear warheads separately.

picture looks substantially better when judged by the fraction of *sites* with potential nuclear bomb material where upgrades have been completed (some 75%) or the fraction of *buildings* containing such material with completed upgrades (some 56%). Figure ES-1 illustrates these differing measures. The buildings figure is probably the best available indicator both of the fraction of the work that has been accomplished and the fraction of the potential theft threat that has been reduced; by that measure, roughly half of the job is completed, and roughly half remains.

In last year's report, we noted, based on the official U.S. government data available at the time, that comprehensive security upgrades had been completed for more nuclear material in the two years before the 9/11 attacks than in the two years after those attacks, and that if the quantity of nuclear material upgraded in FY 2003 continued unchanged, it would take 13 years before upgrades were completed. (The Department of Energy subsequently revised its estimates of the amount of material covered by completed upgrades each year, with the result that the amounts secured in the two years before and the two years after the 9/11 attacks are now thought to have been approximately the same.) As comprehensive upgrades were finished on somewhat less material in FY 2004 than in FY 2003, it remains clear that a dramatic acceleration will be needed to meet DOE's stated goal of finishing the upgrades in less than four years from now (by the end of 2008). DOE appears to be on track to meet its goal of completing comprehensive security and accounting upgrades for an additional 11% of the potential bomb material in the former Soviet Union in FY 2005, nearly tripling the FY 2004 pace. Achieving DOE's stated goals for subsequent years will be more challenging. The dramatic acceleration needed to achieve the 2008 goal remains possible, but only if both President Bush and President Putin make a sustained effort to sweep aside the obstacles to progress—including in particular agreeing on access or other assurances for the last highly sensitive sites where access is still a major problem (an issue that was not resolved at the Bratislava summit, despite some significant progress over the past year).

Figure ES-2
Controlling Nuclear Warheads, Material, and Expertise: How Much Work Have U.S.-Funded Programs Completed?



In other categories, similarly, U.S.-funded programs have made major progress, but are far from finishing the job. Figure ES-2 summarizes a comprehensive set of metrics for assessing the progress of U.S.-funded programs to improve controls on nuclear warheads, materials, and expertise to date, and how much of this progress was made during FY 2004. These estimates are described and documented in Chapter Three of this report. For example, approximately 10% of the Russian sites for actual nuclear warheads (as opposed to nuclear material) had received U.S.-funded comprehensive security upgrades by the end of FY 2004. Many thousands of bombs' worth of Russian bomb uranium has been destroyed—but the stockpile eliminated to date represents less than a fifth of Russia's total. It will still be years before destruction

of substantial quantities of U.S. and Russian excess bomb plutonium even begins. While thousands of nuclear scientists received short-term grants to ease the desperate transition of the 1990s, only a tiny fraction of Russia's excess nuclear weapons experts have yet received self-supporting long-term civilian jobs through internationally funded programs. Outside the former Soviet Union, only a few sites had substantial security upgrades put in place or their potential nuclear bomb material removed.

Such assessments of the number of buildings with security equipment installed, or the tons of HEU destroyed, do not describe the whole picture of nuclear security. "Security culture," in particular, is difficult to measure, but critical, as highlighted in the Bratislava summit statement: if guards are patrolling without ammunition in their guns to avoid accidental firing, monitors are turning off intrusion detectors because of their annoying false alarms, and workers are propping open security doors for convenience, the best equipment will not provide high security. Moreover, measures of how much progress U.S.-funded programs have made, by their nature, miss the improvements Russia and other potential recipient states have made in upgrading security on their own, without U.S. or other foreign assistance (or even foreign awareness that the changes have been made). Such measures are also a snapshot in time that says nothing about how well security will be sustained and improved at sites after international assistance comes to an end. Hence, it is quite possible that some material counted as "completed" in these measures remains insecure—or will become so again in the future as equipment breaks or is no longer used—and that some material counted as "not completed" is already secure.

Proposed Budget Increases and Remaining Opportunities

The Bush administration has requested a significant increase in funding for programs to improve controls on nuclear warheads, materials, and expertise around the world for FY 2006. The proposed budget for these programs is $982 million, a 22% increase over the previous year's appropriation, and more than this group of programs has ever been granted before. The total proposed budget for all cooperative threat reduction efforts around the world (which also include control and elimination of chemical and biological weapons and strategic missiles, bombers, and submarines, among other efforts) for FY 2006, is $1.312 billion, just short of 25% more than the Bush administration's proposal for the previous year. While that amounts to less than one-quarter of one percent of the U.S. defense budget, most programs are limited more by the level of cooperation that has been achieved with potential recipient states than by money. But there are several areas where small increases in available funds could accelerate progress.

Outline of a Maximum Effort

There is an urgent imperative to build a fast-paced global partnership to secure the world's nuclear stockpiles on the foundations laid in the last year, before those opportunities slip away. As the 9/11 Commission most recently put it, what is needed is a "maximum effort" to keep nuclear weapons and the materials needed to make them out of terrorist hands. This global effort will have to be at the top of the diplomatic agenda—an item to be addressed with every country with stockpiles to secure or resources to help, at every level, at every opportunity, until the job is done. A comprehensive global nuclear security partnership would have many ingredients, but there are three that are essential: accelerating and strengthening the effort in Russia, where the largest stockpiles of potentially vulnerable nuclear materials still exist; removing the material entirely from the world's most vulnerable sites; and building a fast-paced global coalition to improve security for the remaining nuclear stockpiles around the world.

Step 1: An Accelerated and Strengthened Partnership with Russia

The first and most crucial step is to put in place an accelerated and strengthened effort with Russia, based on genuine partnership.

In the aftermath of the horrifying slaughter of schoolchildren at Beslan, President Putin should take many

of the same steps to secure Russia's stockpiles that the Department of Energy has taken to secure comparable stockpiles in the United States—sending out a team to rapidly assess nuclear security vulnerabilities and suggest fixes; requiring all facilities with nuclear weapons or materials to put in place security capable of defeating demonstrated terrorist and criminal threats, both from outsiders and insiders; consolidating nuclear weapons and materials at fewer locations, to provide more security at lower cost; working to transform the guard force into an elite fighting force; and substantially increasing nuclear security spending. The United States can share its experience and offer to pay some of the costs of such measures.

President Bush's critical diplomatic tasks in the aftermath of Bratislava include: using his excellent relationship with President Putin to convince the Russian president of the urgency of action, both for Russia's own security and as a central requirement of a positive relationship with the United States; pressing for agreement with Russia on key steps to strengthen and accelerate the nuclear security effort in Russia and around the world; and stepping in to overcome the obstacles to a fast-paced U.S.-Russian nuclear security partnership that still exist on the U.S. side.

Following up on the Bratislava summit statement, the United States and Russia should agree on (a) a joint plan to complete security upgrades for all nuclear warhead and material sites by the end of 2008; (b) approaches to overcoming the key impediments to progress (including compromises on the issues of both access and liability); (c) steps to build strong security cultures at nuclear sites in both countries; (d) a joint plan to provide the resources, organizations, and incentives necessary to sustain and improve security after U.S. and international assistance phases out; and (e) a new initiative to secure, monitor, and in many cases dismantle the most dangerous warheads—particularly those not equipped with modern, difficult-to-bypass electronic locks. The interagency committee on nuclear security cooperation established at the Bratislava summit should be used to focus high-level attention on reaching such agreements and taking the decisions needed to sweep aside the obstacles to accelerated progress.

Building genuine Russian commitment—a sense in Russia that cooperation on nuclear security is not just a favor to the Americans but essential for Russia's own security—will be crucial to success. The United States should (a) encourage Russia to undertake a fast-paced review by Russian experts of security vulnerabilities at Russian sites, judging whether they are adequately defended against Beslan-scale outsider attacks or substantial insider conspiracies; (b) pursue joint U.S.-Russian nuclear theft and terrorism threat briefings for senior officials; (c) sponsor simulations and war games focused on nuclear theft and terrorism for senior officials; (d) develop jointly with Russia, as part of ongoing security awareness training, a video highlighting the very real possibility that terrorists could make a crude nuclear bomb if they got the nuclear material.

To achieve both the top-level Russian commitment necessary to move nuclear security cooperation forward and the working-level Russian "buy-in" essential to ensure that upgraded security systems will be sustained and improved over time, a shift from a donor-recipient relationship toward a true partnership will be essential. In a real partnership, Russia would have to contribute more of its own resources, and the United States would have to pursue a truly joint approach, with Russian and U.S. experts involved in all stages of the conception, design, implementation, and evaluation of these programs. Shifting from a focus only on improving nuclear security in Russia with U.S. help toward a focus on joint U.S. and Russian leadership in improving security around the world (starting with making sure their own houses are in order) can strengthen this sense of partnership. A leading Russian role can greatly strengthen the global effort, as there are key countries where Russia has the relationships necessary to work on nuclear security or negotiate the removal of nuclear material, and the United States does not. Building a genuine nuclear security partnership will be more likely to succeed if political issues that have been souring U.S.-Russian relations and strengthening those who are suspicious of cooperation in these

sensitive areas, on both sides of the ocean, are also addressed.

Step 2: Fast-Paced Removal from Vulnerable Sites Worldwide

The surest way to ensure that nuclear material will not be stolen from a particular site is to remove it, so there is nothing left to steal. What is needed now is a fast-paced effort to remove the weapons-usable nuclear material entirely from the world's most vulnerable sites, particularly including HEU-fueled research reactors. The goal should be to remove the nuclear material entirely from the world's most vulnerable sites within four years—substantially upgrading security wherever that cannot be accomplished—and to eliminate all HEU from civil sites worldwide within roughly a decade. The United States should make every effort to build international consensus that the civilian use of HEU is no longer acceptable, that all HEU should be removed from all civilian sites, and that all civilian commerce in HEU should be brought to an end as quickly as possible. Those goals are challenging, and achieving them will require a substantial effort, but the scale and urgency of the threat demands no less. Success in achieving them will require focusing comprehensively on *all* the facilities that have vulnerable potential nuclear bomb material, not just those that happen to be operating civilian research reactors, or whose nuclear material happens to be Russian-supplied or U.S. supplied. Success will require flexible and creative tactics, with approaches—including incentives to give up the nuclear material—targeted to the needs of each facility and host country, and it will require the United States to convert and adequately secure its own HEU-fueled research reactors as part of convincing others to do so.

Step 3: A Global Partnership to Prevent Nuclear Terrorism

The problem of insecure nuclear material is global. Solving it will require forging a global coalition of countries around the world willing to work together to ensure that every cache of nuclear weapons or weapons-usable nuclear materials worldwide is secure and accounted for, to a level sufficient to defeat plausible terrorist and criminal threats from both outsiders and insiders.

Given the devastating global economic impact a nuclear terrorist attack would have, every country has a strong self-interest in cooperating to reduce this threat. But the intense secrecy surrounding nuclear stockpiles and their security arrangements will make building the needed global effort an extraordinary challenge. The United States should seek to convince the top leadership of states around the world of the urgency of the threat, using approaches similar to those suggested above in the case of Russia.

The United States should (a) put forging such a global nuclear security partnership at the top of its diplomatic agenda with every relevant country with resources to offer or stockpiles to secure; (b) move quickly to implement UNSCR 1540, seeking general agreement that its requirement for "appropriate effective" security requires that every facility with nuclear weapons or potential nuclear bomb material should be secured against the terrorist and criminal threats that have been demonstrated in that country, and moving quickly to help countries around the world put such security in place; (c) adapt threat reduction assistance to new contexts, working with states such as Pakistan, India, and China to ensure that their nuclear stockpiles are secure and accounted for, finding creative ways to do so without forcing these states to reveal sensitive nuclear information; (d) exchange nuclear security and accounting best practices—particularly institutionalized approaches to regularly finding and fixing nuclear security weaknesses—with countries around the world; (e) seek to forge effective and binding global nuclear security standards, building from UNSCR 1540; and (f) work with other states to expand the mission, personnel, and resources of the International Atomic Energy Agency's (IAEA's) Office of Nuclear Security, substantially increasing its contribution to preventing nuclear terrorism.

Steps the G8 and Other Leading Powers Should Take

At their July 2005 summit, the leaders of the G8 (along with the other participants in the Global Partnership Against the Spread of Weapons and Materials of

Mass Destruction) should (a) explicitly identify locking down nuclear stockpiles and interdicting nuclear smuggling as top priorities for expenditure of the $20 billion they have pledged to provide; (b) put the "global" back in the Global Partnership by explicitly focusing the effort not just on Russia and the former Soviet states, but on helping states worldwide put in place the controls on weapons of mass destruction and related materials and technologies required by UNSCR 1540; and (c) take a range of other steps to secure, consolidate, and eliminate dangerous nuclear stockpiles.

All states with nuclear weapons (including Pakistan, India, and Israel), and all states with significant stockpiles of weapons-usable nuclear material, should join in this global nuclear security effort, and adopt national rules requiring every facility with nuclear weapons or weapons-usable nuclear material to be secured against specified outsider and insider threats, comparable to those terrorists and criminals have demonstrated in their country.

The Nonproliferation Treaty (NPT) review conference in May 2005 should (a) call on all states to adopt effective national nuclear security rules, and agree to interpret UNSCR 1540 as requiring such steps; (b) call for new efforts to secure, consolidate, and where possible eliminate nuclear stockpiles (particularly HEU and tactical nuclear weapons); (c) support the rapid conclusion of a verifiable fissile material cutoff agreement, which would limit additions to the stocks that need to be secured; and (d) agree on the need for new measures to control the spread of nationally controlled enrichment and reprocessing facilities (which would add to the sources of new stocks requiring security).

Options for the U.S. Congress

The U.S. Congress should consider additional action to make the priority of these efforts clear, to exert performance-based oversight, to enable and authorize key steps while removing legal constraints, and to mandate particular steps where necessary. In particular, Congress should consider (a) eliminating certification requirements and restrictions, or giving the president long-term authority to waive them when that serves U.S. interests; (b) broadening the government's legal authority to provide incentives to convince vulnerable facilities and their host states to allow potential bomb material to be removed, while ensuring that the programs cover all potentially dangerous caches of nuclear material; (c) providing increased funds and authority for a global effort to help countries implement all the key requirements of UNSCR 1540; (d) appropriating additional funds for efforts to remove and secure nuclear material at vulnerable facilities around the world; and (e) mandating other new initiatives.

Seizing the Opportunities

Much remains to be done to build on the foundations for a fast-paced global nuclear security partnership that were laid in the past year, transforming current programs into the "maximum effort" the 9/11 Commission called for. The need for action is urgent—both because terrorists and criminals will not wait, and because the opportunities created by GTRI, UNSCR 1540, and the Bratislava summit may well be fleeting. Few of the steps recommended here will happen without sustained leadership and political heavy lifting from the White House and its counterparts around the world. President Bush should appoint a senior full-time White House official, with the access needed to walk in and ask for presidential action when needed, to lead these efforts, to keep them on the front burner at the White House every day, to set priorities, to eliminate gaps and overlaps, and to seize opportunities for synergy. If the world can muster the will to change its past approaches, there remains an excellent chance of preventing a nuclear 9/11.

1 INTRODUCTION

On September 1, 2004, 32 terrorists armed with automatic rifles, machine guns, grenade launchers, and explosives seized a school in Beslan, Russia, and took 1,200 schoolchildren and adults as hostages. The attack was carefully planned and well organized. The terrorists quickly wired the gymnasium where they had gathered their hostages with explosives, shot out the windows so that security forces could not fill the gym with incapacitating gas, and dug holes in the floor so that security forces could not come up unnoticed from beneath. In the firefight that ended the standoff, the terrorists slaughtered some 330 hostages, 186 of them children.[1]

The images of the child victims of Beslan shocked Russia and the world. The Beslan attack again confirmed terrorists' ability and willingness to strike in force, without warning or mercy. If the perpetrators of the Beslan atrocity, or of the 9/11 attacks, could get a nuclear bomb, the same hate and heartlessness that produced the Beslan attack could reduce a major city to a smoldering ruin in an instant.

Unfortunately, a force of the size and sophistication of the one that struck at Beslan—or an insider conspiracy as capable as those that have repeatedly stolen valuable items around the world in recent years—might well be sufficient to break through security at a nuclear site in Russia or in many other countries around the world, and steal a nuclear weapon or the nuclear materials needed to make one. Preventing nuclear terrorism requires a multi-pronged approach, including focused offensive action against terrorists with global reach and enhanced efforts to prevent nuclear weapons and materials from being smuggled across national borders.[2] But because nuclear weapons and their essential ingredients do not occur in nature and are too difficult for terrorists to plausibly produce on their own, if nuclear weapons and nuclear materials can be kept out of terrorist hands, terrorism with nuclear weapons can be reliably prevented. Thus the most crucial element in preventing nuclear terrorism, and therefore one of the steps most critical for the security of the United States, Russia, and the world, is to lock down every nuclear weapon and every kilogram of potential nuclear bomb material everywhere. Security for these nuclear stockpiles that is sufficient to defeat the threats terrorists and criminals have already shown they can pose must be put in place as rapidly as that can possibly be done.

This report provides an update on progress in achieving that and other closely related objectives in the last year, along with targeted recommendations for strengthening and accelerating the effort. The past year was still one of slow progress in most categories, raising the danger that the world may fail in securing these stockpiles before terrorists and criminals can get to them. But it was also a year in which the United States and other countries joined in laying what could be the foundation of an urgently needed, fast-paced global partnership to prevent nuclear terrorism. The unanimous passage of UN Security Council Resolution 1540 in April 2004 legally obliges every country in the world to put in place effective controls over weapons of mass destruction and related materials, including effective security and accounting for nuclear material—providing the

[1] Boris Yamshanov, "Bribes Reeking of Explosives," *Rossiiskaya Gazeta*, 16 September 2004; Nikolai Gritchin, "The Actions of Police Officers in Beslan Helped the Terrorists," *Izvestia*, 11 November 2004; Robert Greenali, "What Happened in Beslan?" *BBC News Online*, 10 September 2004; "Terror's New Depths," *Economist* (11 September 2004); Paul Thompson and James Clench, "Two Days of Sheer Terror; Russia's Nightmare," *The Sun*, 4 September 2004; "Beslan Hostage-Taking Death Toll Is 330 - Deputy Prosecutor General," *Interfax News Service*, 30 December 2004.

[2] For a discussion of the steps terrorists would have to take to get and use a nuclear weapon on a U.S. city, and government actions that could prevent these steps from being taken, see Matthew Bunn, Anthony Wier, and John Holdren, "Blocking the Terrorist Pathway to the Bomb," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2003; available at http://www.nti.org/e_research/cnwm/overview/path.asp as of 1 February 2005).

base for an accelerated global effort to put effective security measures for nuclear stockpiles in place.[3] The May 2004 launch of the Global Threat Reduction Initiative (GTRI) by the U.S. Department of Energy offers great potential to accelerate and expand efforts to remove and secure potential nuclear bomb material from insecure sites around the world.[4] The statement on accelerating and strengthening cooperative nuclear security programs agreed to by U.S. President George W. Bush and Russian President Vladimir Putin at their February 2005 summit in Bratislava, Slovakia, creates new possibilities for accelerating and strengthening cooperation to secure nuclear stockpiles in Russia and around the world.[5]

Sustained, daily leadership from both President Bush and President Putin—and from the leaders of other key nuclear states—will be needed to fulfill the promise of the foundations laid in the last year. Translating last year's pledges into this year's rapid action will require a continuing push from the highest levels, as difficult bureaucratic and political impediments persist that cut across agencies and departments and cannot be resolved by officials within any one agency. As the leaders of the two countries that own the vast majority of the world's nuclear weapons and weapons-usable nuclear material, President Bush and President Putin have an historic opportunity to leave behind, as a lasting legacy, a world in which the danger that terrorists could get hold of a nuclear weapon or the materials needed to make it has been dramatically reduced. We hope that this report will help accomplish that objective.

Growing Global Consensus on the Urgency of the Danger

Even for a group combining the cold-blooded motivation and the well-honed preparation of the Beslan terrorists, an attack using an actual nuclear explosive would be among the most difficult types of attack for terrorists to accomplish. For years, many experts around the world have dismissed the possibility of a terrorist nuclear bomb—either a stolen nuclear weapon that terrorists succeeded in detonating, or a bomb they managed to make themselves with stolen plutonium or highly enriched uranium (HEU)—as too far-fetched to require serious attention to prevent it. But difficult is not the same as impossible. As we discussed at length in our previous report, the probability that terrorists could succeed in carrying out a nuclear attack is large enough to justify doing "everything in our power," in President Bush's words, to prevent it.[6]

[3] For the text of the resolution, see United Nations, "1540 Committee" (New York: UN, 2005; available at http://disarmament2.un.org/Committee1540/meeting.html as of 25 February 2005).

[4] For the initial announcement of this effort, see Spencer Abraham, "International Atomic Energy Agency, Vienna: Remarks Prepared for Energy Secretary Spencer Abraham" (Washington, D.C.: U.S. Department of Energy, 2004; available at http://www.energy.gov as of 18 March 2005).

[5] For the text of the Bratislava statement, see "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation" (Bratislava, Slovakia: The White House, Office of the Press Secretary, 2005; available at http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html as of 25 February 2005).

[6] See "Debunking Seven Myths of Nuclear Terrorism and Nuclear Theft" 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. 10-30. Two other particularly important recent publications on nuclear terrorism and its prevention are Graham T. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, 1st ed. (New York: Times Books/Henry Holt, 2004), and Charles Ferguson and William Potter, *The Four Faces of Nuclear Terrorism* (Monterey, Cal.: Center for Nonproliferation Studies, Monterey Institute for International Studies, 2004). These publications have undoubtedly played critical roles in fostering the increased global consensus on the reality of the danger of nuclear terrorism and the urgency of actions to prevent it. So, too, have efforts by a range of non-government experts, in the United States and some other countries. The efforts of the Nuclear Threat Initiative (NTI) have been particularly notable, including the "Safer World" public education campaign in key primary states in 2003-2004, which contributed to greatly increased attention candidates devoted to the subject in the 2004 campaign, and ultimately to the comments in the first presidential debate; statements in many fora by NTI President Sam Nunn and other board members and staff; and NTI's sponsorship of efforts by a range of other groups (including our own work) designed to highlight both the threat and the available opportunities to strengthen global efforts to address it.

Fortunately, the years since the 9/11 attacks have witnessed a growing international understanding of the danger of nuclear terrorism. This emerging global consensus was perhaps best summed up in the last year by the United Nations High-Level Panel on Threats, Challenges, and Change, appointed by UN Secretary-General Kofi Annan, which included leading security figures from around the world, such as Brent Scowcroft, the national security adviser to the first President Bush, and Yevgeny Primakov, a former prime minister of Russia. The panel warned that terrorists might well be able to get hold of "inadequately secured" nuclear material, and that if they did, "scientists have repeatedly warned of the ease with which terrorists could, with parts from the open market, assemble a simple 'gun-type' nuclear device." A terrorist nuclear bomb, the panel warned, might kill "tens of thousands to more than one million people." The panel called for "urgent short-term action" to reduce the danger, focused particularly on "consolidating, securing, and when possible eliminating" nuclear bomb materials and other ingredients of weapons of mass destruction.[7]

In early 2005, Annan himself followed the panel's warnings by emphasizing that nuclear terrorism was not "science fiction," and that the world now had "a last chance for preventive action," including "consolidating, securing, and when possible eliminating" nuclear materials. Annan emphasized that a terrorist nuclear attack would not only be a catastrophe for the country attacked, but was truly a threat to everyone, as it would "stagger the world economy and thrust tens of millions of people into dire poverty," creating "a second death toll throughout the developing world."[8] Similarly, Mohammed ElBaradei, Director-General of the International Atomic Energy Agency (IAEA), warned in late 2004 that the world was in a "race against time" to secure nuclear stockpiles before terrorists and criminals could get to them.[9] Stressing that al Qaeda and other extremist groups were "actively looking into acquiring a nuclear weapon and other weapons of mass destruction," ElBaradei told an interviewer that terrorists armed with a nuclear bomb would be "the most horrible scenario," and warned: "We can't afford one single lapse in the system of security of nuclear material or nuclear weapons."[10] The February 2005 Bush-Putin summit statement, in which the two presidents described nuclear terrorism as "one of the gravest threats our two countries face," and called for accelerated action to secure nuclear stockpiles as a critical element of protecting the national security of both countries, emphasized again that Russian President Putin shares in this consensus on the urgency of the danger.[11]

Within the United States, this was one of the very few topics on which President Bush and Senator John Kerry, his Democratic challenger, agreed in their first 2004 presidential debate, calling the possibility that terrorists would get a nuclear bomb the "single most serious threat" to U.S. national security.[12] As the comments in that debate suggest, concern over the danger of nuclear terrorism, and the need to secure nuclear stockpiles and interdict nuclear smuggling to address it, is shared across the U.S. political spectrum. From the Democratic National Committee to the House Republican Policy Committee to Vice President Cheney to former Attorney General John Ashcroft, more and more policymakers of every political orientation are voicing a belief that the greatest danger

[7] United Nations High-Level Panel on Threats, Challenges, and Change, *A More Secure World: Our Shared Responsibility* (New York: 2004; available at http://www.un.org/secureworld/ as of January 28, 2005), pp. 40, 45.

[8] Kofi Annan, "A Global Strategy for Fighting Terrorism: Keynote Address to the Closing Plenary" in *International Summit on Democracy, Terrorism and Security* (Madrid: Club de Madrid, 2005; available at http://english.safe-democracy.org/keynotes/a-global-strategy-for-fighting-terrorism.html as of 10 March 2005).

[9] Mike Corder, "U.N.'s Elbaradei: It's a Race against Time to Stop Terrorists Getting Nuclear Weapon," *Associated Press Newswires*, 8 November 2004.

[10] "IAEA Chief Says Al Qaeda Sought Nuclear Weapon-TV," *Reuters News*, 9 April 2005.

[11] "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation."

[12] "The First Bush-Kerry Presidential Debate" (University of Miami, Coral Gables, Florida: Commission on Presidential Debates, 2004; available at http://www.debates.org/pages/trans2004a.html as of 31 January 2005).

facing the United States in the war on terrorism is the possibility that al Qaeda or similar groups could gain access to a nuclear bomb.[13] Leading members of the U.S. Congress, from both parties and both chambers, have sponsored legislation to enable and mandate new steps to consolidate, secure, and destroy nuclear stockpiles, and to interdict nuclear smuggling.[14] In its 2004 report, the bipartisan 9/11 Commission, after reviewing the failures and missteps that led to the 9/11 attacks, called upon Americans and their leaders to take action to ensure that nuclear weapons would not be used in any future terrorist attack: "The greatest danger of another catastrophic attack in the United States," the commission said, "will materialize if the world's most dangerous terrorists acquire the world's most dangerous weapons. ... Preventing the proliferation of these weapons warrants a maximum effort... ."[15]

This growing consensus on the danger also includes the community of technical experts with access to the relevant classified information. For example, at a January 2005 conference of nuclear scientists and terrorism experts organized by Los Alamos National Laboratory, when *Washington Post* editor Steve Coll queried the group on the probability of a terrorist nuclear bomb being detonated on U.S. soil in the coming decade, only a handful of conferees said that they thought the risk was less than five percent.[16]

The challenge now is to convert this growing global recognition of the threat of nuclear terrorism into the fast-paced action needed to reduce the danger.

Plan of the Report

This report is the fourth in an annual series, and does not cover every subject we have addressed previously.[17]

[13] The Democratic Party platform concluded, "There is no greater threat to American security than the possibility of terrorists armed with weapons of mass destruction. Preventing terrorists from gaining access to these weapons must be our number one security goal." It can be found at 2004 Democratic National Convention, *Strong at Home, Respected in the World: The 2004 Democratic National Platform for America* (Boston, Mass.: Democratic National Committee, 2004; available at http://a9.g.akamai.net/7/9/8082/v002/www.democrats.org/pdfs/2004platform.pdf as of 31 January 2005). See also, House Policy Committee, Subcommittee on National Security and Foreign Affairs, *All Tools at Our Disposal: Addressing Nuclear Proliferation in a Post–9/11 World* (Washington, D.C.: United States House of Representatives, 2005; available at http://policy.house.gov/assets/ATOD.pdf as of 31 January 2005). The chair of the subcommittee, Representative Heather Wilson (R-NM), summarized the scenario of a nuclear weapon in the hands of a terrorist or rogue state as "everyone's worst nightmare." See "Report: Threat of Nukes in Terrorists' Hands Is Urgent " (Washington, D.C.: House Policy Committee, 2005; available at http://policy.house.gov/html/news_release.cfm?id=162 as of 1 February 2005). Cheney referred to terrorists with weapons of mass destruction, particularly nuclear weapons, in an American city as "the biggest threat we face now as a nation"; see Vice President Dick Cheney, "Vice President and Mrs. Cheney's Remarks and Q&A in Carroll, Ohio" (Carroll, Ohio: Office of the Vice President, 2004; available at http://www.whitehouse.gov/news/releases/2004/10/20041020-2.html as of 13 April 2005). Ashcroft's comments, in which he regarded the possibility that al Qaeda or its sympathizers could gain access to a nuclear bomb as the greatest danger facing the United States in the war on terrorism, were reported in Curt Anderson, "Ashcroft: Nuke Threat the Largest Danger," *Associated Press Newswires*, 27 January 2005.

[14] For discussion of pending legislation, see Anthony Wier, "Legislative Update," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/overview/legislative.asp as of 2 February 2005). Also see "Modest Progress on Nuclear Security at Bush-Putin Meeting" (Washington, D.C.: Russian American Nuclear Security Advisory Council, 2005; available at http://www.ransac.org as of 7 March 2005).

[15] National Commission on Terrorist Attacks upon the United States, *The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States*, 1st ed. (New York: Norton, 2004; available at http://www.gpoaccess.gov/911/index.html as of 28 January 2005), pp. 380-381.

[16] Steve Coll, "What Bin Laden Sees in Hiroshima," *Washington Post*, 6 February 2005. Coll, the author of a book on al Qaeda and the Taliban, emphasizes al Qaeda's long-term determination to get nuclear weapons.

[17] The previous reports are: Bunn and Wier, *Securing the Bomb: An Agenda for Action*; Matthew Bunn, Anthony Wier, and John Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2003; available at http://www.nti.org/e_research/cnwm/overview/report.asp as of 1 February 2005); Matthew Bunn, John Holdren, and Anthony Wier, *Securing Nuclear Warheads and Materials: Seven Steps for Immediate Action* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2002; available at http://www.nti.org/e_research/securing_nuclear_weapons_and_materials_May2002.pdf as of 1 February 2005).

In 2002, the first report in this series recommended seven actions to accelerate and strengthen efforts to secure nuclear stockpiles around the world. In 2003, the second report described all the steps on the terrorist pathway to a nuclear bomb and the actions of the United States and other governments could contribute to blocking each step; it developed for the first time a comprehensive set of metrics for assessing how much progress had been made in securing nuclear stockpiles, interdicting nuclear smuggling, stabilizing employment for nuclear personnel, monitoring nuclear stockpiles, ending further production of nuclear weapons and weapons-usable nuclear materials, and reducing nuclear stockpiles; and it provided comprehensive recommendations for next steps in each of those six categories of effort. In 2004, the third report provided a more detailed assessment of the threat of nuclear terrorism, debunking a series of myths that have led many to downplay the danger; it updated the assessments of progress; and it provided a targeted set of recommendations focused on "security first," stressing locking down nuclear stockpiles as a first step toward the broader actions described the previous year.

Building on our previous work, this report provides updates on the threat and progress in addressing it, along with a detailed set of recommendations—again focused on a "security first" agenda—intended to build on the foundations for rapid progress laid in the last year. After this introduction, Chapter Two reviews key changes in the picture of the threat posed by nuclear terrorism. In Chapter Three, we examine the key developments in efforts to reduce that threat in the past year, and then assess in detail, using a set of quantifiable metrics, both the progress U.S.-funded programs have made to date in reducing the threat posed by inadequate security for nuclear weapons, materials, and expertise in the former Soviet Union and around the world, and the rate at which further progress is being made. The key lesson from the analysis in Chapter Three is that, while progress has remained slow in many areas, real successes have been achieved, demonstrating that effective action to address the threat is not only possible, but is underway every day—and opportunities exist for leadership from the highest levels to sweep aside the obstacles and further accelerate the effort.

But assessing the number of buildings with security equipment installed, or the tons of HEU destroyed, does not describe the whole picture of nuclear security. Many absolutely critical elements of nuclear security—whether the people at the site take security seriously and use the equipment effectively, whether the regulators have the mission, the power, and the resources to set and enforce effective nuclear security rules, and more—are not captured by these standard measures. For each category of efforts, therefore, we offer a description of the issues our metrics do not yet capture, and suggestions of additional measures which, if data became available, could help provide a clearer picture of the real state of progress. The progress assessment is followed by Chapter Four, which reviews the current and proposed U.S. budgets focused on controlling nuclear warheads and materials.

Finally, in Chapter Five we outline an updated action agenda, offering ways that the United States, Russia, and other key states can build toward a global effort whose scope and pace might match the urgency of the threat. Building genuine Russian commitment—a sense in Russia that cooperation on nuclear security is not just a favor to the Americans but an essential step for Russia's own security—will be crucial to success. If President Putin became seized of the issue and made it his mission to resolve it, he could assign the resources necessary for nuclear security, direct his agencies to set and enforce effective nuclear security rules and give them the power and resources to do so, establish assessment teams with the mission of finding nuclear security problems and recommending steps to fix them, and more.

This report and its predecessors have an on-line companion, "Controlling Nuclear Warheads and Materials" (available at http://www.nti.org/cnwm), which provides in-depth supporting information, including the most comprehensive assessments available anywhere of the individual programs focused on keeping nuclear weapons, materials, and expertise out of terrorist hands; an interactive threat reduction budget database; technical background; legislative updates; scores of photographs; and hundreds of annotated links to the best information on these efforts available on the web.

A shift from a donor-recipient relationship toward a true partnership will be essential in achieving both the top-level Russian commitment necessary to move nuclear security cooperation forward and the working-level Russian "buy-in" essential to ensuring that upgraded security systems will be sustained and improved over time. In a real partnership, Russia would have to contribute more of its own resources, and the United States would have to pursue a truly joint approach, with Russian and U.S. experts involved in all stages of the conception, design, implementation, and evaluation of these programs. Shifting from a focus only on improving nuclear security in Russia with U.S. help toward a focus on joint U.S. and Russian leadership in improving security around the world (starting with making sure their own houses are in order) can strengthen this sense of partnership. A leading Russian role can greatly strengthen the global effort, as there are key countries where Russia has the relationships necessary to work on nuclear security or negotiate the removal of nuclear material, and the United States does not.

Rapidly securing the world's nuclear stockpiles is a big job, but a doable one. The technology to do so already exists. These stockpiles exist in hundreds of buildings around the world, not millions. The key is mustering the political will to overcome the secrecy, mistrust, and bureaucratic obstacles that dangerously slow the needed cooperation. The task will require sustained and focused leadership. Finding ways to ensure that high levels of nuclear security are put in place in countries such as Pakistan, India, China, and Israel, where direct foreign access to key nuclear sites is unlikely to be possible in the near term, will demand considerable creativity and perseverance.

As with the previous reports in this series, we focus here narrowly on the threat of terrorism with nuclear explosives, and primarily on U.S.-sponsored efforts to counter that threat. The report does not address dispersal of radioactive materials in a so-called "dirty bomb," or attacks on nuclear energy facilities, or any of the many non-nuclear means by which terrorists might seek to do catastrophic harm. Nor does it discuss the many important and useful cooperative threat reduction efforts focused on goals beyond controlling nuclear weapons and weapons-usable materials—from dismantling missiles and bombers to destroying chemical weapons to improving enforcement of export controls.[18] We concentrate largely on programs that have been funded by the United States, which has been the preeminent, but not the only, sponsor of threat reduction programs to date. This report also does not address a wide range of international efforts aimed at controlling nuclear arms that are not focused on the threat of theft and smuggling of nuclear materials, from negotiated nuclear

[18] Effective export controls are crucially important to preventing transfers of technologies that states could use to produce nuclear weapons, and may have some modest benefit in restraining terrorists' ability to acquire some technologies that would be useful to their efforts to cobble together an improvised bomb. For an excellent discussion of al Qaeda's nuclear weapons potential that includes a mention of export controls as one element of an effort to keep nuclear weapons out of terrorist hands, see David Albright, "Al Qaeda's Nuclear Program: Through the Window of Seized Documents," *Special Forum* 47 (2002; available at http://www.nautilus.org/archives/fora/Special-Policy-Forum/47_Albright.html as of 11 April 2005). For recent treatments of the broader threat reduction agenda, see the following: James E. Goodby et al., *Cooperative Threat Reduction for a New Era* (Washington, D.C.: Center for Technology and National Security Policy, National Defense University, September 2004; available at http://www.ndu.edu/ctnsp/CTR%20for%20a%20New%20Era.pdf as of 21 March 2005); George Perkovich et al., *Universal Compliance: A Strategy for Nuclear Security* (Washington, D.C.: Carnegie Endowment for International Peace, March 2005; available at http://www.carnegieendowment.org/files/UC2.FINAL3.pdf as of 21 March 2005); *Reshaping U.S.-Russian Threat Reduction: New Approaches for the Second Decade* (Washington, D.C.: Russian American Nuclear Security Advisory Council and Carnegie Endowment for International Peace, 2002; available at http://www.ceip.org/files/pdf/Reshaping.Threat.Reduction.pdf as of 3 February 2005); Michael Barletta, ed., *After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation*, Occasional Paper No. 8 (Monterey, Cal.: Center for Nonproliferation Studies, Monterey Institute of International Studies, May 2002; available at http://cns.miis.edu/pubs/opapers/op8/op8.pdf as of 3 February 2005); Robert J. Einhorn and Michele A. Flournoy, eds., *Protecting against the Spread of Nuclear, Biological, and Chemical Weapons: An Action Agenda for the Global Partnership*, 4 vols. (Washington, D.C.: Center for Strategic and International Studies, January 2003; available at http://www.sgpproject.org/publications/publications_index.html as of 3 February 2005). While we point out in this report that much of the work needed to prevent nuclear weapons terrorism has not yet been done, a careful reading of the works just cited makes clear that the fraction of the job of controlling the chemical and biological complexes of the former Soviet Union (and the world) that is already accomplished is far less.

arms reductions and restraints, to IAEA safeguards, to international nuclear export control arrangements, to the Comprehensive Test Ban Treaty (CTBT).[19]

In the end, facing up to the threat of nuclear terrorism will be essential to the homeland security of the United States—and of nations throughout the world. Against the threat of terrorists with a demonstrated ability to find and strike weak spots on a global basis, an insecure cache of potential nuclear bomb material anywhere is a threat to everyone, everywhere. As Senator Richard Lugar, the Republican chairman of the Senate Foreign Relations Committee, has said, the war on terrorism will not be won until every nuclear stockpile, wherever it may be in the world, is secured and accounted for to stringent and transparent standards.[20] The tragedy the world witnessed in Beslan, like similar tragedies the world has seen in recent years, must therefore be more than another sad reminder of the existence of people and groups who will use any weapon they can lay their hands on to destroy lives. These tragedies must also be a call to action to do everything in our power to ensure that terrorists never lay their hands on the fearful destructive power of nuclear weapons.

[19] A strong IAEA safeguards system does make a contribution to preventing nuclear terrorism. It does so by ensuring that nuclear material is accounted for on an international basis; requiring that states meet reasonable standards in accounting for their own nuclear material; identifying sites where accounting may be a problem; putting in place a cadre of inspectors, who sometimes take note if there appear to be serious security problems at a particular site; and encouraging states to fix potentially embarrassing problems before inspectors arrive. Moreover, some of the measures included in the Additional Protocol to safeguards agreements, if widely adopted, might help identify sites where terrorist activity using nuclear materials was taking place. See the brief discussion in Albright, "Al Qaeda's Nuclear Program."

[20] Richard G. Lugar, "NATO after 9/11: Crisis or Opportunity?" (Washington, D.C.: Council on Foreign Relations, 2002; available at http://www.cfr.org/pub4379/richard_g_lugar/nato_after_911_crisis_or_opportunity.php as of 2 February 2005).

2 THE GLOBAL THREAT OF NUCLEAR TERRORISM

Evidence from the last year makes clear that the elimination of al Qaeda's Taliban-led Afghanistan sanctuary did not end the group's decade-long nuclear ambitions—or those of the global jihadist network al Qaeda has spawned. In Russia, security for the many thousands of nuclear weapons and hundreds of tons of potential bomb material left over from the Cold War—still dispersed in hundreds of buildings and bunkers throughout Russia—has improved significantly, but broken alarms often still do not get fixed, security forces often go without adequate body armor and communications equipment, and more. In addition, security culture remains a serious problem, with continuing reports of guards patrolling without ammunition in their guns, workers propping open security doors for convenience, and guards turning off intrusion detectors when they become annoyed by the false alarms.[1] Yet these security systems and the people who are central to their effectiveness must be prepared to defeat outsider threats on the scale of the Beslan attack, or insider threats that have included multiple insiders (including guards) working together to steal valuable items at many types of facilities, including, in some cases, military facilities and nuclear power facilities.

Elsewhere, some 130 civilian research reactors around the world still use HEU as their fuel, yet many have no more security than a night watchman and a chain-link fence. The nuclear stockpile in Pakistan is heavily guarded, but faces deadly threats from armed remnants of al Qaeda in the country and senior nuclear insiders who have marketed nuclear bomb technology around the globe. All told, potential nuclear bomb material exists in some 40 countries, with security that ranges from excellent to

Al Qaeda's Pursuit of Nuclear Weapons

In summarizing the global threat to U.S. interests in February 2005, the leaders of the U.S. intelligence community were unanimous in warning of the continuing desire for weapons of mass destruction on the part of al Qaeda and the global jihadist network, regardless of the disruption of al Qaeda's sanctuary in Afghanistan by the United States and its allies. CIA Director Porter Goss warned that "it may be only a matter of time before al Qaeda or another group attempts to use chemical, biological, radiological, or nuclear weapons." FBI Director Robert Mueller warned that the intelligence community is "extremely concerned with a growing body of sensitive reporting that continues to show al Qaeda's clear intention to obtain and to ultimately use some form of chemical, biological, radiological, or nuclear material in its attacks against the United States."[3]

Even without access to the classified reports referred to by Director Mueller, the quantity of publicly reported incidents linking al Qaeda with interest in nuclear weapons or materials in the last year has been disturbing:

- The commission appointed by President Bush to investigate U.S. intelligence capabilities and past conclusions regarding weapons of mass destruction revealed in March 2005 that in October 2001 the U.S. intelligence community assessed

[1] For discussion, see 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. 31-36.

[2] See Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 36-38; Matthew Bunn, "The Global Threat," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/threat/global.asp as of 3 March 2005).

[3] Mueller's testimony is in Select Committee on Intelligence, *Current and Projected National Security Threats to the United States*, U.S. Senate, 109th Congress (16 February 2005).

that al Qaeda was capable of fabricating at least a "crude" nuclear device if it could obtain the requisite nuclear material—separated plutonium or highly enriched uranium (HEU). The commission also reported that the CIA's Weapons Intelligence, Nonproliferation, and Arms Control Center and its Counterterrorist Center judged in November 2001 that al Qaeda "probably had access to nuclear expertise and facilities and that there was a real possibility of the group developing a crude nuclear device." The commission also emphasized that the documents seized from al Qaeda safe houses in Afghanistan after the overthrow of the Taliban "brought to light detailed and revealing information about the direction and progress of al-Qa'ida's radiological and nuclear ambitions," which had not been available when those earlier judgments were made.[4]

- According to press reports, al Qaeda operative Sharif al-Masri, captured in the Afghan-Pakistani border area in mid-2004, told interrogators that al Qaeda is looking to acquire nuclear materials in Europe and move them to Mexico and from there across the porous border into the United States.[5]

- Two militants arrested in Germany in January 2005—one of whom was an Iraqi who had trained in al Qaeda's Afghanistan camps and was associated with alleged 9/11 planner Ramzi Bin al-Shibh—had reportedly tried to purchase uranium, and had been recorded by authorities discussing specific locations to obtain uranium.[6]

- News reports also revealed that the U.S. Defense Department believes that a Pakistani businessman being detained in Guantanamo Bay, Cuba, met with Osama bin Laden and "recommended to an al Qaeda operative that nuclear weapons should be used against U.S. troops and suggested where these weapons might be obtained."[7]

- Just before and just after the November 2004 elections in the United States, Osama bin Laden and his deputy Ayman al Zawahiri each issued messages directed at the people of the West, giving them "one last piece of advice" that their security was "in their own hands," and warning that jihadists would attack if the United States and its allies did not change their policies.[8] Some analysts saw this as a final warning that in al Qaeda's eyes would justify a large attack on civilians. Al Qaeda had been criticized in some Islamic circles for not offering a warning before the 9/11 attacks that would have given the victims a chance to repent.[9]

Indeed, al Qaeda's search for the bomb stretches back more than a decade. Their first well-documented attempt to buy HEU for a nuclear bomb was in 1993.[10] In a 2004 letter to the House and Senate Intelligence Committees, former CIA analyst Michael Scheuer wrote that in mid- to late-1996, "CIA's Bin Laden unit

[4] Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President* (Washington, D.C.: WMD Commission, 2005; available at http://www.wmd.gov/report/ as of 5 April 2005), pp. 267, 271, 292.

[5] Adam Zagorin, "Bordering on Nukes?" *Time* (22 November 2004). A different report involving movement of nuclear or radiological materials from Mexico, involving claims that several individuals had entered the United States from Mexico with the intent of carrying out a dirty bomb attack, possibly in Boston, has since been discredited.

[6] Faye Bowers, "Eavesdropping on Terror Talk in Germany," *Christian Science Monitor*, 28 January 2005; Craig Whitlock, "Germany Arrests 2 Al Qaeda Suspects; Men Accused of Planning Attacks in Iraq," *Washington Post*, 24 January 2005.

[7] The businessman's name is Saifullah Paracha. He has been held since being captured on a June 2003 business trip to Thailand. The quote comes from a Department of Defense unclassified summary of evidence used during a tribunal to review his status, as reported in Frank Davies, "Authorities Say Pakistani Urged Al-Qaida to Get Nuclear Bomb," *Miami Herald*, 11 February 2005.

[8] "Bin-Ladin Addresses US People on 'Real Reason' for 11 Sep Attack: Transcript of Al-Jazeera Broadcast," *BBC Monitoring Newsfile*, 29 October 2004; "Al-Zawahiri Warns Other Arab 'Regimes' to Expect Iraq's Fate: Transcript of Al-Jazeera Broadcast," *BBC Monitoring Newsfile*, 29 November 2004.

[9] See, for instance, former CIA bin Laden team head Michael Scheuer's comments in Timothy J. Burger, "Bin Laden's New Message," *Time* (27 December 2004).

[10] For a discussion, see Matthew Bunn, "The Demand for Black Market Fissile Material," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2003; available at http://www.nti.org/e_research/cnwm/threat/demand.asp as of 22 February 2005).

acquired detailed information about the careful, professional manner in which al-Qaeda was seeking to acquire nuclear weapons … there could be no doubt after this date that al-Qaeda was in deadly earnest in seeking nuclear weapons."[11] In 2003, Osama bin Laden sought and received a religious ruling or *fatwa* from a radical Saudi cleric authorizing the use of a nuclear bomb against U.S. civilians as permissible under Islamic law. The ruling concluded that their use would be mandatory if it were the only way to stop U.S. actions against Muslims. "If a bomb that killed 10 million of them and burned as much of their land as they have burned Muslims' land were dropped on them, it would be permissible," the ruling concluded.[12]

At the same time, the limited evidence publicly available continues to suggest a broad gap between the capabilities that well-organized and capable terrorist groups *could* put together, and the capabilities they *have* demonstrated to date. While a few of the documents recovered in Afghanistan do include some disturbing sophistication on nuclear subjects, many are extremely naïve. The same is true of a number of other reported instances of al Qaeda pursuits of nuclear or radiological materials. The summaries that have been released of the interrogations of José Padilla, for example, indicate that he and his accomplice presented to top al Qaeda operative Abu Zubaydah the absurd idea that the two of them could make a nuclear bomb using instructions downloaded from the Internet.[13] Zubaydah, according to this account, expressed skepticism and suggested that a dirty bomb would be easier, but warned that this was not as easy as Padilla seemed to think either. Strikingly, "senior al Qaeda detainee #1" (apparently Zubaydah himself, since his statements describe Zubaydah's thinking) reports that Zubaydah, in discussing a dirty bomb, spoke of "explosives wrapped in uranium," again suggesting a rather low level of nuclear expertise, since uranium, which is not very radioactive, would be among the least deadly materials to use in a radiological dirty bomb. Nonetheless, Zubaydah gave Padilla and his accomplice money to travel to meet Khalid Sheikh Mohammed, another very senior al Qaeda operative, in order for Mohammed to evaluate the plan. Mohammed also thought the plan was impractical, and suggested that they focus on simpler attacks (such as bombing apartment buildings by turning on the gas in an apartment and detonating it with a bomb on a timer). Thus, both Zubaydah and Mohammed were immediately skeptical of the feasibility of nuclear and radiological attacks. It may be, however, that Zubaydah and Mohammed's skepticism was based on a low (and possibly accurate) assessment of the personal technological capabilities of Padilla and his accomplice, rather than on a view that nuclear and radiological attacks were impractical in general.

Similarly, in the case of the two al Qaeda operatives arrested in Germany in 2004 and charged with seeking uranium, the sparse information that is publicly available suggests they wanted the uranium for dispersal in a dirty bomb, rather than for use in a nuclear weapon—and the choice of uranium for that purpose again suggests a very rudimentary level of nuclear knowledge.[14] In short, more than a decade after al Qaeda's pursuit of the bomb began, there is as yet no

[11] See Anonymous [Michael Scheuer], "How Not to Catch a Terrorist," *Atlantic Monthly* (2004). Also see, Michael Scheuer, quoted in Eric Rosenberg, "Bin Laden after Nukes from Russia, CIA Expert Says," *Omaha World-Herald*, 21 November 2004. Scheuer further discusses bin Laden's nuclear ambitions in Steve Kroft, "Anonymous Revealed: Michael Scheuer, Former CIA Osama Bin Laden Unit Leader, Discusses Early Intelligence and Opportunities to Kill Osama Bin Laden" in *60 Minutes* (CBS News, 2004).

[12] The translated quote is from testimony by then-Attorney General John Ashcroft, in Committee on the Judiciary, *United States Department of Justice: Hearing before the Committee on the Judiciary*, United States House of Representatives, 108th Congress, 1st Session (5 June 2003; available at http://judiciary.house.gov/media/pdfs/printers/108th/87536.PDF as of 23 February 2005). The author of the fatwa is Nasser bin Hamed al-Fahd. He has since been arrested, and has publicly renounced some of his previous rulings, though whether this one is among them is not clear.

[13] The following discussion is drawn from the extensive summary of the interrogations of Padilla and others that was released by the U.S. Department of Defense. See U.S. Department of Defense, *Summary of José Padilla's Activities with Al Qaeda* (Washington, D.C.: DOD, 2004; available at http://news.findlaw.com/nytimes/docs/padilla/pad52804dodsum5.html as of 26 March 2005).

[14] Bowers, "Eavesdropping on Terror Talk in Germany"; Whitlock, "Germany Arrests 2 Al Qaeda Suspects; Men Accused of Planning Attacks in Iraq."

strong, publicly available evidence that the group or its followers have put together the capabilities that would be necessary to make a nuclear bomb. But unfortunately, we simply cannot know what capabilities al Qaeda and its followers may have managed to keep hidden—or may acquire in the future.

The Continuing Threat to Nuclear Stockpiles in the Former Soviet Union

Evidence in the last year also continued to suggest that nuclear stockpiles around the world remained vulnerable to theft or provision to terrorists, creating a danger that terrorists might be able to acquire the nuclear material without which they cannot make a bomb.

Russia and the states of the former Soviet Union deserve considerable credit for preventing the massive nuclear leakage that many feared in the years immediately following the Soviet Union's collapse—taking action in many cases under very difficult circumstances. Nevertheless, while security for nuclear stockpiles in the former Soviet Union continues to improve, security in many cases still falls far short of what is needed to be able to defeat the outsider and insider threats terrorists and criminals have shown they can pose—despite claims by some senior U.S. and Russian officials that the danger is past.[15] As a CIA report summed it up in November 2004: "Russia's nuclear security has been slowly improving over the last several years, but risks remain."[16] Even Alexander Rumiantsev, head of Russia's Federal Agency for Atomic Energy (Rosatom, formerly Minatom), warned after the September 2004 terrorist attacks in Russia that "today, we have to admit that we cannot fully rule out the possibility that fissile materials, including highly-enriched uranium and plutonium, as well as technologies suitable for manufacturing nuclear weapons, may fall into the hands of international terrorists."[17] In a December 2003 directive, Russian President Putin acknowledged that the threat to Russia's nuclear facilities from domestic and international terrorists is increasing, and that past funding for nuclear safety and security had been inadequate.[18]

Terrorists and criminal groups have already probed at least some of the vulnerabilities in Russia's nuclear security. Senior Russian officials and the Russian state newspaper have confirmed four incidents in 2001-2002 of terrorist teams carrying out reconnaissance on Russian nuclear warheads—two on nuclear warhead storage facilities, and two on nuclear weapon transport trains.[19] The locations of these facilities and the routes

[15] For an overview of nuclear security and accounting in Russia as it stands today, as opposed to a decade ago, see, for example, Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 31-36. Remarkably, then-Undersecretary of State John Bolton argued in 2004, incorrectly, that there has been no "significant risk of a Russian nuclear weapon getting into terrorist hands" for "some number of years." See Barton Gellman and Dafna Linzer, "Unprecedented Peril Forces Tough Calls; President Faces a Multi-Front Battle against Threats Known, Unknown," *Washington Post*, 26 October 2004. There is also the oft-repeated but false claim by Russian Minister of Defense Sergei Ivanov that there has never been a theft of "even a single gram of weapons-grade uranium or plutonium" in Russia, quoted, for example, in "Nuclear Weapons in Russia Are Well Protected - Ivanov," *RIA Novosti*, 14 January 2005. For a longer discussion of several commonly held but demonstrably false beliefs about nuclear terrorism, see "Debunking Seven Myths of Nuclear Terrorism and Nuclear Theft," in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 10-30.

[16] U.S. National Intelligence Council, *Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces* (Washington, D.C.: Central Intelligence Agency, 2004; available at http://www.cia.gov/nic/special_russiannuke04.html as of 5 March 2005).

[17] "Top Russian Official Does Not Rule Out International Terrorists May Obtain Nuclear Materials," *Interfax News Service*, 18 September 2004.

[18] *Ocnovi Gosudarstvennoy Politiki V Oblast'i Obespecheniya Yadernoy I Padiatsionnoy Bezopasnost'i Rossiyskoy Federatsii Na Period Do 2010 Goda I Dal'neyshuyu Perspectivu (Principles of State Policy on Nuclear Safety and Security and Radiation Protection in the Russian Federation for the Period through 2010 and Beyond)*, Presidential Decree 2196 (Moscow: Kremlin, 2003; available at http://www.scrf.gov.ru/Documents/Decree/2003/2196.html as of 23 February 2005).

[19] Original reporting of the incidents of reconnaissance on warhead transport trains is in Vladimir Bogdanov, "Propusk K Beogolovkam Nashli U Terrorista (A Pass to Warheads Found on a Terrorist)," *Rossiskaya Gazeta*, 1 November 2002. General Igor Valynkin, the commander of the force that guards Russia's nuclear weapons, confirmed the cases involving storage sites in October 2001. See "Russia: Terror Groups Scoped Nuke Site," *Associated Press*, 25 October 2001. These incidents are also referred to in U.S. National Intelligence Council, *Safety and Security of Russian Nuclear Facilities and Military Forces*.

of these trains are state secrets in Russia—secrets the terrorists nevertheless apparently managed to penetrate. Also in 2003, proceedings in a Russian criminal case revealed that a Russian businessman had been offering $750,000 for stolen weapon-grade plutonium for sale to a foreign client, and had made contact with residents of the closed nuclear city of Sarov, home of one of Russia's premier nuclear weapons laboratories, to try to close a deal.[20]

In early 2005, the Russian government approved a plan to respond to Putin's nuclear safety and security directive, but much of the plan was focused on preparations for action, such as drafting improved legislation, rather than on-the-ground upgrades of nuclear security. President Putin reportedly dispatched additional troops to guard critical nuclear facilities after the Beslan attacks—but there is little indication that more fundamental issues with nuclear security have yet been resolved. Today, Russian government funding for nuclear security remains far short of what is needed. Russian regulations still do not define the threat that nuclear facilities' security systems must be able to defeat. No systematic process for finding and fixing the worst security vulnerabilities appears to be in place. The Russian government has made virtually no effort to consolidate HEU and separated plutonium in fewer locations. And there continue to be serious problems of security culture, from guards patrolling with no ammunition in their guns to personnel propping open security doors for convenience.[21]

For example, in March 2005, the commander of Interior Ministry troops for the Moscow district said that only 7 of the critical guarded facilities in the district had adequately maintained security equipment, while 39 had "serious shortcomings." He also reported that over half the length of the perimeters of restricted access zones in the district were not protected by fences or other obstacles to stop intruders, while 30 kilometers of the fencing and obstacles that were in place were in need of repair. He said that his troops had stopped 98 trespassers who tried to penetrate the perimeters of restricted access facilities in 2004.[22] Similarly, the acting chief of Russia's Federal Environmental, Technological and Nuclear Inspection Service told a March 2005 press conference that in 2004 there had been 31 reported incidents of trespassing at nuclear research institutes, 22 at HEU-fueled icebreakers, and 29 at nuclear fuel projects. Though he offered assurances that all these incidents were minor trespasses that did not threaten the security of the facility, in each of these cases the reported number of incidents was slightly higher than the previous year.[23]

Few nuclear facilities in Russia (or elsewhere, for that matter) could defend against an attack on the scale of Beslan—32 heavily armed, suicidal terrorists, launching a carefully planned attack with no warning. Nor is that size of attack the upper limit: the Beslan attackers had acquired some of their weapons stockpile in a June 2004 raid on Russian Interior Ministry buildings and arms depots in the neighboring province of Ingushetia that involved at least 200 attackers and

[20] "Russian Court Sentences Men for Weapons-Grade Plutonium Scam," trans. BBC Monitoring Service, *RIA Novosti*, 14 October 2003; "Russia: Criminals Indicted for Selling Mercury as Weapons-Grade Plutonium (Russian)," trans. U.S. Department of Commerce, *Izvestiya*, 11 October 2003.

[21] For an excellent discussion of the security culture issue, see Igor Khripunov and James Holmes, eds., *Nuclear Security Culture: The Case of Russia* (Athens, Georgia: Center for International Trade and Security, The University of Georgia, 2004; available at http://www.uga.edu/cits/documents/pdf/Security%20Culture%20Report%2020041118.pdf as of 18 February 2005). For a picture of a security gate left open, along with information about the reasons, see U.S. Government Accountability Office, *Nuclear Nonproliferation: Security of Russia's Nuclear Material Improving; Further Enhancements Needed*, GAO-01-312 (Washington, D.C.: GAO, 2001; available at http://www.gao.gov/new.items/d01312.pdf as of 28 February 2005). On the guards with no ammunition, see Igor Goloskokov, "Refomirovanie Voisk MVD Po Okhrane Yadernikh Obektov Rossii (Reform of Ministry of Internal Affairs Detachments Guarding Russian Nuclear Facilities)," trans. Dmitry Kovchegin, *Yaderny Kontrol* 9, no. 4 (Winter 2003; available at http://www.pircenter.org/data/publications/yk4-2003.pdf as of 28 February 2005).

[22] "Over 4,000 Trespassers Detained at Moscow District Restricted Access Facilities," *Interfax-Agentstvo Voyennykh Novostey*, 18 March 2005.

[23] Tatiana Sinitsyna, "Russia: Fewer Trespasses Reported from Nuke Plants as Danger Persists in Coal Mines," *RIA Novosti*, 30 March 2005.

left some 80 people dead. In that raid, the attackers dressed in uniforms of the Russian Federal Security Service, Army intelligence, and other special police squads, and overwhelmed local forces, who did not receive reinforcements from federal security service troops for several hours.[24] (This is particularly distressing since the usual approach to security at nuclear facilities—including nuclear weapon storage sites—is to have a relatively modest defensive force on-site, and to rely on reinforcements arriving in a timely way.)

Such problems extend beyond Russia's southern borderlands. Attackers have shown again and again that they can mass forces seemingly anywhere in Russia without warning, and that they can bribe or otherwise collude with insiders. For example, in the week before the Beslan attack, suicide bombers paid bribes and eluded lax airport security to get on two flights out of Moscow, killing all 90 passengers aboard.[25] Also, in October 2004, a month after the Beslan attack, a force of 47 men identified as Dagestanis, armed with clubs and crowbars, seized complete control of a secret non-nuclear military research and development facility in the town of Zelenograd, just north of Moscow, with all of its secret documents and arms prototypes. When confronted by the facility staff, the attackers claimed to work for a firm that had bought the company's stock, and identified one member of their group as the new deputy director of the facility. Local Interior Ministry forces had to retake the facility from the men in an action reportedly involving hand-to-hand struggle and police firing automatic weapons into the air.[26]

The threat of insider theft at nuclear facilities and elsewhere in the former Soviet Union is also severe. In October 2004, sources in the local and regional Ministry of Internal Affairs reported that thieves had stolen three valves, valued at 700,000 rubles (over $20,000), from the Leningrad Nuclear Power Plant. The plant, like all Russian nuclear power plants, is protected by armed guards, leading police to assume that the theft was probably an inside job. Nor was this likely the first time such a theft has occurred: the head of the local branch of the Ministry of Internal Affairs told a reporter, "I don't know why this crime has attracted so much attention...such thefts happen here often."[27] Earlier in 2004, at the Rivne nuclear power plant in Ukraine, police broke up a ring that included four authorized workers and a guard they bribed with $77 in Ukrainian currency; the group had successfully stolen a large steam evaporator worth an estimated $154,000 from inside the guarded plant.[28] It is extraordinarily difficult to design a nuclear security system that will be effective in preventing theft by conspiracies of five insiders, including a guard, working together—and the 2004 CIA report repeatedly highlighted the insider danger.[29]

Indeed, in his February 2005 testimony, CIA Director Goss warned that in Russia "there is sufficient material unaccounted for so that it would be possible for those with know-how to construct a nuclear weapon," and pointed out that because some material was unaccounted for, he could not assure the American public

[24] Mark Deich, "The Ingushetia Knot," *Moskovskii Komsomolets*, 6 August 2004; Boris Yamshanov, "Bribes Reeking of Explosives," *Rossiiskaya Gazeta*, 16 September 2004.

[25] Peter Baker and Susan B. Glasser, "Russian Plane Bombers Exploited Corrupt System," *Washington Post*, 18 September 2004.

[26] Sergey Ptchikin, "Needles of Patriots: Attempts Made to Privatize Unique System for Protection against Terrorists," *Rossiskaya Gazeta*, 21 December 2004.

[27] Andrey Pankov, "S Atomnoy Elektrostantsii Vynesli Tri Dorogostoyashchikh Klapana (Three High-Priced Valves Carried Off from Nuclear Power Plant)," *Novyye Izvestiya*, October 2004. This article is translated and summarized in "Three Pinch Valves Were Stolen from the Leningrad Nuclear Power Plant, Abstract 20040380," in *NTI Research Library: NIS Trafficking Database* (Monterey, Cal.: Monterey Institute for International Studies, Center for Nonproliferation Studies, 2004; available at http://www.nti.org/db/nistraff/2004/20040380.htm as of 28 February 2005).

[28] See, for example, "Rovenskuyu AES Obvorovali (Rivne NPP Was Robbed)," *Infa News Agency*, 5 April 2004; "Praporshchik Pomog Ukrast Agregat S Rovenskoy AES Za Vzyatku V 400 Griven (Warrant Officer Assisted in Stealing a Device from the Rivne NPP for a Bribe of 400 Hryvnyas)," *Interfax*, 5 April 2004. These and other sources are summarized in Center for Nonproliferation Studies, Monterey Institute for International Studies, "Thieves of Nuclear Plant Equipment Arrested in Ukraine," *NIS Export Control Observer* (May 2004; available at http://cns.miis.edu/pubs/nisexcon/pdfs/ob_0405e.pdf as of 5 March 2005).

[29] U.S. National Intelligence Council, *Safety and Security of Russian Nuclear Facilities and Military Forces*.

that enough nuclear material for a bomb was not already in terrorist hands.[30] Russia is still transitioning from a Soviet-era nuclear material accounting system that was designed not to detect nuclear theft but to monitor facilities' performance in meeting their production targets. In essence, each facility measured its input and its output, and as long as the differences were small, they were written off as normal losses to waste—making it possible for careful thieves to steal nuclear material undetected day after day, as long as the individual thefts were small. Over the decades of the Cold War, the few-percent uncertainties tolerated in this accounting system amount to many hundreds of bombs' worth of material that cannot be reliably accounted for. (To be fair, the U.S. nuclear material accounting system was also not good enough during much of the Cold War to rule out the possibility that nuclear material had been stolen: when the United States published its plutonium inventory in the mid-1990s, some two tons of plutonium was "material unaccounted for." Probably this represents material plated out on pipes, plutonium lost to waste, and overestimates of how much was produced in the first place, but no one can demonstrate conclusively that none of it was stolen.)

Today, at a number of sites in Russia where large quantities of nuclear material are processed every year, accounting has been much improved. But at many sites, there are still vast numbers of containers of nuclear material built up over decades, and no one has yet had the time and resources to measure each one to make sure that it still contains the nuclear material that the paper records say it should.

Continuing Nuclear Security Concerns around the World

The danger of nuclear theft is not just a Russia problem, it is a global problem. Evidence of global vulnerabilities in nuclear security and accounting systems has continued to accumulate over the past year. In November 2004, for example, the U.S. Government Accountability Office reported the results of a Department of Energy study that concluded that there are 128 nuclear research reactors or associated facilities around the world with 20 kilograms of HEU or more—a larger number of facilities with enough material for a bomb than had previously been publicly recognized.[31] As noted in last year's report, these facilities exist in dozens of countries around the world, and many have no more security than a night watchman and a chain-link fence.[32]

In Pakistan, investigations of the assassination attempts against President Musharraf in late 2003 suggest that military officers in league with jihadi terrorists were behind them, raising disturbing possibilities for the officers charged with guarding nuclear stockpiles.[33] Investigations of the global black-market nuclear network led by Pakistan's Abdul Qadeer Khan over the past year continued to reveal the extent to which the network had provided one-stop shopping for potential nuclear proliferators. There remains a disturbing possibility that the design for a relatively simple but workable nuclear bomb that the network provided to Libya may also have been provided to terrorists—or might still be in the future.[34] The possibility that terrorists might gain access to

[30] See Goss's testimony in *Current and Projected National Security Threats to the United States*.

[31] U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia*, GAO-05-57 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d0557.pdf as of 2 February 2005).

[32] Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 36-37.

[33] "Escaped Musharraf Plotter Was Pakistan Air Force Man," *Agence France Presse*, 12 January 2005; "Musharraf Al-Qaeda Revelation Underlines Vulnerability: Analysts," *Agence France Presse*, 31 May 2004.

[34] Good summaries of the Khan network can be found in David Albright and Corey Hinderstein, "Unraveling the A.Q. Khan and Future Proliferation Networks," *Washington Quarterly* 28, no. 2 (Spring 2005); Gellman and Linzer, "Unprecedented Peril Forces Tough Calls; President Faces a Multi-Front Battle against Threats Known, Unknown"; Bill Powell et al., "The Man Who Sold the Bomb," *Time* (21 February 2005); Douglas Frantz, "A High-Risk Nuclear Stakeout: The U.S. Took Too Long to Act, Some Experts Say, Letting a Pakistani Scientist Sell Illicit Technology Well after It Knew of His Operation," *Los Angeles Times*, 27 February 2005; William C. Rempel and Douglas Frantz, "Global Nuclear Inquiry Stalls: Authorities Fear That the Extent of a Pakistani Scientist's Proliferation Ring Remains Unknown and That It Will Resume Work If Pressures Ease," *Los Angeles Times*, 5 December 2004.

a nuclear bomb design only heightens the importance of making sure they do not get their hands on the ingredients for that recipe. At the same time, the two senior Pakistani nuclear scientists who acknowledged meeting with bin Laden and Zawahiri and discussing nuclear weapons were never tried or imprisoned (though it appears that they remain under a loose form of house arrest).[35]

As additional states gain access to nuclear weapons or the materials needed to make them, the security of nuclear weapons, material, and expertise will be of increasing concern, and the possibilities for a conscious state decision to give or sell a nuclear bomb or nuclear materials may increase. The past year saw virtually no progress in stopping or rolling back North Korea's nuclear weapons program. After the United States tabled a proposal for verified North Korean disarmament at the six-party talks in June 2004, North Korea declined to return to the table. Later, in February 2005, North Korea publicly announced that it had nuclear weapons and was withdrawing indefinitely from the six-party talks, citing the United States' "hostile policy."[36] North Korea is now thought to have enough plutonium for six to eight nuclear bombs, has restarted its plutonium production reactor to make more, and is believed to be seeking the ability to produce HEU as well. Given Pyongyang's record of selling essentially every type of weapon it had available to anyone who would buy, and its desperation for hard-currency exports, this raises the troubling question of whether, once North Korea has what it considers a sufficient nuclear deterrent for itself, it might be willing to sell nuclear weapons or nuclear materials.[37] However large or small that danger is, there is little doubt that it grew in the past year.

In Iran, by contrast, the known and declared facilities involved in the uranium enrichment program that has provoked international concerns remained frozen for much of the past year, while inspectors worked to unravel Iran's nuclear past and Iran continued negotiations with Europe over trade, political, and security benefits in return for constraining its nuclear program. In early 2005, the United States agreed not to stand in the way of the limited economic incentives the European negotiators proposed to offer Iran (in return for European agreement that if Iran did not agree to a permanent end to its enrichment program it would be referred to the Security Council for possible sanctions). The Bush administration, however, has so far declined to engage Iran directly or to address Iranian concerns over security and other issues.[38] To date, Iran has rejected the permanent end to its uranium enrichment program that European negotiators are seeking, insisting that the current pause will only be temporary: "But as I have said before," Hassan Rohani, secretary of Iran's security council, told *Reuters* in February 2005, "the period of suspension is definitely limited to some months, not a year."[39]

Summary of the Threat

In short, a stream of indicators in the past year has added to the already substantial body of evidence that terrorists are pursuing a nuclear bomb, and that nuclear weapons and materials stockpiles around the world remains dangerously vulnerable to theft.

[35] Information on the two scientists, Sultan Bashiruddin Mahmood and Chaudhary Abdul Majid is available in: David Albright and Holly Higgins, "A Bomb for the Ummah," *Bulletin of the Atomic Scientists* 59, no. 2 (March/April 2003); Peter Baker, "Pakistani Scientist Who Met Bin Laden Failed Polygraphs, Renewing Suspicions," *Washington Post*, 3 March 2002; Peter Baker and Kamran Khan, "Pakistan to Forgo Charges Against 2 Nuclear Scientists; Ties to Bin Laden Suspected," *Washington Post*, 30 January 2002; Kathy Gannon, "Bin Laden and the Pakistani Scientist: Al-Qaida Leader Said to Have Sought A-Bomb Help," *Associated Press Newswires*, 29 December 2002. The two remain on the U.S. government's terrorism watch list, as does Mahmood's charitable organization. See U.S. Treasury, Office of Foreign Assets Control, *Terrorism: What You Need to Know About U.S. Sanctions* (Washington, D.C.: U.S. Treasury, 2005; available at http://www.treas.gov/offices/enforcement/ofac/sanctions/t11ter.pdf as of 28 February 2005).

[36] DPRK Ministry of Foreign Affairs, "DPRK Statement," *Korean Central News Agency*, 10 February 2005.

[37] See "Keeping North Korean Bomb Material Out of Terrorist Hands," in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 32-33.

[38] Sonni Efron, "Bush Softens Stance on Iran," *Los Angeles Times*, 12 March 2005.

[39] "Iran Vows Enrichment Freeze Will Be Short-Lived," *Agence France Press*, 31 January 2005.

The danger of a nuclear terrorist catastrophe remains frighteningly high. As President Bush has said, "the nations of the world must do all we can to secure and eliminate" nuclear stockpiles around the globe.[40]

[40] President George W. Bush, "President Announces New Measures to Counter the Threat of WMD: Remarks by the President on Weapons of Mass Destruction Proliferation, Fort Lesley J. Mcnair - National Defense University" (Washington, D.C.: The White House, Office of the Press Secretary, 2004; available at http://www.whitehouse.gov/news/releases/2004/02/20040211-4.html as of 12 April 2005).

3 KEY DEVELOPMENTS AND PROGRESS IN THE PAST YEAR

The United States, other countries, and the International Atomic Energy Agency (IAEA) have a wide range of efforts under way to secure, monitor, and reduce stockpiles of nuclear weapons and materials in the former Soviet Union and around the world. In this chapter we examine the key developments in efforts to reduce that threat in the past year, and then assess in detail the progress U.S.-funded programs are making in reducing the threat posed by inadequate security for nuclear weapons, materials, and expertise in the former Soviet Union and around the world.

The efforts by the United States and its global partners to reduce the threat of nuclear terrorism have had real, demonstrable successes, representing an excellent investment in American and world security. Enough nuclear material for thousands of nuclear weapons has been permanently destroyed. (Indeed, half of the nuclear-generated electricity in the United States comes from blended-down highly enriched uranium (HEU) from dismantled Russian nuclear weapons.) Security for scores of vulnerable nuclear sites has been demonstrably improved. At least temporary civilian employment has been provided for thousands of nuclear weapons scientists and workers who might otherwise have been driven by desperation to seek to sell their knowledge or the materials to which they had access.

Yet in virtually every aspect of these efforts, much more remains to be done. Progress in many areas of the response continued to be slow in 2004 by comparison to the urgency of the threat. Despite the dedicated efforts of hundreds of U.S., Russian, and international officials and experts, action was slowed by difficult bureaucratic and political obstacles, ranging from disagreements over access to sensitive sites, arcane disputes over provisions for liability in the event of an accident during threat-reduction cooperation, burdensome contracting approaches, and more. As we discuss in detail below, by the end of fiscal year (FY) 2004, U.S.-funded security upgrades had been completed for roughly 56% of the buildings containing weapons-usable nuclear material in the former Soviet Union—but more than half of the potential bomb material is in other buildings where even the first round of "rapid upgrades" has not been completed.[1] Less than a fifth of Russia's stockpile of bomb uranium has been destroyed, and it will still be years before destruction of substantial quantities of U.S. and Russian excess bomb plutonium even begins. Only a tiny fraction of Russia's excess nuclear weapons experts have yet received self-supporting civilian jobs (as opposed to short-term subsidized grants). Beyond the former Soviet Union, cooperative security upgrades are only just beginning, leaving many sites dangerously vulnerable. In President Bush's words: "We've got work to do."[2]

Review of Overarching Developments in the Past Year

The past year has seen a number of important developments that cut across the many elements of the U.S. and global response to the threat of nuclear terrorism. While on-the-ground progress in the last year remained a battle for inches, the last year was one of intense effort to lay the groundwork for faster progress in the future.

UN Security Council Resolution 1540. In April 2004, the United Nations Security Council unanimously passed Resolution (UNSCR) 1540, affirming that the proliferation of weapons of mass destruction (WMD) and their delivery systems is a threat to international

[1] The U.S. federal fiscal year runs from 1 October to 30 September of the year named, so FY 2004 is the fiscal year that ended on 30 September 2004.

[2] President George W. Bush, "President Holds Press Conference" (Washington, D.C.: The White House, Office of the Press Secretary, 20 December 2004; available at http://www.whitehouse.gov/news/releases/2004/12/20041220-3.html as of 3 February 2005).

peace and security and directing all states to take steps to prevent terrorists from getting WMD. The resolution requires all states to pass laws criminalizing proliferation by non-state actors, and to establish "appropriate, effective" physical protection, accounting, export control, and illicit trafficking prevention practices for WMD and related materials. It also requires countries to submit reports within six months on the actions they have taken to meet the directives of the resolution; as of early February 2005, over 100 countries and the European Union had submitted their reports.[3]

UNSCR 1540 has the potential to provide the foundation for binding global standards of nuclear security, and for a global effort to both assess where improvements are needed and help states to make them, but only modest progress has been made in implementing the resolution's requirements. As of early 2005, neither the U.S. government nor international organizations such as the IAEA had detailed what they believed the essential elements of a nuclear security system that would meet the "appropriate effective" standard would be, and few steps had been taken to help countries put in place improved systems to meet their new obligations.[4]

Global Threat Reduction Initiative. Passage of UNSCR 1540 was followed in May 2004 by the announcement by then-Secretary of Energy Spencer Abraham of a Global Threat Reduction Initiative (GTRI) to consolidate and accelerate several Department of Energy (DOE) programs to remove nuclear material from vulnerable sites worldwide, and to secure materials in sites where they remain.[5] Secretary Abraham set targets for GTRI of returning all fresh Soviet-supplied HEU fuel to Russia by the end of 2005, returning all irradiated Soviet-supplied HEU to Russia by the end of 2010, and converting all HEU-fueled research reactors within the United States by 2013. A GTRI Partners Conference was held in September 2004, to build international support for the effort.[6] In the fall of 2004, Congress provided an extra $30 million for removing nuclear material from vulnerable sites around the world, and new legal authority to offer flexible incentives to convince each site to give up their nuclear material.[7]

The launch of GTRI, with the substantial congressional and international support it received, can and should make a major difference in accelerating efforts to remove potential nuclear bomb material from vulnerable sites around the world.

G8 Summit. In June 2004, at their summit at Sea Island, Georgia, the leaders of the Group of Eight (G8) leading industrialized democracies offered an action plan to "prevent, contain, and roll back" WMD proliferation. The action plan called for prompt and complete implementation of UNSCR 1540, with the

[3] For more information and for copies of the country reports, see United Nations, "1540 Committee" (New York: UN, 2005; available at http://disarmament2.un.org/Committee1540/meeting.html as of 25 February 2005).

[4] Interviews with U.S. State Department and International Atomic Energy Agency officials, January 2005; interviews with U.S. State Department and DOE officials, as well as staff of the UNSC 1540 Committee, March 2005.

[5] Spencer Abraham, "International Atomic Energy Agency, Vienna: Remarks Prepared for Energy Secretary Spencer Abraham" (Washington, D.C.: U.S. Department of Energy, 26 May 2004; available at http://www.energy.gov as of 18 March 2005); "Department of Energy Launches New Global Threat Reduction Initiative: Will Accelerate and Expand the Security and Removal of Proliferation-Sensitive Materials" (Washington, D.C.: U.S. Department of Energy, 26 May 2004; available at http://www.energy.gov as of 2 February 2005).

[6] International Atomic Energy Agency, *Global Threat Reduction Initiative: International Partners' Conference: Summary of the Proceedings and Findings of the Conference* (IAEA, 2004; available at http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2004/cn139proc.pdf as of 25 February 2005).

[7] For updates on congressional action regarding controlling nuclear weapons and materials, see Anthony Wier, "Legislative Update," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/overview/legislative.asp as of 2 February 2005). The funding is found in Division C of *Omnibus Appropriations Bill for Fiscal Year 2005*, Public Law 108-447, 108th Congress, 2nd Session (8 December 2004; available at http://thomas.loc.gov/cgi-bin/bdquery/z?d108:h.r.04818: as of 2 February 2005). The authorization is in Section 3132 of *National Defense Authorization Act for Fiscal Year 2005*, Public Law 108-375, 108th Congress, 2nd Session (28 October 2004; available at http://thomas.loc.gov/cgi-bin/bdquery/z?d108:h.r.4200: as of 2 February 2005).

G8 members pledging that they are prepared to assist countries in meeting the requirements of Resolution 1540—a commitment that could lead to cooperative nuclear security improvements in countries around the world. The G8 members recommitted themselves to meeting the $20 billion funding target set at the 2002 Kananaskis summit, and announced that seven more countries had pledged to adhere to the Global Partnership principles and would contribute funding to projects.[8] While the Global Partnership action plan included some financial contributions focused on implementing nuclear security upgrades, the summit did not agree on expanding the effort to securing nuclear stockpiles worldwide, keeping the partnership focused on Russia and a couple of other former Soviet states.[9]

Russian Action Plan for Nuclear Safety and Security. In February 2005, Russia adopted a nuclear safety and security action plan. The plan details a set of specific legislative and regulatory actions governing nuclear energy, materials, and weapons, and delineates the responsible government bodies and deadlines for each task. The multiple tasks include, among other things, establishing the standard threats and intruder profiles to be used in vulnerability analyses (apparently what would be called a "design basis threat" in the United States), developing proposals to address issues of conducting inventories at nuclear facilities, and assigning air defense forces to protect certain nuclear sites.[10]

Even coming in the aftermath of Beslan, however, the plan does not include many of the actions that the United States took after the 9/11 attacks—such as substantially increased nuclear security budgets, rapid vulnerability assessments at nuclear facilities to find and fix security problems, efforts to consolidate nuclear material at fewer locations, consideration of destroying larger quantities of nuclear material that are no longer needed, or providing more authority and resources to those who set and enforce nuclear security rules.

Bush-Putin Summit. Declaring that nuclear terrorism was "one of the gravest threats our two countries face" and that the United States and Russia had a "special responsibility for the security of nuclear weapons and fissile material," Presidents Bush and Putin issued a statement from their February 2005 summit in Bratislava, Slovakia that called for expanded and accelerated cooperation on nuclear security in their two countries and around the globe. They agreed that nuclear security in both their countries already met "current requirements," but had to be "constantly enhanced" to meet changing threats; as a result, they pledged to develop a joint plan of work for security enhancements through 2008, after which the two sides would assess "avenues for further cooperation" in light of the "constantly evolving" threat. They agreed to have U.S. and Russian experts share nuclear facility security "best practices" not only with one another but also with other countries, and announced that their countries would convene a senior-level bilateral meeting on improving the security culture at nuclear facilities. The two presidents called for full implementation of UNSCR 1540, and rapid adoption of the proposed international convention on nuclear terrorism and the proposed amendments to the physical protection convention (discussed below). They also pledged to help convert research reactors using HEU in "third countries" to use low-enriched fuel, and to take back HEU the United States and Russia had supplied. The two presidents also announced

[8] "G8 Action Plan on Nonproliferation" (Sea Island, Georgia, United States: G8 Summit, 9 June 2004; available at http://www.g8usa.gov/d_060904d.htm as of 25 February 2005); G8 Senior Group, "G8 Global Partnership Annual Report" (Sea Island, Georgia, United States: G8 Summit, June 2004; available at http://www.g8usa.gov/d_060904i.htm as of 25 February 2005).

[9] "G8 Action Plan on Nonproliferation."

[10] *Plan Meropriyatii, Cvyazannykh S Vypolneniem Pervogo Etapa Realizatsii 'Osnov Gosudarstvennoi Politiki V Oblast'i Obespecheniya Yadernoi I Radiatsionnoi Bezopasnost'i Rossiskoi Federatsii Na Period Do 2010 Goda I Dal'neishuyu Perspektivu' (Action Plan for Phase One of the Implementation of 'Foundations of Government Policy in the Area of Nuclear Safety and Radiation Protection within the Russian Federation for the Period to 2010 and Beyond')*, trans. U.S. Department of Energy, Order No. 117-r (Moscow: Government of the Russian Federation, 2005; available at http://www.government.ru/data/news_text.html?he_id=103&news_id=16586 as of 25 February 2005).

the formation of a senior interagency bilateral group to implement the summit commitments, led by U.S. Secretary of Energy Samuel Bodman and Rosatom Director Alexander Rumiantsev. The interagency group is required to report to the two presidents by the end of June 2005, and on a regular basis thereafter.[11]

The summit statement was extremely promising, in that it put the personal stamp of both presidents on a call for rapid action, highlighted several of the key steps that need to be taken, and established a mechanism for following up the accord. But the summit statement was also disappointing, in that it did not resolve any of the major obstacles to accelerated progress, did not set any particular milestones to which either government could be held accountable, and did not include any explicit Russian commitment to provide more Russian resources for nuclear security or to sustain security with Russian resources after international assistance phases out. The Bratislava summit could prove to be a transforming event, shifting this effort from a program of U.S. assistance for Russia into a genuine bilateral partnership to upgrade nuclear security in Russia and around the world, with Russian and U.S. experts each playing key roles in the conception, design, and implementation of the effort—but fulfilling the statement's promise will require sustained presidential follow-through on both sides.

Summit Aftermath. In the weeks following the Bratislava summit, the United States moved quickly to attempt to build on what had been achieved, establishing a series of working groups on particular subjects addressed in the summit statement, from nuclear security upgrades to security culture and best practices—and by three weeks after the summit, had proposed to Russia a list of specific steps that might be taken in each of the areas identified in the summit, with proposed meetings to discuss them.[12] In Russia, there were both encouraging and discouraging signs. On the one hand, statements from officials leading some of the agencies most resistant to cooperation emphasized the urgency of the danger that terrorists might get weapons of mass destruction. In early March 2005, for instance, both Nikolai Patrushev, head of the Federal Security Service (successor to the KGB), and Gen. Yuri Baluyevskiy, chief of the Russian General Staff, issued statements warning of the danger that terrorists could get weapons of mass destruction and calling for international cooperation to reduce the threat.[13]

On the other hand, the negative political reaction in Russia to revelations that a draft of the summit statement had included pledges to allow U.S. access at both nuclear material and nuclear warhead sites may make finally resolving the access issue even more difficult. The Kremlin briefly posted on the Internet an earlier draft, which had included a paragraph under which Russia committed to provide lists of nuclear facilities subordinate to both the Rosatom and the Ministry of Defense that required security upgrades, and to allow U.S. visits to these facilities beginning by the end of 2005.[14] When this was reported in the Russian press, it provoked a range of wild charges that somehow the United States was going to "seize control" of Russia's nuclear stockpiles.[15] Indeed, within a month after the Bratislava summit, Russia's Minister of Defense Sergei Ivanov was personally and publicly

[11] "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation" (Bratislava, Slovakia: The White House, Office of the Press Secretary, 24 February 2005; available at http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html as of 25 February 2005).

[12] Interviews with DOE and National Security Council officials, April 2005.

[13] See Vladimir Ivanov and Mikail Tollegin, "Myagkiy Yaderny Kontrol' (Soft Nuclear Inspection)," trans. Russian Press Digest, *Nezavizimaya Gazeta*, 2 March 2005.

[14] See "The Kremlin Web-Site Displayed Remarkable Openness in the Nuclear Sphere," *Kommersant*, 28 February 2005; Nabi Abdullaev, "A Bush Deal and a Missing Paragraph," *Moscow Times*, 1 March 2005.

[15] A wide range of Russian media have spread false rumors that the summit discussions meant that the United States would take control of Russia's nuclear stockpiles, to the extent that a group of Russian Orthodox and Cossack nationalists organized a protest in the center of Moscow against any such transfer of control; see "Moscow Rally Calls to Prevent US Control over Russian Nuclear Facilities," *Interfax News Service*, 20 February 2005.

saying "we are not discussing any possible inspections of Russian nuclear facilities by US experts."[16]

Similarly, the summit does not appear to have made much progress in solving U.S.-Russian disputes over liability in the event of an accident during threat reduction cooperation, despite pre-summit hopes of a breakthrough. For years, the United States had been insisting that Russia accept, in all new or extended threat reduction agreements, the language contained in the original Cooperative Threat Reduction (CTR) umbrella agreement, under which Russia would bear all of the liability even in the event of an accident caused by intentional sabotage by U.S. personnel. Russia has been unwilling to agree to accept this language again, and the U.S. unwillingness to extend agreements without the CTR umbrella language had led to the expiration of agreements on both disposition of excess weapons plutonium and the Nuclear Cities Initiative. In the weeks leading up to the Bratislava summit, the United States offered a liability compromise for plutonium disposition—where the liability problem has delayed the destruction of thousands of bombs' worth of plutonium for years—but the two sides did not reach agreement on the matter in time for the summit.[17] A resolution of this issue not only for plutonium disposition but for the CTR umbrella agreement will be needed by June 2006, when the current extension of the umbrella agreement expires, or nearly all U.S.-Russian cooperative programs to secure and dismantle Cold War arsenals will come to a halt.[18]

Changing Environment in Russia. The Russia of 2005 is not the Russia of the mid-1990s. Russia's economy has stabilized; nuclear workers are now being paid a living wage, on time; the central government has asserted stronger control, and has clamped down on dissent; and the Russian security services are more omnipresent than before, particularly with respect to sensitive issues relating to Russia's nuclear stockpiles. With Russia's new strength, the Russian government has taken a more assertive line in negotiations over nuclear security cooperation, in many cases making obstacles to cooperation more difficult to overcome. This trend continued over the past year.

Changing U.S.-Russian Security Relations. While President Bush and President Putin have a good relationship, and there has been far-reaching U.S.-Russian cooperation in the war on terrorism, substantial parts of the U.S. and Russian security establishments have grown increasingly suspicious of each other in recent years—and this trend has intensified over the past year. In Russia, the U.S.-led attack on Iraq, the U.S. withdrawal from the Anti-Ballistic Missile (ABM) Treaty, the expansion of NATO (including some countries of the former Soviet Union), the U.S. bases in former Soviet states on Russia's borders, and the uprisings against pro-Russian governments in Ukraine, Georgia, and Kyrgyzstan have combined to reignite Cold War-era suspicions, exacerbated by Russia's military weakness, that the United States is seeking to encircle and dominate Russia. Within Russia's nuclear establishment specifically, the U.S. refusal to cooperate in areas such as Generation IV civilian nuclear technology development, or in negotiating a civilian nuclear cooperation agreement that would allow Russia to store U.S.-origin spent fuel from other countries (both of which have been held up because of U.S. concerns over Russian cooperation with Iran), coupled with the U.S. ban on imports of any Russian enrichment services except those from blended HEU, has convinced many that the United States is attempting to freeze Russia out of world markets, and is not willing to engage in a genuine partnership. Indeed, some Russian officials have argued that U.S. expressions of concern over nuclear security are just an effort to discredit Russia's nuclear industry, in order to weaken Russia's position in international nuclear markets. In the United States,

[16] "Russian Defense Minister Says No Plans to Allow US Experts to Inspect Nuclear Arsenal," *Interfax-Agentstvo Voyennykh Novostey*, 22 March 2005.

[17] Peter Baker and Walter Pincus, "U.S.-Russia Pact Aimed at Nuclear Terrorism; Bush, Putin to Announce Plan to Counter Threat," *Washington Post*, 24 February 2005; "Sen. Domenici Has Secretary Rice's Commitment to Advance U.S.-Russia Plutonium Disposition Program" (Washington, D.C.: US Fed News, 2005).

[18] Kenneth Luongo and William Hoehn, "An Ounce of Prevention," *Bulletin of Atomic Scientists* 61, no. 2 (March/April 2005; available at http://www.thebulletin.org/article.php?art_ofn=ma05luongo as of 7 March 2005).

Russia is increasingly seen by many as sliding back toward authoritarianism, waging a brutal civil war in Chechnya, seeking to dominate its neighbors, and opposing the United States on matters ranging from the Iraq war to cooperation with Iran.

Such suspicions inevitably make sensitive nuclear cooperation more difficult, and strengthen the hand of those on both sides who raise arguments against nuclear security cooperation. Although such cooperation has been remarkably resilient through the darkest periods of U.S.-Russian relations over the last decade, there is little doubt that disputes over issues ranging from access to sensitive sites to liability in the event of an accident are more difficult to resolve today than they were a few years ago, and that the Russian security services in particular have been posing more obstacles to cooperation than before. In this atmosphere, deep structural incentives limit both side's willingness to compromise on sensitive nuclear security issues. In Moscow, there is little chance that a Russian security official will be penalized for saying "no" to a sensitive new step in nuclear security cooperation, and every risk that he could be penalized for saying "yes" if something were later judged to have gone wrong; similarly, in Washington, a manager faces little penalty for making one more demand in negotiations of a contract or agreement with Russia, but a substantial career risk if something goes through that is later judged not to adequately protect U.S. taxpayers' resources.

Tracking Detailed Progress in Controlling Nuclear Warheads, Materials, and Expertise

This section reviews progress and key developments of the past year in each of six categories of effort needed to keep nuclear weapons, materials, and expertise out of terrorist hands: securing nuclear warheads and materials; interdicting nuclear smuggling; stabilizing employment for nuclear personnel; monitoring nuclear stockpiles; ending further production; and reducing nuclear stockpiles. For each of these categories, this section provides an updated assessment of the fraction of the job that U.S.-funded programs have accomplished, and the current pace of progress, using a set of rough metrics developed in previous reports (with some modifications introduced this year).[19]

Fundamentally, we are asking four questions:

- What is the problem, or part of the problem, that a particular program is designed to address?
- What is the total scope of the work that would have to be done for this problem or part of the problem to be resolved?
- What fraction of that total scope of work has been done so far?
- How fast is what is left to be done being finished, and in particular, how much has been finished in the year since our last report?

The measures used in this section provide only rough summary estimates of the rate of progress. We have relied on official government measures and data where possible, but in many cases these are not available. The administration, led by the Department of Energy (DOE), has improved the availability and transparency of measures of performance for its programs to control nuclear warheads, materials, and expertise worldwide.[20] But the fact remains that although the

[19] Matthew Bunn, Anthony Wier, and John Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2003; available at http://www.nti.org/e_research/cnwm/overview/report.asp as of 1 February 2005), pp. 61-83; 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. 39-82.

[20] The detailed justifications of their budget proposal supplied by the agencies to the Congress contain performance information and targets for each major activity; for instance, see U.S. Department of Energy, *FY 2006 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, vol. 1, DOE/ME-0046 (Washington, D.C.: DOE, 2005; available at http://www.mbe.doe.gov/Budgets/06Budgets/Content/Programs/Vol_1_NNSA_3.pdf as of 14 February 2005). See the performance assessments of the Energy and State Departments: U.S. Department of Energy, *Performance and Accountability Report: FY*

U.S. government has plans for individual pieces of this problem, it has no comprehensive plan for addressing this threat, and has not put forward a comprehensive set of milestones that would allow the Congress and the public to fully understand both how much progress is being made and where prolonged delays suggest the need for a change in approach.[21] Until that occurs, we will continue to provide the best measurable assessments we can from outside the government.

Such measures to track progress are crucial to the effectiveness of almost any government program. Only by understanding which efforts are showing real results and which efforts are not can mid-course corrections be made, and ineffective efforts be improved. But such measures are inevitably imperfect. As Albert Einstein is once said to have remarked, "Not everything that counts can be counted—and not everything that can be counted, counts." Undue reliance on particular progress metrics can be misleading. Any particular measure of progress reflects one definition of the problem to be addressed, and one idea of the best method for solving that problem, excluding others. A manager focused exclusively on racking up more progress by that measure is likely to miss opportunities for different approaches to taking on the problem—and thus managing to a particular metric can breed complacency.

It is impossible to directly measure the danger of nuclear theft and terrorism, and whether it is increasing or decreasing. Hence, all the measures of progress the U.S. government uses to track progress in these efforts, and all the measures we discuss in this chapter, are intended as partial substitutes for such a direct measure, reflecting progress in implementing some particular approach to addressing one part of this multi-faceted problem. But relying on such measures can be problematic if they leave out key parts of the problem, or of the part of the solution that a particular program is attempting to address. If, for example, a key part of the overall problem is posed as "there are too many civilian research reactors using HEU," and the proposed solution is to convert those research reactors to use low-enriched fuel that cannot be used in nuclear weapons, then it would be logical to track progress by how many reactors have been converted—as DOE has long done, and does today.[22] But if program managers' bonuses are linked to that metric and not others, attention will inevitably be directed away from (a) other tactics, such as giving aging HEU-fueled research reactors incentives to shut down, rather than trying to convert them (many more HEU-fueled reactors have shut down since the conversion effort began in 1978 than have converted, even in the absence of explicit shut-down incentives); (b) other facilities that may have HEU, besides operating civilian research reactors that might be converted (such as shut-down research reactors that still have HEU, facilities that may have large quantities of HEU but no research reactor, military research reactors, naval reactors, icebreaker reactors, and more); and (c) those research reactors that are impractical to convert (at least 56 of which are not included in DOE's assessment of the fraction of the job it has accomplished, because they are not on the list slated for conversion).[23] This is intended only as an example of the dangers of relying too heavily on particular metrics,

2004, DOE//ME0044 (Washington, D.C.: DOE, 2004; available at http://www.mbe.doe.gov/progliaison/doe04par.pdf as of 18 February 2005); U.S. Department of State and U.S. Agency for International Development, "Strategic Goal 4: Weapons of Mass Destruction" in *FY 2006 Performance Summary* (Washington, D.C.: U.S. Department of State, 2005; available at http://www.state.gov/documents/organization/41605.pdf as of 14 February 2005). A handful of relevant programs have been examined using the White House Office of Management and Budget's Program Assessment Rating Tool (PART): see U.S. Office of Management and Budget, "Program Assessment Rating Tool" in *Budget of the United States Government: Fiscal Year 2006* (Washington, D.C.: OMB, 2005; available at http://www.whitehouse.gov/omb/budget/fy2006/part.html as of 18 February 2005).

[21] For a discussion on the absence of a government-wide strategic plan, see U.S. Government Accountability Office, *Weapons of Mass Destruction: Nonproliferation Programs Need Better Integration*, GAO-05-157 (Washington, D.C.: GAO, 2005; available at http://www.gao.gov/new.items/d05157.pdf as of 31 January 2005), pp. 8-17.

[22] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.

[23] U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors*, GAO-04-807 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d04807.pdf as of 2 February 2005), p. 10.

not as a criticism of current efforts—the management of the GTRI effort is aware of all of these issues, and is moving to ensure, to the extent possible, that they have a comprehensive understanding of all the facilities they need to address, not just the operating and potentially convertible HEU-fueled civilian research reactors.

Similarly, many of the measures addressed in this chapter focus on what fraction of facilities of certain types have had modern security and accounting equipment installed. But installing such equipment is far from the only essential element of an effective nuclear security system. Ensuring that the *people* who are essential to effective nuclear security take nuclear security seriously, understand the security rules and follow them, and use whatever equipment they have effectively—rather than turning off intrusion detectors if they send too many annoying false alarms—is at least as crucial to good nuclear security, and progress toward strong nuclear security cultures is far more difficult to measure. Similarly, it is crucial to put in place the resources, organizations, and incentives necessary to ensure that nuclear security will be sustained for the long haul—long after particular U.S. programs come to an end—but assessing how much progress is being made in meeting that objective is quite difficult to do.

Hence, we believe that for many of these programs, allocating more resources to analysis—to probing what all the elements of the problem to be addressed really are, what all the plausible approaches to addressing those elements of the problem are, what approaches might offer the most potential for rapid progress, and what the best indicators for assessing progress might be—could strengthen the overall effort. Devoting a small fraction of total program resources to fund these kinds of analyses might make it possible to identify ways to get these missions done faster, and more cheaply—"more thinking, less muscle," as the saying goes.

In some cases, it may be necessary for programs to invest in collecting additional information on which to base better metrics. For example, at one time in the 1990s, the Customs Service had a serious problem with what was called "port-running" on the U.S.-Mexican border. A port-runner was a truck loaded with drugs which, when it reached the inspection station, would just gun the engine and drive through, seeking to lose pursuers, if any, in crowded urban streets beyond the crossing. A special project team was pulled together to come up with ways to deal with the problem. The team quickly recognized that while a reduction in reported "port-running" incidents was an important measure of their success, it should not be the only one—because such a reduction could actually be a sign of failure, if customs inspectors became so intimidated or corrupted that they simply did not report these incidents. The team realized that if steps to prevent port-running were successful, it ought to become more expensive to hire some one to drive a truckload of drugs into the United States. And so customs intelligence agents were dispatched to find out what the typical cost to hire some one for that job was ($5,000 when the project started), and then to track how that figure changed over time.[24] Nuclear smuggling is too rare an occurrence for there to be a similar "going rate" that can be easily determined. But for a program to interdict nuclear smuggling, data might be collected on the fraction of the time that government testers managed to smuggle nuclear material through a particular border area without detection.

It is extraordinarily difficult, in the midst of the incessant day-to-day challenges of managing a program of this kind, to draw back and think strategically about what the program might be missing. It may be, therefore, that portions of the kind of analysis and evaluation of metrics that we are advocating should be contracted out to entities outside the program itself, whether companies, laboratories, or universities. Already, for example, both DOE's International Nuclear Material Protection and Cooperation program and its Russia Transition Initiatives program have contracted for re-analyses of the threats they are addressing by the RAND Corporation. The material protection program has also contracted, for example, with a group

[24] Malcolm K. Sparrow, *The Regulatory Craft: Controlling Risks, Solving Problems, and Managing Compliance* (Washington, D.C.: Brookings Institution Press, 2000), pp. 124-129.

of experts on smuggling for a re-examination of the nuclear smuggling problem, and with a group of experts on organized crime for analyses of the possible role of organized crime in the former Soviet Union in stealing or smuggling nuclear or radiological material. Similarly, the State Department's Export Control and Related Border Security Assistance program has worked with the University of Georgia's Center for International Trade and Security to evaluate countries' progress in developing export control systems. In general, we believe that all of these programs could benefit from additional in-depth analyses of the problems they are addressing and best ways to solve those problems.

Because each of the measures we discuss in this chapter has its own strengths and weaknesses, in each section we also offer a discussion (necessarily preliminary) of other measures that might offer a more complete picture of progress in reducing the threat of nuclear theft and terrorism, but for which data is not yet publicly available.

Tracking Progress: Securing Nuclear Warheads and Materials

The overall goal in this category is simple: every nuclear weapon and every kilogram of nuclear material anywhere in the world must be secured and accounted for, to stringent standards. Key developments in this area in the last year not already noted above included:

- The effort to amend the international convention on physical protection to cover nuclear materials in domestic use, and to cover not only theft of nuclear material but sabotage of nuclear facilities, moved toward fruition. By mid-January 2005, the required majority of the parties had requested a diplomatic conference to amend the treaty, which is scheduled for early July 2005, and the proposed amendment is expected to be approved.[25] Each party to the treaty will have to ratify the amendment before it takes force for them, and that is likely to take years. Unfortunately, however, the amendment will not create any binding global nuclear security standards with enough specifics to be effective—though it does offer a number of generally worded principles that should help in convincing states to strengthen nuclear security.

- In April 2005, the United Nations General Assembly approved the draft of a new convention on nuclear terrorism, requiring countries that join the convention to put in place criminal laws forbidding a list of specified nuclear terrorist offenses, and to arrest and prosecute those who commit such offenses who are found on their soil. The convention does not require, however, that states take any particular measures related to securing nuclear stockpiles or interdicting nuclear smuggling.[26]

- During FY 2004, comprehensive security and accounting upgrades were completed on an additional 4% of the estimated 600 tons of nuclear material outside of nuclear weapons in the former Soviet Union.[27] In December 2004, the United States and Russia announced the completion of nuclear security and accounting upgrades at Novouralsk, Zelenogorsk, and Novosibirsk—facilities that process tens of tons of potentially

[25] Interview with U.S. State Department official, February 2005. An experts' group convened by the IAEA had drafted a proposed amendment which was forwarded to governments for consideration in 2003, but had failed to reach final agreement on several bracketed points. Austria broke the deadlock by circulating a complete draft amendment with the versions of each disputed point that had the broadest support. The Austrian text is described in detail in Patricia A. Comella, "Revising the Convention on the Physical Protection of Nuclear Material—Chapter V" (paper presented to 45th Annual Meeting of the Institute for Nuclear Materials Management, Orlando, Fla., 2004).

[26] United Nations General Assembly, "International Convention for the Suppression of Acts of Nuclear Terrorism" (New York, NY: UN, 2005; available at http://www.iaea.org/Publications/Documents/Conventions/unga040405_csant.pdf as of 18 April 2005); Evelyn Leopold, "U.N. Approves New Treaty against Nuclear Terrorism," *Reuters News*, 13 April 2005.

[27] The total fraction of material covered by comprehensive upgrades increased to 26% from 22%. As discussed in detail below, the fractions of sites or buildings secured are higher. See U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.

vulnerable HEU every year, and two of which (Novouralsk and Zelenogorsk) represent the first fully completed sites in Russia's closed nuclear cities.[28]

- Programs sponsored by both the Department of Defense (DOD) and DOE made progress in implementing security upgrades at some Russian nuclear warhead sites. By the end of FY 2004, DOE had completed upgrades at 34 of 39 Russian Navy sites where it had been working, and 2 of the 25 Strategic Rocket Forces (SRF) warhead sites where it had been working.[29] The DOD effort, which only recently gained access to key facilities for the first time, completed designs for comprehensive upgrades for its first 10 sites by the end of FY 2004; upgrades based on these designs will be completed in FY 2005 and FY 2006.[30]

- Significant progress was made in addressing the long-troublesome issue of access to sensitive nuclear sites. In a pilot project at a sensitive Russian nuclear facility, the two sides successfully demonstrated new approaches to the access issue—including procedures designed to allow the United States to confirm that U.S. taxpayers' dollars were appropriately spent on security upgrades without requiring direct access by U.S. personnel to the most sensitive areas. The two sides agreed on access arrangements to allow U.S.-funded upgrades to proceed at nearly all of the buildings in Russia's nuclear weapons complex containing weapons-usable nuclear material except those at Russia's two remaining major nuclear weapons assembly-disassembly facilities. Russia also expanded the number of nuclear warhead storage sites where U.S. teams were permitted limited access. In late 2004, the United States allowed an unprecedented visit by Rosatom's top security officials to the U.S. nuclear warhead assembly and disassembly at Pantex, in Amarillo, Texas, bringing them to all the areas that U.S. experts would like to be able to visit at comparable Russian facilities to implement security and accounting upgrades.[31] In December 2004, President Bush offered Russia "equal access" to U.S. nuclear sites, "to build confidence between our two governments."[32] While the access issue was not addressed in the final Bratislava summit statement, it was discussed in the lead-up to the summit.[33]

- During 2004, potentially vulnerable HEU was removed from facilities in Libya, the Czech Republic, and Uzbekistan.[34] The United States and Russia also signed an agreement establishing a standard framework to speed future cooperative operations to return fresh and spent HEU fuel to Russia.[35] Substantial progress was made in resolving bureaucratic obstacles in Russia that had prevented removals of irradiated Soviet-supplied HEU, and as of early 2005, the first return of irradiated HEU to Russia was expected by the end of 2005.[36]

[28] "Security Upgrades Completed at Three Russian Nuclear Facilities" (Washington, D.C.: U.S. Department of Energy, 10 December 2004; available at http://www.nnsa.doe.gov/docs/PR_NA-04-33_Security_upgrades_completed_(12-04).pdf as of 28 February 2005).

[29] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485; U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 135. As noted in last year's report, however, for 21 of the 34 sites considered "completed," only rapid upgrades were done, as these were considered all that was required at those sites. See Bunn and Wier, *Securing the Bomb: An Agenda for Action*, p. 54.

[30] U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006* (Washington, D.C.: U.S. Department of Defense, 2005), p. 41.

[31] See Jim Nesbitt, "Russian Atomic Officials Tour Aiken, S.C.-Area Nuclear Reservation," *Augusta (Ga.) Chronicle*, 18 November 2004. This information was supplemented by interviews with DOE officials, December 2004 and January 2005.

[32] Bush, "President Holds Press Conference."

[33] Yuri Tretyakov, "Interview with Military Expert Major General Vladimir Dvorkin on Russia-USA Nuclear Safety Cooperation (Russian)," trans. Federal News Service, *Trud Daily*, 3 March 2005; Abdullaev, "A Bush Deal and a Missing Paragraph."

[34] C. J. Chivers, "Chechen Rebel Grimly Vows More Attacks," *New York Times*, 18 September 2004; "Beslan Hostage-Taking Death Toll Is 330 - Deputy Prosecutor General," *Interfax News Service*, 30 December 2004;

[35] "United States and Russian Federation Cooperate on Return of Russian-Origin Research Reactor Fuel to Russia" (Moscow: U.S. Department of Energy, 27 May 2004; available at http://www.energy.gov as of 16 February 2005).

[36] Interviews with DOE officials, January 2005.

- The United States extended the deadline for its effort to take back HEU it had exported to countries around the world by a decade, from 2009 to 2019.[37] Almost two-thirds of the HEU the United States exported, however, remained outside the scope of the take-back offer, though DOE began considering approaches to expanding the offer.

- The completed Mayak Fissile Material Storage Facility remained empty, as preparations to load the first material into the facility continued. U.S.-Russian negotiations over transparency arrangements for the facility continued, but did not reach agreement.[38] Moreover, unless current U.S. and Russian policies constraining the use of this facility are changed, Russia only expects to load 25 tons of excess plutonium into the facility, leaving three-quarters of its storage space empty.[39]

- The United States continued to press for cooperation in securing nuclear facilities in key nuclear weapon states outside the former Soviet Union. For example, some important initial progress is now being made with China, with a major security and accounting upgrade at one civilian facility with weapons-usable nuclear material scheduled for completion this year.[40] Bilateral and IAEA-led efforts to review security and recommend improvements in states with more modest nuclear programs continued.

Data is simply not available—publicly or otherwise—on how great the overall security risk at different nuclear facilities around the world is, or on how well nuclear security systems at different sites around the world actually perform. We have therefore relied in this report on metrics very similar (in most cases) to those the U.S. government uses to report the progress of its efforts in these areas. These focus, in particular, on (a) sites, materials, or buildings that have two defined levels of security and accounting equipment upgrades installed with U.S. assistance—"rapid" upgrades and "comprehensive" upgrades—and (b) buildings or sites where the potential nuclear bomb material has been removed entirely, eliminating the theft risk from that location.[41]

By its nature, however, the first category of measure does not include the progress Russia or other potential recipient states have made in upgrading security on their own, without U.S. or other foreign assistance (though, of course, designs for U.S.-sponsored upgrades take into account improvements that have already been made at a site). Moreover, measuring which sites have modern security and accounting equipment installed does not capture whether the *people* at these sites are following effective security procedures and using the equipment in a way that in fact provides high levels of security.[42] DOE is sponsoring harder-to-measure but crucial progress in areas such as providing training, improving security

[37] "Energy Department Extends Acceptance Policy for Spent Nuclear Fuel from Foreign Research Reactors" (Washington, D.C.: U.S. Department of Energy, 6 December 2004; available at http://www.doe.gov/engine/content.do?PUBLIC_ID=16940&BT_CODE=PR_PRESSRELEASES&TT_CODE=PRESSRELEASE as of 28 February 2005); U.S. Department of Energy, "Revision of the Record of Decision for a Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel," *Federal Register* 69, no. 230 (1 December 2004). To be eligible for the original 2009 deadline, the fuel had to have been removed from the reactor before 13 May 2006; that deadline has now been moved to May 2016.

[38] U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 46.

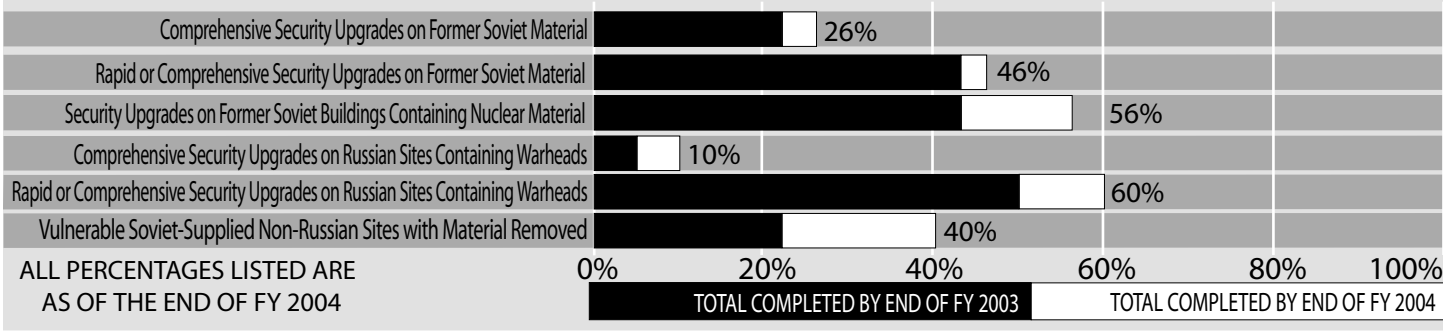
[39] Matthew Bunn, "Mayak Fissile Material Storage Facility," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/securing/mayak.asp as of 14 February 2005).

[40] Interviews with DOE officials, December 2004 and April 2005.

[41] Rapid upgrades include items such as installing nuclear material detectors at the doors, putting material in steel cages that would take a considerable time to cut through, bricking over windows, and counting how many items of nuclear material are present. "Comprehensive" upgrades represent the installation of complete modern security and accounting systems, designed to be able to protect the facility against at least modest insider and outsider theft threats.

[42] For an extensive recent discussion of the importance of the "human factor" in security, in Russia in particular, see Igor Khripunov and James Holmes, eds., *Nuclear Security Culture: The Case of Russia* (Athens, Georgia: Center for International Trade and Security, The University of Georgia, 2004; available at http://www.uga.edu/cits/documents/pdf/Security%20Culture%20Report%2020041118.pdf as of 18 February 2005).

Figure 3-1
How Much Securing Work Have U.S.-Funded Programs Completed?



culture, and strengthening independent regulation of nuclear security and accounting, and these efforts presumably have benefits for securing and accounting for *all* nuclear materials in recipient countries, not just those for which U.S.-funded equipment is being installed. Hence, it is quite possible for some material counted as "completed" by this measure to be insecure. It is equally possible for material counted as "not completed" to be secure, because the recipient state has already taken action to secure it effectively.

Securing Metric 1: Security Upgrades on Former Soviet Nuclear Material

Fraction accomplished. Within the former Soviet Union, as of the end of FY 2004, some 26% of the potentially vulnerable nuclear material outside of nuclear weapons—estimated to amount to roughly 600 tons—had U.S.-funded comprehensive security and accounting upgrades installed.[43] An additional 20% of the material had initial "rapid" upgrades installed, for a total of 46% with either rapid or comprehensive U.S.-funded upgrades completed.[44] Upgrades are underway on a significant additional amount of material. As discussed below, because most of the material not yet covered is located at a small number of massive sites, the fraction of *sites* completed, and the fraction of *buildings* completed, are both substantially higher than the fraction of materials completed. Figure 3-1 shows the amount of material with comprehensive or rapid upgrades completed as a fraction of the total amount of potentially vulnerable nuclear material.

Comprehensive upgrades have been completed for all of the nuclear material in Russia's naval nuclear complex, all of the nuclear material in the non-Russian states of the former Soviet Union, and nearly all of the nuclear material at Russia's civilian sites. Nearly all the remaining material awaiting U.S.-funded security upgrades is in the defense complex of Russia's Federal Agency for Atomic Energy (Rosatom, formerly the Ministry of Atomic Energy, or Minatom), for which the access issue has been the most difficult to resolve. Indeed, some 500 tons of the estimated 600 tons of potentially vulnerable weapons-usable nuclear material outside of nuclear weapons in the former Soviet Union is in Rosatom's defense complex, and as of the end of FY 2004, comprehensive upgrades had been completed on no more than 12% of this material.[45]

It should be noted that the precision in these figures is illusory. The DOE estimate of 600 tons of material

[43] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[44] Interviews with DOE officials, January 2005. For a more detailed discussion of the MPC&A program, see Matthew Bunn, "Materials Protection, Control and Accounting," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2003; available at http://www.nti.org/e_research/cnwm/securing/mpca.asp as of 3 March 2005).
[45] Through FY 2004, comprehensive upgrades had been completed on 100% of the Navy sites housing nuclear material (approximately 60 tons) and no more than 95% of the former Soviet civilian nuclear complex (approx. 40 tons). Combining this figure with the figure of 26% completed for all material allows one to calculate the percentage of comprehensive upgrades completed on the remaining 500 tons of nuclear material estimated in the Russian weapons complex. For the Navy and civilian complex figures, see U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 486-488.

outside of warheads is extremely uncertain; in fact, new internal, unofficial estimates, not yet reflected in DOE's official progress assessments, have revised the 600-ton figure downward. The breakdowns of how much material is in particular buildings and sites—from which the estimates of the percentage covered to date are drawn—are little more than guesses in some cases. Russia has never formally declared how much HEU or separated plutonium it has, how much of those stockpiles are in warheads, or how much material is in each of its many different facilities. In some cases this information is still considered a state secret in Russia.

Rate of progress. During FY 2004, comprehensive upgrades were completed on an additional 4% of the weapons-usable nuclear material outside of nuclear weapons in the former Soviet Union (roughly 24 tons of additional material), increasing the fraction with comprehensive upgrades from 22% to 26%.[46] This represents a significant slowing compared to the previous year, when DOE reports that 35 tons of nuclear material received comprehensive upgrades.[47]

DOE plans to complete comprehensive upgrades on the remaining 74% of the material in Russia in just four more years, by the end of 2008. This will require a dramatic acceleration of current progress, if measured by the percentage of material secured each year; if the current rate remained unchanged, it would take several times that long to complete the effort. DOE argues that if appropriate agreements can be reached to enable nuclear security upgrades to take place at those few places where access is still a serious problem (particularly the two nuclear weapons assembly and disassembly facilities, where huge amounts of nuclear material are believed to be stored), the needed acceleration will occur, as a result of shifting from completing work at buildings with small quantities of nuclear material to completing work at buildings that contain massive quantities of nuclear material. Indeed, DOE hopes to complete comprehensive upgrades for 11% of the potentially vulnerable nuclear material in Russia during FY 2005 (nearly three times the FY 2004 pace), 13% in FY 2006, 23% in FY 2007, and 27% in FY 2008.[48] Under this plan fully half of all the potentially vulnerable nuclear material in Russia would have comprehensive upgrades installed in the last two years of the effort. (This represents primarily the material believed to be located at the last large Rosatom weapons complex sites scheduled to be completed, particularly the weapons assembly and disassembly facilities.) Achieving this level of acceleration is likely to require sustained leadership from both the secretary of energy and the president, focused on overcoming the obstacles to progress as they arise.

Although DOE argued in a 2004 press release that security upgrades in the former Soviet Union were "ahead of schedule,"[49] in fact the current level of upgrades is behind the planned schedule set after the 9/11 attacks—the schedule that first set a 2008 target date. Under that original post–9/11 plan, by the end of FY 2004, comprehensive upgrades were to have been completed for 27% of the potentially vulnerable nuclear material in Russia, and initial rapid upgrades were to have been completed for an additional 50% of this material.[50] As noted above, by the end of FY 2004, comprehensive security upgrades had been completed on 26% of the potentially vulnerable nuclear material, nearly matching the earlier target, but rapid upgrades had been completed for only another 20%, far short of the earlier goal.

In last year's report, we noted, based on the most current data available at that time, that the quantity of nuclear material that received comprehensive security upgrades in the two years following the September 11 attacks was actually less than the quantity

[46] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[47] For discussion of the previous year's progress, with references, see Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 46-47.
[48] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[49] "NNSA Security Upgrades at Russian Sites Are Ahead of Schedule" (Washington, D.C.: U.S. Department of Energy, October 2004; available at http://www.nnsa.doe.gov/docs/NA-04-FS02.pdf as of 28 February 2005).
[50] Kenneth Sheely, "MPC&A Program Overview – Initiatives for Acceleration and Expansion" (paper presented at the 43rd Annual Meeting of the Institute of Nuclear Materials Management, Orlando, Florida, 24 June 2002).

that had received comprehensive upgrades in the two years before. DOE has since revised its estimates of the amount secured each year; under the new estimates, the amounts secured in the two years before and the two years after the September 11 attacks is roughly the same.[51] If DOE's hopes for FY 2005 and beyond are achieved, however, the resulting acceleration will be substantial.

Securing Metric 2: Security Upgrades on Former Soviet Buildings Containing Nuclear Material

U.S.-funded cooperative nuclear security upgrade efforts concentrated first on upgrading particularly vulnerable sites with small quantities of nuclear material—though still enough for a bomb, if stolen. While completing security upgrades at these sites reduced proliferation risks substantially, they covered only a small percentage of the total nuclear material, and as a result, the fraction of materials covered does not fully reflect the fraction of the work that has been accomplished or the fraction of the proliferation threat that has been reduced. Hence, DOE often prefers to emphasize the fraction of sites completed, which is much more impressive. By the end of FY 2004, approximately 75% of the *sites* in the former Soviet Union where weapons-usable nuclear material was located had been completed.[52] "Completed" means that either comprehensive upgrades had been finished, or DOE had determined that only the first round of rapid upgrades were needed at that site (if, for example, the material at the site was of low attractiveness for use in a nuclear weapon).

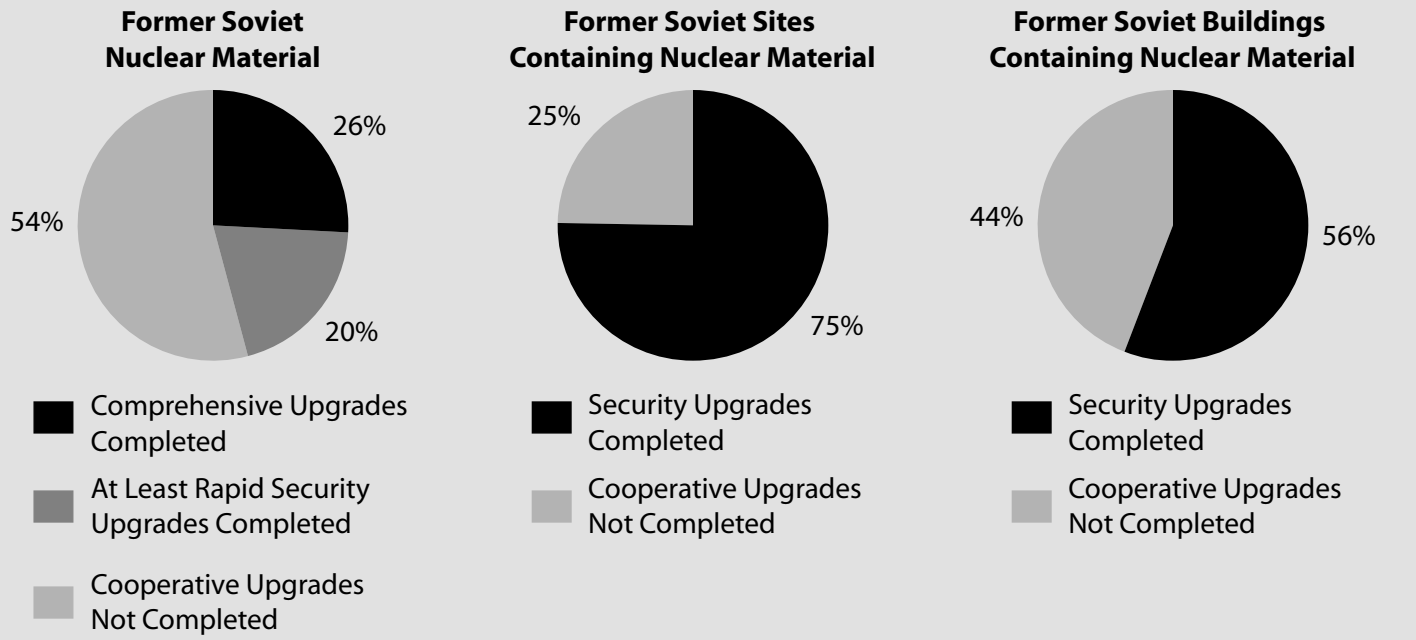
The fraction of the *buildings* completed is a somewhat better measure both of how much the proliferation risk has been reduced, and of how much of the total work has been accomplished, than either the fraction of materials or the fraction of sites completed. Building-level data is more representative than materials-level data because a single building with a given level of security that has enough nuclear material for 1,000 nuclear weapons may pose only a modestly greater theft risk than a building with similar security arrangements and only enough nuclear material for one or two nuclear bombs. Improving security at a building with a massive amount of nuclear material involves more work, but not dramatically more, so the total amount of work is more closely related to the number of buildings than the amount of material. Building-level data is more representative than site-level data because a large site with dozens of buildings containing nuclear material may have dozens of different groups that have access to that material, and because the work of improving security at such a huge and multifaceted site is much more time-consuming, complex, and expensive than the work of improving security at a small site with only one building. We have not previously used building-level data because such data was not publicly available, but DOE has now provided building-level data.

As of the end of FY 2004, U.S.-funded security upgrades had been completed for roughly 56% of the just over 200 buildings housing weapons-usable nuclear material in the former Soviet Union (Figure

[51] "NNSA Security Upgrades at Russian Sites Are Ahead of Schedule." DOE has not released its new year-by-year estimates, making it impossible to compare, for example, the three years before the 9/11 attacks to the three years after those attacks; but given that the amount of material that received comprehensive upgrades in FY 2004 was less than the amount in FY 2003, it seems unlikely that such a comparison would indicate that a substantial acceleration had yet been achieved.

[52] Officially, DOE estimates that 75 of 121 sites where cooperation to upgrade security and accounting for nuclear materials was underway were complete as of the end of FY 2004, or approximately 62% of the total. But 70 of the 121 are nuclear warhead sites, treated below, and two of the sites outside Russia are sites where upgrades were performed for a combination of political reasons and desire to reduce risks of nuclear sabotage, not because there was weapons-usable nuclear material there (the South Ukraine nuclear power plant and the Ignalina nuclear power plant in Lithuania). Therefore there are approximately 49 sites with weapons-usable nuclear material included in the program, of which 37 are completed, or 75%. Calculations based on unpublished data provided by DOE, February 2005. The 75% figure may be a modest overstatement, as there are believed to be a few sites with weapons-usable nuclear material which Russia has not previously agreed to include in the cooperative program and which have not been included in the program's past site lists. The OKBM design institute in Nizhny Novgorod, for example, has several HEU-fueled critical assemblies, but has only recently been added to the sites scheduled for security and accounting upgrades.

FIgure 3-2
Status of Security Upgrades on Sites and Buildings in the Former Soviet Union Containing Weapons-Usable Nuclear Material



Note: The percentages for buildings and sites completed differ somewhat from DOE's official estimate because we include only those buildings and sites containing nuclear material, treating nuclear warheads separately.

3-2 compares the different measures of progress in completing security upgrades).[53]

Rate of progress. Security and accounting upgrades were completed at 38 buildings in FY 2004, a pace more than a third better than had been planned, as the availability of both supplemental funding and needed cooperation at particular sites allowed the completion of some buildings more rapidly than originally planned.[54] Publicly available data is insufficient, however, to determine how many of these 38 buildings were warhead buildings, as opposed to nuclear material buildings. If, as appears to be the case, roughly two-thirds of these 38 buildings were buildings containing nuclear material, then during FY 2004 the total fraction of nuclear-material buildings completed increased from 43% to 56% in a single year, a substantial pace of completion.[55] DOE hopes to achieve a substantial further acceleration of that pace in FY 2005, completing upgrades on 61 additional buildings containing weapons-usable nuclear material.[56] If that target is achieved, by the end of FY

[53] As with the sites figure, this percentage differs somewhat from DOE's official estimate (in this case, DOE's estimate is 59% of buildings completed as of end of FY 2004), because we include in this measure only those buildings containing nuclear material, treating nuclear warheads separately below, while DOE includes those containing nuclear material and warheads in one buildings measure. Of the estimated 275 buildings in the former Soviet Union containing nuclear warheads or nuclear materials where the MPC&A program is working, it appears that roughly 205 are buildings containing nuclear material, as 12 are warhead facilities under the 12th Main Directorate of Russia's Ministry of Defense, 19 are warhead facilities of Russia's Strategic Rocket Forces, and we assume that the 39 Navy warhead sites similarly constitute 39 of the 60 Navy buildings. Calculations based on unpublished data provided by DOE, February 2005.

[54] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 138.

[55] Nine of the buildings listed as completed by the end of FY 2004 were Strategic Rocket Forces buildings, which were almost certainly completed during FY 2004; we are assuming that a modest number of the 39 Navy warhead buildings were also completed during FY 2004.

[56] Calculations based on unpublished data provided by DOE, February 2005.

2005, some 85% of the buildings containing weapons-usable nuclear material in the former Soviet Union will have had U.S.-sponsored security and accounting upgrades completed. Hence, focusing on the buildings-level data makes achieving the 2008 target for completing upgrades appear significantly more plausible than it looks when focusing only on the materials-level data.

Securing Metric 3: Security Upgrades on Russian Sites Containing Warheads

Fraction accomplished. For nuclear warhead sites, the numbers are inevitably murkier, as neither the U.S. government nor the Russian government has published current, detailed estimates of how many nuclear warheads exist in Russia, at how many sites. Even the basic question of what fraction of Russia's warhead sites are covered by current U.S. plans for warhead security upgrades can only be partially answered from publicly available official data.

While Russia has never declared how many warheads it has, and there are large uncertainties in both official and unofficial U.S. estimates, the most recent unclassified estimates suggest that Russia still has roughly 16,000 warheads in assembled form (with just under half that number operational, including both strategic and tactical weapons).[57] By some unclassified estimates, these warheads exist at some 150-210 sites (counting each individually secured perimeter, whether it be a fixed bunker or a location where warheads are temporarily stored, as a separate site)—50-70 of which are national stockpile sites, 60-80 of which are deployed, service-level storage sites, and 40-60 of which are temporary sites (such as rail transfer points and warhead handling areas at operational bases).[58]

DOD and DOE are both working with Russian counterparts to install modern security systems at many of these sites.[59] It is important to understand, however, that as of early 2005, there is no plan to upgrade security for *all* the warhead sites in Russia: in January 2003, the administration took an interagency decision not to provide support for upgrading warhead handling areas in most cases,[60] and from the beginning of the cooperation, there have been some sites that Russian officials have not put on the table as subjects for cooperation—particularly some forward-deployed tactical nuclear warhead sites.[61] Thus, unless there are policy changes in Washington and Moscow, even when current programs are "completed," there will remain a significant number of nuclear warhead sites in Russia that have not had U.S.-funded security upgrades.

Of the 150-210 total sites, DOE currently plans to perform some level of upgrade on 39 Navy sites, 19 Strategic Rocket Forces (SRF) sites, and 12 sites managed by the 12th Main Directorate of the Ministry of Defense (known by its Russian acronym as the 12th GUMO, the organization charged with the nuclear warhead management and security in Russia), for a total of 70 sites.[62] DOD currently plans to upgrade security at

[57] Robert S. Norris and Hans M. Kristensen, "NRDC Nuclear Notebook: Russian Nuclear Forces, 2005," *Bulletin of the Atomic Scientists* 61, no. 2 (March/April 2005; available at http://www.thebulletin.org/article_nn.php?art_ofn=ma05norris as of 1 March 2005).

[58] Charles Thornton, presentation, Harvard University, October 24, 2003. These figures are higher than most available government figures related to the number of warhead sites, because official figures usually do not include all the temporary sites, and because some official figures are based only on the sites where threat reduction assistance is planned, while a number of sites (including most deployed, service-level sites for tactical nuclear weapons) have not been the subject of threat reduction discussions.

[59] For a more detailed account of these warhead security programs, see Matthew Bunn, "Nuclear Warhead Security Upgrades," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/securing/warhead.asp as of 2 March 2005).

[60] U.S. Government Accountability Office, *Weapons of Mass Destruction: Additional Russian Cooperation Needed to Facilitate U.S. Efforts to Improve Security at Russian Sites*, GAO-03-482 (Washington, D.C.: GAO, 2003; available at http://www.gao.gov/new.items/d03482.pdf as of 4 March 2005), pp. 33-34.

[61] Interview with U.S. defense contractor expert, February 2004.

[62] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485. Of the 39 Navy warhead sites, 21 are sites where DOE completed initial "rapid" upgrades, and then did not pursue further upgrades after the interagency decision that in most cases support would not be provided for upgrading warhead-handling sites. DOE's budget justifications used to refer to 42 naval warhead sites; DOE has declined to offer assistance for three of these (apparently because there should not be warheads there

an additional 42 sites, for a total of 112 sites to be upgraded by either DOE or DOD programs—although in some cases the departments may be using the word "sites" differently.[63] This figure, significantly below the estimate of 150-210 total sites, suggests that the set of sites that will not be covered under current U.S. government plans may be significant.[64] (Ultimately, more security could be purchased, probably at lower costs, through consolidating this vast warhead infrastructure into just a few facilities, but U.S. officials have so far made little progress with Russia on the warhead consolidation issue.[65])

To date, rapid upgrades have been completed for all 39 of the Navy sites where DOE is working; rapid upgrade contracts have been signed for all 19 of the

if Russia is fulfilling its pledges under the 1991-1992 Presidential Nuclear Initiatives), leaving the remaining total for which upgrades are planned at 39. Russian requests for assistance at sites of which that was true provoked considerable concern and suspicion within the U.S. government. Interviews with DOE, DOD, and national laboratory officials, 2003 and February–March 2004. Similarly, DOE's budget justification for FY 2005 stated a goal of upgrading 25 SRF sites rather than the current 19; see U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation* (Washington, D.C.: DOE, 2004; available at http://www.mbe.doe.gov/budget/05budget/content/defnn/nn.pdf as of 17 February 2005), p. 446. The 19 sites are now described as those that "have been approved by the U.S. government for MPC&A upgrades." U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485. This suggests that six of the original 25 have not been approved for upgrades; part of the reason is likely to be that some SRF sites are closing as a result of ongoing arms reductions associated with the Moscow Treaty and previous accords.

[63] For the 42-site plan, see U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2005* (Washington, D.C.: DOD, 2004; available at http://armedservices.house.gov/issues/FY05CTR.pdf as of 2 March 2005), p. 41. The 150-210 sites estimate, for example, counts each individually secured perimeter, whether it is a fixed bunker or a location where warheads are temporarily stored, as a separate site.

[64] DOD's initial workplan called for upgrades at 123 sites, matching the Russian request for 123 sets of "quick fix" equipment. (Each set represents 1 kilometer of multiple-layer fencing, with sensors—there is no precise one-to-one correspondence between sets and sites, but it was expected that the number of sites would be similar to the number of sets requested.) Five of the Navy sites where DOE is upgrading security are within the original DOD list, as are the 19 SRF sites and the 12 12th GUMO sites; if these are subtracted from 123, this leaves 87 from the original list not covered by DOE, much more than the 42 sites DOD plans to upgrade. The difference could include: sites that have been closed or will soon be closed (Russia has indicated that reductions under the Moscow Treaty will lead to the closure of several sites); sites that the United States has decided not to offer assistance for; sites the Russian government has not requested assistance for; and varying definitions of "sites." The magnitude of the difference, however, does suggest that even when current DOE and DOD plans are completed, a significant number of the original list of 123 sites will not have received U.S.-sponsored security upgrades. In its FY 2004 report to Congress on threat reduction, DOD indicated that the Russian Ministry of Defense had provided a list of 52 nuclear weapon facilities where U.S.-provided equipment had been or would be used, including 15 large facilities with an average of 5 bunkers each (for a total of 75 bunkers at large facilities), and 37 smaller facilities with 1-2 bunkers each; hence the total for this database is in the range 112-149 sites. (This is merely sites that have received or are slated to receive equipment the United States provided to Russia, not a comprehensive list of all sites—but it is very consistent with the original 123-site plan.) See U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2004* (Washington, D.C.: DOD, 2003), p. 27. In the following year's report, DOD indicated that of the 52 storage facilities, when one subtracted out the Navy and SRF facilities that DOE will address, the sites that will not be upgraded because of the interagency decision on warhead-handling sites, and sites that were no longer in use because of Russian consolidation efforts, the latest DOD plan included only 32 facilities. See U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2005*, p. 57. In the report released in early 2005, this total number of nuclear weapon storage areas to receive upgrades had declined further, to 30 of the 52 areas identified by the Russian 12th GUMO. See U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, pp. 82-83. The further subtraction of two facilities may be the result of closure of some facilities, or of the new expectation that DOE will address some 12 12th GUMO sites (which may be located at only a couple of facilities).

[65] For analyses of the warhead consolidation issue, see Harold P. Smith, Jr., "Consolidating Threat Reduction," *Arms Control Today* (November 2003; available at http://www.armscontrol.org/act/2003_11/Smith.asp as of 22 March 2005); Gunnar Arbman and Charles Thornton, *Russia's Tactical Nuclear Weapons: Part II: Technical Issues and Policy Recommendations*, FOI-R-1588-SE (Stockholm: Swedish Defense Research Agency, 2005; available at http://www.foi.se/upload/pdf/FOI-RussiasTacticalNuclearWeapons.pdf as of 12 April 2005). The Arbman and Thornton paper provides an excellent up-to-date overview of policy issues related to Russia's tactical nuclear warhead stockpile and its security in general. On that topic, see also Anatoli Diakov, Eugene Miasnikov, and Timur Kadyshev, *Non-Strategic Nuclear Weapons: Problems of Control and Reduction* (Moscow: Center for Arms Control, Energy, and Environmental Studies, Moscow Institute of Physics and Technology, 2004; available at http://www.armscontrol.ru/pubs/en/NSNW_en_v1b.pdf as of 17 March 2005); Joshua Handler, "The September 1991 PNIs and the Elimination, Storing, and Security Aspects of TNWs" in *Time*

SRF sites where DOE is working (two of which have rapid upgrades installed); and upgrades have not yet begun for the 12th GUMO sites incorporated in DOE's plans.[66] In the DOD program, teams have visited 10 sites, and both vulnerability assessments and designs for comprehensive security upgrades have been completed for those sites. A large fraction of the equipment needed to upgrade those 10 sites has been ordered, but there has been no public statement that rapid upgrades (or initial "quick fix" equipment, as the first round of upgrades are usually described in the DOD program) have yet been installed at these sites.[67] In addition, Russia's Ministry of Defense has used its own funds to install U.S.-provided "quick fix" sets of security equipment—similar in some respects to what DOE calls "rapid upgrades"—at several dozen additional sites. The total number of sites with rapid upgrades or "quick fix" sets installed may be as high as 90-110.[68] This would represent roughly 50-60% of the total number of warhead sites.[69]

More elaborate comprehensive upgrades have been completed for thirteen Russian Navy sites, but no other warhead sites[70]—representing 6-9% of the total number of warhead sites.[71] There are 21 other naval sites where the U.S. government has concluded that only rapid upgrades are required, and those rapid upgrades are completed, so DOE counts these sites under its total of 34 completed Navy warhead sites.[72] If those are counted toward the total number of sites

to Control Tactical Nuclear Weapons (New York: United Nations, 2001; available at http://www.princeton.edu/~globsec/publications/pdf/untalk.pdf as of 29 March 2005); Allistair Millar, "The Pressing Need for Tactical Nuclear Weapons Control," *Arms Control Today* (May 2002; available at http://www.armscontrol.org/act/2002_05/millarmay02.asp as of 29 March 2005); William Potter et al., *Tactical Nuclear Weapons: Options for Control* (Geneva: United Nations Institute for Disarmament Research, 2000); William Potter and Nikolai Sokov, "Practical Measures to Reduce the Risks Presented by Non-Strategic Nuclear Weapons" (paper presented to the Weapons of Mass Destruction Commission, Stockholm, 2005; available at http://www.wmdcommission.org/files/No8.pdf as of 18 April 2005).

[66] Navy site information is from personal communication from DOE program official, February 2004. SRF and 12th GUMO data is from U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 483-487.

[67] U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 41.

[68] As of late 2003, the Russian Ministry of Defense had officially certified that 47 quick fix sets were installed, but had informally indicated that roughly half of the 123 sets of quick fix equipment had been installed. After discussions of U.S. support for installations of these sets began, the Russian Ministry of Defense largely stopped providing its own funds to install them. (Personal communication with DTRA official, February 2004.) Any additional sets that have been installed since then, therefore, would have been installed by the teams funded by the DOE and DOD programs. If it is still true that half are installed, this would be 61-62 sets, five of which were for Navy sites already covered in the 39 figure mentioned in the text. Hence this suggests that these quick fix sets were installed for roughly 50-60 non-Navy sites as of late 2003. It appears likely that in the DOE-funded work at SRF sites, or in the DOD-funded work at their initial sites, some number of additional sets—perhaps in the range of 10—have been installed since then, for a total that may now be in the range of 50-70 non-Navy sites with rapid or "quick fix" upgrades installed, along with 39 Navy sites.

[69] Some temporary warhead storage sites might not require permanent, fixed security equipment equivalent to the equipment provided in the "quick fix" sets, much less more elaborate comprehensive upgrades; other, rapidly deployable but temporary security measures may be appropriate for such sites. Hence an argument could be made that if these sites are excluded, the fraction of the remaining sites that really require the kind of upgrades represented by the "quick fix" sets which are already covered is higher than estimated here. But temporary sites certainly require some security upgrades, and there is currently no publicly available information suggesting that such temporary security measures have been provided for these types of temporary sites; thus the fraction of the total number of sites that have not yet been equipped with some type of upgrades is in the range described here. Only a few temporary sites outside DOE's Navy program have been a focus of attention to date, and all of the Navy sites are included within our estimates of the total sites upgraded.

[70] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485. While the DOE figures refer to 34 Navy sites as completed, 21 of these were judged only to require rapid upgrades, and hence did not receive comprehensive upgrades. Personal communication from DOE program official, February 2004. Similarly, the two SRF sites listed as completed in 2004 were judged only to require rapid upgrades, and hence did not receive comprehensive upgrades. Data provided by DOE, April 2005.

[71] As noted earlier in the discussion of rapid upgrades, some temporary sites may not be suitable for the kinds of fixed security upgrades envisioned in the "comprehensive upgrades" package for fixed warhead storage sites. If all of the estimated 40-60 temporary sites were considered unsuitable for comprehensive upgrades and subtracted from the estimated total of 150-210 sites, the 15 sites at which comprehensive upgrades have been completed would be 10-13% of the total where comprehensive upgrades are needed, rather than 7-10% of the total. It is unlikely, however, that 100% of the temporary sites are unsuitable for comprehensive upgrades.

[72] Personal communication from DOE program official, February 2004.

that have received all the upgrades they require, then that total is in the range of 15-25% of the total number of sites.

Rate of progress. During FY 2004, comprehensive upgrades were completed on four additional Navy sites.[73] DOD completed designs for comprehensive upgrades for 10 sites, and ordered much of the equipment that will be installed. It appears, in addition, that Russia has identified, and agreed to provide DOD teams access to, an additional six sites beyond the first ten.[74] There were substantial delays in the DOD program in the first half of 2004 because of limits on the funds that could be spent until agreement was reached on an amended agreement covering the work. Before signing an amended implementing agreement that would allow the expenditure of additional funds, DOD insisted that Russia agree that no U.S.-funded security upgrades would be provided for facilities that will close within the next few years; the United States and Russia did not sign an accord to that effect until July 2004.[75] Ironically, the new agreement—which the United States sought to avoid wasting money securing sites that were no longer going to be used—effectively prohibits Russia from consolidating warheads at a smaller number of sites (which it would be very much in the U.S. interest for Russia to do, to achieve more security at lower cost), at least if that involves removing them from sites that have received U.S.-funded security upgrades.[76]

Our estimate of the fraction of sites covered by rapid upgrades has increased modestly in the last year, from 50% to something in the range of 50-60%. For comprehensive upgrades, the six additional sites completed in FY 2004 represent an additional 3-4% of the total.

The pace for completing upgrades during FY 2005 is expected to be significantly higher. DOE plans to complete upgrades at 11 more sites (3 Navy and 8 SRF),[77] and it is reasonable to hope that some or all of the first 10 DOD sites will be completed as well. Overall, though, the timelines for completion remain long: DOE projects that it will take through FY 2007 to complete upgrades at the 19 SRF sites, and through FY 2012 to complete the 12 sites of the 12th GUMO where it expects to sponsor security upgrades—the latter pace largely determined by funding constraints. It appears that DOD's timeline is similar.[78] A substantial acceleration would be needed to complete upgrades at these sites by the end of 2008, as seemed to be envisioned in the Bratislava summit statement. To achieve such an acceleration would require rapid resolution of remaining access issues, more funding, and a sustained effort to overcome other constraints on the pace of work. As noted earlier, unless additional sites are added to current plans, even when those plans are complete there will still be a significant number of nuclear warhead sites in Russia that have not received U.S.-sponsored upgrades.

Securing Metric 4: Vulnerable Non-Russian Sites with Material Removed

Fraction accomplished. The problem of nuclear warheads and materials that may be vulnerable to theft, given today's terrorist and criminal threats, is not just

[73] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485. As noted earlier, only rapid upgrades were completed on two SRF sites in 2004.

[74] DOD reports that of the 42 sites where it plans to support upgrades, 26 are still dependent on Russia identifying and providing access to the sites, suggesting that Russia has so far identified and agreed to provide access to 16 sites. U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 41.

[75] For a mention of the signature of this agreement, see U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 38. Information on delays is from interviews with DTRA official, April and June 2004.

[76] For more discussion on Russian warhead consolidation, see Arbman and Thornton, *Russia's Tactical Nuclear Weapons: Part II: Technical Issues and Policy Recommendations*, pp. 63-72.

[77] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.

[78] DOE estimates are from U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485, supplemented with data provided by DOE, April 2005. This represents a significantly more pessimistic projection than the previous year, when DOE was not yet expecting to be working at 12th GUMO sites, but expected to finish all 25 SRF sites by the end of 2008. DOD's funding plans for the site security enhancements project appear to stretch to FY 2011. See U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 51.

a former Soviet Union problem, it is a global problem. The essential ingredients of nuclear weapons exist in more than 40 countries around the world. In some cases they are well secured, in other cases (such as at civilian research reactors fueled with HEU) they may have no more security than a night watchman and a chain-link fence.[79] Given that the world community is dealing with terrorists who have demonstrated global reach, and an ability to find and strike weak points on a global basis, the goal should be to make sure that every nuclear warhead and every kilogram of nuclear material worldwide is secure and accounted for, to a level adequate to defeat demonstrated terrorist and criminal capabilities.

There has been no global assessment of how much work would need to be done, and where, to reach that goal. With the size of the overall task undefined, it is particularly difficult to develop metrics for assessing progress in completing the task. Moreover, facilities outside the former Soviet Union are being addressed by a wide range of separate programs, some of which focus on reviewing and if necessary upgrading security at such facilities, while others focus on removing nuclear material from them entirely. Some countries have been very open to U.S. or international assistance in improving security for their facilities, while some key countries—particularly those with nuclear weapons programs shrouded in substantial secrecy, such as Pakistan, India, and Israel—have not been enthusiastic about intensive cooperation in this area.[80]

One metric that may be useful is the fraction of the sites identified by the U.S. government as high priorities for removing nuclear material entirely, from which the material has in fact been removed. In 2002, after the removal of 48 kilograms of 80% enriched HEU fuel from the Vinca facility in Yugoslavia, the U.S. State Department indicated that there were two dozen other sites around the world from which similar removal operations were planned.[81] Later discussions clarified that these were not necessarily the highest-priority sites in the world, but simply the sites with HEU that was Soviet-supplied, for which Russia, the United States, and the International Atomic Energy Agency (IAEA) had established a tripartite initiative to move the material back to Russia for secure storage and destruction.[82] It appears that as of the early 1990s, there were approximately 20-22 Soviet-supplied sites with HEU outside of Russia.[83] Since then, U.S.-funded efforts have removed all the HEU from two of these facilities (the Ulba facility in Kazakhstan, from which nearly 600 kilograms of HEU was airlifted in 1994, and a facility in Tbilisi, Georgia, whose HEU was airlifted to the United Kingdom in 1998), and all the fresh, unirradiated HEU has been removed from six more (Vinca, in Yugoslavia, in 2002; Romania and Bulgaria in 2003; and Libya, the Czech Republic, and Uzbekistan in 2004).[84] For these recent six sites, however, substantial quantities of irradiated HEU (most of it not sufficiently radioactive to pose any significant deterrent to theft) still remain.

[79] For a discussion, see Matthew Bunn, "The Global Threat," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/threat/global.asp as of 3 March 2005).

[80] See discussions in Matthew Bunn and Anthony Wier, "Removing Material from Vulnerable Sites," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/securing/vulnerable.asp as of 2 February 2005); Matthew Bunn, "International Nuclear Material Security Upgrades," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/securing/secure.asp as of 4 March 2005).

[81] Robert Schlesinger, "24 Sites Eyed for Uranium Seizure," *Boston Globe*, 24 August 2002.

[82] Interviews with U.S. State Department and IAEA officials, 2003.

[83] These include four sites at that time in Kazakhstan, three in Ukraine, and one each in Belarus, Bulgaria, the Czech Republic, Georgia, Germany, Hungary, Latvia, Libya, North Korea, Poland, Romania, Uzbekistan, Vietnam, and Yugoslavia. (We are not counting, here, the Sukhumi I. Vekhua Institute of Physics and Technology in Sukhumi, Abkhazia, from which HEU was apparently stolen some time after the Georgian civil war broke out in the 1990s. Since HEU is no longer located at that facility, it should not be counted against the total number for judging the fraction of facilities that have been addressed.) Some variations in figures may result from differing definitions of "sites" or "facilities" (in Libya, for example, there is both a research reactor and a critical assembly fueled with HEU at a single research institute, so they are counted by some as two facilities and by others as one site); other variations in figures may be caused by differing cutoff times for data.

[84] See discussion of these cases in Bunn and Wier, "Removing Material from Vulnerable Sites."

If, over-generously, all six of the recent sites are considered to have been fully addressed, then material has been removed from 8 of the original 20-22 sites, or 35-40% of the total. If, on the other hand, only those sites are counted where all HEU that poses a significant proliferation threat has been removed, only two sites have been completed, roughly 10% of the original total.

Of course, the Soviet-supplied sites are not the only sites in the world where there is dangerously vulnerable HEU. DOE's Global Threat Reduction Initiative (GTRI), launched in the spring of 2004 to accelerate the global effort to remove nuclear material from vulnerable sites (as well as securing material that cannot be removed, and reducing the risks from radiological sources around the world), has compiled data that indicates that worldwide, there are 128 research reactors or associated facilities where 20 kilograms or more of HEU is located.[85] Of these, 41 are fuel facilities rather than research reactors themselves.[86] If all facilities with at least five kilograms of U-235 contained in HEU were included (the international standard for the quantity requiring the highest levels of security), the total number of facilities worldwide would presumably be larger, but data on how much larger it would be has not been made public. It may be that the total would be only modestly larger than 128 (perhaps in the range of 140-160), as there would be no additional fuel facilities added by lowering the threshold, and most research reactors that have as much as five kilograms of HEU would be either higher-power facilities likely to have a total of more than 20 kilograms when irradiated fuel is included, or pulse reactors and critical assemblies that often also have more than 20 kilograms. A substantial fraction of the total, however, are facilities in the United States (where removals are usually counted in a separate category from international threat reduction efforts) or in Russia (where removals and security upgrades are already counted in the metrics relating to buildings and materials secured, described above); these two countries may account for half or more of the total.

During the period since U.S.-funded threat reduction efforts began, in addition to the removals from Soviet-supplied sites, there have been about a dozen U.S.-supplied sites from which all HEU has been removed, in addition to the two Soviet-supplied sites from which all HEU has been removed. Thus, we estimate that over the last decade and a half, all the HEU has been removed from approximately 10% of the total number of research reactors and associated facilities with dangerous quantities of HEU worldwide.

The metrics that DOE itself is using so far to judge GTRI's progress in removing HEU from vulnerable sites around the world are somewhat different. First, DOE tracks how many of a targeted list of HEU-fueled reactors have been converted to LEU (as of the end of FY 2004, 39 were listed as converted, but roughly 8 of these were actually still in the conversion process and therefore still had HEU in their core).[87] There are 91 reactors currently targeted for conversion in foreign countries, along with a number in the United States itself, for a total of 105 reactors that DOE hopes to convert by 2014—so the 39 converted or partially converted to date (stretching back to the origins of the conversion program in 1978) represent some 37% of the target group.[88] Of the converted reactors, 31 are fully converted, representing 30% of the targeted group.

DOE has not spelled out what incentives will be offered to convince the remaining reactors to convert to LEU, when many of them already have enough HEU to run for the lifetime of the reactor. As noted earlier, this focus on converting reactors tends to direct attention away from removing HEU from reactors that are already shut down; from difficult-to-convert reactors (some 56 HEU-fueled reactors worldwide are simply not on the list for conversion, and are rarely mentioned);[89] from

[85] U.S. Government Accountability Office, *DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium*, p. 28.
[86] Interviews with Argonne National Laboratory and DOE officials, February 2005.
[87] Data provided by DOE, April 2005.
[88] For the figure of 91 foreign reactors to be converted by 2014, see U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544. For 105 total reactors targeted, see, for example, U.S. Government Accountability Office, *DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium*.
[89] U.S. Government Accountability Office, *DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium*, p. 10.

encouraging reactors to shut down; and from removing HEU from non-reactor facilities.

Second, DOE tracks progress in returning Soviet-supplied HEU to Russia by the number of kilograms of HEU returned. By the end of 2004, 99 kilograms of HEU fuel had been returned to Russia, 7% of the 1,320 kilograms of Soviet-supplied HEU that DOE believes exist outside of Russia.[90] While the number of kilograms of HEU returned is a valuable number, it does not provide any insight into whether, for example, particular sites have had all the HEU that could readily be used for a bomb removed, or only a part of it, leaving enough behind to pose a serious proliferation risk; that is why we emphasize the number of sites with HEU removed.

Third, DOE tracks the progress of the effort to take back U.S.-supplied HEU by the total number of fuel assemblies returned to the United States. By the end of 2004, this figure stood at 6,344 assemblies returned since the take-back program was restarted in 1996, some 28% of the 22,743 assemblies DOE hopes to return to the United States by the extended deadline of 2019.[91] These include both LEU assemblies (from reactors that agreed to convert to HEU in the past or were designed from the outset to avoid the use of HEU) and HEU assemblies; indeed, the majority are LEU assemblies. By not distinguishing between HEU and LEU, this metric makes it difficult to discern how much of the proliferation threat has been reduced, and like the metric for the Russian take-back effort, it obscures the issue of how many sites have had all of their HEU removed. As of the end of FY 2004, the assemblies that had been returned contained approximately 1.2 tons of HEU, some 7% of the 17.5 tons of U.S.-supplied HEU abroad when the take-back effort restarted in 1996.[92] Two-thirds of that 17.5 tons is not even covered by the U.S. offer to take back U.S.-supplied HEU, though DOE is currently considering expanding the offer to cover some or all of this material. Independent studies have indicated that unless DOE offers greater incentives for facilities to return their HEU to the United States, roughly half the material this is covered by the take-back offer is not likely to be returned.[93] DOE has not yet spelled out what additional incentives it may be prepared to offer.

Rate of progress. During 2004, all of the fresh, unirradiated HEU was removed from three Soviet-supplied sites—Libya, the Czech Republic, and Uzbekistan. Hence, more than a third of all the removals of HEU from Soviet-supplied sites in the past 15 years occurred during 2004. With the establishment of GTRI, DOE hopes to further accelerate such removals. DOE has publicly indicated that it plans to complete removals of all fresh, unirradiated Soviet-supplied HEU from countries outside of Russia by the end of 2005.[94] This very challenging deadline is extremely unlikely to be achieved. A variety of groups in Ukraine and Belarus appear to be opposed to giving up the HEU at these countries' facilities under present circumstances—despite studies underway that demonstrate that proposed new facilities to use these materials at some sites could use LEU instead, and despite considerable U.S. efforts to arrange for the removal of the HEU at these facilities.[95] Studies now underway on the feasibility of converting Kazakh research reactors to LEU may help convince Kazakhstan that its HEU is not required for future

[90] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.
[91] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.
[92] Interview with Argonne National Laboratory expert, February 2005. For the 17.5 tons figure, see, for example, U.S. Department of Energy, Office of the Inspector General, *Audit Report: Recovery of Highly Enriched Uranium Provided to Foreign Countries*, DOE/IG-0638 (Washington, D.C.: 2004; available at http://www.ig.doe.gov/pdf/ig-0638.pdf as of 3 March 2005). See also U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia*, GAO-05-57 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d0557.pdf as of 2 February 2005). These figures on tons of HEU refer to the tons of HEU the fuel contained when it was originally shipped from the United States; after irradiation, the number of tons of HEU remaining is significantly less.
[93] U.S. Department of Energy, *Audit Report: Recovery of Highly Enriched Uranium Provided to Foreign Countries*. See also U.S. Government Accountability Office, *DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium*.
[94] Abraham, "International Atomic Energy Agency, Vienna: Remarks Prepared for Energy Secretary Spencer Abraham."
[95] Interviews with DOE officials, and personal communication from William Potter, both April 2005.

research reactor fuel, but removal of the HEU from Kazakhstan is not likely to occur by the end of 2005 either.[96] Nevertheless, removals of fresh Soviet-supplied HEU from facilities in several countries are planned during 2005.[97] Substantial packages of positive and negative incentives, pursued at high levels with considerable creativity and perseverance, are likely to be necessary to achieve the goal of removing all fresh HEU from Soviet-supplied facilities within the next few years.

Substantial quantities of irradiated HEU remain in each of the three Soviet-supplied countries whose fresh HEU was removed in 2004. But 2004 also saw substantial progress in resolving the bureaucratic obstacles within Russia that have so far prevented shipments of irradiated HEU back to Russia. The first shipment of irradiated HEU back to Russia is expected by the end of 2005 (although this expectation may slip, as it has several times before), and after that shipment DOE hopes that it will be possible to carry out subsequent shipments relatively rapidly.[98] DOE has stated that it plans to return all irradiated Soviet-supplied HEU to Russia by 2010. Achieving that objective will require Russia to work quickly through the bureaucratic procedures for each shipment, and may require additional transport casks.

In the U.S. take-back effort, DOE expects to return fewer than 400 fuel assemblies to the United States in FY 2005. The U.S. HEU take-back is not expected to be completed until 2019,[99] and it remains unclear how much of the U.S.-supplied HEU still abroad will be returned by then. DOE expects to convert five additional HEU-fueled reactors in FY 2005 (none were converted in FY 2004),[100] but this goal appears challenging. The effort to convert the 105 targeted reactors is not expected to be completed until 2014.[101]

Improved Securing Metrics for the Future

In essence, there are three goals that programs to improve nuclear security must achieve:

- Security must be improved fast enough, so that the security improvements get there before thieves and terrorists do.
- Security must be raised to a high enough level, to make sure that the threats terrorists and criminals have shown they can pose to such sites can be defeated.
- Security must be improved in a way that will last, including after foreign assistance phases out, so that these sites do not become vulnerable again in a few years' time.

There are clearly tensions among these three goals: putting in place security systems to defeat larger threats, and security systems that will stand the test of time, inevitably takes longer than slapping together less capable and long-lasting systems. Yet meeting all three goals is essential if the objective of keeping nuclear weapons and materials out of terrorist hands is to be met. The metrics discussed in this section really focus only on the first goal, and hence are inevitably incomplete. Moreover, the metrics in this section do not reflect a great deal of other crucial work that is now underway, including an extensive training program to provide qualified personnel for all aspects of nuclear material security, control, and accounting (including in the key elements of security culture); work with Russian regulators to put in place an effective regulatory program that will give facility managers strong incentives to provide good security; investments to ensure that nuclear material is secure during transport; new computerized national-level

[96] Interviews with State Department and DOE officials, January 2005.
[97] Interviews with DOE officials, April 2005.
[98] Rosatom and its contractors completed the legally required environmental assessment and project plans in late 2004, and submitted them to Russian regulators; as of the spring of 2005, these documents are still being reviewed. The first shipment of irradiated HEU should be possible to organize within a very few months of the regulators' approval. Interviews with DOE officials, January and April 2005.
[99] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.
[100] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.
[101] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 544.

systems for real-time accounting for nuclear warheads and materials; programs to improve personnel reliability checks for people involved in managing or guarding nuclear warheads and materials; and more.

Moreover, even for assessing whether security is improving fast enough, looking only at how many sites, or how much material, is equipped with modern security and accounting equipment tells only part of the story. General Eugene Habiger, former "security czar" at DOE's nuclear weapons complex and former commander of U.S. strategic nuclear forces, has said: "good security is 20% equipment and 80% culture."[102] Assessing how well programs are doing in changing the crucial "security culture" at these facilities—that is, the degree to which all of the personnel at the site are trained and motivated to maintain high security at all times—is extremely difficult to do, but extremely important.

Ultimately, a balance of a variety of different measures will be needed to get a realistic picture of how much nuclear security is improving. For assessing progress toward sustainable security over time, plausible metrics might include:

- **The fraction of sites with nuclear security and accounting systems that are performing effectively**. The best single such measure would be one that was performance-based: the fraction of the buildings containing warheads or nuclear material that had demonstrated, in realistic performance tests, the ability to defend against a specified threat. Unfortunately, for nuclear warheads and materials in the former Soviet Union, such data does not yet exist (and even less data of this kind is available for nuclear stockpiles in much of the rest of the world). Another indicator of effective performance—if nuclear regulatory authorities have set effective nuclear security rules, and have effective inspection approaches in place—would be the fraction of facilities that receive high nuclear security marks in regulatory inspections.[103] An even more ambitious approach would be to attempt to assess the overall risk of theft at each site, and then track whether these risks were increasing or decreasing, and by how much. At DOE's own facilities, each facility is required to perform such estimates of overall risk, based on the security system's assessed ability to defeat a specified design basis threat, and on the quantity and quality of nuclear material at the site. If recipient countries undertook similar approaches (possibly with U.S. assistance in doing so), it might be possible to collect at least partial data on whether these overall assessments of risk were increasing or decreasing, and how substantially. Yet another approach would be to assess, for each site, performance in a broad range of areas important to nuclear security and accounting, and then use some form of weighting (based on expert judgment) to provide an overall performance rating—and then track changes in the overall performance rating at different sites.[104]

- **The priority the recipient state's government assigns to nuclear security and accounting.** This could be assessed by senior leadership attention and resources assigned to the effort, along with statements of priority, decisions to step up nuclear security requirements, and the like.

- **The presence of stringent material protection, control, and accounting (MPC&A) regulations that were effectively enforced**. The effectiveness of regulation of nuclear security and accounting could be judged by whether (a) rules have been set which, if followed, would result in effective nuclear security and accounting programs; and (b) approaches have been developed and implemented that successfully convince facilities to abide by the rules to a degree sufficient to achieve that objective. This would have to be done by expert assessment, rather than objective counting of a specific number of regulations written, enforce-

[102] Interview, April 2003.

[103] DOE uses this metric to track the performance of its own nuclear security program. See U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 116.

[104] An approach of this kind was developed at Lawrence Livermore National Laboratory some years ago for use in the MPC&A program, but was never accepted for broad implementation.

ment actions taken, and the like, as such measures of the *quantity* of regulatory action are usually almost unrelated to the actual *effectiveness* of regulation.[105] Surveys of managers and other personnel at nuclear sites about their experience with regulators and inspectors, and with enforcement and other approaches to encouraging compliance, could also be helpful in assessing the effectiveness of regulations.

- **The fraction of sites with long-term plans in place for sustaining their MPC&A systems, and resources budgeted to fulfill those plans.** DOE's MPC&A program has been contracting with facilities to develop cost estimates and plans for maintaining and operating their nuclear security and accounting systems. This metric would assess the fraction of sites that have completed that task, and which appear to have a realistic plan for funding those costs without international assistance, once international assistance comes to an end. A simple metric along the same lines would be the total amount of money a particular country (or facility) is investing in nuclear security and accounting, compared with an assessment of overall needs. (Similar estimates could be made for personnel resources as well as financial resources.)

- **The presence of strong "security cultures."** Effective organizational cultures are notoriously difficult to assess, but critically important. Ideally, nuclear security culture should be measured by actual day-in, day-out behavior—but developing effective indicators of day-to-day security performance has proved difficult. Potential measures of *attitudes* that presumably influence behavior include the fraction of security-critical personnel who believe there is a genuine threat of nuclear theft (both by outsiders and by insiders), who understand well what they have to do to achieve high levels of security, who believe that it is important that they and everyone else at their site act to achieve high levels of security, who understand the security rules well, and who believe it is important to follow the security rules. Such attitudes could be assessed through surveys, as is often done to assess safety culture—though enormous care has to be taken in designing the specifics of the approach, to avoid employees simply saying what they think they are supposed to say.[106]

- **The presence of an effective infrastructure of personnel, equipment, organizations, and incentives to sustain MPC&A**. Each of these areas would likely have to be addressed by expert reviews, given the difficulty of quantification.

In 2001, DOE's MPC&A program took a first cut at the complex task of developing appropriate metrics to assess the real state of progress toward achieving sustainable security at these sites for the long term.[107] The program is now putting a substantial focus on progress toward strong security cultures and long-term sustainability as part of developing a new strategic plan. But there is still more to be done to develop performance measures that adequately reflect the real state of progress, but are simple enough to be useful to policymakers.

Tracking Progress: Interdicting Nuclear Smuggling

Key developments related to interdicting nuclear smuggling in the year since our previous report included:

- Building on the publicized cooperative interception of a shipment of centrifuge parts to Libya that helped expose the proliferation network of Pakistan's Abdul Qadeer Khan, the Proliferation Security Initiative (PSI) took several more important steps

[105] Sparrow, *The Regulatory Craft: Controlling Risks, Solving Problems, and Managing Compliance*.

[106] For a brief discussion of such safety culture surveys, see International Atomic Energy Agency, *Safety Culture in Nuclear Installations: Guidance for Use in the Enhancement of Safety Culture*, IAEA-TECDOC-1329 (Vienna: IAEA, 2002; available at http://www-pub.iaea.org/MTCD/publications/PDF/te_1329_web.pdf as of 28 March 2005).

[107] U.S. Department of Energy, *MPC&A Program Strategic Plan* (Washington, D.C.: DOE, 2001; available at http://www.nti.org/e_research/official_docs/doe/mpca2001.pdf as of 7 March 2005), pp. 26-28.

forward. On top of a February 2004 agreement with Liberia, the United States added ship-boarding agreements with two other countries commonly used by shippers as flags of convenience, Panama (May 2004) and the Marshall Islands (August 2004). The agreements allow the United States, or a PSI partner-state through the United States, to quickly request permission from these countries to stop and search suspect shipments. PSI nations collaborated in several exercises to practice and improve interdiction capabilities at sea, in the air, and over land. Sixty countries have expressed their formal diplomatic support for the Initiative and have participated in some way in PSI activities.[108] In early 2005, UN Secretary-General Kofi Annan said "I applaud the efforts of the Proliferation Security Initiative to fill a gap in our defenses," reflecting the growing international support for the effort.[109]

- By early 2005, U.S. officials testified that all international mail entry points in the United States had equipment to detect nuclear and radiological materials in place, along with most of the major crossings on the U.S.-Canada border. In the FY 2006 budget request released in February 2005, the Bush administration asked for $227 million for a new Domestic Nuclear Detection Office (DNDO) in the Department of Homeland Security, to consolidate efforts focused on nuclear detection at U.S. borders and within the country.[110]

- UN Security Council Resolution 1540 included a legal obligation for every UN member state to put in place "appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat" illicit trafficking in nuclear material and other items related to weapons of mass destruction, along with effective controls on transshipment of such items through each country.[111] As in the case of nuclear security, however, no government or international organization has yet outlined specifically what the essential elements of an effective border control system to prevent such illicit trafficking are, or launched a major effort to help states implement this portion of the resolution.

- As part of the Megaports Initiative, the United States signed new agreements with Sri Lanka (Colombo), Belgium (Antwerp), Spain (Algeciras), the Bahamas (Freeport), and Singapore to install nuclear material detection equipment at major ports to inspect containers being shipped to the United States.[112]

- A 2005 Government Accountability Office report concluded that any overlap in the provision of radiation detection equipment that GAO aired in a 2002 report had largely been resolved by a new arrangement that made the Department of Energy's Second Line of Defense program primarily responsible for portal monitor installation and maintenance. The report nevertheless expressed concern that there was still no government-wide strategic plan delineating the roles or responsibilities of the various agencies working to interdict

[108] See U.S. Department of State, "Proliferation Security Initiative" (Washington, D.C.: U.S. Department of State, no date; available at http://www.state.gov/t/np/c10390.htm as of 1 March 2005).

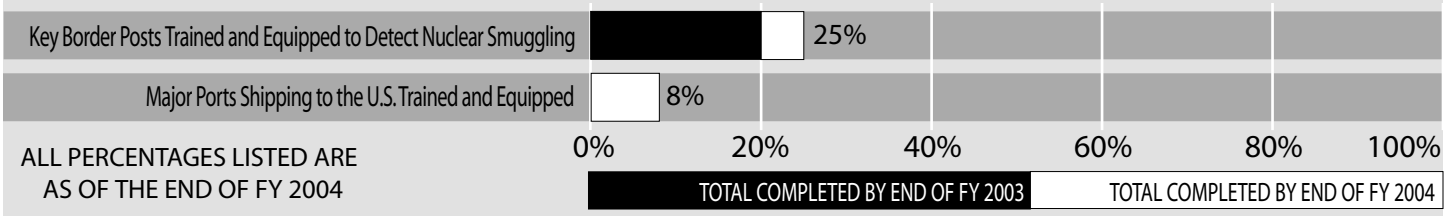
[109] Kofi Annan, "A Global Strategy for Fighting Terrorism: Keynote Address to the Closing Plenary" in *International Summit on Democracy, Terrorism and Security* (Madrid: Club de Madrid, 10 March 2005; available at http://english.safe-democracy.org/keynotes/a-global-strategy-for-fighting-terrorism.html as of 10 March 2005).

[110] On radiation portal monitors, see Committee on Appropriations, Homeland Security Subcommittee, *Chairman Holds a Hearing on Fiscal Year 2006 United States Citizenship and Immigration Services, Customs and Border Protection and Immigration and Customs Enforcement Appropriations - Committee Hearing*, United States Senate, 109th Congress, 1st Session (2 March 2005). On the DNDO, see Committee on Science, *U.S. Representative Sherwood L. Boehlert (R-NY) Holds Hearing on Fiscal Year 2006 Federal Research and Development Budget - Committee Hearing*, United States House of Representatives, 109th Congress, 1st Session (16 February 2005).

[111] United Security Council Resolution 1540 can be found at United Nations, "1540 Committee."

[112] "Nuclear Snoopers to Protect Algeciras," *Lloyd's List* (23 December 2004); "U.S. And Belgian Governments Launch Initiative to Detect Illicit Trafficking of Nuclear Material" (Brussels, Belgium: U.S. Newswire, 24 November 2004); Neelam Mathews, "Sri Lankan Port to Deploy Radiation Detection Equipment," *Homeland Security & Defense* (1 September 2004); Brian Reyes, "Bahamas Signs US Anti-Nuclear Treaty," *Lloyd's List*, 20 January 2005; David Boey, "Radiation Detectors for Singapore Port," *Straits Times*, 11 March 2005.

Figure 3-3
How Much Interdicting Work Have U.S.-Funded Programs Completed?



nuclear smuggling, and that interagency coordination and oversight was still lacking.[113]

Developing metrics for the goal of interdicting nuclear smuggling is difficult, as many different elements are essential to accomplishing the overall goal. These include, among other steps, providing adequate capabilities to detect nuclear materials being smuggled across borders; establishing appropriate police and intelligence units in the relevant countries that are trained and equipped to deal with nuclear smuggling cases; creating stronger legal infrastructures so that nuclear thieves and smugglers face a greater chance of a larger punishment; expanding international intelligence and police cooperation focused on finding and arresting those involved in nuclear smuggling; and carrying out stings and other operations designed to break up nuclear smuggling rings and make it more difficult for thieves and buyers to reliably connect with each other.[114]

Two steps that are necessary but not sufficient to accomplishing the goal are to ensure that:

- at least the most critical border crossings in the key source and transit states for nuclear material have personnel trained, and equipment designed, to detect smuggled nuclear materials; and
- major ports and other locations shipping cargo to the United States, and major ports and other entry points into the United States, are equipped to be able to detect smuggled nuclear weapons or materials.

Measuring progress in these two areas provides a rough guide as to how much of at least the initial steps in addressing nuclear smuggling has been accomplished (see Figure 3-3).

Interdicting Metric 1: Key Border Posts Trained and Equipped to Detect Nuclear Smuggling

Fraction accomplished. Understanding how many sites should be considered high priorities for installing nuclear detection equipment is itself a difficult task. Originally, DOE's Second Line of Defense program targeted nearly 60 border crossings in Russia alone. The Departments of Defense and State were providing funding for installation of similar equipment in other countries judged to be key source or transit states for nuclear smuggling.[115] When the Second Line of Defense effort expanded geographically, and went further down the priority list, they concluded that 393 sites in Russia and 21 nearby countries would ultimately require installation of equipment to detect nuclear smuggling; as DOE refined its threat assessment and plans, that figure was later reduced to 293,

[113] U.S. Government Accountability Office, *Nonproliferation Programs Need Better Integration*. For the 2002 report, see U.S. Government Accountability Office, *Nuclear Nonproliferation: U.S. Assistance Efforts to Help Other Countries Combat Nuclear Smuggling Need Strengthened Coordination and Planning*, GAO-02-426 (Washington, D.C.: GAO, 2002; available at http://www.gao.gov/new.items/d02426.pdf as of 1 March 2005).

[114] For a discussion, see, for example, Anthony Wier, "Interdicting Nuclear Smuggling," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/interdicting/index.asp as of 1 March 2005).

[115] U.S. Government Accountability Office, *U.S. Assistance Efforts to Help Other Countries Combat Nuclear Smuggling Need Strengthened Coordination and Planning*, p. 6.

and then increased back to 330.[116] By the end of FY 2004, DOE had completed providing equipment and training for 64 "core" Second Line of Defense program sites (excluding two megaports, which are noted below).[117] DOE has also taken over maintenance of equipment installed in State Department-sponsored efforts at an unknown number of sites in 22 countries. The Department of Defense's International Counterproliferation Program and Weapons of Mass Destruction Proliferation Prevention Initiative are also providing equipment to improve proliferation controls at borders at an unknown number of sites in Uzbekistan and Ukraine, in cooperation with DOE's Second Line of Defense.[118] All told, it appears likely that the fraction of the identified set of priority border crossings that have been provided with appropriate equipment and trained personnel is in the range of 25%.[119]

Rate of progress. In most cases, U.S. nuclear smuggling interdiction programs generally have had excellent cooperation with recipient states, though DOE reported that during FY 2004, Second Line of Defense work was delayed by difficulties reaching implementing agreements with Ukraine, Kazakhstan, and Slovenia. DOE's Second Line of Defense program had intended to complete 32 sites in FY 2004, a substantial increase in pace over the 19 installed the previous year. By the end of FY 2004, however, DOE only managed to install equipment at 25 border crossing sites (20 in Russia, 1 in Lithuania, and 4 in Greece).[120] DOE expects to complete installation at the 330 currently targeted sites by 2012.[121] It appears that the State Department is no longer separately installing radiation portal monitors at borders, and that the number of sites where installation will be funded by DOD will be small compared to the number of sites the DOE program plans to cover.

As with securing weapons or materials, just because a site has U.S.-provided equipment and training does not mean that it is necessarily invulnerable to nuclear smuggling. Equipment must be maintained and used effectively, and border officials must be honest and alert, for illicit nuclear shipments to be stopped. In many countries, for example, corruption among customs officials is widespread (though many nuclear detector installations attempt to address this problem, for example by having the sensors give their readings not only to an on-site official who might be easily bribed, but to a central station as well).

It is also important to remember that just because a site does not yet have U.S.-supplied equipment and training does not necessarily mean it has no equipment and training. A number of countries around the world are initiating nuclear smuggling interdiction efforts of

[116] This figure represents the total set of sites that are to be equipped with radiation detection equipment—though there are some additional border crossings in these key countries that are not included. Interviews with DOE officials, February 2003, and data provided by DOE, April 2005. The first figure (393) is from U.S. Department of Energy, *FY 2004 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation* (Washington, D.C.: DOE, 2003; available at http://www.cfo.doe.gov/budget/04budget/content/defnn/nn.pdf as of 1 March 2005), p. 658. The second (293) is from U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*. The most recent revision is from U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485. The recent revisions do not specify the number of countries where these sites exist.

[117] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 137.

[118] For the International Counterproliferation program in Uzbekistan, see *Strategic Plan for Nonproliferation Export Control and Related Border Security Assistance in Eurasia* (Washington, D.C.: U.S. Department of State, unpublished, 2003). For the Weapons of Mass Destruction Proliferation Prevention Initiative (WMD-PPI) programs in Ukraine and Uzbekistan, see U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, pp. 60-62. The CTR Annual Report mentions ten locations receiving assistance in Uzbekistan and three in Ukraine from WMD-PPI. DOD will not install any portal monitors in Ukraine (leaving that to DOE), and any portal monitors installed in Uzbekistan will be maintained by DOE beginning in FY 2006. Data provided by DOE, April 2005.

[119] This estimate assumes that the 330 figure represents a good estimate of the total number of sites to be covered by all agencies, not just the number to be covered by DOE.

[120] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 137.

[121] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*.

their own, and donors other than the United States are funding at least limited assistance programs.

Interdicting Metric 2: Major Ports Shipping to the United States Trained and Equipped to Detect Nuclear Smuggling

Fraction accomplished. The United States, in the aftermath of the September 11 attacks, has attempted to "push the borders out" with programs designed to make sure that cargo is examined appropriately before it ever reaches U.S. shores.[122] This is particularly important in the case of possible smuggling of a crude nuclear bomb: inspections after the ship holding the bomb has already arrived at the port in New York or Los Angeles or other U.S. cities could be too late, with the bomb detonating before the inspection occurred and causing horrifying damage. Hence, the U.S. government has launched a "Megaports Initiative," in support of the broader "Container Security Initiative," to equip with radiation detection equipment those ports that generate particularly large volumes of shipping headed for the United States or that DOE believes might otherwise be particularly attractive for nuclear smugglers (the current DOE target is 24 ports).[123] In 2004, DOE completed installation of radiation detection equipment at the first two ports: Rotterdam in the Netherlands and Piraeus in Greece, representing some 8% of the total number of megaports planned to be covered.[124]

Rate of progress. DOE expected to have nuclear detection at 3 of the 24 megaports targeted operational by the end of FY 2004, but it was only able to complete installation at 2 ports. DOE explained that commitments by foreign governments to specific agreements to complete the work were taking longer than anticipated, though implementing agreements have now been signed to work with five other ports: Colombo (Sri Lanka), Antwerp (Belgium), Algeciras (Spain), Freeport (Bahamas), and Singapore.[125] DOE now expects to complete installations at another three ports in FY 2005, and five more in FY 2006, bringing the total by that date to ten ports. Barring any expansion of the number of targeted sites, DOE anticipates completing radiation detection equipment installations at the 24 targeted ports by 2012.[126]

Of course, there are far more than 24 ports that ship cargo to the United States, and some of these other sites may also pose significant risks. Radiation detection equipment and procedures are not invisible, and intelligent smugglers can be expected to take note of which sites are and are not searching most cargo for radiation. As before, sites with such equipment and training provided are also not necessarily proof against nuclear smuggling. And again, sites without U.S.-funded equipment and training may well have at least a modest level of equipment and training already available (for example hand-held detectors that can be used in searching a container identified as suspicious for other reasons). Ultimately, a full system of container security is needed, from where the containers are first loaded to when they reach customers in the United States—and even with such a system in place, there are many other pathways into the United States that may be even more difficult to address (as evidenced by the thousands of illegal aliens and thousands of tons of illegal drugs that cross U.S. borders every year).

Improved Interdicting Metrics for the Future

As noted above, interdicting nuclear smuggling requires a broad complex of activities, many of which

[122] U.S. Department of Homeland Security, *A National Cargo Security Strategy White Paper*, Draft Version 1.8 (Washington, D.C.: DHS, 2004; available at http://www.homelandsecurity.org/bulletin%2FImagesJC%2FDHS%20Conference%20Dec%202004/National_Cargo_Security_Strategy_White_Paper.pdf as of 1 March 2005).
[123] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 490.
[124] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*.
[125] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*; "U.S. And Bahamian Governments to Cooperate on Detecting Illicit Shipments of Nuclear Material - Bahamas to Become First Caribbean Country to Use Detection Equipment" (Nassau, Bahamas: U.S. Department of Energy, 11 January 2005; available at http://www.energy.gov as of 15 April 2005); Mathews, "Sri Lankan Port to Deploy Radiation Detection Equipment"; "U.S. And Belgian Governments Launch Initiative to Detect Illicit Trafficking of Nuclear Material"; "Nuclear Snoopers to Protect Algeciras," *Lloyd's List*; Boey, "Radiation Detectors for Singapore Port."
[126] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.

are not included in a metric focused on the fraction of key border sites trained and equipped to detect nuclear contraband. In particular, official border crossings are only a tiny fraction of the thousands of miles of border across which nuclear material might be smuggled, and many seizures of stolen nuclear material have occurred within countries, not at borders, as a result of effective police and intelligence work. Neither of these factors is captured in these metrics. (U.S. programs do in some cases provide mobile detection equipment and training with national applicability.)

Hence, we believe the U.S. government should also track measures including both the fraction of countries considered key source or transit countries that have at least one unit of the national police trained and equipped to deal with nuclear smuggling cases (and which have informed the rest of the nation's law enforcement personnel about how to involve that unit when such a case arises), and the fraction of those key source or transit countries that have established in-depth intelligence and law enforcement sharing on nuclear smuggling with the United States, with each other, and/or with international agencies. As with securing nuclear stockpiles, measures of actual effectiveness would be even more telling indicators of how much real progress had been made. In the United States, for example, security at airports is often checked by government testers attempting to smuggle knives, guns, or explosives through security checkpoints. One could imagine contracting for testers to attempt to smuggle nuclear material through border crossings that had been equipped with radiation detectors, and tracking the percentage of the time they were detected as one measure of progress. At the national level, an interesting measure of effectiveness to track would be the percentage of nuclear or radiological smuggling cases in which all the conspirators were identified and brought to justice , though these cases, fortunately, are rare enough in any particular country that this percentage might vary randomly a great deal.

In a related vein of attempting to track overall effectiveness at the national level, the State Department's Export Control and Related Border Security (EXBS) Assistance program, beginning in FY 2003, has worked with the University of Georgia's Center for International Trade and Security, a research group known for its focus on national export controls, to assess annually the export control systems of each government receiving assistance from the EXBS program.[127] By the end of FY 2004, this exercise had judged that the export control systems in Poland, Hungary, and the Czech Republic met "international standards," allowing those countries to "graduate" from the State Department export assistance program. By the end of FY 2005, the State Department expects that the export control systems of two more countries will reach the international level. Two more are expected to do so by the close of FY 2006.[128] DOE's International Nonproliferation Export Control Program, whose export control assistance complements the EXBS effort, also prepares assessments of national export control capabilities.

Given the many dimensions of an effective national export control system, these assessments are necessarily complex, and appear to focus primarily on the degree to which various elements judged to be essential to an effective overall system are present.[129] It is unlikely that the data or the resources have been available to perform realistic evaluations of on-the-ground effectiveness (for example, how often, when an exporter is approached about an export that would require a license or would be forbidden to export, the exporter is aware of the rules and abides by them, or how often illicit exports are successfully

[127] U.S. Office of Management and Budget, "Department of State and International Assistance Programs," in *Budget of the United States Government: Fiscal Year 2006—Program Assessment Rating Tool* (Washington, D.C.: OMB, 2005; available at http://www.whitehouse.gov/omb/budget/fy2006/pma/state.pdf as of 1 March 2005), pp. 116-125.

[128] U.S. Department of State and U.S. Agency for International Development, "Strategic Goal 4: Weapons of Mass Destruction," p. 106.

[129] For a discussion of an early version of the University of Georgia's approach to evaluating export control systems, see Gary Bertsch and Michael Beck, *Nonproliferation Export Controls: A Global Evaluation* (Athens, Georgia: Center for International Trade and Security, The University of Georgia, 2000; available at http://www.uga.edu/cits/documents/html/nat_eval_execsumm.htm as of 7 March 2005).

stopped). Nevertheless, putting together such an overall assessment of national systems is a commendable step forward compared to simply counting the number of sites where particular types of equipment is deployed.

Systems to block nuclear smuggling are focused on the enforcement subset of the overall export control system. Blocking nuclear smuggling focuses more on catching activity the perpetrators know is illegal than on making sure that legal exporters understand the rules and constraints under which they must operate. Similar national assessments of countries' ability to effectively enforce export control laws, particularly including the ability to interdict nuclear smuggling, should be an integral component of future assessments of national export control systems. Widely publicizing the full results of each year's assessment might not be appropriate because it might highlight specific, exploitable deficiencies in particular countries' systems, but releasing summary evaluations of the performance of countries' efforts to stop nuclear smuggling systems should not pose any significant risk. At an absolute minimum, relevant policymakers in the executive and legislative branches should have access to the assessments, and, as a management tool, should examine links between countries' year-to-year performance on the assessment and the resources spent in those countries.

Tracking Progress: Stabilizing Employment for Nuclear Personnel

Key developments in this area in the past year included:

- The Russian government decided to cut off federal subsidies for the administrative budgets of Russia's closed nuclear cities beginning in 2006. The move sparked protests by residents and municipal workers in some of the closed cities, including Snezhinsk, home of one of Russia's two principal nuclear weapons design laboratories, and Seversk, home of another large plutonium and HEU processing site. At Zheleznogorsk, a closed city housing a major plutonium production site, the federal subsidies that will be ended amount to 60 percent of the city's 1.8 billion ruble budget. Zheleznogorsk's mayor warned that "we have no idea at all how the budget will be filled… A starving operator of a nuclear power unit is more dangerous than any terrorist."[130] Unless new policies are put in place to effectively replace the subsidies in a timely way, the move will certainly increase the challenges faced by programs working to stabilize the economic situation of experts housed in these cities.

- The United States continued efforts to work with former WMD scientists in Iraq and Libya, out of fear that scientists might be recruited by other proliferating states or non-state groups.[131] Both DOE and the State Department contributed to efforts to redirect former weapons scientists to beneficial civilian work and, particularly in Iraq, to provide a minimum level of subsistence to scientists who might otherwise be tempted to sell their knowledge to other parties. To reflect the program's wider scope, DOE changed the name of its main weapons personnel redirection effort from the Russian Transition Initiatives—which housed both the Nuclear Cities Initiative (NCI) and the Initiatives for Proliferation Prevention (IPP) program—to the Global Initiatives for Proliferation Prevention. The administration has estimated that in Iraq some 500 scientists and an additional number of skilled technicians with some WMD-related knowledge are worthy of assistance, while the administration is targeting assistance at about 150 key personnel and 1,500 support personnel in Libya.[132] These efforts appear to have got

[130] "Protest Picket in Snezhinsk (Russian)," trans. A. Deyanov, Department of Energy, *UralPressInform*, 22 December 2004.

[131] Paul Kerr, "Did Iraqi Materials, Experts Escape?" *Arms Control Today* (November 2004; available at http://www.armscontrol.org/act/2004_11/Iraqi_Materials.asp as of 3 March 2005); Mark Trevelyan, "German Spy Chief Sounds Alarm on Iraq WMD Experts," *Reuters News*, 7 October 2004.

[132] State Department estimates are in U.S. Department of State, *FY 2006 Congressional Budget Justification for Foreign Operations* (Washington, D.C.: U.S. Department of State, 2005; available at http://www.state.gov/documents/organization/42245.pdf as of 3 March 2005), pp. 136-137. DOE also discusses its cooperation in U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 450,472.

off to a delayed start, and the efforts in Iraq have struggled with security concerns for participants and program officials.[133]

- In Russia, despite the September 2003 expiration of the U.S.-Russian Nuclear Cities Initiative implementing agreement, DOE continued to carry out NCI projects through the International Science and Technology Centers (ISTC) in Moscow and the Ukraine or the Civilian Research and Development Foundation (CRDF). The Nuclear Cities Initiative is planning to largely phase out its assistance for projects in Sarov and Snezhinsk and shift attention to Seversk and Zheleznogorsk, particularly to help the transition of these cities as the United States works to shutdown the plutonium production reactors in Seversk and Zheleznogorsk.[134] Estimates suggest that some 6,000 workers could be made excess through the shutdown of the final plutonium production reactors and their associated reprocessing infrastructure.[135]

- Programs focused on redirecting Russian nuclear and other WMD scientists received expanded support from others in the G8 Global Partnership, including Canada, the United Kingdom, and the European Union. Canada formally joined the governing board of the International Science and Technology Centers in Moscow and Ukraine; the United Kingdom, meanwhile, focused projects on the closed nuclear city of Seversk.[136]

As we have discussed in previous reports, developing metrics for assessing how much has been done to stabilize the personnel with access to nuclear weapons, materials, and expertise is complicated by the wide range of different conceptions of the threat such programs are designed to address, and therefore the specifics of the job to be done.[137] Boiled down to their essence, there are four conceptions of the threat to be addressed:

- leakage of nuclear expertise and technologies by nuclear scientists, particularly by the estimated 2,000-3,000 individuals from the former Soviet Union who could design a bomb or make a major contribution to doing so, and the roughly 10,000-15,000 who have at least some knowledge that could be critical to the nuclear weapons program of a hostile state or terrorist group;[138]

- nuclear theft or collaboration with attackers by the larger number of individuals at weapons and civilian nuclear facilities who have access to nuclear weapons or materials, including guards at such facilities;

- decisions to leak nuclear technology or expertise by the facilities themselves; and

- reconstruction of a Cold War–scale nuclear threat, by the return of large production facilities to mass production of nuclear weapons.[139]

Developing metrics in this area is particularly difficult given that there is little agreement on which of these four dangers is the most important to address. Indeed, the relation of these dangers may differ from

[133] Joseph B. Verrengia, "U.S. Squirrel Expert Is Unlikely Patron in Iraq, Paying Ex-Weapons Scientists to Resist Temptation," *Associated Press Newswires*, 8 January 2005; Michael Roston, "Redirection of WMD Scientists in Iraq and Libya: A Status Report," *RANSAC Policy Update* (April 2004; available at http://www.carnegieendowment.org/pdf/npp/ransac_iraqlibya_scientists.pdf as of 3 March 2005); Richard Stone, "Coalition Throws 11th-Hour Lifeline to Iraqi Weaponeers," *Science* 304, no. 5679 (2004).

[134] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 493-497.

[135] Oleg Bukharin, *Russia's Nuclear Complex: Surviving the End of the Cold War* (Princeton, N.J.: Program on Science and Global Security, Woodrow Wilson School of Public and International Affairs, Princeton University, May 2004; available at http://www.ransac.org/PDFFrameset.asp?PDF=bukharinminatomsurvivalmay2004.pdf as of 8 March 2005), p. 14. DOE estimates even higher job losses, in the range of 10,000 to 18,000, from the shutdown of these three reactors. Data provided by DOE, April 2005.

[136] G8 Senior Group, "Annex: G8 Consolidated Report of Global Partnership Projects" (Sea Island, Georgia, United States: G8 Summit, 2004; available at http://www.g8usa.gov/pdfs/GPConsolidatedReportofGPProjectsJune2004.pdf as of 25 February 2005).

[137] Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 75-78; Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 64-72.

[138] Estimates provided by Oleg Bukharin, Princeton University, personal communication, March 2004.

[139] See a longer discussion on this topic in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 65-67.

one situation to another. Addressing the problem of intellectual proliferation in the vast nuclear complex left to the former Soviet states, after a decade of economic transition and government-to-government collaboration, is certainly a different task than targeting the relatively limited number of scientists with critical proliferation knowledge who are trying to adjust to a dangerous, uncertain future in post-Saddam Iraq.[140]

Russia is a very different country than it was in the early to mid-1990s, when programs like ISTC and IPP were first established. Initially, the idea was to fund useful civilian research with short-term grants to keep key weapons scientists from becoming desperate enough to sell their knowledge before the Russian economy recovered. Although it took some time for key programs such as the ISTC to get up and running on a large scale, they played a critical role for many nuclear facilities and scientists. For example, even before the worst of the 1998 Russian financial crisis, ISTC funding was covering at least a quarter of the salary funds available at the nuclear weapons design institute in the closed nuclear city of Sarov.[141]

After several years of Russian government surpluses driven by high oil prices, and a stabilizing economy, nuclear scientists and technicians—at least those who are still working in their institutes—appear to be doing better financially. Nuclear workers in Sarov, for instance, now appear to be earning wages well above the Russian average.[142] (Nevertheless, a 2002 survey of Russian scientists, most of whom had received ISTC assistance, did find that their average income from grants nearly equaled the income from their regular salary.[143]) The remaining dangers appear to be less from desperate scientists still in place who would be willing to provide sustained help to another state trying set up a complete nuclear weapons program, and more from those scientists, technicians, and security personnel who have lost their jobs or see they are about to, who still might have access to nuclear material, and who might provide assistance to a state or non-state group trying to acquire a single bomb.[144] (Of course, the international proliferation network led by Pakistan's A.Q. Khan, who had a very comfortable lifestyle and was nationally revered, shows that there may always be those who are not desperate but would still seize opportunities for greater wealth through illicit collaboration.)

These changed circumstances require a rethinking of approaches to these programs, and this is taking place. Overall, in the former Soviet Union there is an increasing shift away from short-term grants to tide individuals over until better times, toward efforts to build sustainable commercial employment for former nuclear weapons scientists and workers. Yet the creation of sustainable commercial jobs remains a difficult and slow enterprise, particularly in locations as remote, and with as little experience competing in the global economy, as Russia's closed nuclear cities. At the same time, relatively short-term grants supporting useful scientific investigation can be an important tool to keep former Soviet scientists connected to Western scientists and scientific activity, and to open up facilities to Western access and interaction. Indeed, such relationships may well help to reduce the willingness of former Soviet scientists to collaboration with proliferation-sensitive states or non-state groups for reasons other than the monetary value of the assistance.[145]

[140] The original philosophy in coping with Russia, namely, tiding over scientists to stave off desperation, has largely driven the opening phase of interaction with Iraqi former WMD scientists; see U.S. Department of State, *FY 2006 Congressional Budget Justification for Foreign Operations*, p. 136.

[141] Bukharin, *Surviving the End of the Cold War*, p. 18.

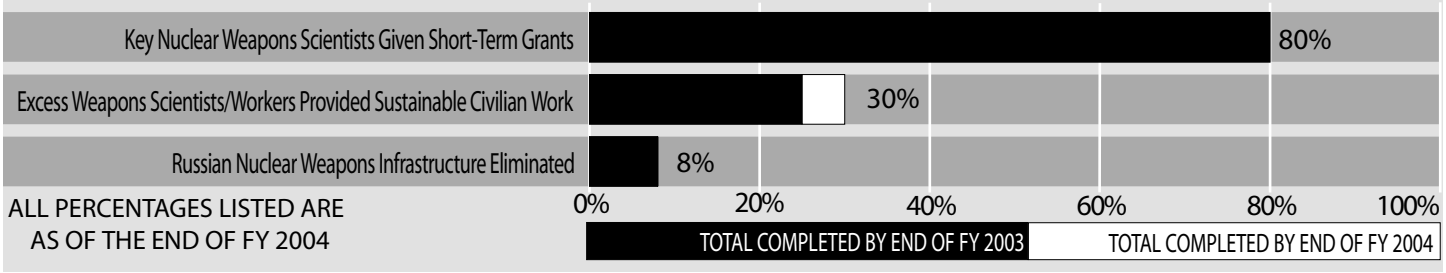
[142] Bukharin, *Surviving the End of the Cold War*, p. 19.

[143] Deborah Yarsike Ball and Theodore P. Gerber, "A Survey of Russian Scientists: Will They Go Rogue or Can Western Assistance Help Keep Them Home?" *International Security* (forthcoming).

[144] Laura S. H. Holgate, "New Approaches to Managing Nuclear Expertise" (paper presented at the 4th International Working Group Meeting, Brussels, Belgium, September 2004).

[145] Ball and Gerber, "A Survey of Russian Scientists." The authors suggest this may be the case because they find that attitudes among Russian nuclear, chemical, and biological scientists about collaborating with foreign authoritarian regimes differ depending on whether the scientists have received foreign grant assistance or merely Russian grant assistance—foreign grant recipients are less

Figure 3-4
How Much Stabilizing Work Have U.S.-Funded Programs Completed?



In the discussion below, we will focus on three simple measures: the fraction of the key nuclear weapon scientists who received short-term grants to tide them over the worst times; the fraction of excess nuclear weapon scientists and workers provided with sustainable civilian employment for the long haul; and the fraction of Russia's nuclear weapons infrastructure eliminated. (Our measures continue to focus exclusively on Russia, as the new programs focused on Iraq and Libya are still at such early stages that it is too early to begin to assess, with the information that has been made public, what fraction of the nuclear scientists from those countries those efforts are successfully engaging.) Here, as elsewhere, it is important to try to distinguish between what U.S.-funded programs can take credit for, and what has been accomplished through Russia's own efforts or those of others.

Stabilizing Metric 1: Key Nuclear Weapons Scientists Given Short-Term Grants

Fraction accomplished. Because there is no accepted list of the former Soviet scientists and engineers with the most proliferation-sensitive knowledge, there is no data publicly available concerning how many of that group have received grant assistance. From the anecdotal information that is available, as we have discussed in our previous reports, it seems likely that in the nuclear sector at least, ISTC, IPP, or similar projects have provided grants to a very large fraction—perhaps 80% or more—of those nuclear scientists and technicians most in need and seeking assistance (see Figure 3-4).[146] Our estimate this year is the same, as the programs focused on short-term grants are focusing less on expanding their reach to additional individuals than on helping grant recipients make the transition to long-term sustainability.

Such anecdotal evidence is backed up by a 2002 survey of Russian nuclear, chemical, and biological scientists that found that fewer than 20% of those scientists who had sought Western grant assistance had failed to receive any.[147] These percentages are likely even lower for the nuclear field, as the study's authors were unable to include scientists at nuclear weapons research institutes—which have been heavily targeted by ISTC, IPP, and DOE's Nuclear Cities Initiative—and because the survey's results had been calibrated to reduce the over-representation of nuclear scientists, the field receiving the most foreign attention thus far. (Despite a heightened focus by U.S. programs in the last several years, the fraction reached by grant assistance is likely less in the chemical and, especially, biological areas,

likely than Russian grant recipients to say that they would be willing to work for an authoritarian regime on weapons-related work. The authors suggest, therefore, that it is not merely the short-term cash support that reduces desperation and subsequent willingness to work for a foreign weapons program. They also point out that there is a difference in attitudes between those who have received foreign grant assistance, and those who applied for such assistance but were rejected, suggesting that it is not just those who would be inclined to seek foreign assistance who would also be more inclined to reject collaboration with foreign authoritarian regimes.

[146] Bunn and Wier, *Securing the Bomb: An Agenda for Action*, p. 68; Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 74-77.

[147] There were also nearly 40% of the scientists surveyed who had never sought such assistance; see Ball and Gerber, "A Survey of Russian Scientists."

where security sensitivities still remain high. For instance, some key biological facilities have yet to open to foreign assistance programs, meaning scientists who still work at these facilities have not been eligible to participate in programs such as ISTC.)

Positive results on this metric do not necessarily mean that the underlying problem has been mostly resolved. For instance, if grant assistance and foreign engagement does in fact affect scientists' attitudes towards working with other regimes, it is not clear whether that shift is permanent, or whether attitudes might revert to pre-engagement levels once opportunities for foreign collaboration dry up. Also, those nuclear weapons experts who have already retired or who left their facilities for civilian jobs that have since disappeared are not readily captured by this metric, because current programs offer no formal mechanism for scientists unconnected with institutes to seek assistance. These categories of experts could continue to pose a risk, as they likely retain much of the earlier nuclear weapons knowledge they acquired. Finally, scientists and personnel at facilities that remain completely off-limits to foreigners—including Russia's remaining nuclear weapons assembly and disassembly facilities—are not generally eligible for grant assistance, because the U.S. government requires the ability to access and at least partially audit the facility where the recipients work.

Instead of our measure of the percentage of scientists addressed, the State Department and DOE use comparable, absolute performance measures listing the number of former Soviet weapons scientists, engineers, and technicians, or their institutes, "engaged" by their programs.[148] Their measures do not indicate how many scientists or institutes are targeted for engagement, so it is not possible to see how much of the problem the government itself believes is still not solved. In the case of the annual metric of individuals engaged, it is also not clear how the results reported count those scientists receiving a second or third round of grant assistance, or who are involved in multi-year grants.

Rate of progress. On this metric (if not on others) the effort in the nuclear sector has more or less stabilized, though U.S. programs have identified no clear target for ending grant assistance. As noted above, it is not clear how many, if any, key former Soviet nuclear scientists have not yet been reached by foreign grant assistance, with the exception of those at the warhead assembly/disassembly facilities. Regardless, the focus in recent years has been shifting towards transitioning scientists and their institutes to more sustainable positions.

Stabilizing Metric 2: Excess Nuclear Weapon Scientists and Workers Provided Sustainable Civilian Work

Fraction accomplished. Total employment at the large nuclear facilities in Russia's ten closed nuclear cities is estimated to be in the range of 120,000-130,000 people, of whom approximately 75,000 (as of 2000) were employed directly in nuclear weapons-related work.[149] In 1998, Russia's Atomic Energy Ministry (now the federal agency Rosatom) announced that it was planning to shrink the number of defense employees

[148] DOE's Global Initiatives for Proliferation Prevention (formerly the Russian Transition Initiatives) reports that over 8,000 scientists were engaged by the program in FY 2004; see U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 132. All told, DOE reports that nearly 16,000 scientists, engineers, and technicians have been engaged since 1994; "Initiatives for Proliferation Prevention (IPP)" (Washington, D.C.: National Nuclear Security Administration, no date; available at http://www.nnsa.doe.gov/na-20/ipp.shtml as of 9 March 2005). The Department of State reports that its Nonproliferation of WMD Expertise program, which includes support for the ISTC and other bilateral biological and chemical scientist redirection efforts, engaged 430 "proliferation-relevant" institutes through FY 2003; see U.S. Office of Management and Budget, "Department of State and International Assistance Programs," p. 216.

[149] See Matthew Bunn, "Nuclear Cities Initiative," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2002; available at http://www.nti.org/e_research/cnwm/stabilizing/nci.asp as of 3 March 2005). See also Oleg Bukharin, Frank von Hippel, and Sharon K. Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities: An Update Based on a Workshop Held in Obninsk, Russia, June 27–29, 2000* (Princeton, N.J.: Princeton University, 2000; available at http://www.princeton.edu/~globsec/publications/pdf/obninsk1.pdf as of 3 March 2005).

in Russia's nuclear weapons complex by some 35,000 employees by 2005.[150] Reducing the active workers with access to nuclear secrets and materials is a highly desirable goal for the long term, but turning them out without any sustainable alternative employment could make those workers a dangerous proliferation risk. As DOE put it, these "35,000 nuclear experts represent a knowledge base that terrorist groups and proliferant countries could target for clandestine nuclear programs."[151] If workers inside institutes with so little work or salary that the workers or the institutes are tempted to hire out their services are a proliferation concern, then surely so are workers who have lost their jobs (or are about to lose their jobs) and who have no other job prospects. Job creation, therefore, remains an important measure of success.

The goal for U.S.-funded job-creation programs is almost certainly not as high as this 35,000 figure, however. Progress on the plan has been slow: 2005 has arrived, and Rosatom's 1998 downsizing goal has clearly not been met. There has been some progress on consolidation, such as the end of warhead assembly/disassembly work in the closed cities of Zarechnyy and Sarov in 2003, and the move of all weapons-related fissile material processing to Ozersk, but in the words of one expert, "the Russian nuclear weapons complex remains far too large for its present and future missions."[152] Since the most difficult years of the late 1990s, increased central government support for the nuclear defense mission and expanded governmental revenue from high oil prices and nuclear fuel and services exports (including the U.S.-Russian HEU Purchase Agreement) have eased the pressure for making difficult downsizing decisions. Nevertheless, the Russian nuclear weapons complex is oversized and real reductions cannot be delayed indefinitely. Just as one example, as noted above, the end of plutonium production at Zheleznogorsk and Seversk will likely put approximately 6,000 people out of work on its own.[153]

Some of the reduction in the Russian nuclear weapons complex will be achieved through retirement. An estimated 25% of workers in Russia's nuclear cities are fifty or older, and nearing retirement (Russia's official retirement age is 55 for men and 60 for women).[154] Significant downsizing can thus occur simply by not replacing these workers, a process that appears to be already underway. Though in the past many workers stayed on well after their retirement age—indeed, in 1999 some 5% of nuclear weapons workers were over 60[155]—the improving Russian economy has allowed the government to offer nuclear weapons workers a more attractive retirement package that many have accepted. Indeed, the workers came to refer to the package as "Putin's pension."[156]

Nevertheless, the remainder of nuclear workers targeted for downsizing will need other civilian employment. Thousands are likely to find other work without help, and thousands more are likely to be re-employed in civilian nuclear projects or other conversion projects sponsored by Rosatom. The remaining need may be in the range of 15,000-20,000 jobs.[157] Creating thousands of civilian jobs in Russia

[150] This reduction was included in the plan for restructuring the nuclear weapons complex approved in Russia in 1998. See Bukharin, Hippel, and Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities*, p. 14.

[151] U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 459.

[152] Bukharin, *Surviving the End of the Cold War*, p. 22.

[153] For more on the oversized complex, see Bukharin, *Surviving the End of the Cold War*, pp. 28-30. A less recent but more detailed discussion is in Bukharin, Hippel, and Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities*, pp. 60-71.

[154] See Figure 2.5 in Valentin Tikhonov, *Russia's Nuclear and Missile Complex: The Human Factor in Proliferation* (Washington D.C.: Carnegie Endowment for International Peace, 2001; available at http://www.ceip.org/files/Publications/NPPDemoStudy.asp as of 9 March 2005), p. 36.

[155] Tikhonov, *Russia's Nuclear and Missile Complex*, p. 36.

[156] Bukharin, *Surviving the End of the Cold War*, p. 21.

[157] In 2004, the DOE program now known as the Global Initiatives for Proliferation Prevention stated as a goal providing 15,000 civilian jobs outside the WMD complex (so presumably including chemical, biological, and missile workers as well) by 2030; see U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 459. The next year, that target had been dropped, and DOE instead stated its hope of engaging 9,000 scientists annually by 2015; see U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*.

is a daunting mission, as is accurately measuring how many jobs actually were created.

As we have discussed at length in our previous reports, the employment gap left by necessary downsizing efforts is being addressed in a number of ways.[158] DOE's Global Initiatives for Proliferation Prevention (GIPP, the new name for the office housing both the Nuclear Cities Initiative and the Initiatives for Proliferation Prevention) and the State Department's Nonproliferation of WMD Expertise program (particularly through support of the ISTC's program to partner with foreign companies) have directly supported creating commercial operations based on technologies and expertise drawn from the weapons complex. It is very difficult to estimate how many of the jobs in these firms are in fact held by former nuclear complex personnel, but there are nonetheless a few useful data points. NCI claims to have created over 1,600 jobs in the Russian nuclear cities of Sarov, Snezhinsk, and Zheleznogorsk, while IPP claims that it has created some 2,000 new jobs in Russia and Ukraine since 1994.[159] Through the end of FY 2004, DOE estimates that 36 technologies have been commercialized or businesses created through GIPP programs, adding 16 since the end of FY 2003.[160] A very limited, but unknown, number of ISTC projects have also been directly commercialized, while the State Department–supported CRDF has also supported the creation of an unknown number of ventures.[161] As we have noted in our previous reports, NCI also supplied seed money to set up European Bank for Reconstruction and Development (EBRD) loan programs in Sarov, Snezhinsk, Zheleznogorsk, and Seversk.[162] These programs have made over a thousand small-business loans in these cities, presumably supporting the creation of thousands of new jobs in these towns, some of which may be held by former employees of the nuclear weapons complex.

Other U.S.-funded programs not directly focused on job creation have also led to the creation of large numbers of jobs. The most important of these is the U.S.-Russian HEU Purchase Agreement, which has created significant orders for Russian employees and enterprises to fulfill, and which has provided revenues for Rosatom to use in its own conversion program.[163] Other U.S.-funded programs, such as the MPC&A program and programs to develop new monitoring and detection technologies and procedures, are also employing hundreds, if not thousands, of Russian nuclear experts and workers. Russian efforts to sustain this work once international assistance phases out would help make some of these jobs sustainable, though how many jobs this might create is unknown. Other U.S.-supported efforts to improve the business climate and promote general economic development in Russia's nuclear cities, such as the International Development Centers in Zheleznogorsk and Snezhinsk, might also help add to job growth that could absorb former nuclear weapons workers.

Privately financed initiatives have also created substantial numbers of jobs for former nuclear workers.[164] In addition, other countries, through the G8 Global Partnership, help contribute to job creation. The United Kingdom is spending £4-5 million

[158] The following discussion draws heavily from, and attempts to summarize, our two previous reports on measurement: Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 68-72; Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 74-77.

[159] Data provided by DOE, April 2005.

[160] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 495.

[161] The ISTC annual report notes the first direct agreement to commercialize a project came in 2003; see International Science and Technology Center, *Annual Report: 2003* (Moscow: ISTC, 2004; available at http://www.istc.ru as of 9 March 2005), p. 13. For anecdotal information on CRDF commercialization, see "Star Wars into Ploughshares - Science in the Former Soviet Union," *The Economist* (5 March 2005).

[162] See also, Sharon K. Weiner, "Preventing Nuclear Entrepreneurship in Russia's Nuclear Cities," *International Security* 27, no. 2 (Spring 2002), p. 156.

[163] Beyond our discussion from last year's report, see, for example, remarks by then-First Deputy Minister of Atomic Energy Lev Ryabev, quoted and discussed in Bukharin, Hippel, and Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities*.

[164] These include independent ventures by private companies, as well as work supported by non-governmental operations such as the Nuclear Threat Initiative; see Bunn and Wier, *Securing the Bomb: An Agenda for Action*, p. 70.

per year on its own Nuclear Cities Partnership in Sarov, Snezhinsk, and Seversk, while EU, Japanese, and other contributions combined match about 80% of U.S. funding for the ISTC.[165] Though there clearly has been some contribution, specific numbers of jobs created by these endeavors are unknown. To the extent Russia's own efforts create sustainable, long-term jobs, the total requirement for jobs to be created by U.S. or other internationally funded efforts is also reduced.

In last year's report, we estimated that, including jobs created by the EBRD loans, these combined efforts may have created approximately 25% of the roughly 15,000-20,000 jobs that may be needed to cope with nuclear complex's downsizing. With new EBRD loans being made and commercialization efforts continuing, it is reasonable to estimate that this percentage has moved to 30% in the past year, through a combination of jobs added by direct U.S. efforts and jobs created in some other manner (which reduce the total number of jobs that need to be provided to address the proliferation problem). This is quite probably an overestimate, as the figures for jobs created probably include workers who are not coming directly from the nuclear weapons complex.

Rate of progress. As just noted, the publicly available data on the total number of jobs provided for former nuclear weapons scientists and workers in the last year is very limited, but it appears unlikely to have been more than 5% of the total need per year. In its efforts to commercialize technology and support the creation of new businesses, DOE did greatly exceed its expectations, nearly doubling its cumulative total, to 36 ventures, when it expected to add only one last year.[166]

Stabilizing Metric 3: Russian Nuclear Weapons Infrastructure Eliminated

Fraction accomplished. Russia's nuclear weapons complex remains far too large for its mission of supporting Russia's current nuclear stockpile (estimated at some 16,000 total warheads, including 7,200 active warheads), much less for a smaller stockpile of around 5,000-6,000 strategic, tactical, and reserve warheads that would be consistent with Russia's obligations under the 2002 Strategic Offensive Reductions Treaty.[167] A downsized complex would still need to carry out a number of functions: nuclear weapons research and development, including stockpile stewardship; warhead assembly and disassembly; manufacture of HEU and plutonium components; production or recycling and processing of tritium; and production of non-nuclear components. By consolidating work into a limited number of existing facilities, Russia could support a defense mission consistent with its security needs and international obligations while reducing the overall size of the weapons complex it would need to support. By one estimate of what facilities would still be needed were Russia to appropriately size its complex for such a smaller stockpile, we can form an appropriate target for downsizing that U.S. programs should support. In this scenario, Russia's nuclear weapons complex could be focused in four closed cities (and a few facilities in open cities) and would employ about 30,000 people (a difference of about 45,000 employees from 2000).[168]

[165] On the UK nuclear cities work, see "Donor Fact Sheets: Scientist Employment," in *Strengthening the Global Partnership Project* (Washington, D.C.: Center for Strategic and International Studies, 2004; available at http://www.sgpproject.org/Donor%20Factsheets/ProjectAreas/SciEmploy.html as of 9 March 2005). ISTC data is from International Science and Technology Center, *Annual Report: 2003*.

[166] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 495.

[167] Estimates of the warhead stockpile size come from Norris and Kristensen, "NRDC Nuclear Notebook: Russian Nuclear Forces, 2005."

[168] See Oleg Bukharin's discussion in Appendix II in Bukharin, Hippel, and Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities*, pp. 60-71. An updated version can be found in Bukharin, *Surviving the End of the Cold War*. This would include consolidation of several functions into fewer facilities: HEU and plutonium component manufacture would be centered at Mayak in Ozersk (as has mostly already occurred), Lesnoy would handle warhead assembly and disassembly and some non-nuclear component manufacture, and weapons R&D and other non-nuclear component work would take place at VNIIEF in Sarov, VNIITF in Snezhinsk, and the Institute of Automatics in Moscow. Though the three plutonium production reactors at Zheleznogorsk and Seversk are no longer serving a specific military purpose, the connected workers are part of the 75,000 baseline used to establish the target for this metric, so the reactors' eventual shutdown will contribute to progress on this metric.

Only one U.S. program, NCI, is specifically focused on supporting Russia in closing down excess nuclear weapons-related facilities; indeed, an original rationale behind the program was to alleviate Russian reluctance to downsize facilities without viable local civilian alternatives to which the facility and its employees might turn. Though the formal NCI intergovernmental agreement expired in 2003, the program has continued to support projects approved before the agreement expired, and has sought to direct money for new projects through the ISTC or CRDF.[169] NCI has set nuclear weapons complex reduction targets for six Russian nuclear weapons complex sites, including two nuclear weapons assembly-disassembly facilities (Avangard in Sarov and Zarechnyy), two plutonium production facilities (Seversk and Zheleznogorsk), and two weapons design institutes (VNIIEF at Sarov and VNIITF at Snezhinsk).[170] To date, NCI has focused work on projects at Sarov, Snezhinsk, and Zheleznogorsk but the program now plans to phase out most work in Sarov and Snezhinsk in the next one to two years: in Sarov, NCI believes the situation has improved enough to shift resources elsewhere, and in Snezhinsk, Russia is refocusing the nuclear facility on its defense mission, reducing the need for defense conversion efforts.[171] NCI now plans to shift its attention to projects in Seversk and Zheleznogorsk, in part to help absorb the excess employees and infrastructure created as another U.S.-sponsored program works to shut down Russia's remaining plutonium production reactors.[172]

NCI has met with moderate success in supporting Russian weapons complex downsizing. The program facilitated the transition of roughly 40% of the Avangard nuclear weapons assembly and disassembly facility from weapons work to open civilian work, and Russia subsequently closed the entire Avangard facility on its own. The remaining employees at Avangard were absorbed into the VNIIEF weapons-design institute also located in the city of Sarov. With roughly 2,700 employees in 2000, Avangard was thought to be the smallest of Russia's four warhead assembly/disassembly facilities.[173] Without U.S. assistance, Russia has also closed its next-smallest nuclear weapons assembly and disassembly facility, at Zarechnyy (though some non-nuclear weapons work may still be going on there).[174] Only the two largest weapons assembly-disassembly plants—Lesnoy and Trekhgorny—remain in operation. In addition, Russia appears to have closed one of its two facilities for manufacturing HEU and plutonium components for nuclear weapons (at Seversk). Most of the thousands of employees at Seversk who once worked manufacturing weapons components are reportedly now involved in dismantling these components and blending the HEU down for sale to the United States as commercial reactor fuel,[175] though as noted above, thousands of workers remain at the plutonium production reactors at Seversk who will be displaced by those reactors' closure.

If one subtracts Zarechnyy from the total mission remaining to be accomplished (weighting it by its larger size of some 7,000-10,000 workers), then by contributing to the closure of Avangard (a smaller facility, with around 2,700 employees), NCI has helped shut down roughly 7-8% of Russia's remaining excess nuclear weapons complex.[176] (If the target is

[169] Personal communication with DOE officials, October 2004.

[170] "Nuclear Cities Initiative" (Washington, D.C.: National Nuclear Security Administration, no date; available at http://www.nnsa.doe.gov/na-20/nci/about_unprec.shtml as of 29 March 2005); U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 496.

[171] Personal communication with DOE officials, October 2004. See also, Bukharin, *Surviving the End of the Cold War*, p. 21.

[172] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 496.

[173] By comparison, Lesnoy (formerly Sverdlovsk-45) is thought to have had some 7,000-10,000 employees in 2000; Trekhgorny (formerly Zlatoust-36) probably had some 3,600; and Zarechnyy (formerly Penza-19) also had some 7,000-10,000 workers. In all of these cases, some of these workers probably also performed some work related to non-physics nuclear weapons component manufacturing. Bukharin, Hippel, and Weiner, *Conversion and Job Creation in Russia's Closed Nuclear Cities*, pp. 38-42, 57-59.

[174] Interview with former First Deputy Minister of Atomic Energy Lev Ryabev, September 2003.

[175] Personal communication from Oleg Bukharin, Princeton University, March 2004.

[176] In last year's report, we calculated that NCI had contributed to shutting down "roughly 11% of the non-Zarechnyy capacity of Russia's warhead assembly-disassembly complex." The final target in that metric focused on completely eliminating the Russian

the complete elimination of Russia's nuclear weapons complex, then the reduction would be about 4% of the total.)

DOE's newly named Global Initiatives for Proliferation Prevention program has reported that some 53% of the program's internal "workforce reduction and facility closure" targets in six nuclear cities have been met through FY 2004.[177] The specific targets have not been made public, making it difficult to judge the degree to which achieving these targets would meet the overall objective of reducing Russia's ability to rapidly restart mass production of warheads should circumstances change.

Rate of progress. There is still no agreement for the United States and Russia to cooperate on closing down more of Russia's nuclear weapons complex (though Russia has downsized some of its complex without direct support), but NCI is shifting its focus to cooperation in Seversk and Zheleznogorsk. Further reductions in the nuclear weapons labs at Sarov and Snezhinsk are unlikely. In FY 2004 DOE stated that it had accomplished an additional 4% of its internal "nuclear complex reduction targets."[178] DOE's most recent statement was that it did not plan to meet these goals until 2015, though it did not publish this target in its most recent congressional budget justification.[179]

Improved Stabilizing Metrics for the Future

We acknowledge that this discussion on how well the United States is doing in securing nuclear expertise in the former Soviet Union is not entirely satisfying. Of the four fundamental questions on performance measurement discussed earlier in this chapter, the information publicly available provides very little good data on the total scope of the problem being addressed, and on what fraction of that problem has been addressed by the work performed. Thus it makes it very difficult to judge from the outside how effectively current efforts are addressing the problem of uncontrolled nuclear expertise. The measures that are readily available provide essential information on the outputs of the programs, such as the number of institutes engaged or the number of scientists receiving grants. But to the policymaker or citizen outside the program, such output measures do not answer their essential questions: the situation may well be getting better, but how much better? If we spent more, then how much more quickly would the situation get better?

Of course, if such measures were easy to come by, we would see them by now. These programs have made commendable strides in providing more quantifiable and more transparent data. (Indeed, the White House's Office of Management and Budget gave the State Department's Nonproliferation of WMD Expertise program high marks for its program measures in its most recent assessment of that program.[180]) Establishing the full scope of the problem by identifying and quantifying just who did and still does what in one of the most sensitive national security activities—the production of nuclear weapons—in the successor states of the Soviet Union is an extremely challenging task. Given its sensitivity, much of that task can not be carried out in the public realm.

In essence, more data is needed on the denominator of the problem, that is, the total scope of the problem to be addressed. Different kinds of nuclear workers each pose a different type of concern. There is the

assembly-disassembly complex. In contrast, as noted above, this year's metric focuses on the entire weapons complex, but assumes that the complex will shrink enough to still maintain a reduced weapons stockpile.

[177] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 133. Although the only major facility whose closure the United States has substantially contributed to is Avangard, DOE's statement that 53% of the combined total of the reduction targets for the six sites have been accomplished suggests that the targets for the other five may be modest.

[178] The FY 2003 performance level was 49%; see U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 458.

[179] U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 458. In contrast, see U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 496.

[180] OMB states that the program does "have a limited number of specific long-term performance measures that focus on outcomes and meaningfully reflect the purpose of the program." U.S. Office of Management and Budget, "Department of State and International Assistance Programs," p. 210.

lead scientist who could design an entire weapon. There is the engineer who might be able to help another state acquire an indigenous nuclear capability, for example by providing knowledge relevant to centrifuge manufacture or machining of nuclear weapons components. A production worker might be able to access HEU or plutonium, and might provide a terrorist group with enough fissile material for a bomb, while a security officer might provide crucial help in getting others inside a facility. The baseline question is, what is the employment distribution of these types of workers in the former Soviet nuclear complex today? How are these categories distributed among defense-related facilities, non-defense enterprises, retirees, or other jobs? And how many could be expected to retire in the near future?

Then, in evaluating program performance, we would want to know how many workers from each of these categories have been redirected into sustainable civilian employment where they no longer have access to nuclear material and where they are not in a desperate economic situation. At the same time, Russian performance in their efforts to create alternative civilian employment and to restructure their weapons complex should also be tracked, to recalibrate as necessary the scope of the problem U.S. and other international programs would need to address.

We acknowledge that getting specific answers on all these questions is an ideal that will not be achieved in full. But finding more detailed, more accurate information will only serve to help these programs better articulate and execute their mission. Better data on exactly what these efforts have been able to achieve will also make it easier for these programs to find supporters and fend off critics. At the same time, continued efforts to assess the potential willingness of nuclear scientists and workers to contribute to proliferation activities—through polling, individual interviews, focus groups, and the like—can also help improve understanding of the threat, and of the extent to which these programs are in fact helping to convince these individuals not to sell their knowledge or the material to which they have access.[181]

Tracking Progress: Monitoring Nuclear Stockpiles and Reductions

All non-nuclear-weapon states that are parties to the nuclear Nonproliferation Treaty (NPT)—that is, all but nine of the countries of the world—are required to declare all of their weapons-usable nuclear material and place it under international monitoring.[182] Over time, putting in place at least limited declarations and monitoring for the nuclear stockpiles in the nuclear weapon states and the states outside the NPT could contribute substantially to ensuring that these stockpiles remain safe and secure, and that international assistance intended to improve controls over them is spent appropriately—and could provide an important foundation for deep reductions in nuclear arms.[183] Of the nuclear weapon states, the United Kingdom has gone furthest in building transparency with respect to its own current stockpiles, declaring precisely how much military and civilian plutonium it possesses, how much of these military stocks are now excess to its military needs, and the fact that in the future it plans to possess fewer than 200 operational nuclear warheads.[184] The United States has also taken substantial

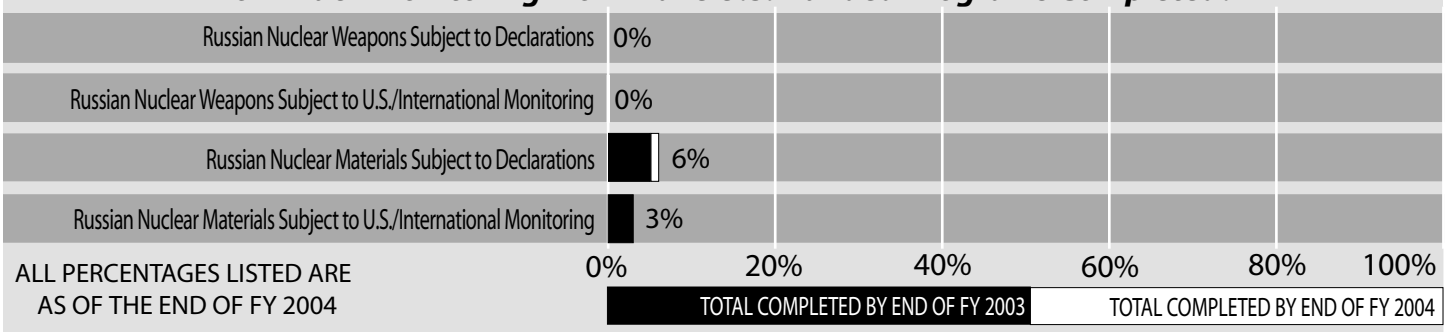
[181] For examples of such polling and interviews, see Ball and Gerber, "A Survey of Russian Scientists"; Tikhonov, *Russia's Nuclear and Missile Complex*.

[182] The NPT recognizes five nuclear weapon states (the United States, Russia, France, the United Kingdom, and China) which are not required to declare or accept monitoring of their nuclear stockpiles. There are three states (India, Pakistan, and Israel) which have never been parties to the NPT, and so face no such obligations, and one state (North Korea) which violated and then withdrew from the NPT.

[183] See discussion in Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 147-149. For an in-depth discussion of such measures in the context of deep nuclear arms reductions, see Nicholas Zarimpas, ed., *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions* (Oxford: Oxford University Press for the Stockholm International Peace Research Institute, 2003).

[184] See U.K. Ministry of Defence, *Plutonium and Aldermaston: An Historical Account* (London: British Ministry of Defence, 2000; available at http://www.mod.uk/publications/nuclear_weapons/aldermaston.htm as of 15 February 2005); U.K. Ministry of Defence, "Chapter 4: Deterrence and Disarmament" in *Strategic Defence Review* (London: British Ministry of Defence, 1998; available at http://www.mod.uk/issues/sdr/deterrence.htm as of 15 February 2005).

Figure 3-5
How Much Monitoring Work Have U.S.-Funded Programs Completed?



steps toward increased transparency, declaring the size and detailed history of its plutonium stockpile, the number of nuclear weapons dismantled each year over a substantial period, some limited information on its HEU production, and other information.

Currently, however, while the U.S. government is working with Russia on a few initiatives focused on particular "islands of transparency" (such as transparency for the ongoing HEU Purchase Agreement), it is simply not pursuing a comprehensive regime to declare or monitor stockpiles of nuclear warheads and materials. Hence it is not surprising that little progress toward such declarations and monitoring is being made.

During 2004, the United States did propose a number of transparency measures focused on non-strategic nuclear weapons, to be implemented bilaterally between the United States and Russia.[185] No progress has been reported, however, in reaching agreement on such measures. Also during 2004, there was continued success in implementing transparency measures for the HEU purchase agreement; continued talks without final agreement on transparency measures for the Mayak Fissile Material Storage Facility (though that facility had been completed the previous year); and continued efforts, not yet successful, to reach agreement on implementing specific inspection approaches for the plutonium oxide in storage at Seversk and Zheleznogorsk, produced in Russia's military plutonium production reactors after that material stopped being used in nuclear weapons (though an agreement requiring measurements has been in force for several years).[186] As metrics for judging progress in this area, we use the fraction of Russia's nuclear warheads and materials that have been the subject of detailed declarations, and the fraction that are subject to actual monitoring (see Figure 3-5).

Monitoring Metric 1: Russian Nuclear Weapons and Materials Subject to Declarations

Fraction accomplished. Remarkably, the United States and Russia have never told each other how many nuclear weapons or how many tons of plutonium and HEU they have. Nor has either country ever allowed the other to verify the dismantlement of a single nuclear warhead. Therefore the fraction of nuclear warheads subject to detailed declarations is zero. In the case of nuclear materials, every year another 30 tons of HEU is blended down, and becomes subject to declarations (and monitoring, as described below) as part of that process (while also removing that HEU from the total of material remaining to declare or monitor). In addition, Russia makes declarations every year on its stockpiles of

[185] This is mentioned, for example, in U.S. Department of State and U.S. Agency for International Development, "Strategic Goal 4: Weapons of Mass Destruction."

[186] For a discussion of HEU transparency during FY 2004, see U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 499-503. Information on the lack of a final agreement on Mayak transparency is from interviews with State Department officials, January 2005. The lack of final agreement on inspections for Seversk and Zheleznogorsk plutonium was confirmed in interviews with State Department officials, November 2004.

separated civilian plutonium. As of the end of 2003 (the most recent year for which declarations are yet available), Russia's civil separated plutonium declaration included 38.2 tons of material.[187] Hence, the total amount of nuclear material subject to declarations is approximately 68 tons, just over 5% of the estimated 1275 tons of weapons-usable nuclear material in Russia as of the end of 2003,[188] or 11% of the 600 tons of that total stockpile that is believed to be outside of nuclear weapons themselves.

Rate of progress. There has been no increase in the amount of material subject to declarations in the past year, except for the additional ton of civilian plutonium that Russia's most recent declaration includes. In the future, if transparency measures are eventually agreed for the Mayak Fissile Material Storage Facility and fissile material begins to be loaded there, that material will effectively come under declarations, as the United States will be informed of roughly how much material is present in the facility. Thus, over the next few years, some 25 tons of plutonium should be added to the amounts just described—or more, if the United States and Russia agree on policy changes that would allow more material to be stored there.[189] Beyond that, progress in bringing additional weapons or materials under declarations is minimal, though it is conceivable that some tactical nuclear weapons might become subject to declarations if the U.S. proposals tabled in 2004 eventually lead to an agreement.

Monitoring Metric 2: Nuclear Weapons and Materials Subject to U.S. or International Monitoring

Fraction accomplished. As with declarations, no warheads are currently subject to monitoring. In the case of nuclear materials, the 30 tons of HEU being downblended each year are subject to limited monitoring during that process (and are removed from the total stockpile). It is worth noting that during 2004, continuous monitoring equipment to monitor the point at which the HEU and blendstock are actually blended to LEU was installed at the third of the three facilities in Russia where this work is done. During 2004, some 75% of the LEU delivered was subject to such continuous blend monitoring, but this should increase to nearly 100% in subsequent years.[190] Limited monitoring of the plutonium produced in Russia's plutonium

[187] See International Atomic Energy Agency, *Communication Received from the Russian Federation Concerning Its Policies Regarding the Management of Plutonium*, INFCIRC/549/Add.9/6 (Vienna: IAEA, 2004; available at http://www.iaea.org/Publications/Documents/Infcircs/2004/infcirc549a9-6.pdf as of 15 February 2005). As the annual increases in Russia's reports have been increasing by amounts ranging from 1 ton to 2.8 tons in recent years, by the end of 2004, Russia's total quantity of civilian separated plutonium probably amounted to 39-40 tons.

[188] This figure is the sum of: an estimated 145 tons of military plutonium; 38 tons of civilian separated plutonium reported by Russia; an estimated 1070 tons of remaining military HEU; and an estimated 22 tons of civilian HEU. These estimates all have substantial uncertainties: the total is uncertain to plus or minus hundreds of tons. These updated estimates for the end of 2003 are from David Albright and Kimberly Kramer, eds., *Global Fissile Material Inventories* (Washington, D.C.: Institute for Science and International Security, October 2004; available at http://www.isis-online.org/global_stocks/tableofcontents.html as of 14 February 2005). They are consistent, well within the range of uncertainty, with our earlier estimate of 1230 tons as of the end of 2002. See Matthew Bunn, "Unclassified Estimates of Russia's Plutonium and HEU Stockpiles—and World Civil Separated Plutonium Stockpiles: A Summary and Update, Rev. 1" (Cambridge, Mass.: unpublished, 2003).

[189] Currently, the United States takes the view that only weapon-grade plutonium or weapon-grade HEU which will never be returned to weapons can be stored in this facility. Russia takes the view that the HEU in this category is already being blended for sale to the United States under the HEU purchase agreement and does not require storage at Mayak, and the only plutonium it is willing to place in this category is the 34 tons covered by the 2000 U.S.-Russian Plutonium Management and Disposition Agreement, of which 9 tons is material produced in the plutonium production reactors in recent years and stored there, leaving only 25 tons of plutonium eligible for placement in the Mayak storage facility—enough to fill one-quarter of the facility. The United States is considering approaches that would allow additional material to be stored at Mayak, such as having one portion of the facility limited to excess plutonium that would never be returned to weapons and would be subject to monitoring, and another portion where Russia could store a portion of the plutonium still reserved for support of its military stockpile. See Bunn, "Mayak Fissile Material Storage Facility."

[190] See U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 499-500.

production reactors since 1994 (amounting to some 8-11 tons of plutonium) is now occurring, although as of early 2005 the United States and Russia were still debating the specifics of what kind of equipment could be used to take measurements on the canisters containing the plutonium at these sites.[191] Together, the plutonium and HEU being monitored represents some 3% of Russia's total nuclear material stockpile, or nearly 7% of the estimated 600 tons outside of weapons.

Rate of progress. As noted earlier, there are no current plans for monitoring of warhead stockpiles. For material stockpiles, the rate of increase in the amounts of materials subject to monitoring has been painfully slow. As just noted, 25 tons or more of plutonium is slated to be loaded into the Mayak Fissile Material Storage Facility over the next few years, and if all goes well, this will be subject to some form of transparency. Over the longer term, monitoring of plutonium being burned as fuel in the plutonium disposition effort would begin, but all of this material would be either from the plutonium stored at Mayak (which, if transparency arrangements are agreed, will already be subject to monitoring), or plutonium from the stocks at Russia's plutonium production reactors (also already subject to monitoring). No date for completing monitoring arrangements for warheads and materials has been established.

Improved Monitoring Metrics for the Future

The U.S. government should assess what declarations, monitoring, and other transparency measures would give it confidence that nuclear weapons and weapons-usable nuclear materials around the world were safe and secure, and being managed in compliance with international agreements. It should then track what fraction of the measures needed to achieve that confidence have yet been put in place.

Tracking Progress: Ending Production

World stocks of nuclear weapons, separated plutonium, and HEU are far larger than needed for any current or future military or civilian purposes. Adding further to these stockpiles will increase the cost and complexity of ensuring they are effectively guarded and controlled. Hence, ending production is an important objective.

Clearly, the most important part of that objective is ending (or preventing) production in countries where that production may be used to build a new nuclear arsenal—such as North Korea and Iran. As noted earlier, there has been no progress in the past year in limiting or rolling back North Korea's nuclear program, and in February, 2005, North Korea announced that it had nuclear weapons and was pulling out of the six party talks for an indefinite time.[192] North Korea is thought to have sufficient plutonium for 6-8 nuclear weapons, and its one operating plutonium production reactor, restarted in early 2003, is believed to be producing roughly enough plutonium for one more each year. North Korea is believed to be attempting to establish a centrifuge enrichment facility to make HEU for weapons as well, but there is as yet no public evidence that any such facility is operational.[193]

All of Iran's known and declared facilities relating to uranium enrichment are frozen as part of a temporary agreement with France, Britain, Germany, and the European Union, reached in the fall of 2004. But whether European negotiators will be able to translate that accord into a lasting deal that ends Iran's enrichment program remains in doubt, particularly given the Bush administration's continued unwillingness to participate in the talks or address Iranian security concerns. Iranian leaders have said that Iran's suspension of uranium enrichment will only be temporary, but assert

[191] These monitoring visits finally began to occur in 2002. See "Warhead and Fissile Material Transparency (WFMT) Program" (Washington, D.C.: National Nuclear Security Administration, no date; available at http://www.nnsa.doe.gov/na-20/wfmt.shtml as of 16 February 2005). See also U.S. Department of Energy, Moscow Office, *Summary of DOE Programs in Russia: FY '03 Accomplishments and FY '04 Goals* (Moscow: U.S. Embassy, 2004), pp. 31-33.

[192] DPRK Ministry of Foreign Affairs, "DPRK Statement," *Korean Central News Agency*, 10 February 2005.

[193] See, for example, testimony of CIA Director Porter Goss, in Select Committee on Intelligence, *Current and Projected National Security Threats to the United States*, U.S. Senate, 109th Congress (16 February 2005). Goss indicates only that North Korea continues to "pursue" such a capability.

that Iran plans to produce only low-enriched uranium for fuel, not HEU for weapons.[194]

Perhaps surprisingly, there are no current efforts in place to put an end to further production of nuclear warheads in the United States and Russia. Both the United States and Russia are decreasing, rather than increasing, their nuclear warhead stockpiles, but both retain the right to manufacture new warheads if needed to replace existing warheads. Similarly, there are no current efforts to reach agreements to end nuclear weapon manufacture in the other nuclear weapon states.

Globally, efforts to end production of weapons-usable nuclear material were dealt a blow in July 2004, when, after a protracted policy review, the Bush administration announced that the United States would no longer support a verified fissile material cutoff treaty (FMCT). The statement indicated that while the United States still supported a legally binding treaty banning production of nuclear materials for weapons, it no longer supported including verification measures, as even extensive measures would not provide "high confidence in our ability to monitor compliance," and even attempting to provide such confidence "would require an inspection regime so extensive that it could compromise key signatories' core national security interests and so costly that many countries will be hesitant to accept it."[195] The argument that an FMCT could not be verified has little merit, as existing IAEA safeguards approaches applied to enrichment and reprocessing plants could do most of the job.[196] This announcement effectively killed prospects for near-term progress toward concluding an FMCT—prospects which were already slim, as the non-NPT states who would be crucial parties to such a treaty (India, Pakistan, Israel, and North Korea) do not appear ready to agree to such a pact, and some of the NPT nuclear weapon states are officially supportive but not enthusiastic. Nevertheless, in late 2003, when China removed the previous stumbling block to negotiations by dropping its insistence that it would not allow FMCT negotiations to begin unless negotiations on space weapons began simultaneously, there had seemed to be some hope for at least beginning negotiations—a hope that the Bush administration's announcement brought to an abrupt end.[197]

As currently envisioned, an FMCT would only ban production of weapons-usable nuclear materials for use in nuclear weapons—production of such materials for civilian purposes, or permitted military purposes (such as naval fuel) would be permitted. Worldwide, there is little if any current production of HEU for non-weapons purposes, but civilian separation and use of weapons-usable plutonium continues on a massive scale. Each year, some 20 tons of civilian plutonium is reprocessed from spent fuel, and only 10 tons of that is fabricated into fuel and used in reactors, adding some 10 tons to the global stockpile every year.[198] Already, over 230 tons of weapons-usable civilian plutonium

[194] See, for example, "Iran Vows Enrichment Freeze Will Be Short-Lived," *Agence France Press*, 31 January 2005.

[195] U.S. Department of State, "Fissile Material Cut-Off Treaty Policy" (Washington, D.C.: State Department, 2004). The original statement to the Conference on Disarmament was made by U.S. Ambassador Jackie W. Sanders on July 29, 2004.

[196] It is true that covert facilities for producing small amounts of nuclear material are difficult to detect, but that problem is most relevant in the case of states that do not yet have nuclear weapons, all of whom are already obligated under the NPT not to produce weapons material. It is also true that verifying that HEU produced after entry into force for use as naval fuel was not in fact used for weapons, without undue intrusiveness, would raise some difficulties. But these are issues that could readily be addressed through negotiation, and putting a verified cap on production at the known military production facilities in the weapon states and the non-NPT states would have substantial benefits with little risk; if the non-NPT states could be convinced to agree, it would cap their arsenals and bring them a step closer to the international nonproliferation regime.

[197] The FMCT is being discussed in the Conference on Disarmament in Geneva, which operates on the basis of consensus. As many other parties oppose the Bush administration's approach, it appears extremely unlikely that this approach will provide the basis for a consensus to start negotiation of an FMCT. For a discussion, see Matthew Bunn, "Fissile Material Cutoff Treaty," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials*, ed. Matthew Bunn and Anthony Wier (2004; available at http://www.nti.org/e_research/cnwm/ending/fmct.asp as of 15 February 2005).

[198] See David Albright, "Separated Civil Plutonium Inventories: Current Status and Future Directions," in *Global Fissile Material Inventories*, ed. David Albright and Kimberly Kramer (Washington, D.C.: Institute for Science and International Security, 2004; available at http://www.isis-online.org/global_stocks/separated_civil_pu.html as of 15 February 2005).

has built up in civilian stores around the world, and within a few years, these stocks of civilian separated plutonium will exceed the total amount of plutonium in all the world's military stockpiles. Yet as of today, there are no U.S. programs in place designed to reduce this massive buildup of civilian separated plutonium. In short, metrics measuring how much of the jobs of (a) stopping production of bomb material in potential new nuclear weapon states, or of (b) stopping production of military and civilian bomb material worldwide, would show very little progress made so far.

The main part of ending production where some progress is being made—and a considerable amount of money is planned to be spent—is shutting down production of military plutonium in Russia. Under a program called Elimination of Weapons Grade Plutonium Production (EWGPP), the United States plans to provide alternate power sources to replace Russia's last three plutonium production reactors, in the cities of Seversk and Zheleznogorsk, allowing them to be shut down without leaving the nearby towns in the cold and the dark. Between them, the three reactors produce approximately 1.2 tons of weapon-grade plutonium per year, adding to Russia's already large stockpile of excess plutonium. Under current plans, the two reactors at Seversk are expected to shut down in 2008, and the one reactor at Zheleznogorsk is expected to shut in 2011.

Key developments in the past year included:

- In November 2004, the Seversk project passed the critical decision reviews at DOE that provided U.S. authorization to begin construction.[199]

- In January 2005, DOE signed a $285 million contract with Washington Group International (WGI) for the next phase of WGI's work as the integrating contractor for the work at Seversk, overseeing the work of Russian contractors who will do the actual construction.[200] This followed specific contracts granted during 2004 for the various boilers, turbines, and related systems that are to be upgraded.[201]

- In February 2005, DOE requested a budget of $132 million for this effort for FY 2006, three times the $44 million appropriated for FY 2005, and well over twice the budget previously projected for FY 2006.[202] The drastically increased budget was not intended to accelerate the effort, but only to meet the previous schedule in the face of cost estimates that have more than doubled, to some $1.1 billion.[203]

- In early 2004, Russia finally began allowing U.S. experts needed access to the construction sites at Seversk and Zheleznogorsk. The site where the Zheleznogorsk power plant is to be built was only chosen, and acquired by the Russian government, in February 2004.[204]

- Congress passed legislation enabling DOE to solicit international contributions that would go directly to the account for the program to shut down these reactors, and in early 2005, the United Kingdom pledged some $20 million to the Zheleznogorsk project.[205]

[199] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 506.
[200] "U.S. Signs Contract as Part of Effort to Permanently Shut Down Plutonium Production Reactors in Russia" (Washington, D.C.: U.S. Department of Energy, 20 December 2004; available at http://www.nnsa.doe.gov/docs/PR_NA-04-34_Contract_signed_for_electricity_plant_in_EWGPP_program-shutting_down_pu_reactors_(12-04).htm as of 20 February 2005).
[201] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 506.
[202] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 505; U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 467.
[203] This cost estimate is mentioned, for example, in U.S. Government Accountability Office, *Nuclear Proliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, GAO-04-662 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d04662.pdf as of 14 February 2005).
[204] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 506-507. Why access had been a serious issue at these sites remains something of a mystery, as there are no sensitive nuclear activities taking place at either one.
[205] "Griffiths Announces £12 Million Pledge to End Weapons-Grade Plutonium Production in Former Soviet Union" (London: U.K. Department of Trade and Industry, 26 January 2005).

- In February 2005, DOE organized an international conference in Switzerland to solicit funding support.[206]

In short, after a decade of delays and wrong turns, this effort made significant progress in the past year. The project remains fraught with difficulties and uncertainties, however:

- The new cost estimates, at roughly $1.1 billion, are very high for the amount of plutonium whose production will be avoided by this effort. This is particularly the case for the Zheleznogorsk project, which would shut only one reactor, rather than two, but is projected to cost roughly twice as much as the Seversk project (because a whole new power plant will have to be built)—and which will not shut the reactor down until 2011, which may be only a few years before its advancing age would force Russia to shut it down in any case.[207] DOE has indicated that it will solicit international contributions to reduce the cost to the United States of shutting the Zheleznogorsk facility.

- As a Government Accountability Office report in June 2004 noted, the project involves a welter of different U.S. and Russian organizations that all must coordinate successfully, raising significant concerns over the difficulty of managing the effort. The Russian contractor that is supposed to oversee most of the work, in particular, is a Rosatom-owned entity created in 2002, which has never before worked with U.S. contractors on a large construction project, and has limited staff, budget, and authority.[208]

- Although it would be relatively simple to shut these reactors down for much of the summer, when their heat is not needed, and thereby reduce their plutonium production, Russia has not agreed to do so.[209]

- Russia has declined U.S. assistance to upgrade the safety of these reactors—some of the most dangerous in the world, based on a design that was the predecessor of the Chernobyl reactor design—apparently because of a reluctance to allow the level of U.S. access to these facilities that this assistance would have required.[210]

Ending Production Metric 1: Reduction in Russian Weapons-Usable Material Production

Fraction accomplished. The ultimate metric here is very simple: the reduction in the rate of weapons-usable material production resulting from U.S.-sponsored programs. So far, this is zero, as U.S.-funded programs have not affected this production rate—and it will remain zero until the first of the three remaining plutonium production reactors actually shuts down (see Figure 3-6 on the following page). The picture is somewhat more promising if judged by the fraction of all the work that needs to be done to shut these reactors down that has been completed. In the budget justifications released in February 2005, DOE estimated that as of the end of FY 2004, 13% of the work

[206] "Nations Gather to Help Nuclear Cities Shut Down Plutonium Production Reactors" (Washington, D.C.: National Nuclear Security Administration, 14 February 2005; available at http://www.nnsa.doe.gov/docs/PR_2005-02-14_NA-05-03.htm as of 17 February 2005).

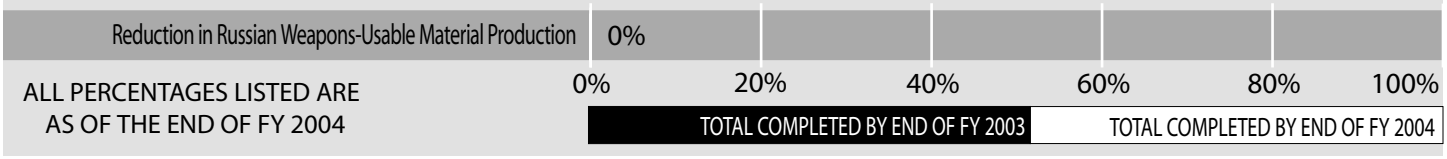
[207] There have been a series of different estimates over the years of when age would force these reactors to shut down, ranging from as early as 2012 to as late as 2020. The key issue is radiation-induced swelling of the graphite blocks that are the moderator for these reactors.

[208] U.S. Government Accountability Office, *Nuclear Proliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, pp. 12-16.

[209] U.S. Government Accountability Office, *Nuclear Proliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, pp. 17-18.

[210] U.S. Government Accountability Office, *Nuclear Proliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, pp. 18-20. Russia's sensitivity over access to these reactors is somewhat difficult to understand, as these reactors are no longer producing plutonium intended for military purposes, and will soon shut down; moreover, U.S. personnel have had extensive access to the nearly identical plutonium production reactors that are already shut down. For a discussion of the history of efforts to end plutonium production at these reactors, see Frank N. von Hippel and Matthew Bunn, "Saga of the Siberian Plutonium Production Reactors," *Federation of American Scientists (F.A.S.) Public Interest Report* 53, no. 6 (November/December 2000; available at http://www.fas.org/faspir/v53n6.htm as of 30 April 2005).

Figure 3-6
How Much Ending Production Work Have U.S.-Funded Programs Completed?



for the Seversk project had been completed, based on the fraction of the total estimated cost of the project that had been expended[211]—but that fraction was based on the previous cost estimate, roughly half the current cost estimate, and thus a more accurate estimate of the fraction of the work completed for the Seversk project would be in the range of 6-7%.[212] For the Zheleznogorsk project, the fraction completed is only about 2-3%.[213] Russian production of HEU for weapons ended, and most of Russia's plutonium production reactors were shutdown, before cooperative threat reduction programs began, and so U.S.-funded programs cannot take credit for those steps. The plutonium production rate at the last three production reactors has been reduced because of reductions in their permitted peak power imposed by Russia's nuclear safety regulatory agency, but this was not the result of U.S. programs intended to reduce plutonium production. Russia continues to separate roughly a ton of weapons-usable civilian plutonium each year as well, and the Bush administration abandoned a promising Clinton-era effort to end that production, so there are no current U.S. programs to reduce that production.

Rate of progress. As just noted, DOE estimates that 13% of the work needed to shut down the Seversk reactors was done by the end of FY 2004, though more realistic estimates would cut that figure roughly in half; all but 1% of that work was accomplished during FY 2004. DOE plans to have 32% of the Seversk project completed by the end of FY 2005, and to almost double the FY 2005 figure, to 61%, in FY 2006, finishing the project in early FY 2009.[214] The Zheleznogorsk effort is projected to move slowly until the Seversk project is largely completed, primarily because of budget constraints.[215]

Improved Ending Production Metrics for the Future

The U.S. government should develop: (a) measures to assess progress in ending (or preventing) production of nuclear material in potential or new nuclear weapon states such as North Korea and Iran; (b) an estimate of global production of nuclear materials for weapons each year, and progress in bringing that production to an end; and (c) an estimate of *total* worldwide production of weapons-usable nuclear material each year, both military and civilian, and of progress in reducing (and ultimately ending) that production.

Tracking Progress: Reducing Nuclear Stockpiles

Ultimately, the only way to guarantee that any particular nuclear weapon or cache of weapon-usable nuclear material will not be stolen is to destroy it. Reductions in the total size of these stockpiles are also an important long-term foundation for deep

[211] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 508.
[212] DOE reports that the 13% figure came from having expended $22 million out of a total estimated cost of $171 million. U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, p. 127. Current estimates of the total cost for the Seversk projects are more than twice as high.
[213] DOE estimates 5%, but that is again based on the fraction of earlier cost estimates expended. U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 508.
[214] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 508.
[215] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 508.

and difficult-to-reverse reductions in nuclear arms. To date, however, there are no arms control agreements that call for destroying nuclear warheads themselves (as opposed to simply taking them off of delivery systems)—though the United States and Russia made unilateral pledges to destroy specified fractions of certain types of warheads in 1991-1992. With respect to reductions in nuclear materials, the key agreements in place are the U.S.-Russian HEU Purchase Agreement, which commits Russia to eliminating 500 tons of weapon-grade HEU by blending it to low-enriched uranium (LEU) for sale to the United States,[216] and the Plutonium Management and Disposition Agreement (PMDA) of 2000, which commits both Russia and the United States to carry out disposition of 34 tons of weapon-grade plutonium (possibly mixed with up to an additional four tons of reactor-grade plutonium).[217] Implementation of the HEU Purchase Agreement (and of unilateral U.S. programs to reduce its own excess HEU stockpile) continues, but the PMDA, while being provisionally applied, has not yet entered into force, and disposition of both U.S. and Russian excess plutonium has been delayed for years.

Key developments in this area in the last year included:

- As noted above, the U.S.-Russian impasse over liability provisions of agreements on plutonium disposition continued. This disagreement led the Bush administration to allow the U.S.-Russian agreement on technical cooperation on plutonium disposition to expire the previous year. The lack of any plutonium disposition agreement including liability protection has delayed both "Russianizing" the design of a plutonium fuel fabrication facility and construction of such facilities in Russia and the United States. In early 2005, the Bush administration finally decided to compromise on liability language different from that included in the U.S.-Russian Cooperative Threat Reduction umbrella agreement.[218] This raised hopes that the issue would be resolved in time for the Bratislava summit, but it was not.[219] As of March 2005, U.S.-Russian discussions of the subject were continuing, and construction of plutonium fuel fabrication facilities in both the United States and Russia remained largely in limbo, though DOE has found ways to move forward on some initial steps even in the absence of liability protection.[220] Senator Pete Domenici (R-NM) summed up the situation in February 2005, after the administration's liability compromise had been proposed, saying: "We are putting so much in jeopardy by not resolving this issue. While I am pleased with recent progress, I remain frustrated that opposition from within our own government over the liability issue has delayed the startup of operations beyond 2009. The delay is likely to result in substantial penalties to the federal government due to our failure to dispose of the [plutonium] in a timely manner."[221]
- In early 2005, DOE formally notified Congress that the legislated deadline of 2009 for beginning to

[216] Matthew Bunn, "HEU Purchase Agreement," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2003; available at http://www.nti.org/e_research/cnwm/reducing/heudeal.asp as of 29 March 2005).
[217] U.S. Department of Energy, *Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation* (Washington, D.C.: DOE, 2000; available at http://www.nnsa.doe.gov/na-20/docs/2000_Agreement.pdf as of 30 March 2005).
[218] See, for example, Daniel Horner, "Bush, Putin Pledge Cooperation on Upgrading Nuclear Security," *Nuclear Fuel*, 28 February 2005.
[219] The liability issue went unmentioned in the final Bratislava statement. For discussion, see Horner, "Bush, Putin Pledge Cooperation on Upgrading Nuclear Security."
[220] DOE, for example: has been working closely with Russian regulators to develop an approach for rapid review and licensing of the Russian facility once the liability impasse is overcome; has contracted with the French firm whose MOX technology is to be used to send the plant design to Russia so that work on adapting the design to Russian circumstances can get underway, since France already has a liability agreement in place with Russia; and has identified initial steps (such as clearing construction sites) that can be taken without liability provisions in place. See, for example, Daniel Horner, "Work on MOX Plants Could Start This Year Despite Liability Issue," *Nuclear Fuel*, 31 January 2005; Daniel Horner and Ann MacLachlan, "DOE Using 'French Option' to Send MOX Design Information to Russia," *Nuclear Fuel*, 22 November 2004.
[221] "Sen. Domenici Has Secretary Rice's Commitment to Advance U.S.-Russia Plutonium Disposition Program."

fabricate plutonium fuel at Savannah River—a deadline South Carolina's congressional delegation insisted on, to ensure that the material would not stay at Savannah River in indefinite storage—would not be met.[222] Under the law, if delays continue, DOE will face substantial financial penalties.

- In late 2004, DOE shipped 140 kilograms of weapon-grade plutonium to France for fabrication into uranium-plutonium mixed oxide (MOX) lead test assemblies for use in the U.S. reactors slated to burn plutonium fuel.[223] There was considerable controversy over whether security for this shipment was sufficient.[224] In late 2004, the Nuclear Regulatory Commission (NRC) indicated that there was "no rational reason" that the reactors that would burn this MOX fuel would need substantially increased security, and in early 2005, NRC approved the use of the lead test assemblies fabricated in France in the Catawba reactors in South Carolina.[225]

- Talks on an international financing and management approach for disposition of Russian excess weapons plutonium continued, but no final agreement was reached. Final agreement is likely to require some resolution of the liability issue. To date, the pledges that countries have made are sufficient to cover roughly half the estimated cost of disposition of the 34 tons of excess weapons plutonium covered by the 2000 PMDA—enough to build the needed plutonium fuel fabrication facility, but not enough yet to operate it as well.[226]

- The U.S. House of Representatives attempted to slash a substantial portion of the plutonium disposition program's FY 2005 budget, because the delays resulting from the liability dispute had led to large unspent balances.[227]

- In its FY 2006 budget request, the Bush administration requested $10 million to restart work on plutonium immobilization, for material not covered under the PMDA and not suitable for use in MOX fuel—work the administration had previously canceled.[228]

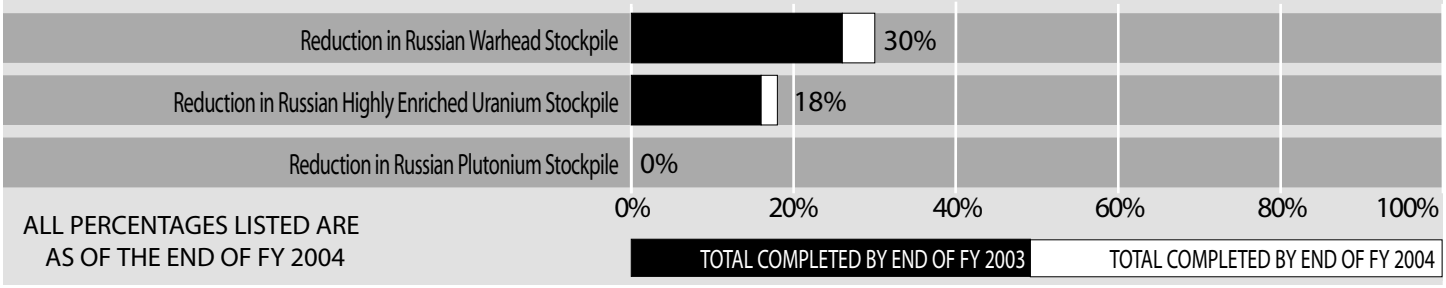
- In early 2005, the director of the plutonium disposition program at DOE resigned. Since he had run all aspects of the effort, and had fought tenaciously to move it forward, his resignation—with no replacement immediately in sight—reduced confidence in the effort in Congress and elsewhere.

- An additional 30 tons of HEU from Russian dismantled nuclear weapons was blended to LEU and shipped to the United States.

- The initiative to slightly increase the pace at which the United States purchased Russian HEU, by purchasing some HEU for U.S. research reactors, was substantially delayed, as the United States and Russia were unable to agree on prices, and DOE requested no additional money for the effort in its FY 2006 budget.[229]

[222] Sammy Fretwell, "Bomb-Grade Plutonium Conversion Delayed; Production of Fuel for Power Plants Was to Start at SRS in Four Years," *The State (Columbia, S.C.)*, 10 February 2005.
[223] Ann MacLachlan, "Opponents Protest as U.S. Pu Makes Its Way to Cadarache," *Nuclear Fuel*, 11 October 2004.
[224] Daniel Horner, "House Members Raise Questions over Plutonium Shipment to France," *Nuclear Fuel*, 30 August 2004; MacLachlan, "Opponents Protest as U.S. Pu Makes Its Way to Cadarache."
[225] For the decision making the remarkable statement that there is "no rational reason" why a MOX-fueled reactor should have increased security, see U.S. Nuclear Regulatory Commission, *In the Matter of Duke Energy Corporation (Catawba Nuclear Station, Units 1 and 2)*, CLI-04-29 (Washington, D.C.: NRC, 2004; available at http://www.nrc.gov/reading-rm/doc-collections/commission/orders/2004/2004-29cli.pdf as of 29 March 2005). For the announcement of the authorization to load MOX lead test assemblies into the Catawba reactors, see U.S. Nuclear Regulatory Commission, "NRC Authorizes Use of Mixed Oxide Fuel Assemblies at Catawba Nuclear Power Plant" (Washington, D.C.: NRC, 2005; available at http://www.nrc.gov/reading-rm/doc-collections/news/2005/05-043.pdf as of 28 March 2005).
[226] Interviews with State Department and DOE officials, December 2004.
[227] Wier, "Legislative Update."
[228] Lauren Markoe, "SRS Slated for New Surplus Plutonium Disposal," *The State (Columbia, S.C.)*, 20 February 2005.
[229] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 549.

Figure 3-7
How Much Reducing Work Have U.S.-Funded Programs Completed?



- Disposition of U.S. HEU continued, with another 20 tons downblended or shipped for downblending (bringing the total to 65 tons so far, out of 174 tons of U.S. HEU declared excess), and six additional tons of HEU were added to the project in which the Tennessee Valley Authority will use fuel that does not quite meet commercial specifications, made from downblended U.S. HEU.[230]

- The U.S. Department of Defense halted its funding for Russian trains transporting nuclear weapons to storage and dismantlement facilities for much of the year, in a dispute over transparency measures for these shipments.[231] This program is perhaps the closest thing to direct U.S. assistance for dismantlement of Russian nuclear warheads that currently exists.

The metrics in this area are very simple—the fractions of the relevant stockpiles that have been reduced (see Figure 3-7).

Reducing Metric 1: Reduction in Russian Warhead Stockpile

Fraction accomplished. Although the Nunn-Lugar cooperative threat reduction program is often thought of as a weapons dismantlement effort, the fact is that the United States has never paid for the dismantlement of a single Russian nuclear warhead, because Russia and the United States have never been able to agree on the kind of monitoring measures the United States would require to ensure that the dismantlements for which it was paying were really occurring. DOD's Cooperative Threat Reduction program does pay for shipments of warheads to dismantlement sites, and it routinely pays for the dismantlement of nuclear missiles, bombers, and submarines, but not for dismantlement of the warheads themselves.

Nevertheless, Russia has dismantled thousands of nuclear warheads since the collapse of the former Soviet Union. Under DOD's nuclear warhead transportation program, the United States has paid for over 250 nuclear warhead shipments, typically carrying some 20-30 warheads each, either to central storage facilities or to dismantlement facilities. While what is hoped to be a temporary halt in this effort began in 2004, if the issues that led to that pause are resolved, DOD anticipates supporting approximately 70 shipments per year over the next five years.[232]

The U.S.-Russian HEU Purchase Agreement has also provided a financial incentive to dismantle warheads, by arranging for the commercial sale of uranium blended from the HEU warheads contain. By the end of 2004, over 230 tons of HEU had been blended down under this agreement; if we assume that, on average, Russian warheads contain 25 kilograms of HEU, this is the equivalent of more than 9,000 nuclear warheads.[233] Presumably a large fraction of the warheads

[230] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 516-517.
[231] U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, pp. 12, 43.
[232] Interview with DOD official, January 2004, supplemented by U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 43. DOD reports that 45 shipments took place in FY 2004.
[233] USEC, "Chronology: US-Russian Megatons to Megawatts Program: Recycling Nuclear Warheads into Electricity (as of December 31, 2004)" (Bethesda, Md.: USEC, 2005; available at http://www.usec.com/v2001_02/HTML/Megatons_chronology.asp as of 28 March 2005).

transported to dismantlement facilities with U.S. assistance were the same as warheads dismantled to provide HEU for the HEU Purchase Agreement, and hence these figures should not be added together. What is unknown, however, is (a) how much of the HEU blended down to date was from warheads dismantled even before the HEU Purchase Agreement was negotiated (whose dismantlement the agreement therefore could not take credit for), and (b) how many warheads Russia had when the agreement began. By some public estimates, Russia had some 32,000 warheads in 1993, when the HEU Purchase Agreement began, and has since reduced this figure to some 16,000.[234] If all of the HEU blended to date came from warheads dismantled in part as a result of this HEU deal (a generous assumption), then it could be argued that U.S. programs have contributed to the dismantlement of nearly 30% of the total stockpile of nuclear warheads that Russia had when the agreement began.

Rate of progress. Today, some 30 tons of HEU is being blended down every year under the HEU Purchase Agreement, representing the equivalent of some 1,200 warheads per year, roughly an additional 4% each year of the warheads Russia had when the HEU Purchase Agreement began. The HEU Purchase Agreement is currently scheduled to end in 2013. As there is no program in place to directly fund Russian warhead dismantlement, there is no planned completion date for such an effort.

Reducing Metric 2: Reduction in Russian Highly Enriched Uranium Stockpile

Fraction accomplished. As just noted, by the end of 2004, 231.5 metric tons of HEU had been destroyed (by blending it to low enriched uranium reactor fuel) as part of the U.S.-Russian HEU Purchase Agreement. In addition, by the end of FY 2004, some 5.4 tons of HEU had been destroyed as part of the Material Consolidation and Conversion (MCC) effort in DOE's MPC&A program.[235] This represents some 18% of the over 1,200 tons of weapon-grade HEU equivalent Russia was believed to possess when the HEU deal began.[236]

Rate of progress. As already described, an additional 30 tons of HEU is currently being destroyed each year, representing roughly an additional 2% of the original Russian HEU stockpile. The program is currently scheduled to end in 2013, after 500 tons—some 40% of the original stockpile—has been blended. In addition, DOE plans to blend down roughly an additional two tons per year in the MCC effort during FY 2005-2006.[237] Russia is also consuming some of its HEU stockpile as fuel for naval, icebreaker, research, and plutonium production reactors, and is using some for commercial production of LEU fuel from European reprocessed uranium.[238] To address a larger fraction of the stockpile more quickly, the blend-down of HEU should be substantially accelerated, and expanded well beyond the 500 tons initially agreed.

Reducing Metric 3: Reduction in Russian Plutonium Stockpile

Fraction accomplished. Years of effort and hundreds of millions of dollars of investment have been focused on laying the groundwork for disposition of excess weapons plutonium. But the program is not yet at the point where any substantial amounts of excess weapons plutonium have been used as reactor fuel or otherwise transformed into forms unsuitable for weapons use. Hence, the fraction accomplished to date in actually reducing the stockpile is zero.

[234] Norris and Kristensen, "NRDC Nuclear Notebook: Russian Nuclear Forces, 2005."
[235] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[236] David Albright has recently estimated that Russia had 1070 tons of military HEU as of the end of 2003, and 15-30 tons of civil HEU. (These are somewhat inconsistently expressed, as the 1070 figure is also the centerpoint of an estimate with a wide uncertainty range.) These figures would have been somewhat more than 200 tons higher when the HEU Purchase Agreement began, before HEU began to be destroyed in that effort. See Albright and Kramer, eds., *Global Fissile Material Inventories*. For a discussion of a range of previous unclassified estimates, and of the various uses that are drawing down Russia's HEU stockpile over time, see Bunn, "Unclassified Estimates of Russia's Plutonium and HEU Stockpiles—and World Civil Separated Plutonium Stockpiles."
[237] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[238] Bunn, "Unclassified Estimates of Russia's Plutonium and HEU Stockpiles—and World Civil Separated Plutonium Stockpiles."

Rate of progress. To date, the annual rate of progress in reducing excess plutonium stockpiles is also zero. The last year, like the year before it, was a difficult one for the plutonium disposition effort, with the liability dispute blocking efforts to move toward construction of U.S. and Russian facilities to make reactor fuel from excess weapons plutonium. The U.S. government is seeking a U.S.-Russian liability protocol and a multilateral agreement on funding and managing Russian plutonium disposition, as envisioned in the PMDA. These could provide the basis for actual construction and operation of the large facilities required—but progress toward resolving these issues have been slow.

Efforts are still underway to pull together an international financing package. Despite the inclusion of plutonium disposition as one of the priorities in the $20 billion G8 Global Partnership, total pledges for the effort are still far below the $2 billion estimated cost of disposition of the 34 tons of Russian weapons plutonium covered by the 2000 agreement (let alone the larger cost of disposition of a much larger fraction of Russia's weapons plutonium, which would be necessary if the effort was to make a significant difference in reducing the nuclear theft and rearmament threats this material poses). It seems clear that the decision to rely on an international funding approach, rather than paying for this effort with U.S. funds and allowing other nations to fund other priorities, has already delayed progress and will likely result in a more complex and less responsive management structure, reporting to multiple governments, in the future. Because of the uncertainties in resolving the liability and financing issues, among others, DOE does not even project a target date for when the Russian plutonium disposition program might be finished.[239]

If both the liability problem and the international financing and management issues can be resolved quickly, DOE hopes that construction of the needed plutonium fuel facilities could begin in FY 2006, and could be completed by approximately FY 2011.[240] Actual loading of substantial quantities of fuel made from excess weapons plutonium will probably not occur until 2011-2012. At the initial stage, current plans are to begin destroying approximately two tons per year of Russian excess weapons plutonium at that time, and then to attempt to increase this rate to four tons per year. Russia will carry out disposition of approximately 38 tons of separated plutonium under the U.S.-Russian Plutonium Disposition and Management agreement, including 34 tons of excess weapons plutonium and 4 tons of reactor-grade plutonium with which it will be blended, to maintain the confidentiality of the precise isotopic mix in Russia's weapons plutonium. If operations in fact began in 2011, and the four ton per year rate were achieved quickly, disposition of the material covered by this initial agreement could be completed in 2021-2022; if the program remained at two tons per year, disposition of this material would not be completed until 2029.

The 38 tons of material covered in this agreement, however, represents less than one-quarter of Russia's total stockpile of over 180 tons of separated plutonium (counting both weapons plutonium and weapons-usable civil plutonium).[241] Indeed, as Russia's plutonium production reactors continue to produce plutonium, and Russia continues to separate weapons-usable civilian plutonium as well, if these are not stopped in a timely way, a two-ton-per-year disposition program would effectively be running in place—eliminating as much plutonium every year as is produced every year.[242] If production

[239] This has now been true for years, as the liability dispute has dragged on. See U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 517; U.S. Department of Energy, *FY 2005 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, p. 480.

[240] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 517.

[241] Albright estimates a total Russian stockpile of 145 tons of military plutonium as of the end of 2003 (again, with substantial uncertainty bounds), and Russia has officially declared that as of that time, it also possessed 38.2 tons of separated civilian plutonium. Albright and Kramer, eds., *Global Fissile Material Inventories*; International Atomic Energy Agency, *Communication Received from the Russian Federation Concerning Its Policies Regarding the Management of Plutonium*.

[242] The plutonium production reactors continue to produce in the range of 1.2 tons of plutonium per year, and Russia's declarations of separated civilian plutonium have increased, on average, by 1.3 tons per year for the past several years. Thus, the total increase in separated plutonium stocks is in the range of 2.0–2.5 tons per year.

were stopped, but disposition of all 170 tons of Russia's stockpile except the amount needed to sustain a stockpile of 10,000 warheads were included in the program, at four tons a year, completion of the plutonium disposition effort would stretch beyond 2040 (or beyond 2070 at two tons per year).

Improved Reducing Metrics for the Future

The U.S. government should develop an assessment of (a) the total world military stockpiles of HEU and separated plutonium, and (b) the total world civilian stockpiles of HEU and separated plutonium, and track progress in reducing these total stockpiles.

Summary: How Much of the Job is Done?

Figure 3-8 summarizes what fraction of the job has been accomplished, when judged by the metrics described above for each of the six categories of effort. Also shown is the fraction of the job that was accomplished during FY 2004, to give an impression of the current rate of progress when judged by these metrics. There are substantial uncertainties in all of these estimates—even those based on official government data, since that data itself is uncertain.

Overall, it is clear that while much has been accomplished in these efforts, across a broad range of metrics, less than half of the job has yet been done, after more than a decade of threat reduction efforts. There remains too much grey space on this chart—grey space that represents thousands of insufficiently secure warheads, enough insecure nuclear material for tens of thousands more, and thousands of excess nuclear weapons scientists and workers not yet permanently redirected to civilian work. Some of the bars are only inching across that grey space. In some cases, the rate of progress even three years after the September 11 attacks remains so slow that if the current rate were continued, it would still be a decade or more before the job is done. Terrorists and thieves may not give the world the luxury of that much time.

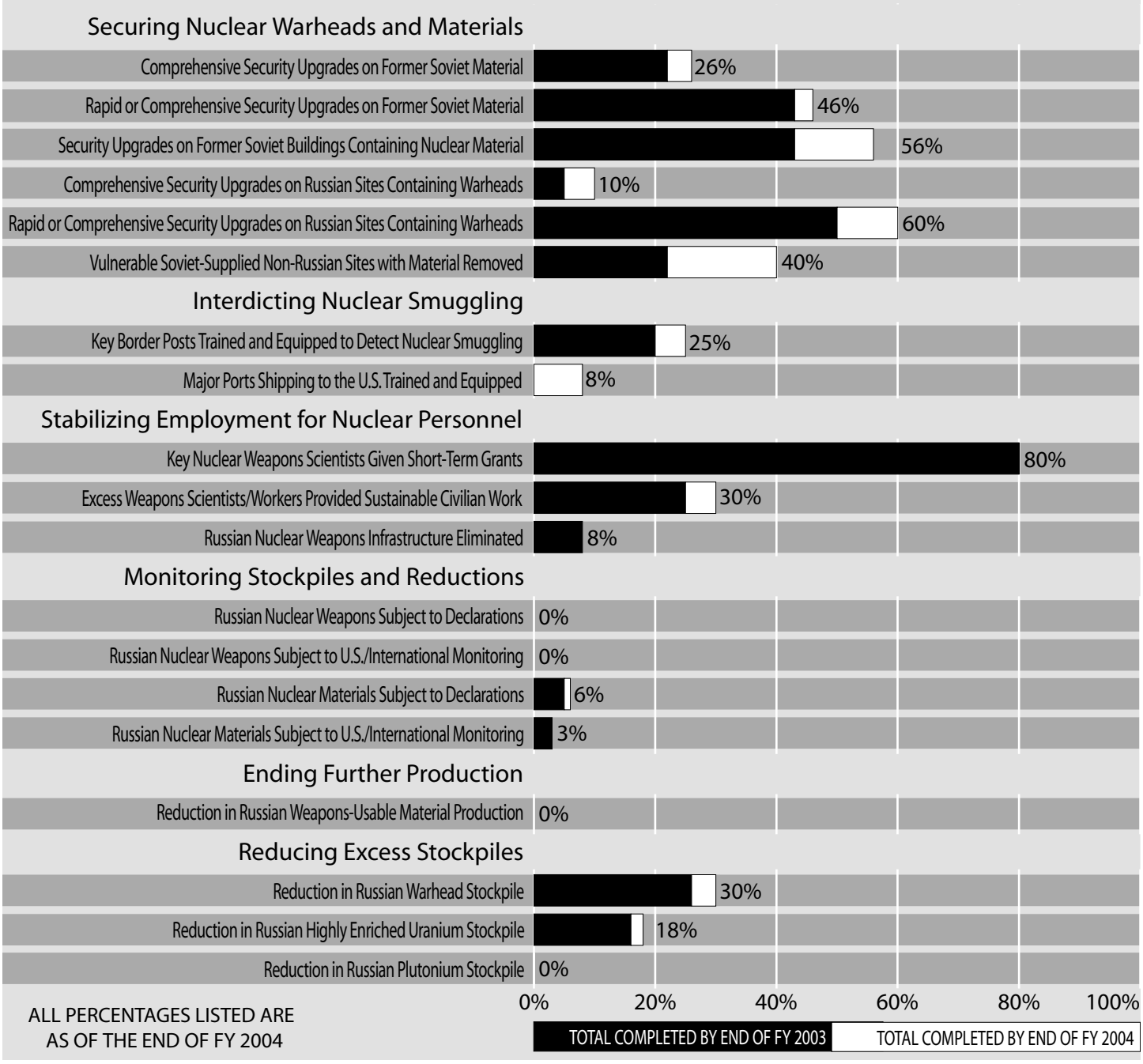
It would certainly not be correct to argue that nothing is being done to address this threat. The fact is that at the working level, hundreds of nuclear experts in the United States, Russia, and other countries have been working with dedication and creativity to move these efforts forward. Hardly a week goes by without four to eight separate U.S. teams traveling to Russia just for projects focusing on improving security for nuclear warheads and materials—with a comparable number of teams traveling for the various other projects considered in this report.[243] From travel to remote, frozen locales, to families left behind for weeks at a time, to frustration over the remaining obstacles to getting their jobs done, the participants in these efforts have endured considerable hardships with remarkably good spirit. Even at the cabinet level, former Secretary of Energy Spencer Abraham pushed hard to move this agenda forward, meeting frequently with Russian counterparts, launching new initiatives such as the GTRI, and setting demanding objectives for these programs to meet—and early indications are that his successor, Samuel Bodman, also plans to make this agenda a high priority. President Bush himself has eloquently highlighted the threat, reportedly has repeatedly prodded his staff about whether enough was being done to address it,[244] and clearly pushed for action at the Bratislava summit.

Yet when one looks objectively at what is being done, and poses the question, "Are the actions now being taken sufficient to ensure, within a few years, that all the world's stockpiles of nuclear weapons and weapons-usable nuclear material will be secure enough to be protected against the threats that terrorists and criminals have demonstrated they can pose?" the answer is plainly "no."

Securing the world's nuclear stockpiles has been largely left to the Department of Energy (along with

[243] Drawn from weekly data compiled by the U.S. Department of Energy's Moscow office. A similar weekly number of DOD CTR teams can be added to these figures, covering a broad range of types of threat reduction activities, going well beyond nuclear material and nuclear weapon security.
[244] Interviews with administration officials, January 2005.

Figure 3-8
Controlling Nuclear Warheads, Material, and Expertise: How Much Work Have U.S.-Funded Programs Completed?



the modest portion of the Defense Department's Cooperative Threat Reduction program focused on that topic, and the even more modest portions of the Department of State's efforts devoted to it). For better or for worse, the Department of Energy has never been one of the leading national security agencies of the U.S. government, and the energy secretary rarely participates in the meetings where key security and diplomatic policies are formulated. There have been only intermittent efforts by the most senior White House officials to identify and correct the obstacles to progress, and the subject is only rarely on the agenda when the president and the top national security officials of the government are meeting with their foreign counterparts. Yet most of the impediments to an expanded and

accelerated effort involve issues of enormous political and security sensitivity, stretching across agency boundaries—issues, in short, that only sustained presidential leadership is likely to be able to resolve.

Unfortunately, the same is even more true in Russia, and in many of the other countries that can and should play key roles in a fast-paced global effort to secure the world's nuclear stockpiles. President Putin has not directed his government to allocate the resources that are clearly needed to secure Russia's nuclear stockpiles; has not intervened to prevent Russia's security agencies from throwing up obstacles to cooperation focused on improving nuclear security; has not given his nuclear agencies the mission, authority, and resources to set and enforce stringent nuclear security rules; has not given orders to consolidate Russia's far-flung nuclear stockpiles in a small number of secure locations; and has done little to put Russia in the position of jointly leading an effort to secure nuclear stockpiles beyond Russia's borders. Both President Bush and President Putin appear to have given orders that nuclear security should be improved, and that cooperation to that end should go forward. But neither has devoted the sustained attention needed to making sure that these efforts are not delayed by bureaucratic and political impediments they are in a position to sweep aside.

In both governments, there is a natural reluctance to raise issues to the presidential level if there is some hope of resolving them short of that. It may well be, as a result, that neither president is even aware, for example, that dozens of sets of sensors and fencing that Russian security experts requested and the United States provided for a "quick fix" of security at Russia's nuclear warhead storage sites are still sitting in warehouses, more than four years after they were delivered; or that the $300 million Mayak Fissile Material Storage Facility is still sitting empty (and will stay three-quarters empty unless either U.S. or Russian policies are changed); or that Russia's nuclear agencies have refused to force facilities that no longer have any genuine need for weapons-usable nuclear material to give it up, or to allow the United States to give them incentives to do so; or that deep problems of security culture, if not resolved, may mean that sites will still not have strong security even after modern security and accounting equipment is installed.

In short, while steps were taken in the last year to lay the foundation for potentially rapid progress in the future, an enormous amount of work is still needed to seize those opportunities, to build a structure of rapid action on the ground on the foundations that have been built. Doing so is likely to require intensive efforts coming not only out of the implementing agencies but from the U.S. and Russian presidents, along with other world leaders, in order to overcome difficult obstacles that stretch across agency boundaries. If such a sustained presidential effort is not forthcoming, a potentially deadly gap between the urgency of the threat and the scope and pace of U.S. and Russian efforts to address it is likely to remain.

4 UPDATE OF THE BUDGET PICTURE

The Bush administration has requested a significant increase in funding for programs to improve controls on nuclear warheads, materials, and expertise around the world for Fiscal Year (FY) 2006. Although adequate annual funding is not a sufficient condition for progress in securing nuclear stockpiles, it is certainly a necessary one. For several programs working to control nuclear warheads, materials, and expertise around the globe, managers are pushing up against constraints other than budgets, from disputes over how to cooperate to upgrade security at particularly sensitive nuclear facilities without unduly compromising nuclear secrets, to disagreements over liability in the event of a nuclear accident in the course of cooperation.

But for some initiatives, as discussed below, additional funding would expand both the scope and pace of the work program officials can carry out. And if the non-monetary obstacles could be overcome for other programs, more money would surely be needed to carry out an expanded, strengthened, and accelerated effort. The United States should act to ensure that sufficient funding is available so that budgets do not constrain progress in these efforts, as the costs of these programs are small compared to the untold human and economic costs of a terrorist nuclear attack.

Highlights of the FY 2006 Budget Proposal

For FY 2006, which will start October 1, 2005, the Bush administration is proposing a budget of $982 million to control nuclear warheads, materials, and expertise around the world, as shown in Table 4-1.[1] If approved, that resource level would be just over $175 million greater than the approved level for FY 2005, a 22% increase. As Figure 4-1 shows, the FY 2006 proposal would provide more annual funding for this group of programs than has ever been granted before.

With most of the headlines about the administration's proposals for federal spending focusing on how little money there is to go around and how many politically sensitive programs are slated for the chopping block, the group of programs aimed at controlling

[1] This is out of a total threat reduction request of $1.312 billion (using a broad definition that includes programs beyond the boundaries of the former Soviet Union, but does not include spending on managing the United States' own stockpiles). The total request is discussed in detail below. These figures are recorded in Anthony Wier, "Interactive Budget Database," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2005; available at http://www.nti.org/e_research/cnwm/overview/funding.asp as of 15 March 2005). Users can use this database to compile custom charts on the cooperative threat reduction goals, agencies, and programs of their choice. For a discussion of which programs are counted in our totals, see Anthony Wier, "Funding Summary," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/overview/funding.asp as of 15 March 2005). It should be noted that many programs related to controlling expertise or interdicting smuggling cover chemical, biological, and missile technologies as well as nuclear technologies, and hence, by including the full budgets for these programs, we inevitably overestimate somewhat the total budget that is specifically for controlling nuclear warheads, materials, and expertise. The figures are taken from the following budget documents: U.S. Department of Energy, *FY 2006 Congressional Budget Request: National Nuclear Security Administration—Defense Nuclear Nonproliferation*, vol. 1, DOE/ME-0046 (Washington, D.C.: DOE, 2005; available at http://www.mbe.doe.gov/Budgets/06Budgets/Content/Programs/Vol_1_NNSA_3.pdf as of 14 February 2005); U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006* (Washington, D.C.: U.S. Department of Defense, 2005); U.S. Department of State, *FY 2006 Congressional Budget Justification for Foreign Operations* (Washington, D.C.: U.S. Department of State, 2005; available at http://www.state.gov/documents/organization/42245.pdf as of 3 March 2005). For initial summaries of the FY 2006 proposals, also see: William Hoehn, "Preliminary Analysis of the U.S. Department of Defense's Fiscal Year 2006 Cooperative Threat Reduction Budget Request" (Washington, D.C.: Russian American Nuclear Security Advisory Council, 2005; available at http://www.ransac.org/PDFFrameset.asp?PDF=preliminary_analysis_fy2006_ctr_request.pdf as of 15 March 2005); William Hoehn, "Preliminary Analysis of the U.S. Department of Energy's Fiscal Year 2006 Nonproliferation Budget Request" (Washington, D.C.: Russian American Nuclear Security Advisory Council, 2005; available at http://www.ransac.org/PDFFrameset.asp?PDF=preliminary_analysis_fy2006_doe_nn_request.pdf as of 15 March 2005).

Table 4-1
Proposed and Approved U.S. Budgets for Controlling Nuclear Warheads, Material, and Expertise

(US$ in millions, by fiscal year)	FY 1992–FY 2003 Enacted	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Securing Warheads and Materials	2,471.9	323.5	310.0	409.8	453.2	43.4	10.6%
Interdicting Nuclear Smuggling	468.6	120.9	127.1	131.7	192.9	61.2	46.5%
Stabilizing Employment for Nuclear Personnel	721.4	105.0	106.5	105.8	105.5	-0.3	-0.3%
Monitoring Stockpiles and Reductions	158.8	35.2	38.9	38.7	34.0	-4.8	-12.3%
Ending Further Production	139.3	81.8	50.1	44.0	132.0	88.0	200.2%
Reducing Excess Stockpiles	713.2	56.2	74.0	73.4	64.0	-9.4	-12.8%
Total [1]	***4,673.3***	***722.6***	***706.6*** [2]	***803.3*** [2]	***981.5***	***178.2***	***22.2%***

[1] The totals reported for FY 1992–2003 and FY 2004 Final Enacted in Table 4-2 of our 2004 report differs slightly from this year's report because of changes in past budget information from DOD and DOE, a rescission of prior year DOD balances that was applied to FY 2003, and the expiration of FY 2001 funds for the Elimination of Weapons Grade Plutonium Production program transferred from DOD to DOE.

[2] As of April 2005, Congress and the administration were still deliberating on a FY 2005 supplemental appropriations bill, so no funding from that supplemental is reflected in this table. Initial versions of the bill passed in the House of Representatives and the Senate included $55 million in FY 2005 funding for projects to secure nuclear materials outside the former Soviet Union. The House also included $55 million for the Megaports program, while the Senate initially allocated only $29 million.

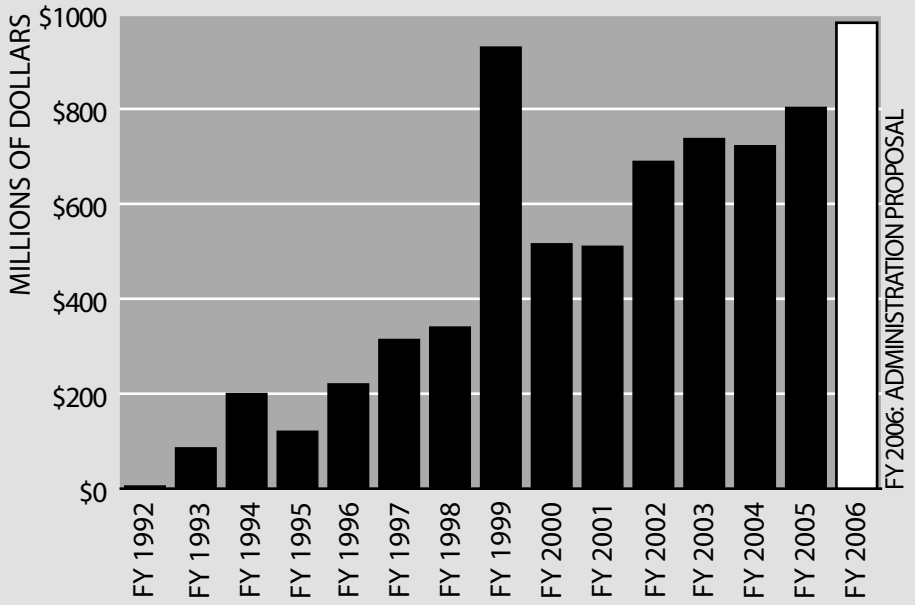
nuclear warheads, materials, and expertise have managed on the whole to come out very well, though it is only a few individual programs that are responsible for most of the cumulative increase. Some of the significant changes for individual programs being proposed for the FY 2006 budget include:

- The Department of Energy (DOE) is requesting a near tripling of the annual budget of the Elimination of Weapons Grade Plutonium Production program, from $44 million in FY 2005 to $132 million. This proposal alone accounts for over half of the total proposed increase for programs to control nuclear weapons, materials, and expertise overseas. The increase is due to revised cost estimates to build fossil fuel energy plants to replace the heat and electricity provided by three plutonium production reactors in the Russian nuclear cities of Seversk and Zheleznogorsk.

- The Second Line of Defense (SLD) program, which we count separately from DOE's Material Protection, Control, and Accounting (MPC&A) program because of its focus on interdiction rather than security, would receive a $54 million increase in the administration's FY 2006 proposed budget. The Megaports Initiative within the SLD program is requesting nearly $59 million more for FY 2006, raising the annual request to $74 million, meaning that the "core" SLD program of installing and maintaining radiation detection equipment at key border crossings in and around the former Soviet Union is slated for a $5 million decrease, to a proposed budget of $24 million.

- The Nuclear Weapons Transportation Security program at the Department of Defense (DOD) is requesting a $30 million budget for FY 2006, after DOD had reallocated its entire $26 million FY 2005

Figure 4-1
Annual U.S. Budgets for Controlling Nuclear Warheads, Material, and Expertise



Note: FY 1999 includes one-time funding of $325 million added by the FY 1999 Omnibus and Supplemental Appropriations Act to buy natural uranium to solidify the HEU Purchase Agreement, and a one-time appropriation of $200 million to support Russian plutonium disposition.

Source: Authors' calculations, based on data in "Interactive Budget Database," Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials, March 2005 (available at http://www.nti.org/e_research/cnwm/overview/funding.asp as of 22 March 2005).

budget to the Nuclear Weapons Storage Security program.[2]

- The administration is proposing to gather the various component pieces making up the Global Threat Reduction Initiative (GTRI) into a unified budget line item. Within the new GTRI budget line, for FY 2006 the administration is looking to increase by $6 million, to almost $25 million, the funding available for the Reduced Enrichment for Research and Test Reactors (RERTR) program. Money added by Congress for FY 2005 had increased RERTR funding by $10 million over its final FY 2004 level of $9 million.

- Also within GTRI, the administration is proposing to keep funding for the Russian Research Reactor Fuel Return (RRRFR) program at about the final $15 million FY 2005 level, though the FY 2005 level had been increased by $5 million over the original administration level by congressional additions. The administration is also proposing to nearly double for FY 2006, from $4.5 million to just over $8 million, the budget for U.S. Foreign Research Reactor Spent Nuclear Fuel Return, to repatriate spent research fuel originally provided by the United States to foreign countries.

- The administration is also proposing within the GTRI budget line to eliminate funding for the program to purchase HEU research reactor fuel from Russia, which received nearly $10 million in FY 2005. Meanwhile, the program to secure the spent fuel from Kazakhstan's BN-350 reactor is slated to see an increase from $2 million in FY 2005 to $8 million in FY 2006.

[2] U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*, p. 80.

- The $24 million International Radiological Threat Reduction program is being transferred from the MPC&A budget to the GTRI budget line, while a $13 million proposal for domestic radiological threat reduction (a $5 million increase over comparable FY 2005 efforts) is new to our accounting of the budget for controlling nuclear weapons, materials, and expertise (contributing on paper to the overall increase for such programs noted above).[3]

- In our accounting, the MPC&A program, excluding the SLD program, shows a $30 million paper reduction from the FY 2005 final allocation to the FY 2006 proposal. This is largely because of the proposed transfer in FY 2006 of the International Radiological Threat Reduction program to the GTRI budget line. Within the MPC&A program, DOE is proposing to increase funding by $33 million to secure civilian nuclear sites, particularly outside the former Soviet Union, to $47 million for FY 2006. That increase is offset by proposed significant funding reductions for: securing the Russian Navy complex (by $9 million, to approximately $6 million); securing Russian Strategic Rocket Forces sites (to $48 million in FY 2006, a $14 million drop); and sustainability initiatives (to $30 million, down by $11 million). Even so, the "core" MPC&A program—that is, excluding the SLD and International Radiological Threat Reduction program—is slated to receive over $46 million total more in FY 2006 than it did in FY 2004.

The FY 2006 budget proposal comes on the heels of a FY 2005 budget season in which Congress added significant funding beyond the administration's initial request for the MPC&A account and for activities under the new Global Threat Reduction Initiative, among other things. Some of the most significant outcomes from the FY 2005 congressional budget cycle included:[4]

- For FY 2005, the MPC&A program, excluding the SLD portion, received a final budget allocation of $275 million, a nearly 30% increase over the final FY 2004 level of $212 million, and a nearly 40% increase over the Bush administration's request. The House of Representatives, led by Energy and Water Appropriations Subcommittee Chairman David Hobson (R-OH), initially tried to increase funding by over $35 million more than that, but finally agreed to a slightly lower level.

- After initial hesitation following the administration's announcement of the GTRI, Congress added $30 million in unrequested funding for GTRI-related activities. With a combined $94 million in FY 2005 funding, the component programs of the GTRI collectively have $24 million more to spend in the current fiscal year than they did in FY 2004.

- The House of Representatives initially added $65 million to the SLD FY 2005 $39 million request, but agreed in conference with the Senate on a final level of $44 million, a $5 million increase.

- The FY 2005 budget for the Elimination of Weapons Grade Plutonium Production program was cut by $10 million from its $50 million proposed level. The program escaped an even deeper cut proposed initially by the House, but also benefited from the reappropriation of $4 million in expired funds originally transferred from DOD.

All told, after accounting for various program decisions and budget reallocations, the current budget level for FY 2005 for cooperative programs focused on countering the threat of nuclear weapons, materials, and expertise is $803 million, $80 million more than the final FY 2004 level, and nearly $100 million,

[3] In general, our budget categories for controlling nuclear warheads, materials, and expertise focus only on nuclear weapons and the materials from which they could be made, rather than radiological materials, but we have included the radiological funding here because, as an effort within larger line items that are focused on controlling nuclear material (previously MPC&A, now GTRI), it is difficult to separate out in budget accounting.

[4] For a recap of the 2004 legislative session, see Anthony Wier, "Legislative Update," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/overview/legislative.asp as of 2 February 2005). The highlights that follow are derived from that analysis.

or over 13%, greater than the Bush administration's FY 2005 request.

As of April 2005, the final budget for FY 2005 may also be subject to further change before the end of the fiscal year. The Congress and the administration are deliberating over a large supplemental appropriation package submitted by the administration in February 2005, to support on-going military and anti-terrorism activities and other international assistance. The original administration request included $110 million in supplemental funding for the Megaports program to support deployment of radiation detection equipment and training for officials at four additional overseas ports.[5] In its initial version of the bill, the House of Representatives halved Megaports Initiative funding to $55 million, providing the remaining $55 million "to address urgent priorities outside of the former Soviet Union to secure nuclear materials from diversion or theft by terrorists or states of concern."[6] In its version, the Senate retained the $55 million for securing nuclear materials outside the former Soviet Union, but reduced Megaports funding to $29 million because, as the Senate Appropriations Committee explained, the Megaports Initiative could not expect to spend any more by the end of the fiscal year.[7] As of early April 2005, the two houses of Congress were still negotiating to reconcile competing versions of the bill, so the final budget allocations arising from the supplemental bill are not yet known.

The administration's FY 2006 budget proposal will affect the various goals for controlling nuclear warheads, materials, and expertise in different ways.

Securing Nuclear Warheads and Materials. As shown in Table 4-2, the most critical part of the mission to control nuclear weapons and materials is slated to receive increased budgetary support during the current and upcoming budget cycles. As noted above, Congress added significant unrequested funding in the FY 2005 budget season for the MPC&A program and the administration's new GTRI effort, and for FY 2006 the administration is proposing to largely sustain the previous year's additions.

Even with expanded funding and authority for the new GTRI effort to secure and remove nuclear and radiological materials from vulnerable sites, however, GTRI does not yet have sufficient funding to offer a broad range of incentives to a large number of sites and governments to convince them to give up their dangerous materials. A funding increase targeted at GTRI could give program officials greater freedom to explore incentives to convince facilities and states to give up nuclear material that could fuel a terrorist nuclear attack. It is worth remembering that Project Sapphire, the operation in 1994 to remove nearly 600 kilograms of HEU from Kazakhstan, ended up costing some $40 million with all the incentives the Kazakh government was given;[8] certainly not every removal operation will require such investments, but program

[5] U.S. Office of Management and Budget, "Estimate #1—Emergency Supplemental (Various Agencies): Ongoing Military Operations in the War on Terror; Reconstruction Activities in Afghanistan; Tsunami Relief and Reconstruction; and Other Purposes—2/14/05," in *Budget of the United States Government: Fiscal Year 2005* (Washington, D.C.: OMB, 2005; available at http://www.whitehouse.gov/omb/budget/amendments/supplemental_2_14_05.pdf as of 11 April 2005).

[6] See the initial House version of U.S. House of Representatives, *Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005*, 109th Congress, 1st Session, H.R. 1268 (2005; available at http://thomas.loc.gov/cgi-bin/bdquery/z?d109:h.r.01268: as of 11 April 2005). The explanation of the targets of the money can be found in U.S. House of Representatives, *Report by the House Appropriations Committee on the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005*, 109th Congress, 1st Session, House Report 109-16 (2005; available at http://thomas.loc.gov/cgi-bin/cpquery/z?cp109:hr16.109: as of 11 April 2005).

[7] For the Senate explanation of its initial funding allocation, see U.S. Senate, *Report by the Senate Appropriations Committee on the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005*, 109th Congress, 1st Session, Senate Report 109-52 (2005; available at http://thomas.loc.gov/cgi-bin/cpquery/z?cp109:sr52.109: as of 11 April 2005).

[8] Matthew Bunn and Anthony Wier, "Removing Material from Vulnerable Sites," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/securing/vulnerable.asp as of 2 February 2005). Also see Philipp C. Bleek, *Global Cleanout: An Emerging Approach to the Civil Nuclear Material Threat* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, September 2004; available at http://bcsia.ksg.harvard.edu/BCSIA_content/documents/bleekglobalcleanout.pdf as of 13 April 2005).

Table 4-2
U.S. Funding for Securing Nuclear Warheads and Materials

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Material Protection, Control, & Accounting	DOE	212.147 [1]	199.000 [1]	275.451 [1]	245.506 [2]	-29.945	-10.9%
Nuclear Weapons Storage Security - Russia	DOD	48.000	48.672	73.899 [3]	74.100	0.201	0.3%
Nuclear Weapons Transportation Security - Russia	DOD	23.200	26.300	0.000 [3]	30.000	30.000	N/A
Global Threat Reduction Initiative (GTRI)	DOE	[69.464]	-	11.000 [4] [93.803]	97.975	[4.172] [5]	[4.4%] [5]
Reduced Enrichment for Research and Test Reactors (RERTR)	DOE	8.860	9.965	18.813 [6]	[24.732] [6]	[5.919] [5]	[31.5] [5]
Russian Research Reactor Fuel Return	DOE	9.691	9.866	15.246 [6]	[14.703] [6]	[-0.543] [5]	[-3.6%] [5]
Foreign Research Reactor Spent Nuclear Fuel Acceptance Program	DOE	6.115 [7]	4.918	4.500 [6]	[8.712] [6]	[4.212] [5]	[93.6%] [5]
BN-350 Fuel Security	DOE	8.270	2.000	1.984 [6]	[8.000] [6]	[6.016] [5]	[303.2%] [5]
International Nuclear Security	DOE	7.167 [8]	9.230	8.884	5.578	-3.306	-37.2%
Total, Securing Nuclear Warheads and Materials		***323.450***	***309.951*** [9]	***409.777*** [9]	***453.159***	***43.382***	***10.6%***

[1] Excludes Second Line of Defense funding. Includes funding for the Radiological Dispersal Device program, which will be rolled into the Global Threat Reduction Initiative budget line in FY 2006.

[2] Excludes Second Line of Defense funding, and excludes funding for the Radiological Dispersal Device program, which will be rolled into the Global Threat Reduction Initiative budget line in FY 2006.

[3] Updated to reflect allocation specified in *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*.

[4] Reflects Emerging Threats component of FY 2005 GTRI funding. Through FY 2005, funding for component programs rolled into GTRI are shown under each original funding line. DOE estimates comparable FY 2005 total GTRI component funding to be $93.803 million.

[5] Bracketed figures reflect the changes in funding proposed between FY 2005 and FY 2006 for the GTRI component activities, and for the sum of those components. DOE estimates comparable FY 2005 total GTRI component funding to be $93.803 million.

[6] Funding for subsequent fiscal years have been rolled into the Global Threat Reduction Initiative budget line. FY 2006 bracketed figures show comparable funding level.

[7] Updated to reflect allocation specified in FY 2006 DOE Congressional Budget Justification.

[8] According to FY 2005 DOE Congressional Budget Justification, includes funding for program formerly known as "Russia/NIS Safeguards Sustainability," and for efforts to remove nuclear material from vulnerable sites.

[9] As of early April 2005, Congress and the administration were still deliberating on a FY 2005 supplemental appropriations bill, so no funding from that supplemental is reflected in this table. Initial versions of the bill passed in the House of Representatives and the Senate included $55 million in FY 2005 funding for projects to secure nuclear materials outside the former Soviet Union.

officials should be empowered to pursue every reasonable option to guarantee that nuclear material will not fall into the wrong hands.

Similarly, for material that cannot be removed from vulnerable sites, additional funding could enable DOE to provide security upgrades for those facilities, particularly in the non-nuclear weapons states.[9] UN Security Council Resolution (UNSCR) 1540, which was passed largely through the initiative of the United States, creates a binding legal obligation on every country on earth to put in place "appropriate effective" security and accounting for their nuclear and other weapons of mass destruction stockpiles.[10] Additional funding beyond DOE's proposed $6 million budget for the International Nuclear Security effort could increase the scope and pace of work to help other countries meet the UNSCR 1540 standard in securing caches of nuclear materials.

As noted above, one of the proposed reductions for FY 2006 in DOE's MPC&A budget is for efforts to ensure that Russia can sustain U.S.-provided infrastructure over the long term. DOE is looking to reduce annual funding for this program from $41 million in FY 2005 to $30 million in FY 2006.[11] DOE explains that the reduction will be enabled by DOE's ability to move the purchase of 10 hardened railcars for nuclear material transport forward to FY 2005. But with security upgrades being completed for more and more sites, and with DOE's 2008 deadline for completing all nuclear material security upgrades in Russia fast approaching, it seems counterintuitive that DOE is reducing the budget for MPC&A sustainability preparation. Presidents Bush and Putin at their February 2005 summit in Bratislava announced that their two countries will convene a bilateral workshop to focus attention on improving nuclear security culture, including fostering well-trained security personnel and well-maintained security systems.[12] Current and future budget proposals—in both countries—will need to be calibrated to support the initiatives that come out of that workshop.

As noted above, both the House and the Senate also have approved initial versions of supplemental legislation to provide an extra $55 million in FY 2005 funding to support operations to secure nuclear materials outside the former Soviet Union. As of April 2005, a final version of that legislation has not been signed into law, and so is not counted in the charts above.

Interdicting Nuclear Smuggling. The FY 2005 and 2006 budget levels will sustain, and in some cases expand, the enhanced budgetary support programs to interdict nuclear smuggling overseas have received since the 9/11 attacks (see Table 4-3).

While the increase being requested by DOE's Megaports Initiative in the Second Line of Defense budget line would fund installation of radiation detection equipment at five major international ports, DOE expects that the reduced annual funding for the "core" SLD will reduce the number of new sites with SLD radiation detection equipment from 29 new sites in FY 2005 to 12 in FY 2006.[13] Meanwhile, the nearly $8 million proposed increase for the State Department's Export Control and Related Border Security Assistance program, an 18% increase over the FY 2005 allocation, would allow the program to fund cooperative projects, related to nuclear and other export control efforts, in over 40 countries.[14] UNSCR 1540

[9] Currently, funding for security upgrades in non-nuclear weapons states outside the former Soviet Union comes from the Global Nuclear Security budget line, while the MPC&A program funds upgrades in other states, including the former Soviet Union.
[10] United Nations, "1540 Committee" (New York: UN, 2005; available at http://disarmament2.un.org/Committee1540/meeting.html as of 25 February 2005).
[11] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, pp. 489-491.
[12] "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation" (Bratislava, Slovakia: The White House, Office of the Press Secretary, 2005; available at http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html as of 25 February 2005).
[13] DOE notes that there were 66 sites with radiation detection equipment by the end of FY 2004, and of those 66, 2 were megaports, leaving 64 other sites. For FY 2005, the target is 98 sites total, 5 of which are megaports. For FY 2006, the target is 115 cumulative, 10 of which are megaports. U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 485.
[14] U.S. Department of State, *FY 2006 Congressional Budget Justification for Foreign Operations*, pp. 128-132.

Table 4-3
U.S. Funding for Interdicting Nuclear Smuggling

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Second Line of Defense	DOE	46.349 [1]	39.000 [2]	44.000 [2]	97.929 [2]	53.929	122.6%
Export Control and Related Border Security Assistance	State	35.788	38.000	37.696	44.400	6.704	17.8%
WMD Proliferation Prevention	DOD	29.400	40.030	39.900 [3]	40.600	0.700	1.8%
International Counterproliferation	DOD	9.400	10.100	10.100	10.000 [4]	-0.100	-1.0%
Total, Interdicting Nuclear Smuggling [5]		***120.937***	***127.130*** [6]	***131.696*** [6]	***192.929***	***61.233***	***46.5%***

[1] Funding listed under the Material Protection, Control, & Accounting budget line item. Updated to reflect allocation specified in FY 2006 DOE Congressional Budget Justification.

[2] Funding listed under the Material Protection, Control, & Accounting budget line item.

[3] Updated to reflect allocation specified in *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006*.

[4] Estimated amount, until further information is made available by the Defense Department.

[5] This total does not include amounts requested for radiation detection at U.S. borders or inside the United States. For example, for FY 2006 the Department of Homeland Security is requesting $227 million to fund the Domestic Nuclear Detection Office, to coordinate development and deployment of a national domestic nuclear detection architecture.

[6] As of early April 2005, Congress and the administration were still deliberating on a FY 2005 supplemental appropriations bill, so no funding from that supplemental is reflected in this table. Initial versions of the bill passed in the House of Representatives included $55 million for the Megaports Initiative, while the Senate initially allocated only $29 million.

creates a legal obligation for all 191 member states of the United Nations to put in place "appropriate effective" controls on the movement of WMD and related materials across their borders, and most of these states will require assistance to put effective controls in place, but these U.S.-sponsored programs would need additional money and personnel to help countries around the world meet the UNSCR 1540 mandate.[15]

As noted above, the House approved an initial version of supplemental legislation that would create an extra $55 million in FY 2005 funding to support the Megaports Initiative. The Senate, meanwhile, only provided $29 million to support the Megaports program. As of April 2005, the two chambers have yet to reconcile their competing versions of the bill, and final legislation has not been signed into law, so no additional funding for Megaports is counted in the charts above.

Stabilizing Employment for Nuclear Personnel. The cumulative FY 2006 budget proposed for the programs pursuing this goal is almost identical to the final allocation of FY 2005 (see Table 4-4).[16] Indeed, the budgets for these programs have been

[15] United Nations, "1540 Committee."

[16] None of the programs focus solely on redirecting former Soviet scientists and engineers with nuclear expertise (except for the Nuclear Cities Initiative component of the Global Initiatives for Proliferation Prevention), but their entire budgets are included here because of the difficulty of breaking out how much of each is spent on nuclear scientists and engineers versus other scientists and engineers with WMD knowledge.

Table 4-4
U.S. Funding for Stabilizing Employment for Nuclear Personnel

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
International Science and Technology Centers/ BW Redirection	State	50.202 [1]	-	-	-	N/A	N/A
Nonproliferation of WMD Expertise	State	-	50.500 [2]	50.096 [2]	52.600 [2]	2.504	5.0%
Global Initiatives for Proliferation Prevention [3]	DOE	39.764	41.000	40.675 [4]	37.890	-2.785	-6.8%
Civilian Research and Development Foundation	State	15.000 [5]	15.000 [5]	15.000 [5]	15.000 [5]	0.000	0.0%
Total, Stabilizing Employment for Nuclear Personnel		***104.966***	***106.500***	***105.771***	***105.490***	***-0.281***	***-0.3%***

[1] Budget information does not show enough detail to provide component targeted at nuclear weapons scientists and engineers.

[2] Replaces budget item called "International Science and Technology Centers/BW Redirection." Budget information does not show enough detail to provide component targeted at nuclear weapons scientists and engineers.

[3] DOE and congressional documents combine amounts for the Nuclear Cities Initiative and the Initiatives for Proliferation Prevention into the Global Initiatives for Proliferation Prevention line item. This account was formerly called "Russian Transition Initiatives." DOE changed the name in the FY 2006 Congressional Budget Justification.

[4] Updated to reflect allocation specified in FY 2006 DOE Congressional Budget Justification.

[5] Estimated amount, until further information is made available by the State Department.

remarkably stable in nominal terms over the last several years. The previous chapter showed that these efforts have a long way to go in meeting meaningful goals for creating sustainable civilian work for former Soviet scientists and for helping to downsize Russia's nuclear weapons complex to a level appropriate to its planned stockpiles. As we have discussed in prior reports, having anything more than a marginal effect on the wrenching transition of the ten entire cities in Russia where most of Russia's nuclear materials and nuclear personnel reside will require fundamental changes in the effort along with additional funding.[17]

For FY 2006 the State Department's Nonproliferation of WMD Expertise budget line will also fund projects to support civilian employment for former Iraqi and Libyan weapons scientists.[18] It is not clear whether the $2.5 million requested increase for the larger budget line will be enough to cover expansion of work in Iraq and Libya, or whether these additions will require reductions in other program activities, including support of the International Science and Technology Centers in Moscow and Ukraine.

Both the DOE and State Department efforts are trying to elicit greater contributions from private partners in

[17] 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. 70-71; Matthew Bunn, Anthony Wier, and John Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2003; available at http://www.nti.org/e_research/cnwm/overview/report.asp as of 1 February 2005), pp. 141-146.

[18] U.S. Department of State, *FY 2006 Congressional Budget Justification for Foreign Operations*, pp. 136-137.

Table 4-5
U.S. Funding for Monitoring Weapons and Warhead Stockpiles and Reductions

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
HEU Transparency Implementation	DOE	17.894	20.950	20.784	20.483	-0.301	-1.4%
Warhead and Fissile Material Transparency	DOE	15.814	16.431	16.431	13.482	-2.949	-17.9%
Trilateral Initiative	DOE	1.500 [1]	1.500 [1]	1.500 [1]	0.000 [2]	-1.500	-100.0%
Total, Monitoring Stockpiles and Reductions		***35.208***	***38.881***	***38.715***	***33.965***	***-4.750***	***-12.3%***

[1] While funding for this activity is embedded in a larger budget line item, in recent years, this project is thought to have been funded at approximately $1.5 million per year.

[2] Previous levels had been assumed pending further information; as the effort is largely dormant, no assumption is made for FY 2006 until further information becomes available.

scientific redirection projects, and are increasing training and support so that scientists and their institutes can move away from U.S. support. DOE boasts that for FY 2004 it received matching contributions equal to 100% of U.S. governmental funding, an indicator of commercial interest in supported projects.[19] For FY 2003, 10% of State Department funds, which in the past have tended to support fundamental scientific research that were not directly ready for commercial activity, were matched by private groups.[20]

Monitoring Stockpiles and Reductions. Funding for these programs have also largely been stable, though for FY 2006 the Bush administration is proposing to reduce funding for the Warhead and Fissile Material Transparency program by $3 million, an almost 18% decrease from its $16 million level in FY 2005 (see Table 4-5).[21] In general, funding is not the greatest constraint for these efforts. As we discussed in our March 2003 report, the most critical issues blocking or delaying progress are almost entirely policy issues, though additional funding would likely be needed were those policy issues resolved.[22]

Ending Further Production. As noted above, for FY 2006 the administration is proposing to nearly triple the annual funding for the program to construct fossil fuel plants in the Russian closed nuclear cities Seversk and Zheleznogorsk to replace the heat and energy generated by three reactors that continue to produce 1.2 metric tons of weapon-grade plutonium every year (as shown in Table 4-6). The proposed funding increase reflects new estimates of the projected costs of the projects, not an effort to accelerate the 2008 shutdown of the two Seversk reactors or the 2011 shutdown of the Zheleznogorsk reactor.[23] Indeed, in order to maintain the 2011 scheduled shutdown for the Zheleznogorsk reactor,

[19] U.S. Department of Energy, *Performance and Accountability Report: FY 2004*, DOE/ME0044 (Washington, D.C.: DOE, 2004; available at http://www.mbe.doe.gov/progliaison/doe04par.pdf as of 18 February 2005), p. 134. It is important to note, however, that these matching funds in most cases represent U.S. companies paying for their own work on joint projects, not money that actually employs additional WMD experts from the former Soviet Union.

[20] U.S. Office of Management and Budget, "Department of State and International Assistance Programs," in *Budget of the United States Government: Fiscal Year 2006—Program Assessment Rating Tool* (Washington, D.C.: OMB, 2005; available at http://www.whitehouse.gov/omb/budget/fy2006/pma/state.pdf as of 1 March 2005), p. 217.

[21] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 473.

[22] Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 147-150.

[23] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 511. For more information, see U.S. Government Accountability Office, *Nuclear Proliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and*

Table 4-6
U.S. Funding for Ending Further Production of Weapons-Usable Nuclear Material

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Elimination of Weapons Grade Plutonium Production	DOE	81.835 [1]	50.097	43.969 [2]	132.000	88.031	200.2%
Total, Ending Further Production		***81.835***	***50.097***	***43.969***	***132.000***	***88.031***	***200.2%***

[1] All $32.1 million in FY 2001 funds transferred to DOE from DOD expired, and were reappropriated to DOE n FY 2004 by the *National Defense Authorization Act of FY 2004*.

[2] $4.189 million in FY 2002 funds transferred to DOE from DOD expired, and were reappropriated to DOE in FY 2005 by the *National Defense Authorization Act of FY 2004*.

Table 4-7
U.S. Funding for Reducing Excess Stockpiles of Weapons-Usable Nuclear Material

(US$ in millions, by fiscal year)	Dep't.	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Russian Plutonium Disposition	DOE	55.218 [1]	64.000	63.493 [1]	64.000	0.507	0.8%
HEU Reactor Fuel Purchase	DOE	1.000	10.000	9.920 [2]	[0.000] [2]	-9.920	-100.0%
Total, Reducing Excess Stockpiles [3]		***56.218***	***74.000***	***73.413***	***64.000***	***-9.413***	***-12.8%***

[1] Updated to reflect allocation specified in FY 2006 DOE Congressional Budget Justification.

[2] Funding for subsequent fiscal years will be rolled into the Global Threat Reduction Initiative budget line. DOE nevertheless proposes to zero out funding for this program in FY 2006.

[3] Total does not include funding to dispose of U.S. excess plutonium and HEU. For FY 2006, DOE is requesting a combined $589 million for these programs.

even with the increased budgets stretching at least five years in the future, DOE says it will require international contributions.[24] For FY 2006, DOE may face some difficulties in obtaining this additional funding: in its initial effort to reduce FY 2005 funding for the program, the House Appropriations Committee reasoned, "The Committee is unprepared to perpetuate the Department's preference for proposing new initiatives with inadequate cost estimates, only to be confronted with significant cost increases once Congress has begun funding the activity."[25]

Reducing Excess Stockpiles. The program to dispose of Russia's excess weapons plutonium also escaped a House effort to halve new funding for the program, using the failure of the United States and Russia to agree on how liability for accidents and sabotage would be distributed for construction projects

Final Shutdown Is Uncertain, GAO-04-662 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d04662.pdf as of 14 February 2005).

[24] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 511.

[25] United States House of Representatives, *Energy and Water Development Appropriations Bill, 2005*, 108th Congress, 2nd Session, House Report 108-554 (2004; available at http://thomas.loc.gov/cgi-bin/cpquery/z?cp108:hr554.108: as of 15 March 2005).

Table 4-8
Proposed and Approved Funding Levels for All U.S. Cooperative Threat Reduction Efforts

(US$ in millions, by fiscal year)	FY 1992–FY 2003 Enacted	FY 2004 Final Enacted	FY 2005 President's Budget	FY 2005 Final Enacted	FY 2006 President's Budget	Change from FY 2005 Final	% Change from FY 2005 Final
Department of Energy [1]	2,897.0	466.1	484.9	583.6	720.7	137.2	23.5%
Department of Defense [2]	4,300.9	466.8	421.1	419.8	427.0	7.3	1.7%
Department of State [3]	883.3	145.8	153.0	149.5	164.5	15.0	10.0%
Total	***8,081.2*** [4]	***1,078.8*** [4]	***1,059.0*** [4]	***1,152.9*** [5]	***1,312.3***	***159.4***	***13.8%***

[1] In its own documents, the administration reports that it is requesting $1,013 million in FY 2006 for cooperative nonproliferation programs as part the G8 Global Partnership Against the Spread of Weapons of Mass Destruction, with $526 million of that coming out of the Department of Energy. The administration figure only includes spending in the former Soviet Union, while our figure includes all programs with a cooperative threat reduction component for which information is available.

[2] The administration's count for the Pentagon's proposed contribution in FY 2006 to the G8 Global Partnership is $416 million, though that estimate does not include, as we do, an estimated $10 million for the International Counterproliferation program, or an estimated $1.5 million for the Arctic Military Environmental Cooperation program.

[3] The administration also reports that it is requesting $71 million for the State Department in FY 2006 for cooperative nonproliferation programs as part the G8 Global Partnership. This figure includes only the parts of the Export Control and Related Border Security Assistance program and the Nonproliferation and Disarmament Fund expected to go towards work in the former Soviet Union, while our figure includes the entirety of these programs' funding. The government figure also does not include, as we do, an estimated $15 million for the Georgia Border Security and Law Enforcement program (which has some nonproliferation benefits), and an estimated $15 million for the Civilian Research and Development Foundation.

[4] The totals reported for FY 1992-2003, FY 2004 Final Enacted, and the FY 2005 President's Budget in Table 4-1 of our 2004 report differ slightly from those reported here due to revisions in past budget information available from DOD and DOE; a $50 million rescission of prior year DOD balances that was applied to FY 2003; and the expiration of $32.1 million in FY 2001 funds and $4.2 million in FY 2002 funds transferred from DOD to DOE for the Elimination of Weapons Grade Plutonium Production program (which were subsequently reappropriated to FY 2004 and 2005, respectively).

[5] As of April 2005, Congress and the administration were still deliberating on a FY 2005 supplemental appropriations bill, so no funding from that supplemental is reflected in this table. Initial versions of the bill passed in the House of Representatives and the Senate included $55 million in FY 2005 funding for projects to secure nuclear materials outside the former Soviet Union. The House also included $55 million for the Megaports program, while the Senate initially allocated only $29 million. The House initially did not include $15 million for the Nonproliferation and Disarmament Fund, while the Senate did.

(see the final FY 2005 level in Table 4-7).[26] As of April 2005, with the Russian construction season fast approaching and with both the United States and Russia planning to begin site preparation activities in May 2005, a liability deal had still not yet been reached, though as noted earlier the United States has offered compromise language and hopes are running high that a deal will be concluded soon. DOE and the State Department are also working to secure financing from other governments rather than having the United States pay entirely for this effort on its own (having secured $850 million in commitments thus far, counting U.S. commitments, which is enough to fund facility construction, but not operation), though here too a lack of resolution on the liability issue may be holding up greater international support.[27]

For HEU, as we discussed in earlier reports, sufficient funds are in place to carry out the current approaches to disposition of U.S. HEU, and for the purchase of Russian HEU, which is financed primarily through commercial means rather than government

[26] *Energy and Water Development Appropriations Bill, 2005*.

[27] See National Nuclear Security Administrator Linton Brooks's testimony in Armed Services Committee, Subcommittee on Strategic Forces, *Hearing on the Fiscal Year 2006 Energy Department Budget Request for Atomic Energy Defense Activities*, United States House of Representatives, 109th Congress, 1st Session (2 March 2005).

expenditure. For FY 2006, DOE proposes to cut all new funding from the initiative to purchase HEU fuel from Russia for use in American research reactors. DOE attributed the proposed cut to delays in reaching an agreement with the Russians on the price and manner of transporting the HEU.[28] If the United States and Russia decided to pursue a large-scale acceleration of the HEU blend-down rate, as proposed in detail in our 2003 report, significant additional funding would be required.

Total Threat Reduction Funding

As Table 4-8 shows, with the FY 2005 allocation, total appropriations since 1992 for all cooperative threat reduction efforts, including chemical, biological, and other nonproliferation cooperation, has eclipsed $10 billion (using a broad definition of threat reduction funds that includes some funds spent outside the former Soviet Union that the administration does not count toward its G8 Global Partnership contribution). Just over half of that sum, nearly $5.2 billion, has been appropriated to DOD, though DOE programs have accounted for most of the recent growth, and over recent years has received roughly the same amount of annual funding as DOD.

For FY 2006, at $1.312 billion, the proposed budget for all cooperative nuclear, chemical, biological and missile threat reduction activities would be $159 million higher than the final approved FY 2005 budget, and just short of 25% greater than the Bush administration's own proposal for FY 2005.[29] The DOD threat reduction budget is slated to fall in FY 2005 and 2006, compared to its FY 2004 level, as less new funding is required to pay for construction of a chemical weapons destruction facility at Shchuch'ye, Russia.

Beyond the accomplishments already discussed in this report, that $10 billion investment has produced clear results. Over 6,500 former Soviet warheads have been deactivated, over 1,100 intercontinental and submarine-launched ballistic missiles have been destroyed, and over 25 ballistic missile-carrying strategic submarines have been demolished, for example.[30] Taken as a whole, the effort started over a decade ago has directly contributed to substantial reductions in the nuclear, chemical, biological, and missile threat pointed at the United States, at a remarkably low cost in comparison to other major defense efforts.

[28] U.S. Department of Energy, *FY 2006 Defense Nuclear Nonproliferation Budget Request*, p. 549.
[29] Wier, "Interactive Budget Database."
[30] U.S. Defense Threat Reduction Agency, "Cooperative Threat Reduction: Scorecard" (Washington, D.C.: DTRA, 2005; available at http://www.dtra.mil/toolbox/directorates/ctr/scorecard.cfm as of 15 March 2005).

5 RECOMMENDATIONS

Terrorists are energetically seeking nuclear weapons and their essential ingredients. If the world is to win the race to lock down nuclear stockpiles before terrorists and criminals can get to them, current efforts must be transformed into a fast-paced global partnership for nuclear security. That partnership must have a simple but ambitious goal: to ensure, as rapidly as possible, that every nuclear weapon and every kilogram of separated plutonium and highly enriched uranium (HEU), wherever it may be in the world, is secure and accounted for, to standards adequate to defeat the threats that terrorists and criminals have shown they can pose. The 9/11 Commission recommended a "maximum effort" to keep nuclear weapons and other weapons of mass destruction out of terrorist hands; the recommendations in this chapter are designed to transform the current efforts into such a "maximum effort."

During the last year, with the launch of the Global Threat Reduction Initiative (GTRI), the passage of UN Security Council Resolution (UNSCR) 1540, and the Bratislava Bush-Putin summit, the United States and other countries laid critically needed foundations for such an effort, in three key areas—accelerating and strengthening U.S.-Russian nuclear security cooperation, removing potential bomb material from vulnerable sites around the world, and locking down the remaining nuclear stockpiles worldwide. These new foundations themselves create new imperatives for action, for without an intense and high-level international effort to follow through, these opportunities may be lost. To meet these new imperatives and build a global nuclear security partnership that can act at the pace and the scale required, both President Bush and Russian President Putin will have to push persistently and creatively to overcome the political and bureaucratic impediments to action, putting this effort near the top of their national security agendas. Breaking through these obstacles requires presidential action, as many of the obstacles cut across agencies and departments, and cannot be addressed by individual ministers or cabinet secretaries acting alone, however energetic or well-intentioned they may be. Success will require not just occasional encouraging statements, but in-depth, day-to-day engagement. The effort will have to be at the top of the diplomatic agenda as well—an item to be addressed with every country with stockpiles to secure or resources to help, at every level, at every opportunity, until the job is done.

A comprehensive global nuclear security partnership would have many ingredients, but the three just mentioned are essential: accelerating and strengthening the effort in Russia, where the largest stockpiles of potentially vulnerable nuclear materials still exist; removing the material entirely from the world's most vulnerable sites; and building a fast-paced global coalition to improve security for the remaining nuclear stockpiles around the world.

Step 1: An Accelerated and Strengthened Partnership with Russia

The first and most crucial step is to put in place an accelerated and strengthened effort with Russia, based on genuine partnership. Between them, President Bush and President Putin have the power to overcome the disputes that have been allowed to slow progress in these efforts.

Actions by President Putin, in particular, are the key to success in building a transformed U.S.-Russian nuclear security partnership. If he decided to make securing nuclear stockpiles from theft a top national security priority, as he should, he has the power to assign the needed resources to put in place and sustain effective security for all of Russia's nuclear stockpiles, to sweep aside the obstacles to accelerated international cooperation that his agencies have raised, and to give his nuclear agencies the mission, authority, and resources to set and enforce nuclear security rules that would ensure that only facilities that have demonstrated the ability to defend against plausible

terrorist and criminal threats (from both insiders and outsiders) were allowed to have nuclear weapons or weapons-usable nuclear material on-site.

Security for all of Russia's nuclear stockpiles sufficient to defeat the threats that terrorists and criminals have shown they can pose in Russia is critical to Russia's own security, for there is a very real chance that if extreme Chechen or other Islamic terrorists got hold of a nuclear bomb, Moscow or St. Petersburg could be their target.[1] As President Putin agreed in the Bratislava statement, nuclear terrorism is one of the "gravest threats" that *Russia* faces; it is not just an American problem. Russia's nuclear stockpiles are ultimately Russia's to secure, and with a large cadre of nuclear experts (many of whom are now familiar with modern security and safeguards approaches), Russia now has the resources and capabilities to take many of the actions needed to ensure effective nuclear security.

This is not to say that U.S.-funded threat-reduction programs are no longer urgently needed investments in U.S. national security; they are. Russian stockpiles can be secured more quickly and more effectively, in a way that gives the rest of the world more transparency and more confidence that effective security measures are in fact in place, if Russia works with the United States and the other participants in the G8 Global Partnership. Whatever Russia's recent economic successes, its federal budget remains a small fraction of the U.S. federal budget, and with a complex web of social, political, and economic transformations underway, Russia faces many other urgent priorities; as a result, U.S. and other international resources remain a key part of the solution to managing Russia's Cold War legacies. For the moment, it is still true that many of the tasks being financed by the roughly $1 billion per year in U.S. threat reduction spending (representing less than one quarter of one percent of the U.S. defense budget) would simply not occur, or not occur at anything resembling the same pace, if U.S. assistance were unavailable. But over time, Russia needs to move toward providing the resources needed to sustain and improve effective nuclear security on its own, and Russian facilities need to be weaned from their current dependency on U.S. nuclear security assistance.

President Bush's critical diplomatic tasks in the aftermath of Bratislava include: using his excellent relationship with President Putin to convince the Russian president of the urgency of action, both for Russia's own security and as a central requirement of a positive relationship with the United States; pressing for agreement with Russia on key steps to strengthen and accelerate the nuclear security effort in Russia and around the world; and stepping in to overcome the obstacles to a fast-paced U.S.-Russian nuclear security partnership that still exist on the U.S. side. Some of the issues on the U.S. side President Bush must address include: excessive access and liability demands; undue linkage to a variety of extraneous political concerns (as reflected in congressional certification requirements and bans on proceeding with certain projects until disputes over Russia's cooperation with Iran are resolved); cumbersome contracting and visa procedures that introduce unnecessary delays; and a variety of negotiating approaches that reflect lingering Cold War suspicions and attitudes.[2]

There are a number of specific actions President Putin can and should take immediately to ensure that security adequate to meet today's threats is put in place for all of Russia's nuclear stockpiles. In the aftermath of the 9/11 attacks, the United States took a broad range of actions to improve nuclear security at Department of Energy (DOE) facilities:

- immediately strengthened guard forces;
- launched a fast-paced review of security at all DOE sites with nuclear weapons or weapons-usable

[1] See, for example, Simon Saradzhyan, *Russia: Grasping Reality of Nuclear Terror*, International Security Program Discussion Paper 2003-02 (Cambridge, Mass.: Belfer Center for Science and International Affairs, 2003; available at http://bcsia.ksg.harvard.edu/BCSIA_content/documents/saradzhyan_2003_02.pdf as of 22 March 2005).

[2] See "What Are the Main Impediments to Action?" 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. 74-75.

nuclear materials, to find vulnerabilities and suggest ways to fix them;

- imposed new requirements for DOE nuclear facilities to defend against larger and more lethal terrorist threats;

- took steps (admittedly slow-moving, to date) to consolidate nuclear material at fewer locations;

- examined approaches to transforming DOE guard forces into a highly trained, elite fighting force; and

- increased spending on nuclear security, by a substantial margin.[3]

So far, in the aftermath of Beslan, Russia appears to have taken the first of these steps—increasing guard forces at facilities—but not the others.[4] Following up on the discussions in Bratislava, President Putin should direct that the remainder of these steps be taken in Russia as well.

President Putin and President Bush must also pursue together a broad agenda to translate the Bratislava words into effective actions:

- **Develop a fast-paced joint strategic plan.** U.S. and Russian experts should rapidly agree on a joint strategic plan for implementing comprehensive security upgrades for *all* nuclear warheads and weapons-usable nuclear materials in Russia by the end of 2008, allocating both U.S. and Russian resources to accomplish the joint objectives.

- **Overcome obstacles.** The Bodman-Rumiantsev interagency committee established at the Bratislava summit should move rapidly to identify the most important impediments to accelerated and strengthened action, and should work out specific steps to overcome them, to be taken below the presidential level where possible, or forwarded to both presidents for immediate action where necessary.

- **Resolve the access problem.** The United States and Russia should reach a rapid accord on: an agreed approach to access to sensitive sites, including Russian agreement to offer access to all but a few of the most sensitive areas of Russian nuclear sites; U.S. follow-through on President Bush's offer of "equal access" to comparable areas of comparable sites in the United States; and agreed arrangements for accomplishing security upgrades at those few areas that are genuinely too sensitive for either side to be willing to allow access to the other (such as provision of photographs, videotapes, and operational records of installed equipment, and other measures).[5] The controversy in Russia over misinterpretations of the access issue as focused on the United States "seizing control" over Russia's nuclear stockpile is certain to make the access issue even more difficult and politically sensitive to resolve, however.[6]

- **Agree on liability.** The United States and Russia should reach a rapid compromise on the issue of liability in the event of an accident during such threat reduction cooperation. Accords will be needed both for the specific issue of plutonium

[3] Summarized in Matthew Bunn, "Nuclear Security in the United States: Response to 9/11" (unpublished: 2005).
[4] "Security Tightened at Russian Nuclear Facilities - Tass," *Dow Jones International News*, 1 September 2004.
[5] The United States and Russia already reached a signed agreement outlining such measures for particularly sensitive sites in 1999, but unfortunately, the United States effectively repudiated the arrangement and demanded direct access by U.S. personnel wherever new contracts for cooperative upgrades were to be agreed. That mistake has slowed or prevented progress at sites where a substantial fraction of Russia's nuclear material exists for years. For a roughly contemporaneous discussion of this episode and its other implications, see 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).
[6] "Moscow Rally Calls to Prevent U.S. Control over Russian Nuclear Facilities," *Interfax News Service*, 20 February 2005; Nabi Abdullaev, "A Bush Deal and a Missing Paragraph," *Moscow Times*, 1 March 2005; Vladimir Ivanov and Mikail Tollegin, "Myagkiy Yaderny Kontrol' (Soft Nuclear Inspection)," trans. Russian Press Digest, *Nezavizimaya Gazeta*, 2 March 2005; "Russian Nuclear Installations Not to Be Inspected by Americans," *RIA Novosti*, 1 March 2005.

disposition and for the Cooperative Threat Reduction umbrella agreement, which will otherwise expire in June 2006. If Russia is unwilling to extend the umbrella agreement again with the liability language that it finds offensive, the United States may have to modify its insistence that Russia again accept language under which Russia would bear all of the liability even if an accident was caused by intentional sabotage by U.S. personnel. The United States is alone among the major participants in the G8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction in insisting on such language, and in failing to reach an acceptable liability arrangement with Russia.

- **Consolidate stockpiles.** The United States and Russia should reach a rapid agreement on consolidating nuclear warheads and weapons-usable nuclear materials at a smaller number of sites. To date, unfortunately, Russia has taken little action toward consolidation, and U.S. efforts to promote consolidation have made only modest progress. Protecting a much smaller number of sites would make it possible to achieve more security at lower cost, as has already been the case where consolidation has been accomplished in the U.S. complex.[7] Because many Russian sites are opposed to giving up their potential nuclear bomb material, a consolidation initiative should include steps both sides can take to require sites to give up their unneeded stockpiles or at least to give them incentives to do so. For example, putting in place stringent nuclear security rules would inevitably impose substantial ongoing costs on facilities with weapons-usable nuclear material, creating an incentive for facilities to give up such materials where they are not needed. The United States and Russia should agree to use the giant, highly secure Mayak Fissile Material Storage Facility not just for weapon-grade plutonium and HEU that will never again be returned to weapons, but as a site to send any separated plutonium or HEU that would otherwise pose a proliferation and terrorism threat.[8] The United States should consider, if necessary, providing assistance to rapidly provide consolidated facilities for nuclear warhead storage.[9] The

[7] Harold P. Smith, Jr., "Consolidating Threat Reduction," *Arms Control Today* (November 2003; available at http://www.armscontrol.org/act/2003_11/Smith.asp as of 22 March 2005).

[8] Currently, the United States insists that only weapon-grade material that Russia commits will never again be used in nuclear weapons should be stored in the Mayak facility. Russia has indicated that since the only weapon-grade plutonium it is legally bound not to ever again use in nuclear weapons is the 34 tons of weapons plutonium covered by the U.S-Russian Plutonium Management and Disposition Agreement, of which roughly nine tons is plutonium oxide produced by Russia's plutonium production reactors that is already in secure storage at Seversk and Zheleznogorsk, only about 25 tons of plutonium is available for storage at Mayak under these conditions—which would leave three-quarters of the storage spaces in the facility empty. One potentially promising approach is to segregate different areas of the facility, with part of the facility assigned to material that will meet the criteria of being weapon-grade and committed never to be returned to weapons, and the remainder of the facility available for storage of any plutonium and HEU that poses a proliferation or terrorism threat. See Matthew Bunn, "Mayak Fissile Material Storage Facility," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/securing/mayak.asp as of 14 February 2005). As of early 2005, loading of the Mayak facility with nuclear material had not yet begun, though the facility had been completed in late 2003, as U.S.-Russian disagreements over transparency measures to be applied to the facility had not yet been fully resolved. For a discussion of the transparency talks, see U.S. Department of Defense, *Cooperative Threat Reduction Annual Report to Congress: Fiscal Year 2006* (Washington, D.C.: U.S. Department of Defense, 2005). A somewhat similar recommendation, that the Mayak facility be used for storage of potentially vulnerable HEU stockpiles, can be found in Charles Ferguson and William Potter, *The Four Faces of Nuclear Terrorism* (Monterey, Cal.: Center for Nonproliferation Studies, Monterey Institute for International Studies, 2004), p. 327.

[9] As four examples of possible approaches that Russia could take, with U.S. assistance or on its own if it judged U.S. assistance in some of these cases to be too sensitive: (a) Russia could re-open some centralized national nuclear warhead stockpile sites that have been closed, and ship warheads to those sites from their current dispersed locations; (b) Russia could make space for essentially all its stored nuclear warheads available in the gigantic and highly secure underground facility at Yamantau Mountain, which Russia spent billions of dollars building in the 1990s, and which appears to be controlled already by the Ministry of Defense, though Russia has never been willing to explain its purpose publicly; (c) Russia could make space for thousands of warheads available in the large underground plutonium production facility at Zheleznogorsk, where there are huge empty concrete rooms (more than 100 meters long) built for reprocessing facilities that were never installed, and which are already in a highly secure facility, and could readily be adapted for storage of warheads if institutional issues (the ownership of the facility by Rosatom rather than the Ministry

United States should: provide briefings to key Russian officials on the substantial cost savings and security benefits the United States has managed to achieve through consolidating nuclear material in fewer sites and buildings within its own complex, and its ongoing consolidation efforts; work to convince the Russian government to direct its facilities to give up nuclear materials that are no longer needed; and raise the subject to higher levels if progress is not forthcoming.

- **Strengthen security culture.** U.S. and Russian experts should jointly identify key actions that both sides can take to strengthen security culture in their two countries and ensure that all security-critical personnel give security the priority it requires.[10] The two governments should then immediately begin implementing the steps identified, in cooperation and on their own. Developing a list of steps for immediate action by governments should be the goal of the security culture workshop agreed to in Bratislava. The current cooperative effort to put in place "culture coordinators" at Russian facilities, similar to the security awareness coordinators at DOE facilities, should be expanded to include all sites with significant amounts of nuclear material.

- **Institute design basis threats that match the dangers.** As already suggested, Russia should act rapidly (with U.S. cooperation to the extent Russia desires) to put in place regulations that require every facility where nuclear weapons or significant quantities of weapons-usable nuclear material are located to put in place security arrangements capable of defending against Beslan-scale outsider threats, or insider threats of several individuals working together, as a condition of being allowed to continue to have such nuclear stockpiles onsite.[11] The security and accounting upgrades now being installed in U.S.-Russian cooperative efforts are designed to defend against significantly smaller threats; putting in place security rules requiring facilities to be able to defeat threats comparable to those demonstrated at Beslan and in insider thefts that have taken place in Russia would require expanding guard forces in many cases, and installing additional security and accounting equipment in some cases.

- **Find and fix weaknesses.** Russia should act rapidly (with U.S. cooperation to the extent Russia desires) to put in place effective mechanisms to inspect and test nuclear security arrangements, and to work with sites to ensure that any needed corrective actions are implemented. Russia needs to

of Defense) could be addressed; (d) Russia could rapidly build simple, low-cost, but effective additional bunkers for warhead storage at existing central warhead storage facilities (possibly comparable to the nuclear warhead bunkers at Pantex in the United States, for example; though Pantex is one of the most secure facilities in the U.S. complex, the bunkers are little more than Quonset huts covered with a thick layer of dirt, with huge steel security doors barred by massive concrete blocks at the entrances). For a discussion of the first of these options, see Gunnar Arbman and Charles Thornton, *Russia's Tactical Nuclear Weapons: Part II: Technical Issues and Policy Recommendations*, FOI-R-1588-SE (Stockholm: Swedish Defense Research Agency, 2005; available at http://www.foi.se/upload/pdf/FOI-RussiasTacticalNuclearWeapons.pdf as of 12 April 2005). For a discussion of Yamantau Mountain, see "Yamantau" (Washington, D.C.: GlobalSecurity.org, undated; available at http://www.globalsecurity.org/wmd/world/russia/yamantau.htm as of 18 March 2005). For a discussion of the underground facility at Zheleznogorsk as a possible location for consolidation, see Matthew Bunn and John P. Holdren, "Managing Military Uranium and Plutonium in the United States and the Former Soviet Union," *Annual Review of Energy & the Environment* 22, no. 1 (1997), p. 423.

[10] An excellent discussion of the nuclear security culture in Russia can be found in Igor Khripunov and James Holmes, eds., *Nuclear Security Culture: The Case of Russia* (Athens, Georgia: Center for International Trade and Security, The University of Georgia, 2004; available at http://www.uga.edu/cits/documents/pdf/Security%20Culture%20Report%2020041118.pdf as of 18 February 2005).

[11] The IAEA recommendations on physical protection for nuclear facilities recommend that every country put in place such a regulatory design basis threat. International Atomic Energy Agency, *The Physical Protection of Nuclear Material and Nuclear Facilities*, INFCIRC/225/Rev.4 (Corrected) (Vienna: IAEA, 1999; available at http://www.iaea.or.at/Publications/Documents/Infcircs/1999/infcirc225r4c/rev4_content.html as of 22 March 2005). Russia and many other countries, however, have not yet done so. The nuclear safety and security plan adopted by the Russian government in February 2005 does call for preparing a standardized model of potential intruders, for use in assessing the security at nuclear facilities, by the end of 2005—but it is not clear from the text whether, once such a model of potential intruders is developed, regulations will be put in place and enforced that would require facilities to have security arrangements in place capable of defeating the specified threat.

ensure that appropriate agencies have the legal authority, power, resources, and expertise to inspect and regulate nuclear security effectively. Some of this mission will inevitably be carried out by the Russian regulatory agency Rostekhnadzor (which incorporates the agency previously known as Gosatomnadzor). But Rosatom's internal capability to set, inspect, and enforce effective nuclear security rules should also be strengthened, as should the Ministry of Defense group charged with regulating security for nuclear weapons, nuclear material used by the military, and work involving nuclear weapons components at Rosatom.[12] A regular system of realistic testing of security performance, where "red teams" playing outside attackers or insider thieves attempt to overcome the system, would be an essential part of this overall effort.

- **Exchange "best practices" and lessons from past mistakes.** As called for in the Bratislava summit, the United States and Russian should begin as soon as possible in-depth discussions both of the best approaches to dealing with particular nuclear security and accounting issues that each country has developed over the years and of techniques for systematically finding and fixing past mistakes and problems.[13] This is not likely to be a one-way conversation, as Russian approaches to some aspects of nuclear security appear to be superior to U.S. approaches—or at least to work better in a Russian context.[14] This discussion of best practices and best approaches to finding and fixing problems should then be made into a global discussion, as envisioned in the Bratislava summit statement.

- **Launch a new initiative to secure, monitor, and dismantle the most dangerous warheads.** In the age of nuclear terrorism, the most dangerous warheads are not those atop deadly accurate intercontinental ballistic missiles, but the warheads most vulnerable to theft—in particular, warheads not equipped with modern, difficult-to-bypass electronic locks to prevent unauthorized use if stolen. A substantial fraction of Russia's remaining tactical nuclear warheads are believed not to have such modern locks, and in some cases are stored at remote, difficult-to-defend storage sites.[15] The United States and Russia should launch another round of reciprocal initiatives, comparable to the Presidential Nuclear Initiatives of 1991-1992, but with two critical differences: this round should be focused particularly on reducing risks of nuclear theft, and it should include some monitoring to confirm that the pledged actions are being taken. As part of such an initiative, the United States and Russia should exchange information on how many tactical nuclear warheads they have, they should discuss means to reduce this number as

[12] Already, with U.S. assistance, Rosatom is reportedly performing internal physical protection inspections at 6-8 sites per year, and material control and accounting inspections at a comparable number. Interview with DOE officials, April 2005.

[13] "Joint Statement by President Bush and President Putin on Nuclear Security Cooperation" (Bratislava, Slovakia: The White House, Office of the Press Secretary, 24 January 2005; available at http://www.whitehouse.gov/news/releases/2005/02/20050224-8.html as of 25 February 2005).

[14] For example, in the United States little effort is made to monitor the presence of possible attackers in areas outside the fence of nuclear facilities, while in Russia, security agencies attempt to have at least some awareness of a much larger zone surrounding nuclear facilities—in the hope of beginning to organize a response well before attackers show up at the fence of a facility. See the discussion in Dmitry Kovchegin, "Approaches to Design Basis Threat in Russia in the Context of Significant Increase of Terrorist Activity" (paper presented at the Institute of Nuclear Materials Management 44th Annual Meeting, Phoenix, Arizona, 2003). On the control of information that might be passed during travel by cleared individuals, Russia takes a draconian approach: key personnel at nuclear weapons facilities do not have daily access to their passports, which are held in the safe of the site security officer and only released after official government permission for a particular foreign trip has been granted. This continues to be true for five years after a nuclear weapon designer retires and no longer has access to classified information. (Interview with Russian nuclear weapon designer, September 2003.)

[15] Gunnar Arbman and Charles Thornton, *Russia's Tactical Nuclear Weapons: Part I: Background and Policy Issues*, FOI-R-1057-SE (Stockholm: Swedish Defense Research Agency, 2003); Arbman and Thornton, *Russia's Tactical Nuclear Weapons: Part II: Technical Issues and Policy Recommendations*; Anatoli Diakov, Eugene Miasnikov, and Timur Kadyshev, *Non-Strategic Nuclear Weapons: Problems of Control and Reduction* (Moscow: Center for Arms Control, Energy, and Environmental Studies, Moscow Institute of Physics and Technology, 2004; available at http://www.armscontrol.ru/pubs/en/NSNW_en_v1b.pdf as of 17 March 2005).

much as possible, and they should ensure that all of them are stored in facilities with the highest practicable levels of security. Specifically, the United States and Russia should each agree to: (a) take several thousand warheads—including all of those posing the greatest risk of theft[16]—and place them in secure, centralized storage; (b) allow visits to those storage sites by the other side to confirm the presence and the security of these warheads; (c) commit that these warheads will be verifiably dismantled as soon as procedures have been agreed by both sides to do so without compromising sensitive information; and (d) commit that the nuclear materials from these warheads will similarly be placed in secure, monitored storage after dismantlement.[17]

- **Provide resources, organizations, and incentives to sustain security.**[18] President Bush should seek a clear commitment from President Putin that Russia will provide the resources to sustain effective security and accounting for all of its nuclear stockpiles after international assistance phases out. Such a clear commitment from the top is needed to convince facilities to begin planning to wean their nuclear security and accounting programs from U.S. assistance, and support the current efforts to draft a joint sustainability plan. Russia and the United States should act to ensure that each facility with one or more nuclear weapons or a significant amount of weapons-usable nuclear material has appropriate trained personnel assigned to the key tasks of nuclear security and accounting, and that each agency charged with managing nuclear material has a group specifically charged with overseeing nuclear security and accounting, with appropriate authority and resources to accomplish their task. Wherever practical the United States and Russia should continue and strengthen DOE's practice of emphasizing "inherently sustainable" upgrades—such as massive concrete blocks to bar access to material—and should consider the life-cycle cost of operating, maintaining, and replacing equipment when designing all security system improvements. The two countries should also act to ensure that sufficient effectively trained personnel are and will continue to be available for accomplishing key nuclear security and accounting tasks. Perhaps most important, the two countries should take actions to give facility managers and security personnel strong incentives to devote their time and resources to achieving high levels of nuclear security. Managers will always be tempted to cut spending on security—which brings in no revenue—unless strong incentives not to do so are put in place. Regulations are crucial: if managers know their facilities are going to be inspected, and fined or shut down if they do

[16] Ultimately all nuclear warheads not equipped with modern electronic locks should be dismantled. In the near term, however, neither side is likely to be willing to dismantle all such warheads, as U.S. submarine-launched warheads are critical to the U.S. nuclear deterrent but are not equipped with such locks integral to the warheads, and the same is believed to be true of some warheads critical to the Russian deterrent. In general, however, warheads on submarines or on ICBMs in concrete silos pose a lesser risk of theft than warheads scattered in forward-deployed storage facilities. Hence, for the immediate initiative, for all warheads not equipped with modern electronic locks, each side should either (a) include them in the set subject to secure, monitored storage and eventual verified dismantlement, or (b) provide the other side with sufficient information to build confidence that they are highly secure. Where warheads not equipped with modern electronic locks are not in immediate use, and are not mounted on SLBMs or ICBMs—as when they are being kept as spares, for example—they should be stored in partly disassembled form, ideally with critical parts in separate locations, to make them more difficult to steal.

[17] For an earlier description of this idea, see, for example, Matthew Bunn, Anthony Wier, and John Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2003; available at http://www.nti.org/e_research/cnwm/overview/report.asp as of 1 February 2005), pp. 132-134. For an up-to-date discussion of the risks posed by tactical nuclear weapons and steps to reduce them, see William Potter and Nikolai Sokov, "Practical Measures to Reduce the Risks Presented by Non-Strategic Nuclear Weapons" (paper presented to the Weapons of Mass Destruction Commission, Stockholm, 2005; available at http://www.wmdcommission.org/files/No8.pdf as of 18 April 2005).

[18] See "Achieving Sustainable Security," in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 48-49. See also Bukharin, Bunn, and Luongo, *Renewing the Partnership: Recommendations for Accelerated Action to Secure Nuclear Material in the Former Soviet Union*, pp. 27-44.

not meet stringent requirements, those managers will invest in security.

Building Russian Commitment

Many of the steps just outlined are steps the United States has proposed in the past, but Russia has not accepted. U.S. officials reading these recommendations may be saying to themselves: "We tried that already. How do we get agreement on it?" Clearly a shift in official Russian approaches will be essential if such a far-reaching agenda is to be agreed upon. In particular, it is crucial to change the prevailing attitude among the nuclear technical elite in Russia—and in most countries around the world—that the nuclear terrorist threat is far-fetched and that existing security approaches are adequate. The Beslan tragedy, which showed that the terrorists Russia faces can and will strike in force and kill even schoolchildren, may have begun to undermine this complacency; indeed, additional troops were dispatched to guard nuclear facilities after that crisis. But even today, few of Russia's nuclear leaders believe that substantial improvements in nuclear security are urgently needed.

As already noted, the Bratislava statement puts President Putin's personal imprimatur on the notion that nuclear terrorism is one of the "gravest threats" to Russia's own national security. President Putin should make it clear throughout his government that addressing this grave threat is a top Russian national security priority. U.S. officials should spare no opportunity to remind their Russian counterparts of President Putin's statement that insecure nuclear stockpiles pose a grave threat to Russian security, and to draw out the implications of that conclusion.

Several steps might help build the needed sense of urgency among Russia's key decision-makers:

- **A fast-paced survey of nuclear security vulnerabilities.** President Bush should encourage President Putin to assemble a team of Russian experts to conduct a fast-paced assessment of potential vulnerabilities and recommendations for fixing them at all Russian sites with nuclear weapons or weapons-usable nuclear material. Such a review would give President Putin an independent assessment, circumventing those with an incentive to present the most positive side of Russia's nuclear security to the president. Russia's security services could play a central part in such a fast-paced assessment, and Russia now has a substantial cadre of experts trained in both Russian and Western approaches to vulnerability assessment. No U.S. personnel need take part—indeed, in a review that really explored every weakness, Russia would not allow U.S. personnel to take part. Any thorough review would reveal that many of these facilities are not adequately defended against either Beslan-scale outside attacks or substantial insider conspiracies. Such a fast-paced review would parallel, for example, action DOE took to quickly review security at its own nuclear facilities in the aftermath of the 9/11 attacks. The United States should offer to share its own experience with such fast-paced reviews and offer to help cover the cost of the security upgrades the review recommends.

- **Nuclear terrorism war games.** War games and similar exercises have been effective in getting policymakers in a number of countries to think through, and understand at an emotional, experiential level, the urgent challenges they face. A war game or series of war games for Russia's national security policymakers, focused on nuclear theft and terrorism (similar to an exercise recently conducted in Europe) could help convince participants that more needs to be done to secure nuclear stockpiles.[19]

- **Joint U.S.-Russian threat briefings.** A series of briefings by Russian and U.S. experts for key Russian policymakers could outline in detail terrorist desire for and efforts to get nuclear weapons, and the very real possibility that terrorists could make at least a crude nuclear bomb if they got the needed nuclear materials. Ongoing training for nuclear security personnel should highlight

[19] The Center for Strategic and International Studies and the Nuclear Threat Initiative (NTI) organized the "Black Dawn" war game in Europe and are now working to organize a similar event in Moscow.

the urgency of maintaining high security, ideally in graphic terms that get to the heart, as well as the head. (As part of the nuclear safety training program in the U.S. nuclear navy, for example, key personnel are required every year to listen to a several-minute audiotape of a submarine that failed, killing everyone aboard.[20] Presentations to policymakers and key nuclear security officials of images from Hiroshima and Chernobyl might similarly highlight, in an emotionally gripping way, the scale of the catastrophe that could occur if nuclear security measures failed and terrorists succeeded in detonating a nuclear bomb or sabotaging a major nuclear facility.)

From Assistance to Partnership

Ultimately, gaining the needed Russian commitment to this effort, and the buy-in of Russian experts crucial to long-term sustainability, will require a genuine partnership, in which Russian experts play key roles, working with foreign partners, in the conception, design, implementation, and evaluation of the entire effort.[21] Indeed, data from a wide range of other types of international assistance efforts makes clear that the success rate is far higher when assistance recipients are deeply involved in project design and implementation than when this is not the case.[22]

How would a real, and not just rhetorical, shift from assistance to partnership actually be different? Both the United States and Russia would have to change some of their past approaches to this work. Russia would have to assign more of its own resources to the effort, it would need to reverse the past habit, in many areas, of cutting Russian funding for activities the United States is willing to help pay for, and it would need to be willing to openly discuss key issues for the joint effort, such as how nuclear security arrangements are and will be funded, or how good security performance by managers, guards, and workers is and will be rewarded. Russia's security services would have to do less to impede cooperation and more to facilitate it. The United States would have to be willing to bring Russian experts more fully into the process by which decisions are made on what security upgrades will be done.

Strategic plans, timetables, and milestones should be developed jointly, using both U.S. funds and Russia's own funds, rather than in Washington alone, without Russian consultation, as has often been past practice. Guidelines for the kinds of upgrades and the standards of security needed should be discussed and agreed wherever possible. In the past, the United States has often decided what kinds of security measures to tell its teams to put in place without consulting Russian experts, and has kept Russian experts from seeing those guidelines even as they were used as the basis to reject security upgrade projects that Russian experts proposed. Progress should be reviewed by experts from both sides working together, replacing the past U.S. practice of having U.S.-only evaluation teams assess progress of each project and recommend changes. Key personnel should lead the effort at particular sites for extended periods of time, so they can build the site-level relationships needed for a real partnership to grow.

A partnership approach does not necessarily mean putting U.S.-funded projects under Russian management—which might well slow projects down rather than speeding them up. A good example of how the kind of partnership recommended here works in practice can be found in the case of the work to improve security and accounting for the nuclear warheads and materials of the Russian Navy. In that case, a small, consistent U.S. team has been leading the effort for years, building confidence with Russian counterparts over time. A Russian team at the Kurchatov Institute has taken the lead in overseeing much of the work, and, with a daily on-the-ground presence

[20] See testimony of Rear Admiral Paul E. Sullivan, Naval Sea Systems Command, in Committee on Science, *NASA's Organizational and Management Challenge*, U.S. Congress, House of Representatives (29 October 2003).

[21] Bukharin, Bunn, and Luongo, *Renewing the Partnership: Recommendations for Accelerated Action to Secure Nuclear Material in the Former Soviet Union*.

[22] See, for instance, World Bank, *Assessing Aid: What Works, What Doesn't, and Why*: *A World Bank Policy Research Report* (New York: Oxford University Press, 1998).

in Moscow and Russian security clearances, has been able to overcome obstacles far more effectively than remote U.S. managers would be able to do. A highly committed Russian Navy team has also been willing to make the hard decisions needed to move forward, and to provide Navy resources for sustaining the new security and accounting equipment once installed.[23]

The United States should also take advantage of its Russian partners' expertise wherever possible. Although Russia is not likely to be in a position to help financially with security improvements in the United States, as part of the ongoing discussion of "best practices," when Russian experts visit key U.S. nuclear facilities, the United States should actively solicit their suggestions for security improvements and should make a conscious effort to adopt in the United States any Russian equipment, software, or procedures that may be useful. Few steps could more quickly dispel the perception of Russia as a passive recipient of U.S. assistance than well-publicized U.S. adoption of an innovative piece of Russian equipment or a Russian procedure superior to U.S. approaches for improving security at U.S. nuclear facilities.

Finally, as suggested in the Bratislava statement, rather than U.S.-Russian cooperation on nuclear security focusing only on U.S. assistance for improvements in Russia, the United States and Russia, as the countries with the largest nuclear stockpiles and the greatest experience in securing them, should jointly lead a global effort to secure nuclear stockpiles around the world. Beyond addressing real nuclear security problems around the world, visible actions to cooperate in securing material in the rest of the world would go a long way toward demonstrating that this really was a partnership in which Russia has a leading part to play, thereby strengthening the effort within Russia itself. Building support in Moscow for the United States and Russia working together as joint leaders of a global effort—beginning with getting their own houses in order—will be far easier than gaining support for the notion that Russia is a weak country that needs even more U.S. help to secure its own nuclear stockpiles.

Russia's help in leading a global effort could be important in many countries, in validating the issue as not just a "U.S.-only" concern, in bringing additional experiences and best practices to the table, and in adding to the pool of available experts for security reviews, training, and the like. Russian leadership could be crucial in a number of key cases where the United States does not have the relationships to succeed:

- **North Korea.** Russia should pressure North Korea to return the significant quantity of HEU still present at the Soviet-supplied IRT research reactor in North Korea, and should accept the return of that fuel with or without help from the United States to pay for the costs.

- **Iran.** Russia should work with Iran to convince the Iranian government to allow the U.S.-supplied research reactor HEU in Iran to be removed. Russia might be able to broker a deal, for example, in which Russian experts would package and transport the material, but the material would ultimately be shipped to the United States or Europe.[24]

- **India.** As India's principal nuclear supplier, Russia should work to ensure that India puts in place adequate security measures at India's most important nuclear facilities, both military and civilian.

- **Libya.** Russia should actively work with Libya to accelerate the effort to convert Libya's research reactor to low-enriched uranium (LEU) and ship the HEU now in that reactor's core back to Russia, in cooperation with U.S. experts.

- **Soviet-supplied HEU.** Russia should actively provide incentives for countries that received Soviet-supplied HEU to send it back to Russia as quickly

[23] For an account, see, for example, 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).

[24] Since this material is subject to U.S. obligations under the Atomic Energy Act, it cannot be legally shipped to Russia until the United States and Russia negotiate an Agreement for Cooperation under Section 123 of the Act—which the United States has refused to do until U.S.-Russian disputes over Russia's cooperation with Iran are resolved.

as possible, instead of continuing to do nothing unless the United States pays all of Russia's costs for each step. Russia should also insist that countries that possess Soviet-supplied HEU provide stringent security for it, and should send physical protection teams to find and fix any security vulnerabilities for this material that may exist, pending removal.

Such a genuine partnership cannot be built in a political vacuum. As noted in Chapter Three, a range of factors have increased suspicions between the U.S. and Russian security establishments in recent years, despite the strong Bush-Putin relationship. Such suspicions inevitably make sensitive nuclear cooperation more difficult, and strengthen the arguments of those who oppose such cooperation. Addressing these concerns will require a sustained diplomatic effort, going well beyond the scope of this report—but it is nonetheless likely to be an important ingredient of success in reducing the threats of nuclear terrorism.

As part of that larger effort, the United States should undertake a substantially increased public diplomacy effort to build support for cooperation to secure, consolidate, and eliminate nuclear stockpiles, in Russia and around the world. The United States should sponsor articles, workshops, briefings, and the like that emphasize such matters as: how much has been accomplished that serves Russia's own security interests; how limited the access to sensitive sites the United States has requested really is, and how few nuclear secrets are actually revealed; the United States' willingness to give parallel access at its own sites; the large fraction of the equipment that is being installed that is produced by Russian manufacturers, in systems designed and installed by Russian experts, not American ones; and the benefits to the Russian public's safety and security from this cooperation. Expanded efforts should be pursued to engage the Russian Duma, the Russian press, non-government organizations, and the rest of civil society in Russia in these critical issues for Russia's national security.

Finally, to build and sustain such a partnership, and to overcome the impediments to progress as they arise, new mechanisms for organizing the effort are likely to be essential—in both Washington and Moscow. The new interagency committee on nuclear security that President Bush and Russian President Putin agreed to establish at their Bratislava summit is potentially an important first step; while its co-chairmen, Rosatom Director Alexander Rumiantsev and Secretary of Energy Samuel Bodman, do not have the power themselves to resolve many of the difficult obstacles that reach across agencies, this committee can and should be used as a mechanism for finding such obstacles and raising them quickly to higher political levels for action to address them. To ensure that this effort moves forward as quickly as possible, both presidents should appoint a senior official, with the access necessary to get a presidential decision whenever needed and with responsibility for leading the joint effort to ensure that all potentially vulnerable nuclear stockpiles are secured as quickly as possible. It would also be desirable to re-establish the mechanism of bilateral interagency meetings just below the summit level, perhaps twice per year—in the past, when these were chaired by the U.S. vice president and the Russian prime minister, these events proved a useful mechanism for bringing issues and obstacles forward to high political levels for action to move the joint cooperation forward.

Step 2: Fast-Paced Removal from Vulnerable Sites Worldwide

The surest way to ensure that nuclear material will not be stolen from a particular site is to remove it, so there is nothing left to steal. What is needed now is a fast-paced effort to remove the weapons-usable nuclear material entirely from the world's most vulnerable sites, particularly including HEU-fueled research reactors. The goal should be to remove the nuclear material entirely from the world's most vulnerable sites within four years—substantially upgrading security wherever that cannot be accomplished—and to eliminate all HEU from civil sites worldwide within roughly a decade.[25] The United States should make every effort to build international consensus that the

[25] In saying that all the HEU should be removed from the world's most vulnerable sites within four years—a recommendation we have been making for several years—we are *not* suggesting that it is possible to convert every HEU-fueled research reactor within

civilian use of HEU is no longer acceptable, that all HEU should be removed from all civilian sites, and that all civilian commerce in HEU should be brought to an end as quickly as possible. The basic principle should be to secure, consolidate, and eliminate both stocks of HEU and commerce in HEU wherever possible.

The goals just outlined are challenging, and achieving them would require a substantial effort, but the scale and urgency of the threat demands no less. Success in achieving them will require focusing comprehensively on *all* the facilities that have vulnerable potential nuclear bomb material, not just those that happen to be operating civilian research reactors, or whose nuclear material happens to be Russian-supplied or U.S. supplied. It will require flexible and creative tactics, with approaches—including incentives to give up the nuclear material—targeted to the needs of each facility and host country. And it will require the United States to convert and adequately secure its own HEU-fueled research reactors, as part of convincing others to do so.

A Comprehensive Approach

In the past, different U.S. programs have focused on particular subsets of the problem posed by weapons-usable nuclear material around the world, leaving substantial gaps uncovered.[26] Reactor conversion efforts focused primarily on high-power research reactors that needed regular supplies of fresh fuel. One HEU removal effort focused on that portion of the HEU the United States exported that was eligible for the renewed U.S. take-back offer announced in 1996 (which amounted to only about one-third of the material the United States had exported), while another focused on Soviet-supplied HEU. Fortunately, the Global Threat Reduction Initiative (GTRI), launched in the spring of 2004, is explicitly intended to take a comprehensive approach, and fill such gaps. To its credit, DOE has prepared a first draft of a list of the facilities around the world where weapons-usable nuclear materials exist, and is planning to transform this list into a regularly updated database.[27]

But there is still much to be done to match the scope of the actual effort to the ambition of the statements that have been made in describing it. DOE is now working to identify all the caches of nuclear material that could pose a theft threat, and develop means to address them. In that context, it is important to ensure that the GTRI effort will fully address the following.

- **The two-thirds of U.S.-supplied HEU abroad that is not yet covered by the U.S. take-back offer.** Some 12 tons of U.S.-supplied HEU abroad is not covered by the U.S. takeback offer. When the takeback offer was renewed in 1996, it was limited to types of HEU for which the United States already had capabilities or plans for processing for disposal. DOE has extended the takeback offer in time, and is considering extending the offer to additional categories of U.S.-supplied HEU, but no decision has yet been reached.

- **Facilities other than research reactors.** Of the 128 research reactors or associated facilities worldwide estimated to have 20 kilograms or more of HEU, 41 are fuel fabrication and processing facilities, not research reactors at all (and many of those have large quantities of HEU, often in its particularly proliferation-sensitive metallic form, as most HEU research reactor fuel is manufactured from metal).[28]

four years. Rather, the argument is that all HEU should be removed from those sites identified as having both (a) enough HEU for a nuclear bomb, and (b) inadequate security to meet the threats they face, within that time. In some cases, this may mean encouraging reactors that are no longer needed to shut down rather than converting; where neither conversion nor shut-down is realistically possible in a short time span, substantial security upgrades need to be put in place rapidly, sufficient to remove the site from the list of the world's most vulnerable facilities.

[26] See "Gaps in Current Programs to Remove HEU From Vulnerable Sites," in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 58-59.

[27] Interview with DOE officials, February and April 2005.

[28] The 128-facility figure is mentioned in U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors*, GAO-04-807 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d04807.pdf as of 2 February 2005), p. 28. The 41 fuel facilities figure is from interviews with DOE and Argonne National Laboratory experts, February 2005.

- **Shut-down research reactors.** A number of the research reactors around the world with the most worrisome stocks of HEU are facilities that are already shut down. As a result, the issue of conversion may not be relevant (except for facilities that are seeking to establish some renewed HEU-fueled operation), but the facilities nevertheless require significant attention either to removing or to securing their fuel (or both).

- **Research reactors in Russia.** Russia has more HEU-fueled research reactors than any other country. Though there are now signs that Russia is moving to convert a small number of its own research reactors,[29] to date, no Russian HEU-fueled research reactor has converted to LEU, and Russian authorities have been unwilling to lay out a comprehensive plan for converting Russian reactors. The Bratislava summit statement referred only to converting reactors in "third countries," a point Russian officials have since emphasized in refusing to engage in depth on conversion of reactors in Russia. Yet despite U.S.-funded security and accounting upgrades, many of these facilities continue to pose serious security risks—and maintaining security sufficient to protect against demonstrated terrorist and criminal threats at all these sites will cost far more than the research these reactors are doing is worth. Moreover, if Russian reactors are unwilling to give up their HEU and convert to LEU, it will be much more difficult to convince the operators of Soviet-supplied HEU-fueled facilities in other countries to do the same. Converting or shutting down HEU-fueled research reactors within Russia should be a high priority, as one part of an effort to consolidate nuclear weapons and materials in fewer locations, as recommended above.

- **Research reactors that would be difficult to convert to LEU.** Of the more than 130 research reactors worldwide still operating with HEU fuel, 56 (over 40%) are not targeted for conversion under current plans—and a substantial number of additional facilities are not likely to convert unless a very substantial package of positive and negative incentives can convince them it is in their interest to do so.[30] Many of these facilities are not realistically needed, and should be given strong incentives to shut down, rather than converting (an issue discussed in more detail below).

- **Critical assemblies and pulse reactors.** Many of the world's research reactors are critical assemblies and pulse reactors—systems used to model nuclear reactor cores and other processes, in which only a few fissions occur, or fissions occur only in brief pulses. These facilities effectively never consume their HEU fuel, and hence never need new fuel—and the fuel they have, even when inside the core of the reactor, typically is effectively identical to fresh HEU fuel. Some of these facilities have huge quantities of HEU, but because they never need new fuel, attention is only beginning to be devoted to converting them to LEU, or otherwise addressing the security risks they pose.

- **Reactors for medical isotope production.** There have long been efforts to develop means to produce medical isotopes using LEU targets instead of HEU targets, and to convince the isotope production firms to convert to LEU. But there is currently little progress in convincing some of the

[29] Two Russian research reactors have told U.S. officials that they have been instructed to convert to LEU. Interviews with DOE officials, April 2005.

[30] As the U.S. General Accountability Office points out, DOE's conversion effort covers 105 reactors worldwide, of which 29 have already fully converted to LEU (and are no longer on the list of reactors currently operating with HEU); 10 have partly converted (and are still operating with some HEU in their core); 35 more could convert with already developed fuels; and 31 cannot convert without significant reductions in capability until new, denser fuels are developed. In addition, there are 56 operating HEU-fueled reactors that are not slated for conversion, including (among others) fast-neutron reactors (which cannot readily be converted to use LEU), military research reactors, reactors with specialty fuel types for which developing new fuels for small numbers of facilities has not been judged cost-effective. U.S. Government Accountability Office, *DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium*, pp. 10-11, 38-39. Hence the total number of research reactors currently using HEU, by this accounting, is 10+35+31+56=132.

key producers (notably Canada's MDS Nordion) to convert. One step that should certainly not be taken is to substantially weaken U.S. controls on the export of HEU for these facilities, as is proposed in the new version of the energy bill now being debated in the 109th Congress.[31]

- **Icebreaker, naval, and military production reactors.** Russia's nuclear icebreakers use hundreds of kilograms of weapons-usable HEU every year but no significant effort to convert those reactors has yet been funded. Similarly, no significant effort to convert naval or those military plutonium-production or tritium-production reactors that use HEU "spike" fuel has yet been undertaken.

- **HEU not supplied by either the United States or Russia.** Past U.S. programs to remove HEU from vulnerable sites focused primarily on bringing U.S.-origin HEU back to the United States, and Russian-origin HEU back to Russia. While the United States and Russia supplied the vast majority of the world's civilian HEU, there are stockpiles to be addressed that do not come from either source. One obvious example the GTRI program is now considering is the substantial stockpile of HEU at the Safari reactor in South Africa, much of which was produced by South Africa itself (including material produced for its former nuclear weapons program).

In addition to these categories of HEU to be addressed, there is the problem of separated plutonium, whose proliferation risks must be addressed as well. Today, there is a large industry, focused in France, Britain, Russia, and Japan, separating plutonium from civilian spent fuel for recycling as fuel in large power reactors. This material is weapons-usable, and it is essential that security and accounting commensurate with post–9/11 threats be maintained throughout all stages of that process.[32] The large investments in plutonium separation facilities that have already been made make it unlikely that proposals for an immediate moratorium on plutonium reprocessing will be adopted.[33] But the Bush administration should renew the effort to negotiate a U.S.-Russian moratorium, and over the long term, civilian use of separated plutonium should be phased out, in favor of fuel cycles that do not use weapons-usable separated plutonium. As with HEU, there are also a few research reactors or other small and potentially vulnerable facilities using separated plutonium as fuel, and the security issues these pose must also be addressed.

A Creative and Flexible Set Of Tactics for Addressing the Problem

Rapidly convincing facilities and countries all over the world to stop using potential nuclear bomb material and allow the material they have to be removed will be an immense challenge, requiring considerable tactical creativity, flexibility, and perseverance. A number of approaches that will likely need to be included are described below.

A broad range of incentives. One overwhelming message from past removals of HEU from vulnerable sites is that each case was unique, and required a different set of incentives to convince the facility and the country to allow the HEU to be removed. Some of these incentives related directly to the nuclear facility itself, such as the Nuclear Threat Initiative's help with managing the remaining nuclear waste on-site that proved to be crucial to getting a deal with Yugoslavia to remove the HEU from Vinca in 2002, but others were almost entirely unrelated, such as the broader

[31] For more on this topic, see Peter Bradford et al., "Letter to Representatives Joe Barton and John Dingell, Energy and Commerce Committee" (Washington, D.C.: 2005). For the latest on relevant legislative action, see also Anthony Wier, "Legislative Update," in *Nuclear Threat Initiative Research Library: Controlling Nuclear Warheads and Materials* (2004; available at http://www.nti.org/e_research/cnwm/overview/legislative.asp as of 2 February 2005).

[32] For a brief discussion, see Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, p. 128. For a disturbing recent analysis of security for transport of separated plutonium in France (authored by an engineer with long experience in physical protection at DOE, though commissioned by Greenpeace), see Ronald E. Timm, "Security Assessment Report for Plutonium Transport in France" (Paris: Greenpeace International, 2005).

[33] George Perkovich et al., *Universal Compliance: A Strategy for Nuclear Security* (Washington, D.C.: Carnegie Endowment for International Peace, March 2005; available at http://www.carnegieendowment.org/files/UC2.FINAL3.pdf as of 21 March 2005).

threat reduction assistance provided to Kazakhstan as part of the arrangements for Project Sapphire, or the relief from sanctions provided to Libya as part of its agreement to abandon its weapons of mass destruction programs and allow the fresh, unirradiated HEU at its nuclear research institute to be removed.[34] Hence, it is important, as GTRI moves forward, to be creative and flexible in offering packages of incentives for HEU removal, tailored to the needs of each individual facility. This could include help with converting to LEU or with shutting and decommissioning a reactor, contracts for other research by the scientists at a site after agreement is reached to shut the site's reactor, help with managing the wastes from a research reactor, and other steps, many of which will not even be thought of until a particular case arises.[35] It appears that additional incentives are also likely to be needed to convince facilities to return even that portion of the U.S.-supplied HEU abroad that is covered by the current U.S. take-back offer.[36]

In legislation sponsored by Senator Pete Domenici (R-NM) and Senator Dianne Feinstein (D-CA) in 2004, Congress took an essential step in the right direction, authorizing the provision of an enumerated list of incentives to convince facilities to give up their HEU. This year, Congress should consider broader language authorizing the secretary of energy to take such actions as may be necessary to implement GTRI effectively.

Shut-down, in addition to conversion. Most of the world's research reactors are aging and unneeded. The best answer for many of them is to provide incentives to shut them down. The same is true for the 56 HEU-fueled research reactors that are currently considered too difficult to convert to LEU. There is good evidence that such an approach can succeed, as even in the absence of any effort to provide shut-down incentives, far more HEU-fueled reactors have shut down since 1978, when the effort to convert these reactors to LEU began, than have successfully converted.[37] Indeed, IAEA experts have estimated that of the more than 270 research reactors still operating in the world (both HEU-fueled and otherwise), only 30-40 are likely to be needed in the long term.[38] Helping reactor operators see the virtues in shutting down will take considerable care, as no approach perceived by the world's reactor operators as anti-science or anti-nuclear is likely to succeed. As part of such an effort, the international community should help establish a smaller number of more broadly shared research reactors—the same direction that high-energy particle accelerators went long ago.

Security upgrades, in addition to material removals. Removing nuclear material from the world's most vulnerable sites should be done as quickly as possible, but it cannot happen overnight. Therefore efforts to remove nuclear material should go in parallel with programs to upgrade security at the sites where the material now resides. The international community should not be shy about investing to provide effective security at a site where the material will be removed in a few years; such an investment avoids leaving a weak link in nuclear security during the critical time before removal takes place. Through GTRI or whatever other rubric is most appropriate, the United States should assist countries around the world in strengthening security at small, vulnerable sites with weapons-usable nuclear material, and should work with states to put in place nuclear security rules re-

[34] Philipp C. Bleek, *Global Cleanout: An Emerging Approach to the Civil Nuclear Material Threat* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, September 2004; available at http://bcsia.ksg.harvard.edu/BCSIA_content/documents/bleekglobalcleanout.pdf as of 13 April 2005).

[35] Where necessary, this should include help paying for the cost of new LEU fuel (especially in cases were reactor otherwise would not buy new LEU fuel because it already has HEU that will last for many years, or for the lifetime of the reactor).

[36] U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia*, GAO-05-57 (Washington, D.C.: GAO, 2004; available at http://www.gao.gov/new.items/d0557.pdf as of 2 February 2005).

[37] Iain Ritchie, "IAEA Presentation on Threat Reduction Activities" (paper presented at the Global Threat Reduction Initiative International Partners' Conference, Vienna, Austria, 18-19 September 2004).

[38] International Atomic Energy Agency, "New Life for Research Reactors? Bright Future But Far Fewer Projected" (Vienna: IAEA, 2004; available at http://www.iaea.org/NewsCenter/Features/ResearchReactors/reactors20040308.html as of 22 March 2005).

quiring that every facility with significant quantities of weapons-usable material on hand have security measures sufficient to defeat plausible terrorist and criminal threats. (The cost of complying with such regulations will provide a strong incentive to facilities to eliminate the nuclear material they have on hand.) In particular, those remaining research reactors that are still genuinely needed and cannot convert to available LEU fuels without a substantial degradation of their scientific performance should be effectively secured for now, and given incentives to convert when development of new, higher-density LEU fuels is completed—which is not likely to occur until early in the next decade.

High-level, high-priority diplomacy. In the past, conversion of research reactors to LEU, and removal of HEU from vulnerable sites, have in most cases been handled by program managers and technical experts, not by cabinet or subcabinet national security officials. They have been treated, in essence, as "nice to do" nonproliferation initiatives, not as urgent national security priorities deserving of attention from the highest levels. In part as a result, discussions with many reactors around the world have dragged on for years, often with the hope that agreement to convert the reactor is just around the corner, but often never quite getting there. If the United States is now to succeed in drastically increasing the pace of HEU removals around the world, it is likely to be necessary to put this issue on the agenda for senior officials, as one critical element of the global effort to keep nuclear bomb material out of terrorist hands and therefore a high priority for U.S. diplomacy. In some cases, such as in the effort to convince Ukraine to allow the HEU to be removed from its nuclear facilities, this is already beginning to occur.

Effective, partnership-based management and approaches. The effort to remove HEU from more than 100 sites around the world, in scores of countries, including the conversion or shut-down of more than 100 research reactors around the world, will inevitably be challenging and technically, politically, and institutionally complex. Personnel with experience in such efforts, familiarity with the sites and their operators, and considerable creativity in finding ways to surmount the obstacles to success will be essential. Convincing a research reactor operator to adopt a new LEU fuel, never before tried in his reactor, will require building trust and confidence—elements that will be even more essential for convincing states to shut reactors down—and that will require personnel who have built relationships with these operators over the years.

For all these reasons, DOE's recent decision to shift the leadership of the reactor conversion effort away from the Argonne team that had been leading it for decades, in favor of personnel with little prior experience in the effort, is almost certain to result in both technical delays and increased difficulties in working with reactor operators around the world.[39] DOE should now take action to: (a) ensure against further rapid changes in approach or personnel that could undermine confidence among reactor operators being asked to participate in the effort (while continuing to be open to changes that could build confidence and strengthen the effort); (b) pursue approaches that involve the operators of research reactors and other key foreign decision-makers on these potentially vulnerable nuclear stockpiles in direct partnership where possible; and (c) convince personnel with extensive experience in the conversion effort to continue to take an active part, keeping them as close to the heart of the enterprise as possible.

Getting the United States' Own House in Order

If the United States wants to convince other countries to convert their research reactors to use fuels that cannot be used in nuclear weapons, to put rules in place requiring high security for those facilities where HEU is still present, and to ensure stringent security for all potential nuclear bomb material, whether in military or in civilian use, it needs to be willing to do the same itself. In particular, the United States should take the following steps.

[39] For a discussion of this recent shift, see, for example, Ann MacLachlan, "DOE Replaces Long-Time Heads of Program to Convert HEU Reactors," *Nucleonics Week*, 11 November 2004.

Convert all U.S. HEU-fueled research reactors to LEU as soon as possible. In 1986, the Nuclear Regulatory Commission approved a rule requiring all U.S. HEU-fueled research reactors to convert to LEU as soon as appropriate fuels and DOE financing for the conversions were available.[40] Yet nearly 20 years later, there are still eight U.S. HEU-fueled research reactors slated for conversion that could convert with existing fuels, but which have not converted, because DOE has not yet provided the necessary funds (along with six more reactors slated for conversion that require the new fuel still in development before they will be able to convert).[41] Converting U.S. reactors is a critical step, not only because of the security risks they pose themselves, but because research reactors all over the world point to the lack of U.S. action as reason to delay action themselves. Many research reactor operators continue to believe—however unjustified this view may be—that using HEU will provide more scientific opportunities, and do not want to accept a double standard in which U.S. facilities may use HEU and they may not.

In launching GTRI, former Secretary of Energy Spencer Abraham pledged conversion of U.S. HEU-fueled research reactors would be completed by 2013 (when the fuel now in development is expected to be licensed and commercially available),[42] but it is worth noting that (a) there is no mention of funding for U.S. reactors to convert in the administration's FY 2006 budget request; and (b) nine U.S. HEU-fueled reactors are not currently on the target list for conversion at all (because they are military research reactors which probably could not perform their missions with current or projected LEU fuels).[43] In the spring of 2005, DOE announced that it would fund the conversion of two U.S. reactors. DOE should (a) provide funding to convert all HEU-fueled reactors that can use available fuels as rapidly as possible; (b) take every action available to ensure that development, licensing, production, and use of new, higher-density LEU fuels remains on track, and is accelerated if possible; and (c) explore whether all of the U.S. reactors currently using HEU are still needed, or whether some should be shut down.

Require U.S. HEU-fueled research reactors to maintain effective security. Remarkably, U.S. HEU-fueled research reactors are exempted from key security requirements. All facilities licensed by the U.S. Nuclear Regulatory Commission (NRC) that possess more than five kilograms of U-235 in HEU—unless the HEU is in a form so radioactive that it would be difficult to steal, referred to as "self-protecting," in NRC parlance—must maintain so-called Category I physical protection, which involves security arrangements (including armed guards) capable of defeating a specified "design basis threat." But when this rule was first put in place, research reactors were exempted from a key element of it: as long as the *fresh* HEU on-site contains less than five kilograms of U-235, research reactors do not have to have security capable of defeating any particular threat, even if the HEU in the reactor core and in the spent fuel pool is not self-protecting and is more than enough for a nuclear bomb.[44] Thus weapons-usable nuclear material that would require stringent protection were it

[40] U.S. Nuclear Regulatory Commission, "Limiting the Use of Highly Enriched Uranium in Domestically Licensed Research and Test Reactors," *Federal Register* 51, no. 37 (25 February 1986; available at http://www.rertr.anl.gov/REFDOCS/NRCRULE.pdf as of 20 March 2005).

[41] U.S. Government Accountability Office, *DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium*, pp. 13-22.

[42] Spencer Abraham, "International Atomic Energy Agency, Vienna: Remarks Prepared for Energy Secretary Spencer Abraham" (Washington, D.C.: U.S. Department of Energy, 26 May 2004; available at http://www.energy.gov as of 18 March 2005).

[43] Data provided by U.S. laboratory officials. Of the nine, three are at Sandia (the Annular Core Research Reactor, the Sandia Pulse Reactor II, and the Sandia Pulse Reactor III); four are at Los Alamos (SKUA, FLATTOP, GODIVA, and Honeycomb); and two belong to the Department of Defense (the Army Pulsed Radiation Facility Reactor at the Aberdeen Proving Grounds, and the Fast Burst Reactor at White Sands Missile Range).

[44] U.S. Nuclear Regulatory Commission, "Limiting the Use of Highly Enriched Uranium in Domestically Licensed Research and Test Reactors." In addition, see Edwin Lyman and Alan Kuperman, "A Re-Evaluation of Physical Protection Standards for Irradiated HEU Fuel" (paper presented at the 24th International Meeting on Reduced Enrichment for Research and Test Reactors, Bariloche, Argentina, 5 November 2002).

located anywhere else does not require high security if it happens to be located at a research reactor.

This exemption was made because, except for a few very high-power research reactors, most research reactor fuel is not radioactive enough to be self-protecting, and the reactors complained that they simply could not afford the cost of serious security for their facilities and would be forced to shut down if required to maintain Category I protection. The exemption, approved in the 1970s, was intended to be temporary, giving the reactors time to convert to LEU, arrange to maintain less than five kilograms of U-235 at any time, or make other arrangements. But the exemption has never been lifted. The result is that most U.S. HEU-fueled research reactors, prior to the 9/11 attacks, had no on-site armed guards at all; today, many have only one. None has a security plan in place to defeat the NRC-specified design basis threat for theft of nuclear material.

NRC should immediately modify its rule, requiring all research reactors that have more than five kilograms in HEU that is not self-protecting to meet Category I security requirements. It should also substantially increase the radiation level considered self-protecting against theft: the radiation from material at the current lower limit for self-protection, set long before the 9/11 attacks, would do little to deter suicidal terrorists from stealing nuclear material.[45]

Modify DOE definitions of material requiring high security. Just as the NRC has an exemption to its security rules for research reactors, DOE's security rules exempt a wide range of types of material that pose serious security risks from major security requirements, including most HEU research reactor fuel. DOE's rules define any material that has less than 10% by weight U-235 as falling outside Category I, which is the only category that requires stringent security measures.[46] This applies even in the case, for example, of 90% enriched HEU research reactor fuel containing uranium and aluminum with less than 10% of the weight coming from the U-235—though separating aluminum from uranium is so easy a chemical separation that it could be carried out in a covert facility, such as a large garage, by personnel with no specialized nuclear chemistry experience. DOE should modify its categorization of nuclear material, eliminating this exemption from Category I requirements for material with less than 10% by weight weapons-usable nuclear material.[47]

Require effective security for U.S. civilian use of separated plutonium. In 1994, a committee of the National Academy of Sciences argued that because getting the essential ingredients of nuclear weapons was the hardest part of making a nuclear bomb, HEU and separated plutonium should, to the extent practicable, be secured to the same standards applied to nuclear weapons themselves—and argued further that this "stored weapon standard" should be applied to all separated plutonium and HEU worldwide.[48]

Although DOE at one time endorsed this standard,[49] it is now pushing in very much the opposite direction as part of the plutonium disposition program. DOE's

[45] Currently, in both NRC regulations and IAEA guidelines, material is considered self-protecting if it emits more than 100 rad/hr at 1 meter. Calculations by one U.S. nuclear laboratory suggest that terrorists stealing nuclear material would receive a radiation dose roughly equal to the hourly radiation rate at one meter, divided by the number of terrorists who divided up the task. Thus if five terrorists stole the material, they might each get a dose of 20 rads. A dose of 400 rads will kill roughly half of those exposed, over the course of days or weeks after exposure; it takes substantially higher doses still to be acutely disabling. For discussion, see Lyman and Kuperman, "A Re-Evaluation of Physical Protection Standards for Irradiated HEU Fuel."

[46] For the specifics of categorizing different types of material, current DOE orders still refer back to U.S. Department of Energy, *Guide to Implementation of DOE 5633.3b, Control and Accountability of Nuclear Materials (April 1995)* (Washington, D.C.: DOE, 1995).

[47] HEU and plutonium should be Category I materials except in cases where chemical processing experts judge that it would be extremely unlikely that terrorists would be able to recover the nuclear material for use in a bomb.

[48] Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington, D.C.: National Academy Press, 1994; available at http://books.nap.edu/html/plutonium/0309050421.pdf as of 20 March 2005), pp. 31, 102.

[49] U.S. Department of Energy, "Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement," *Federal Register* 62, no. 13 (21 January 1997; available at http://www.eh.doe.gov/nepa/rods/1997/3014.pdf as of 31 March 2005).

new policy risks undermining U.S. efforts to ensure stringent security for weapons-usable nuclear material in use at reactors around the world. Under NRC security rules, fabricated uranium-plutonium mixed oxide (MOX) fuel is considered Category I material requiring the most stringent security arrangements. As part of the plutonium disposition program, however, Duke Energy, which plans to burn MOX fuel in its Catawba and McGuire plants, has applied for exemptions from many of NRC's Category I security requirements, arguing that MOX fuel would not be an attractive target for theft, and that there should be no need to increase the current guard force intended to protect the reactor from sabotage to protect the fresh MOX fuel from theft. The NRC has now authorized the use of MOX fuel at these facilities, and has indicated that although the plants would "technically" be Category I facilities, "there is no rational reason" for them "to have a significantly different level of security than is already existing at the reactor site."[50]

For the United States to take the position that its reactors can use fuel containing weapon-grade plutonium with no significant increase in security would make it impossible for the United States to credibly urge other countries to provide stringent security for weapons-usable material when it was in use at their reactors, be they power reactors using MOX or research reactors using HEU. It would also make it essentially impossible for the United States to insist that Russia maintain stringent security for weapons plutonium throughout the disposition process. Risking U.S. national security in these ways is entirely unnecessary, as DOE is paying the cost for the MOX program, and paying for the complete Category I security requirements to be met would be a trivial increase in the cost of the disposition program. DOE should immediately direct Duke Energy to withdraw its request for an exemption, and NRC should require that all facilities with Category I nuclear materials provide security meeting NRC's Category I requirements.

Step 3: A Global Partnership to Prevent Nuclear Terrorism

The problem of insecure nuclear material is global. Solving it will require forging a global coalition of countries around the world willing to work together to improve security for nuclear materials, wherever they may be. The steps already described, if successful, will drastically reduce the security risks posed by nuclear weapons and weapons-usable nuclear materials in Russia and at facilities around the world from which weapons-usable nuclear materials can rapidly be removed. But there will inevitably be vulnerable caches of potential nuclear bomb material that are not in Russia and cannot be rapidly removed. Hence, a crucial third step is a global effort to ensure that every cache of nuclear weapons or weapons-usable nuclear materials worldwide is secure and accounted for, to a level sufficient to defeat plausible terrorist and criminal threats (both outsiders and insiders).

Given the devastating global economic impact a nuclear terrorist attack would have, every country has a strong self-interest in cooperating to reduce this threat. But senior officials in many countries around the world simply do not see nuclear terrorism as a significant threat, downplaying the likelihood that terrorists could get nuclear bomb material or could make a nuclear bomb from it if they could. Hence, an absolutely critical element of success in forging the needed global campaign to secure these stockpiles will be convincing governments around the world that the threat of nuclear theft and terrorism is real, urgent, and a threat to their countries as well as to the United States. Approaches similar to those suggested above in the Russian case—joint briefings on the nuclear terrorist threat, simulations and war games focused on nuclear terrorism scenarios, training videos for nuclear personnel that highlight the dangers, and rapid reviews of nuclear security vulnerabilities by each country's own personnel—should also be pursued with other countries around the world. Even if governments can be convinced of the reality of

[50] U.S. Nuclear Regulatory Commission, *In the Matter of Duke Energy Corporation (Catawba Nuclear Station, Units 1 and 2)*, CLI-04-29 (Washington, D.C.: NRC, 2004; available at http://www.nrc.gov/reading-rm/doc-collections/commission/orders/2004/2004-29cli.pdf as of 29 March 2005).

the danger, the intense secrecy surrounding nuclear stockpiles and their security arrangements, and the decades-long practice of leaving decisions on how much security to provide to nuclear stockpiles almost entirely to each state where these stockpiles exist, will mean that building the needed global effort will be an extraordinary challenge, again requiring sustained presidential leadership. A number of the steps that should be taken are described below.

Build a global nuclear security partnership. Despite the creation of the G8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction in 2002, the reality today is that no global coalition genuinely focused on rapidly improving nuclear security around the world yet exists. The non-U.S. members of the Global Partnership have allocated only a tiny fraction of their Global Partnership efforts to improving security for nuclear stockpiles or interdicting nuclear smuggling. No country other than the United States has made any substantial investments in assistance to improve nuclear security beyond the former Soviet Union, and the IAEA office intended to help member states improve nuclear security struggles along with a budget and staff that are dwarfed by the scale of the work to be done.

The U.S. government should place high priority on convincing leading states that could contribute to nuclear security upgrades, or whose stockpiles are critical to secure, to join in a fast-paced coalition of the willing to upgrade nuclear security. Institutionally, such a coalition could be based on a transformed Global Partnership, or it could be a new effort in parallel to the existing Global Partnership. One group of U.S. non-government experts, for example, has proposed the creation of a "Contact Group to Prevent Nuclear Terrorism," including many of the G8 states along with China, India, Pakistan, Israel, and other states with weapons-usable nuclear material that wish to join, designed to pursue securing the world's nuclear stockpiles at very high levels of each government.[51] In many cases, countries might find it easier to explain to their domestic audiences that they are joining with the United States and other leading nuclear powers in leadership of a cooperative effort to solve a global security problem, instead of acknowledging that they require U.S. assistance because they cannot adequately control their own nuclear stockpiles.

Put nuclear security at the top of the diplomatic agenda. Forging such a global effort and getting on-the-ground action moving at the pace required to meet the threat will likely require a substantial increase in the intensity and political level at which the subject of nuclear security is addressed with other leading states. The leaders of the critical states need to hear, at every opportunity, that action to ensure nuclear security is crucial to their own security and to a positive relationship with the United States. The United States can no longer afford to let the issue languish when obstacles are encountered, or to leave the discussion to specialists. The United States government should make nuclear security a central item on the diplomatic agenda with all of the most relevant states.[52]

Implement U.N. Security Council Resolution 1540. UNSCR 1540, approved unanimously in April 2004, creates new binding legal obligations on every U.N. member state to put in place "appropriate effective" laws making it a crime to help non-state actors with weapons of mass destruction. It requires states to put in place "appropriate effective" laws and procedures for export, border, and transshipment controls. And, for those states that possess nuclear, chemical, or biological weapons and their means of delivery or related materials, UNSCR 1540 mandates "appropriate effective" security and accounting and physical

[51] See Perkovich et al., *Universal Compliance: A Strategy for Nuclear Security*, pp. 87-88.

[52] The experience in Russia has been that cooperation has proceeded best when either (a) it was allowed to go forward "under the radar screen," with technical experts communicating directly with each other with relatively modest intervention from central governments, or (b) at the other extreme, when action was taken at the presidential level to push the cooperation forward and overcome obstacles. When the discussion was lodged at levels in between those extremes, officials who wanted to raise objections were able to do so, and officials who wanted to sweep aside these obstacles did not have the power to do so. In the case of countries such as Pakistan, India, and China, however, it appears likely that nuclear security cooperation will be so sensitive and so closely monitored by conservative government security agencies, that the "under the radar screen" approach may not be possible.

protection for these stockpiles. This provides a crucial opportunity for the United States to work with other countries and the IAEA to: (a) detail the essential elements of an "appropriate effective" system for nuclear security; (b) assess what improvements countries around the world need to make to put these essential elements in place; and (c) assist countries around the world in taking the needed actions. Indeed, the entire global effort to put in place stringent nuclear security measures for all the world's stockpiles of nuclear weapons and weapons-usable nuclear materials can be considered simply as the implementation of the unanimously approved obligations of UNSCR 1540.

This opportunity may be fleeting, however: it is now already a year since UNSCR 1540 was approved, and there has been little pressure on states to change their practices to fulfill its mandates in the intervening year. Many states are therefore likely becoming complacent that little or nothing will be required of them. The United States should immediately join with other leading powers in a fast-paced effort to implement UNSCR 1540, defining what is needed to meet its obligations, assessing what countries need to meet those standards, and helping countries put the necessary measures in place as quickly as possible.

Adapt cooperative threat reduction to new contexts. Adapting the threat-reduction approaches developed in cooperation with Russia and other former Soviet states to the specific circumstances of each other country where cooperation must go forward is likely to be an enormous challenge. Attempts to simply copy the approach now being used in Russia are almost certain to fail.[53] For many states, describing the cooperation as joining with the world's leading nuclear nations in the leadership of a global effort to solve a global problem may be substantially more appealing politically than describing it as U.S. assistance to put in place controls they are unable to put in place on their own. Cooperation with states with small nuclear weapons arsenals, such as Pakistan, India, China, and Israel, is likely to be especially difficult. For all of these states, nuclear activities take place under a blanket of almost total secrecy, and direct access to many nuclear sites by U.S. personnel is likely to be impossible in the near term.

Nonetheless, there is much that can be done cooperatively to improve nuclear security in such cases, including (a) training experts in vulnerability assessment, physical protection system design, material accounting, nuclear security regulation, and other areas of expertise critical to an effective nuclear security and accounting system; (b) discussions of "best practices" and means to find and fix nuclear security vulnerabilities; and (c) provision of modern security and accounting equipment for these states to install themselves, with their own funds.[54] Methods that have been developed in U.S.-Russian cooperation to assure that U.S.-financed upgrade work has been completed as agreed without requiring direct access could also be pursued, such as photographs and videotapes of installed equipment and operational reports on its use, and reliance on personnel who are citizens of the recipient country, with security clearances from that country, but employed by a U.S. contractor, who can visit relevant sites and certify that work has been done appropriately—so-called "trusted agents." In general, working out arrangements to improve nuclear security—and to build confidence that effective nuclear security really is in place—will require considerable creativity and per-

[53] For discussion, see "Challenges of Adapting Threat Reduction to New Contexts," in Bunn and Wier, *Securing the Bomb: An Agenda for Action*, pp. 104-105. See also James E. Goodby et al., *Cooperative Threat Reduction for a New Era* (Washington, D.C.: Center for Technology and National Security Policy, National Defense University, September 2004; available at http://www.ndu.edu/ctnsp/CTR%20for%20a%20New%20Era.pdf as of 21 March 2005); Lee Feinstein et al., *A New Equation: U.S. Policy toward India and Pakistan after September 11* (Washington, D.C.: Carnegie Endowment for International Peace, May 2002; available at http://www.ceip.org/files/pdf/wp27.pdf as of 21 March 2005); Rose Gottemoeller and Rebecca Longsworth, *Enhancing Nuclear Security in the Counter-Terrorism Struggle: India and Pakistan as a New Region for Cooperation* (Washington, D.C.: Carnegie Endowment for International Peace, August 2002; available at http://www.ceip.org/files/pdf/wp29.pdf as of 21 March 2005).

[54] These types of assistance would in no way violate the nuclear weapon states' Nonproliferation Treaty obligations not to assist other states in acquiring nuclear weapons. And, with appropriate care, they could be implemented while remaining fully within the export control rules in place in the United States and in other countries.

sistence. The United States should step up its efforts to move such cooperation forward, as part of the broader global partnership described in this section. U.S. officials should seek to discuss with counterparts from these countries possibilities for cooperation that would not reveal any nuclear secrets. In some cases, it may be desirable to build confidence initially with less sensitive cooperation, such as programs focused on installing radiation portal monitors at key border sites to interdict nuclear smuggling.

Exchange best practices. As noted above, discussions of best practices in nuclear security and accounting—including means that have been used to rapidly find and fix nuclear security weaknesses—should take place globally, not just between the United States and Russia. Such discussions can provide a rapid, non-intrusive, and low-cost means to help countries around the world improve their nuclear security and accounting approaches. The IAEA's Office of Nuclear Security can play a key role in identifying and promoting best practices, and organizing international discussions. It should be given the resources and mandate to do so.

In addition, the nuclear industry should establish a cooperative industry organization focused on improving security standards worldwide through exchanges of best practices, peer reviews, and peer assistance, comparable to the role the World Association of Nuclear Operators (WANO) has played in improving nuclear safety around the world. A terrorist nuclear attack using stolen plutonium or HEU would be a political disaster for the nuclear industry on a scale even larger than the Three Mile Island and Chernobyl accidents; hence, just as in the case of safety, the industry has a strong self-interest in ensuring that those facilities with the worst security performance are helped to reach the standards of the top performers.

Forge stringent global nuclear security standards. Facing terrorists with global reach, nuclear security is only as good as its weakest link: as former Senator Sam Nunn has said, insecure nuclear material anywhere is a threat to everyone, everywhere. Yet today, there are no binding global standards for how well nuclear weapons and materials should be secured, and the actual security in place ranges from excellent to appalling. Efforts to negotiate an effective global standard in a treaty have not succeeded in the past, and are not likely to succeed in the near-term future, as such negotiations inevitably become bogged down by country representatives who see little urgency for action and considerable potential for added costs and unwanted intrusion for the organizations they represent. But UNSCR 1540, in creating overnight a binding legal obligation on every state to provide "appropriate effective" security and accounting for whatever nuclear stockpiles it may have, creates an opportunity that should not be missed. If broad agreement could be reached on what a nuclear security and accounting system must include to meet the "appropriate effective" requirement, that would, in effect, become a legally binding global standard for nuclear security.

If the words "appropriate effective" mean anything, they should mean that nuclear security systems could effectively defeat threats that terrorists and criminals have shown they can pose. Thus one possible definition would be that to meet its UNSCR 1540 physical protection obligation, every state with nuclear weapons or weapons-usable nuclear materials should have a well-enforced national rule requiring that every facility with a nuclear bomb or a significant quantity of nuclear material must have security in place capable of defeating a specified set of insider and outsider threats comparable to those terrorists and criminals have demonstrated in that country (or nearby). This approach has the advantages that (a) the logic is simple, easy to explain, and difficult to argue against; (b) the standard is general and flexible enough to allow countries to pursue their own specific approaches, as long as they are effective enough to meet the threats; and (c) at the same time, it is specific enough to be effective, and to provide the basis for questioning, assessment, and review.[55] Others have proposed other standards to meet similar objectives: Graham T. Al-

[55] Questions to explore a country's compliance with this standard could include such items as: is there a rule in place specifying that all facilities with nuclear weapons or significant quantities of weapons-usable nuclear material must have security in place capable of defending against specified insider and outsider threats? Are those specified threats big enough to realistically reflect

lison, for example, has proposed a "gold standard," arguing that given the devastating potential consequences of nuclear theft, all nuclear stockpiles should be secured to levels similar to those used for large stores of gold such as Fort Knox.[56] As noted above, a committee of the U.S. National Academy of Sciences proposed a "stored weapon standard," arguing that to the extent practicable, plutonium and HEU should be subject to the same stringent standards of security and accounting that nuclear weapons themselves are (an approach that presupposes that nuclear weapons themselves have effective protection, which may not always be the case).[57]

The United States should immediately begin discussions with other leading governments to attempt to reach broad agreement on a stringent definition of the nuclear security measures required for an "appropriate effective" system, and integrate that understanding with assessment and assistance efforts designed to implement UNSCR 1540. The amendments to the physical protection convention that are likely to be approved at a diplomatic conference scheduled for July 2005 are valuable, but contain only very generally worded principles, not binding standards, and are no substitute for an effort to build effective global nuclear security standards from the foundation provided by UNSCR 1540.[58]

Build confidence that effective nuclear security is in place. Among the most difficult issues related to nuclear security is the problem of building international confidence that effective nuclear security is in fact in place. Every country has a direct national security interest in making sure that all countries with nuclear weapons and weapons-usable materials provide effective security for them. But in nearly every country with such stockpiles, the details of nuclear security arrangements are highly classified, making it difficult to reveal enough information to prove that the security measures in place are fully effective. The problem is especially difficult in cases such as Pakistan, India, and Israel, whose nuclear programs are deeply shrouded in secrecy. For those countries willing to accept international peer reviews of their security arrangements, IAEA-led peer reviews can be effective in building confidence, and such peer reviews should increasingly become a normal part of the nuclear business for developed and developing states alike, just as international safety reviews are.

Graham Allison has proposed that nuclear weapon states invite experts from another nuclear weapon state to review their nuclear security arrangements and certify that they are effective. This is a sensible goal to aim for, though it will be extremely difficult to achieve.[59] In the immediate term, states should do more to provide general descriptions of their nuclear security approaches, photographs of installed equipment, results of security tests, and related data that could be made public without providing data that could help terrorists and criminals plan their attacks.

demonstrated terrorist and criminal capabilities in that country or region? How is this requirement enforced? Is there a program of regular, realistic tests, to demonstrate whether facilities security approaches are in fact able to defeat the specified threats? Are armed guards used on-site at nuclear facilities, and if not, how is the system able to hold off outside attack or insider thieves long enough for armed response forces to arrive from elsewhere?

[56] Graham T. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, 1st ed. (New York: Times Books/Henry Holt, 2004).

[57] Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium*, pp. 31, 102. Other sources could also be drawn on for insight in defining what should be included in an "appropriate effective" physical protection system, including the "principles and objectives" in the proposed amendment to the physical protection convention (though these are very general and include few specifics), and the IAEA's recommendations on physical protection (INFIRC/225 Rev. 4). Unfortunately, while both of these provide valuable considerations for physical protection, it is possible to comply fully with both of them and still not have a secure system.

[58] The multi-year effort that led to these proposed amendments is an example of the difficulty of forging global nuclear security standards. Although the United States at one point proposed making the IAEA physical protection recommendations mandatory, this was rejected by essentially all the parties; all options that would have actually imposed legally binding standards for nuclear security were rejected by most of the negotiators. The resulting amendments have significant value in providing some general guidelines, but compliance with them would by no means ensure that a nuclear security system was effective enough to meet modern-day threats.

[59] Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, pp. 150-153.

Strengthen the role of the IAEA. The IAEA's Office of Nuclear Security, established in its current form in the wake of the 9/11 attacks, can play a crucial role in helping to set standards and disseminate best practices for nuclear security, in providing training, in assessing countries' needs, and in coordinating nuclear security assistance to countries around the world. In many countries, assessment teams and assistance organized by the IAEA would be far more welcome than U.S. assessment and assistance. With UNSCR 1540, there are now scores of countries that may require assistance to meet the binding legal obligations to provide effective nuclear security that they now face. Yet the Office of Nuclear Security has so far labored with an extraordinarily small staff and a tiny budget (a total of $35 million has been pledged to the IAEA's Nuclear Security Fund in the three and a half years since the 9/11 attacks, while the cost of substantially upgrading security at one site often exceeds $10 million).

The United States should work with other leading governments to expand the mission, personnel, and resources of the Office of Nuclear Security, allowing the IAEA to substantially increase its contribution to preventing nuclear terrorism. Specifically, this office should be given the resources to perform larger numbers of more in-depth nuclear vulnerability assessments and other evaluations of needs for prevention of nuclear terrorism. It should be allocated sufficient funds to finance some of the security upgrades identified in reviews as needed itself, rather than relying entirely on donor states to provide needed upgrades. And it should be given the mission and resources to take a leading role in assessing states' needs and helping them to comply with the nuclear provisions of UNSCR 1540. The annual budget of the Office of Nuclear Security should be increased to at least the range of $30-$50 million, and the office's budget should become part of the IAEA's regular assessed budget, rather than relying entirely on voluntary contributions.

Steps the G8 and Other Leading Powers Should Take

The leaders of the G8 and the other participants in the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction have a crucial role to play in all three of the key steps to secure nuclear weapons and materials around the world just described. At the G8 summit slated for June 2005, the G8 leaders should join in forging a fast-paced global partnership for nuclear security, including the following steps:

- Explicitly identify locking down nuclear stockpiles and interdicting nuclear smuggling as top priorities for expenditure of the $20 billion they have indicated they will provide;

- Put the "global" back in the Global Partnership, explicitly focusing the effort not just on Russia and the former Soviet states, but on helping states worldwide put in place the controls on weapons of mass destruction and related materials and technologies mandated in UNSCR 1540 (in parallel with strengthening their own controls, gaps in which have been revealed by the Abdul Qadeer Khan network);

- Agree that, given that expanded global mandate, the original $20 billion target should be significantly increased;

- Agree that, to meet their binding legal obligation under UNSCR 1540 to provide "appropriate effective" security and accounting for all nuclear stockpiles, states must establish national rules requiring every facility with nuclear weapons or significant quantities of weapons-usable nuclear material to be protected against demonstrated terrorist and criminal threats;[60]

- Agree that they will work with other countries that have received weapons-usable nuclear material from them to ensure that they meet this standard

[60] Having the support of all of the G8 leaders—whose countries control 95% or more of the world's stockpiles of nuclear weapons and weapons-usable nuclear materials—for such a standard would be a dramatic step forward. But ideally, private discussions should be pursued with states such as China, India, and Pakistan, which are not members of G8, to gain their general support as well, so that any G8 accord on this subject does not appear to force them to agree to something worked out solely among other powers.

where possible, and that they will require that it be met in any further exports of weapons-usable nuclear materials; and

- Agree on specific steps to accelerate the consolidation of weapons-usable nuclear material into fewer sites and buildings around the world. (Britain and France, in particular, as states with major facilities capable of processing irradiated research reactor fuel, should agree to join with the United States and Russia in being willing to accept research reactor fuel without requiring that wastes from it eventually be returned, creating a more flexible set of options for locations to send potentially vulnerable HEU stockpiles.)

Each of the G8 leaders should then follow through consistently, appointing senior officials to be responsible directly to them for ensuring rapid action on securing nuclear stockpiles, and for finding and fixing obstacles to progress.

Each of the states in the world with nuclear weapons bears a special responsibility for ensuring that these stockpiles are effectively secured. Security improvements are likely to be needed in all of the nuclear weapon states.[61] Pakistan's nuclear stockpile, in particular, while reportedly heavily guarded, poses urgent risks because of the immense threats it faces, both from armed remnants of al Qaeda operating in the country and from nuclear insiders with strong sympathies for extreme Islamic causes and a proven willingness to provide nuclear technology to others.[62] In China and India, the potential threats to nuclear stockpiles appear to be less extreme than in Pakistan, but nonetheless worrisome—and these countries have traditionally placed only modest reliance on modern safeguards and security technologies. Almost nothing is known publicly about nuclear security in Israel, but Israel has long experience in battling terrorist threats and a reputation for taking harsh measures against those involved in nuclear security breaches (as in the case of former nuclear weapons worker Mordechai Vanunu).[63] In all of these cases, a commitment to securing nuclear stockpiles against demonstrated terrorist and criminal threats will be important.

China's leaders should:

- Adopt national rules requiring every facility with nuclear weapons or weapons-usable nuclear material to be secured against specified outsider and insider threats, comparable to those terrorists and criminals have demonstrated in China;

- Agree that UNSCR 1540's requirement for "appropriate effective" physical protection should be interpreted as requiring such national rules;

- Agree to join in a global nuclear security partnership, including approving broad cooperation with the United States, the IAEA, and others to ensure that China is able to share in the nuclear security technologies, approaches, and best practices adopted elsewhere (while protecting China's legitimate nuclear secrets), and possibly assisting with nuclear security in other states with which China has a close relationship, such as Pakistan;[64]

[61] The case of Russia is discussed above. Problems also exist in the United States. For a blistering critique of security in the U.S. nuclear weapons complex, published shortly after the 9/11 attacks, see Project on Government Oversight, "U.S. Nuclear Weapons Complex: Security at Risk" (Washington, D.C.: POGO, 2001; available at http://www.pogo.org/p/environment/eo-011003-nuclear.html as of 29 April 2005). For a recent summary of progress made in improving security since then, and problems still remaining, including both official views and those of critics, see Committee on Energy and Commerce, Subcommittee on Oversight and Investigations, *A Review of Security Initiatives at DOE Nuclear Facilities*, U.S. Congress, House of Representatives, 109th Congress, 1st Session (18 March 2005). In France and Britain, too, there are well-informed critics who argue that more should be done. For a recent example, see Timm, "Security Assessment Report for Plutonium Transport in France."

[62] For a discussion arguing that Pakistan's nuclear stockpiles pose among the most urgent threats of nuclear theft in the world, see Bunn and Wier, *Securing the Bomb: An Agenda for Action*, p. 38.

[63] For a discussion of what is publicly known about the situations in Pakistan, India, Israel, and China, see Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 123-128.

[64] Graham Allison has proposed an innovative approach under which, to address the serious security concerns Pakistan would inevitably have about U.S. personnel checking security at Pakistan's nuclear facilities, Chinese experts would be enlisted to do so. See Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, pp. 152-153.

- Make public information chosen by China, such as general descriptions of nuclear security arrangements, photographs of installed nuclear security equipment, results of security tests, and the like, that would build international confidence that effective nuclear security was in place (while protecting China's legitimate nuclear secrets); and

- Seek to consolidate nuclear stockpiles to the extent possible, including launching efforts to convert China's HEU-fueled research reactors (and those China has exported) to LEU.

India's leaders should:

- Adopt national nuclear security rules similar to those just discussed for China;

- Agree that UNSCR 1540's requirement for "appropriate effective" physical protection should be interpreted as requiring such national rules;

- Agree to join in a global nuclear security partnership, including approving broad cooperation with the United States, the IAEA, and others, similar to that just described for China (while ensuring that no information is transferred that would be contrary to the Nonproliferation Treaty's prohibition on directly assisting states such as India with their nuclear weapons);

- Keep all nuclear weapons in partly disassembled form, ideally with key components necessary for a nuclear detonation stored at separate locations;

- Make public information chosen by India, such as general descriptions of nuclear security arrangements, photographs of installed nuclear security equipment, results of security tests, and the like, that would build international confidence that effective nuclear security was in place (while protecting India's legitimate nuclear secrets); and

- Seek to consolidate nuclear stockpiles to the extent possible, including completing the conversion of its Apsara HEU-fueled research reactor that India is carrying out without U.S. cooperation.[65]

Pakistan's leaders should:

- Adopt national nuclear security rules similar to those just discussed for China and India;

- Agree that UNSCR 1540's requirement for "appropriate effective" physical protection should be interpreted as requiring such national rules;

- Agree to join in a global nuclear security partnership, including approving broad cooperation with the United States, the IAEA, and others, similar to that just described for China and India (while ensuring that no information is transferred that would be contrary to the Nonproliferation Treaty's prohibition on directly assisting states such as Pakistan with their nuclear weapons);

- Keep all nuclear weapons in partly disassembled form, ideally with key components necessary for a nuclear detonation stored at separate locations;

- Make public information chosen by Pakistan, such as general descriptions of nuclear security arrangements, photographs of installed nuclear security equipment, results of security tests, and the like, that would build international confidence that effective nuclear security was in place (while protecting Pakistan's legitimate nuclear secrets); and

- Seek to consolidate nuclear stockpiles to the extent possible, including returning to the United States the HEU provided long ago for Pakistan's research reactor.

Israel's leaders should:

- Adopt national nuclear security rules similar to those just discussed for China, India, and Pakistan (to the extent that such approaches are not in place already);

[65] Data provided by U.S. laboratory officials.

- Agree that UNSCR 1540's requirement for "appropriate effective" physical protection should be interpreted as requiring such national rules;

- Agree to join in a global nuclear security partnership, including approving broad cooperation similar to that just described for China, India, and Pakistan (while ensuring that no information is transferred that would be contrary to the Nonproliferation Treaty's prohibition on directly assisting states such as India with their nuclear weapons);

- Keep all nuclear weapons in partly disassembled form, ideally with key components necessary for a nuclear detonation stored at separate locations;

- Make public information chosen by Israel, such as general descriptions of nuclear security arrangements, photographs of installed nuclear security equipment, results of security tests, and the like, that would build international confidence that effective nuclear security was in place (while protecting Israel's legitimate nuclear secrets); and

- Seek to consolidate nuclear stockpiles to the extent possible, including following through on the plan to shut its HEU-fueled research reactor in 2006,[66] and removing all HEU from the site expeditiously after that occurs.

The Nonproliferation Treaty Review Conference

The NPT review conference scheduled for May 2005 should:

- Call on all states with nuclear weapons or weapons-usable nuclear material to adopt national rules requiring every facility where these stockpiles exist to be secured against outsider and insider threats comparable to those terrorists and criminals have demonstrated;

- Agree that UNSCR 1540's requirement for "appropriate effective" physical protection should be interpreted as requiring such national rules;

- Agree that all states should, as required by UNSCR 1540, immediately put in place: "appropriate effective" criminal laws barring any assistance to terrorists in acquiring weapons of mass destruction, "appropriate effective" export laws and requirements, and "appropriate effective" border and transshipment controls to interdict illicit trafficking in materials and technologies related to weapons of mass destruction;

- Call on all states in a position to do so to help other states put these controls in place;

- Agree that as soon as possible HEU should be eliminated from all civilian sites, and civil commerce in HEU should be phased out;

- Call on all states with HEU-fueled research reactors to convert them or shut them down as soon as possible, and to eliminate their HEU fuel;

- Call on all states to seek to end additional accumulation of stockpiles of weapons-usable separated plutonium, and to phase out the civil use of separated plutonium as more proliferation-resistant technologies become available;

- Call for the rapid conclusion and entry into force of amendments to both the physical protection convention and the proposed convention on nuclear terrorism;

- Call for new steps to ensure security, improve transparency, and pursue continued reduction and eventual elimination of tactical nuclear weapons;

- Call for the rapid conclusion and entry into force of a verifiable fissile material production cutoff agreement, which, by ending further production of HEU and plutonium for weapons purposes, would limit further additions to the stockpiles to be secured; and

- Agree that the technologies of uranium enrichment and plutonium reprocessing should not spread further, and to achieve that objective,

[66] Data provided by U.S. laboratory officials.

agree on (a) the five-year moratorium on new enrichment and reprocessing facilities that IAEA Director-General Mohammed ElBaradei has proposed, and (b) on new arrangements in which the major nuclear fuel suppliers, backed by the IAEA, would offer guaranteed lifetime nuclear fuel supplies and guaranteed lifetime management of spent fuel, at excellent prices, for all nuclear reactors in any country that agrees that it will not establish enrichment or reprocessing facilities of its own, and will accept the Additional Protocol to verify that commitment. Like the fissile cutoff, this would constrain the growth in the number of possible sources of plutonium and HEU, and hence ease the task of securing the world's nuclear stockpiles.

Strengthening the Later Lines of Defense

Preventing nuclear weapons and weapons-usable nuclear materials from being stolen in the first place is the strongest leverage point in the battle to prevent nuclear terrorism. Once stolen, these items could be anywhere, and finding and recovering them, or interdicting their smuggling, is an extraordinarily difficult task. Nonetheless, because efforts to lock down nuclear stockpiles around the world may not be 100% successful—and because some undetected thefts of nuclear material may already have occurred—investment in later lines of defense is important as well.

Smuggling interdiction. As described in the review of progress in key areas earlier in this report, the United States and other countries are now making substantial investments in putting in place improved means to detect smuggling of nuclear materials, particularly detection at border crossing points in key countries. What is needed now is to pull existing efforts together into a prioritized strategic plan that goes well beyond detection at borders. This plan would detail what police, border, customs, and intelligence entities in which countries should have what capabilities by when—and what resources will be used to achieve those objectives. Making the needed connections between terrorists who want nuclear material and nuclear workers in a position to steal such material already appears to be one of the more difficult obstacles that potential nuclear terrorists face. There is much that intelligence and law enforcement agencies can do to make this connection still harder to make, through sting operations, scams, publicizing opportunities for people who become aware of a nuclear theft or smuggling incident in progress to inform the authorities, and more.

Improved approaches to nuclear monitoring at the U.S. borders and within the United States are also needed—as the Bush administration has proposed with the establishment of the new Domestic Nuclear Detection Office (DNDO) in the Department of Homeland Security. But it should be recognized that once a nuclear bomb has reached U.S. shores, it may already be too late (which is the rationale for the ongoing Megaports initiative, designed to ensure that at the ports sending most container cargo to the United States, containers are inspected for nuclear contraband at the ports where they depart). Moreover, given the long, complex, and heavily trafficked U.S. borders, and the difficulty of detecting the material needed for a nuclear bomb, such measures will never be more than a very partial last line of defense.

Global nuclear emergency response. Within the United States, the Nuclear Emergency Support Team (NEST, formerly the Nuclear Emergency Search Team) is charged with searching for and disabling a terrorist nuclear bomb, in the event of a nuclear terrorist threat or other information suggesting that such an attack may be imminent. NEST teams are equipped with sophisticated nuclear detection equipment, and specialized technologies which, it is hoped, would make it possible to disable even a booby-trapped bomb before it went off. Because of the great difficulty of detecting nuclear material at long range, broad-area searches are not practicable; if the only information available was that there was a nuclear bomb somewhere in a particular city, the chances of finding it would be slim. But if additional information made it possible to narrow the search to an area of a few blocks, the chances of finding it would be substantial. The United States should work with other countries to ensure that an international rapid-response capability is put in place—including making

all the necessary legal arrangements for visas, import of technologies such as the nuclear detectors used by the NEST team (some of which include radioactive materials), and the like—so that within hours of receiving information related to stolen nuclear material or a stolen nuclear weapon anywhere in the world, a response team could be on the ground.

Stabilizing employment for nuclear personnel. With Russia's economy stabilized, nuclear workers in Russia are now paid an above-average wage, on time; the desperation of the late 1990s has largely eased. The situation at many nuclear facilities has substantially stabilized.[67] With thousands of nuclear workers soon to lose their jobs as major facilities close, however, serious proliferation risks remain. (In early 2005, for example, a group of Russian Strategic Rocket Forces officers—people who had spent their career working with nuclear weapons, and presumably know a great deal about security arrangements for them—became so desperate after having been left behind with their families in a remote garrison when the missile base was closed down that they agreed to bypass the Ministry of Defense and petition the United States directly for assistance.[68]) The threat is not just nuclear weapons scientists who might help a foreign state develop a nuclear bomb, but nuclear workers or guards who might help thieves steal the essential ingredients of a bomb.[69] The United States should work closely with Russia and other countries to take a broader approach, using all the economic tools available, to revitalizing the economies of those nuclear cities where the major facilities are closing or shrinking, and reemploying other nuclear workers and experts who could otherwise pose a proliferation threat.[70]

Stockpile reduction. In addition to securing nuclear material at sites, and removing material from especially vulnerable sites, actually destroying nuclear material is a key tool in the theft-prevention toolbox. As noted earlier, the United States is currently buying LEU blended from 30 tons of Russian HEU each year—but similar efforts to destroy stockpiles of excess weapons plutonium have not yet begun. A relatively modest capital investment in providing more blending capability at Russian nuclear sites, coupled with modest expenditures for additional operations costs, could make it possible to substantially increase the blend-down rate, eliminating the proliferation risks posed by more HEU, faster. While the commercial market is not ready to absorb additional quantities of HEU, the United States or other countries could pay Russia to blend the additional material to LEU and keep it off the market in monitored storage until the market was ready for it, decoupling the national security imperative from the market constraint.

While official discussions in 2002 did not produce agreement on a substantial increase in the blend-down rate, at the same time Russia agreed to a non-official study, financed by the Nuclear Threat Initiative, of the feasibility and costs of a range of different options for accelerated HEU blend-down. That study is almost complete, and could provide the basis for government action to move forward in rapidly destroying additional stockpiles of HEU, eliminating the nuclear terrorist risks that the destroyed stockpiles would pose.[71]

At the same time, it is important to move forward as quickly as possible with safe, secure, and transparent

[67] For an excellent update on the status and future of Russia's nuclear complex, see Oleg Bukharin, *Russia's Nuclear Complex: Surviving the End of the Cold War* (Princeton, N.J.: Program on Science and Global Security, Woodrow Wilson School of Public and International Affairs, Princeton University, May 2004; available at http://www.ransac.org/PDFFrameset.asp?PDF=bukharinminatomsurvivalmay2004.pdf as of 8 March 2005).

[68] "US Money Lost on Way to Former Russian Army Servicemen," trans. BBC Monitoring Service, *Ekho Moskvy*, 15 February 2005; Aleksey Terekhov and Yevgeniy Latyshev, "Russian Missile Officers to Petition US for Resettlement Aid," *Novye Izvestiya*, 14 February 2005. We are grateful to Charles L. Thornton for pointing this incident and its significance out to us.

[69] John V. Parachini, David E. Mosher, et al., *Diversion of Nuclear, Biological, and Chemical Weapons Expertise for the Former Soviet Union: Understanding an Evolving Problem*, DB-457-DOE (Santa Monica, Cal.: RAND, 2005).

[70] See "Chapter 12, Stabilizing Employment for Nuclear Personnel," in Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 141-146.

[71] See our discussion in Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 154-156. For another report on the options in blending down excess HEU, see Gunnar Arbman et al., *Eliminating Stockpiles of Highly Enriched Uranium: Options for an Action Agenda in Co-Operation with the Russian Federation*, Swedish Nuclear Power Inspectorate

disposition of excess weapons plutonium. Disposition of the 34 tons of excess Russian plutonium and the 34 tons of excess U.S. plutonium covered by the U.S.-Russian Plutonium Management and Disposition Agreement, however, will only be a substantial contribution to U.S. and international security if it is but the first step toward a much larger reduction in the stockpiles of weapons plutonium that now exist.[72]

Information and Intelligence to Support Policy

Solid information on the scope of the nuclear security problem worldwide, on where the most urgent problems lie, on which global changes create new opportunities for reducing these threats, on what factors pose the most difficult obstacles to addressing those threats, on which issues and perceptions most affect the thinking of key foreign leaders on these topics, and more will be critical to success in carrying out all the initiatives just described. As the report of the commission on U.S. intelligence on weapons of mass destruction noted, good intelligence is crucial to the struggle to prevent nuclear terrorism, and this must be a top priority for U.S. intelligence agencies (and those of other countries as well)—but current U.S. intelligence in this area is weak.[73] Not all of the needed information should be collected by intelligence agencies: much of the needed information is available by more open means, and should be collected and analyzed in ways that do not carry the taint, with other governments, of U.S. "spying." Indeed, one of the greatest challenges for gathering and analyzing information to support policy in these areas is to find the best means to balance and integrate open and secret collection of information, so that the best of each can be used without either undermining the other. In particular, if experts visiting nuclear sites to help upgrade security come to be seen as spies there to collect nuclear secrets—or worse yet, are confirmed to be such—that may well be fatal to efforts to build the trust and partnership necessary for success in securing the world's nuclear stockpiles.

A prioritized global threat assessment. Perhaps the first priority for information collection and analysis is a prioritized assessment of which facilities worldwide pose the most urgent risks of nuclear theft to be addressed. An assessment of the overall risk posed by each facility would involve analyzing the probability of successful theft from that site (determined by the effectiveness of the security arrangements at the site, and the magnitude of the insider and outsider threats those arrangements must defeat) and the consequences of such a theft (determined by the quantity and quality of the nuclear weapons or materials at that site). DOE has developed a list of facilities believed to have weapons-usable nuclear material around the world, and is working to integrate what limited information is available about security arrangements and threats at these sites and to turn it into a regularly updated database, as we have recommended in previous studies.[74] But to date, this list represents an inventory, not a risk-based assessment of where the highest priorities for action lie. Such a prioritized global threat assessment should be developed as quickly as possible—identifying not only what is known that gives reason for concern, but what is not known, and using those knowledge gaps to drive efforts to collect additional information to fill them. The record of past U.S. interactions with nuclear facilities should also be documented to the extent possible, so that U.S. officials are aware, in their discussions with facility operators, of what has gone before; in this way, judgments of where the highest-priority risks reside can be integrated with judgments concerning where the highest-leverage opportunities may be, or where higher-level political intervention may be needed to make progress.

(SKI) Report, no. 15 (2004; available at http://www.pugwash.org/reports/nw/heu-200415.pdf as of 18 April 2005). For an initial report on the NTI study, see Daniel Horner, "NTI Blend-Down Study of Russian HEU to Examine Many Options for Speed-Up," *Nuclear Fuel* 28, no. 6 (17 March 2003).

[72] Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 156-161.

[73] Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President* (Washington, D.C.: WMD Commission, 2005; available at http://www.wmd.gov/report/ as of 5 April 2005).

[74] Bunn and Wier, *Securing the Bomb: An Agenda for Action*, p. 103.

Refocused intelligence. While penetrating the terrorist organizations that might be planning a nuclear terrorist attack is an extraordinarily difficult challenge, many of the other pieces of information crucial to supporting an effective global effort to prevent nuclear terrorism are much more readily available. As noted above, developing a prioritized assessment of the greatest dangers of nuclear theft requires information on the facilities around the world where nuclear caches exist, the quantity and quality of nuclear weapons and materials at these sites, their security levels, and the terrorist and criminal threats to these facilities. Some of this information is difficult to acquire, but many sites are open civilian facilities where crucial data on everything from the amount and types of material on site to the pay and morale of workers can be collected easily, by visiting and asking. (Indeed, in many cases this information should be collected by open programs of cooperation, untainted by an intelligence connection.) Today, no one in the U.S. government (or other governments, as far as we are aware) is collecting information in a focused way on, for example, the conditions for workers at HEU-fueled research reactors in developing or transition countries, or what levels of corruption and crime may exist at or near these nuclear facilities. Closing that gap primarily requires simply reallocating current collection and analysis efforts, to focus on the issues that are most important to the problem that President Bush has identified as the most urgent national security threat to the United States.

Similarly, a greatly intensified effort to track and analyze nuclear and radiological smuggling, and to smash nascent nuclear smuggling rings, is urgently needed. Key indicators and potential observables for all the steps on the terrorist pathway to the bomb should be identified, and collection efforts focused on them. International intelligence and law enforcement cooperation in this area should be dramatically strengthened, with the goal of bringing cooperation in blocking smuggling of nuclear weapons and materials, or of other materials and technologies of mass destruction, to a level of intensity and effectiveness comparable to that which now exists in counterterrorism more generally. The new U.S. director of national intelligence, John Negroponte, should make putting in place a focused intelligence effort on all aspects of preventing nuclear terrorism an early priority.

Options for the U.S. Congress

The U.S. Congress has a crucial role to play in furthering global efforts to lock down nuclear stockpiles—making the priority of these efforts clear, exerting performance-based oversight, enabling and authorizing key steps while removing legal constraints, and mandating particular steps where necessary. In 2004, Congress again authorized threat-reduction cooperation going beyond the boundaries of the former Soviet Union, and played a key role in the establishment of GTRI, passing legislation that provided key legal authorities for the effort and appropriating $30 million beyond the budget request to accelerate it. Further congressional steps in 2005 can help ensure that the opportunities created by the Bratislava summit, UNSCR 1540, and the launch of GTRI are seized. Indeed, some legislation focused on these objectives has already been proposed.[75] The steps Congress should take can be grouped in several categories.

Authorizing policy efforts and removing obstacles. First, Congress should act to remove obstacles it has created in the past. Congress has imposed a range of requirements that the president certify that recipient countries are meeting particular standards before threat reduction funds can be spent. When President Bush declined to certify Russia's compliance with all of its arms control obligations, crucial threat reduction programs ground to a halt for months, until Congress passed waiver authority and President Bush issued a waiver. But the president's legal authority to waive these certification requirements if the national security demands it ex-

[75] For brief summaries of bills introduced by Senator Richard Lugar (R-IN); by Senator Joe Biden (D-DE); by Representatives Adam Schiff (D-CA) and Christopher Shays (R-NY); and by Representatives Ellen Tauscher (D-CA), John Spratt (D-SC), and Martin Meehan (D-MA), see "Modest Progress on Nuclear Security at Bush-Putin Meeting" (Washington, D.C.: Russian American Nuclear Security Advisory Council, 2005; available at http://www.ransac.org as of 7 March 2005).

pires this year. Congress will have to act to ensure that critical threat reduction programs, including securing nuclear weapon sites, are not cut off again. Congress could choose to approve permanent or long-term waiver authority, or could eliminate the certification requirements entirely, as Senator Richard Lugar (R-IN) has proposed.[76]

Last year, Congress authorized the secretary of energy to offer an enumerated list of incentives for facilities to give up their HEU.[77] But past experience suggests that the incentives needed to close a deal in each situation are different, and cannot be predicted in advance. Hence, Congress should consider broadening the authorization provided last year, by authorizing the secretary of energy to take such actions as may be necessary to accomplish the objective of removing potential nuclear bomb material from vulnerable sites around the world.[78] Congress should also authorize the administration to expend threat reduction funds from DOE, DOD, and the State Department on a global effort to help states around the world put in place the effective controls on weapons of mass destruction and related materials and technologies mandated by UNSCR 1540. Finally, Congress should authorize the use of the Mayak Fissile Material Storage Facility to store any separated plutonium or HEU that could otherwise pose a threat to the United States, rather than limiting its use only to material that fits essentially arbitrary definitions of "weapon-grade."

Appropriating budgets. Congress should consider targeted increases to the administration's budget requests in a number of areas. To help countries around the world put in place the controls mandated by UNSCR 1540, Congress should significantly increase budgets for DOE programs to improve nuclear security; DOE, DOD, and State Department programs to interdict nuclear smuggling; and DOE and State Department programs to help countries improve export controls. To ensure that GTRI has the resources it needs to provide facilities substantial incentives to give up their HEU, and the flexibility needed to seize opportunities as they arise, Congress should consider again adding $20-$40 million to GTRI's budget, while ensuring that DOE would be free to shift priorities within the GTRI program as needed. To create an opportunity for substantially accelerating the destruction of dangerous HEU, Congress should consider making a conditional appropriation in the range of $200-$300 million, to finance accelerated blend-down of HEU in Russia, should U.S. and Russian negotiators be able to reach agreement on such an accelerated blend-down.[79]

Mandating and directing new actions. Congress can also launch new programs or require the administration to take particular actions. Having been initiated by congressional action in 1991, the entire Nunn-Lugar cooperative threat reduction effort is a perfect example. Congress could consider passage of broad legislation mandating fast-paced efforts to secure nuclear stockpiles and interdict nuclear smuggling worldwide, including removing potential nuclear bomb material from as many sites as possible. Such legislation might also provide important direction and authorities for such efforts, and require the president to take a number of specified actions to accelerate and strengthen efforts to lock down all the world's nuclear stockpiles.

Congress may also wish to consider legislating on the subject of liability. Given the ongoing delays in

[76] United States Senate, *Nunn-Lugar Cooperative Threat Reduction Act of 2005*, 109th Congress, S. 313 (2005; available at http://thomas.loc.gov/cgi-bin/bdquery/z?d109:s.00313: as of 22 March 2005). Lugar's legislation would also authorize threat reduction funds to be spent anywhere in the world they are needed, without limit, and authorize such programs to be carried out "notwithstanding any other provision of law," making it possible, for example, to carry out threat reduction programs in states that are otherwise under sanctions, if necessary.

[77] Wier, "Legislative Update."

[78] Legislation sponsored by Representatives Adam Schiff (D-CA) and Christopher Shays (R-NY) includes a provision that would have this effect. See United States House of Representatives, *Omnibus Nonproliferation and Anti-Nuclear Terrorism Act of 2005*, 109th Congress, H.R. 665 (2005; available at http://thomas.loc.gov/cgi-bin/bdquery/z?d109:h.r.00665: as of 22 March 2005).

[79] For discussion of this approach, see Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, pp. 154-156.

disposing excess plutonium caused by the liability dispute, and the very real possibility that the entire cooperative threat reduction effort could collapse in June 2006 if the dispute is not resolved, the need for near-term action is clear. Members of Congress have a variety of tools at their disposal, from putting holds on key nominees until they are satisfied with the actions the administration is taking, to requiring reports on progress in solving the problem (potentially every month in the months leading up to June 2006), to passing legislation that restrains the ability to spend money for certain critical activities until the matter is resolved, to directing specifically that the administration propose language that would abandon the U.S. insistence that Russia accept liability for sabotage by U.S. personnel.

Exercising performance-based oversight. Congress should set clear goals, and insist that the executive branch prepare coherent plans for achieving them, including measurable milestones. And it should hold the executive branch accountable for performance in achieving these goals. At the same time, Congress should give the executive branch considerable flexibility in how these goals are achieved, making it possible to seize opportunities and adapt approaches as circumstances change. To exercise such flexible, performance-based oversight, Congress will need to delve into the progress and problems of these efforts in detail, learning both the good news and the bad news. For that purpose, in-depth hearings on the threat and what is being and could be done to address it will be essential—possibly complemented with staff investigations. It is crucial that such hearings include testimony from independent witnesses—hearing only from the government officials managing these efforts, Congress will rarely hear the bad news.

A Senior Leader for a Strengthened Effort

None of what we have recommended here will happen without sustained leadership and political heavy lifting from the White House and its counterparts around the world. President Bush should appoint a senior full-time White House official, with the access needed to walk in and ask for presidential action when needed, to lead these efforts, and keep them on the front burner at the White House every day. That official would be responsible for finding and fixing the obstacles to progress in the scores of existing U.S. programs scattered across several cabinet departments of the U.S. government that are focused on pieces of the job of keeping nuclear weapons out of terrorist hands—and for setting priorities, eliminating overlaps, and seizing opportunities for synergy.

Seizing the Opportunities

Much has been done in the last year to build the foundation for the fast-paced global partnership to secure nuclear stockpiles around the world that is so urgently needed. But much remains to be done to build on those foundations, to transform current programs into the "maximum effort" the 9/11 Commission called for. The steps described here are an initial sketch of such a maximum effort. But the need for action is urgent—both because terrorists and criminals will not wait, and because the opportunities created by GTRI, UNSCR 1540, and the Bratislava summit may well be fleeting. If, a year from now, no substantial breakthrough in accelerating, expanding, and strengthening global efforts to lock down nuclear materials has been reached, the opportunities for rapid action created by the actions of the last year may be lost. But President Bush and President Putin, working with other world leaders, have the power to take actions that would transform the global effort to secure nuclear stockpiles and interdict nuclear smuggling. Between them, they have an historic opportunity to leave behind, as a lasting legacy, a world in which the danger of nuclear terrorism has been drastically reduced. If the world can muster the will to change its past approaches, there remains an excellent chance of preventing a nuclear 9/11.

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All responsibility for remaining errors and misjudgments, of course, is our own.

ABOUT THE PROJECT ON MANAGING THE ATOM

The Project on Managing the Atom (MTA) at Harvard University brings together an international and interdisciplinary group of scholars and government officials to address key issues affecting the future of nuclear weapons and nuclear energy, particularly where these futures intersect.

MTA is based in the Belfer Center for Science and International Affairs of Harvard University's John F. Kennedy School of Government, and represents a collaboration of the Center's programs on Science, Technology, and Public Policy; International Security; and Environment and Natural Resources. Much of the project's work is international in nature. MTA hosts research fellows from a variety of countries, and its members engage collaborative projects with colleagues around the world.

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Current research priorities include reducing the threats of nuclear and radiological terrorism; securing, monitoring, and reducing nuclear warhead and fissile material stockpiles, and reshaping nuclear complexes; strengthening the global nonproliferation regime; addressing the security risks posed by nuclear programs in Iran, North Korea, and South Asia; limiting proliferation risks of the civilian fuel cycle, including management of spent nuclear fuel and radioactive wastes containing weapon-usable materials; the future of nuclear energy; and democratic approaches to nuclear decision-making.

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