Matthew Bunn

Reducing the greatest risks of nuclear theft & terrorism

In April 2009, President Obama warned that there was still a real danger that terrorists might get and use a nuclear bomb, calling that possibility "the most immediate and extreme threat to global security." He announced "a new international effort to secure all vulnerable nuclear material around the world within four years."

Keeping nuclear weapons and the difficult-to-manufacture materials needed to make them out of terrorist hands is critical to U.S. and world security – and to the future of nuclear energy as well. In the aftermath of a terrorist nuclear attack, there would be no chance of convincing governments, utilities, and publics to build nuclear reactors on the scale required for nuclear energy to make any significant contribution to coping with climate change.

But Obama's four-year goal will not be easy to achieve. At sites in dozens of countries around the world, the security measures in place for plutonium or highly enriched uranium (HEU) – the essential ingredients of nuclear weapons – are dangerously inadequate, amounting in some cases to no more than a night watchman and a chain-link fence. Changing that in four years will take sustained White House leadership, broad international cooperation, a comprehensive plan, and adequate resources.[1] The fundamental key to success will be convincing policy-makers and nuclear managers around the world that nuclear terrorism is a real threat to *their* countries' security, worthy of new investments of their time and resources to reduce the risks – something many of them do *not* believe today.

Resources for this mission are not infinite, and choices will have to be made. Clearly there is little prospect of arranging for every building that has some plutonium or HEU to have a division of armed troops to guard it. It is critical to focus resources on reducing the most serious risks. But how can we judge where those most serious risks lie?

There remains a very real danger that terrorists could get and use a nuclear bomb, turning the heart of a major city into a smoldering radioactive ruin. Tens or hundreds of thousands of people would be killed, and devastating economic shock waves would reverberate throughout the world, creating a second death toll in the developing world from the ensuing increase in global poverty, as then UN Secretary-General Kofi

Annan warned in 2005. The horror of such an event, were it ever to occur, would change America and the world forever.

The al Qaeda terrorist network has been seeking nuclear weapons for years. Osama bin Laden has said that he feels a "religious duty" to acquire nuclear and chemical weapons, and al Qaeda operatives have made repeated attempts to buy stolen nuclear material in order to make a nuclear bomb. They have tried to recruit nuclear weapon scientists to help them, including, but not limited to, the two extremist Pakistani nuclear weapon scientists who met with bin Laden and Ayman al-Zawahiri shortly before the 9/11 attacks to discuss nuclear weapons. Documents recovered in Afghanistan reveal a significant al Qaeda research effort focused on nuclear weapons. This effort included preliminary tests with conventional explosives in the Afghan desert. Long after the removal of al Qaeda's Afghanistan sanctuary, bin Laden sought and received a religious ruling, or *fatwa*, from a radical Saudi cleric authorizing the use of nuclear weapons against American civilians. In the 1990s, the Aum Shinrikyo terror cult, which launched the nerve gas attack in the Tokyo subways, also sought nuclear weapons. Russian officials have confirmed two cases of terrorist teams, presumably Chechens, carrying out reconnaissance at secret Russian nuclear weapon storage sites. With at least two groups pursuing nuclear weapons in the last 15 years, we must expect that others will, too, in the future.

Repeated government studies in the United States and in other countries have concluded that if a technically sophisticated terrorist group could get the HEU or plutonium they need, they might well be able to make at least a crude nuclear bomb. Making a bomb does not take a Manhattan project: more than 90 percent of that 1940s-era effort was devoted to making the nuclear material, not making the bomb; and that was before the basic principles of nuclear bombs were widely known, as they are today. One study by the now-defunct congressional Office of Technology Assessment summarized the threat: "A small group of people, none of whom have [*sic*] ever had access to the classified literature, could possibly design and build a crude nuclear explosive device. . . . Only modest machine-shop facilities that could be contracted for without arousing suspicion would be required."

Theft of potential nuclear bomb materials is not just a hypothetical worry; it is an ongoing reality, highlighting the inadequacy of the nuclear security measures in place today: the International Atomic Energy Agency (IAEA) has documented some 18 cases of theft or loss of plutonium or HEU confirmed by the states concerned (and there are more cases that the relevant states have so far been unwilling to confirm, despite the conviction of some of the participants). In virtually all of the known cases, no one had ever noticed the stolen material was missing until it was seized, suggesting that other thefts may have gone undetected.

Fortunately, there is no convincing evidence that any terrorist group has yet gotten the nuclear material or the expertise needed to make a bomb (though we cannot know what capabilities they may have succeeded in keeping secret). Also fortunately, hostile states are highly unlikely to choose to provide nuclear weapons or the materials needed to make them to terrorist groups, because of the possibility that this would be traced back to them and that overwhelming, regimedestroying retaliation would follow. Moreover, making plutonium or HEU on their own is beyond the plausible capabilities of any terrorist group today. Hence, if the world's stockpiles of nuclear weapons, plutonium, and HEU can be kept under tight state control, nuclear terrorism can be prevented.

A multilayer defense against nuclear terrorism is certainly needed, including efforts to stymie terrorist nuclear plots and interdict nuclear smuggling; but the greatest policy leverage on reducing the risk is in the first layer, in preventing nuclear weapons and materials from being stolen in the first place. The plutonium or HEU needed for a bomb would fit easily in a suitcase, and is not radioactive enough to make it dangerous for nuclear smugglers to transport or easy for border officials to detect. Thus, once someone succeeds in getting these materials out of the facility where they are supposed to be, they could be anywhere, and the problem of finding and recovering them multiplies a thousandfold. In short, insecure nuclear material anywhere is a threat to everyone, everywhere – and that threat must be addressed by a fast-paced global campaign to ensure that all nuclear weapons and all of the materials needed to make them are secure and accounted for.

Terrorists seeking a nuclear bomb or the materials to make one – or thieves seeking to supply them – will steal wherever they think they have the best chance of success in meeting their objectives. This means not only that the theft itself has to be successful, but that the terrorists have to be able to set off a nuclear bomb with what they get. The risk of nuclear theft from any particular facility or transport operation depends on:

- The quantity and quality of the material available to be stolen (that is, how difficult it would be to use it to make a nuclear bomb);
- The security measures in place (that is, what kind of insider and outsider thieves could the security measures protect against, with what probability); and
- The threats those security measures must protect against (that is, the probability of different levels of insider or outsider capabilities being brought to bear in a theft attempt).

The overall risk of nuclear theft depends on the balance among these factors. The few sites where the tails of two distributions intersect – sites or transport routes with particularly weak security measures facing adversaries with particularly effective capabilities – dominate the global risk of nuclear theft, both because terrorists are more likely to target them and because they are more likely to succeed if they do.

Because these factors interact, a one-size-fits-all approach to nuclear security will not work. A security system effective enough to reduce the risk to a low level in a country like Canada, where it is highly unlikely that nuclear facilities would be attacked by dozens of well-armed outsiders or have to cope with conspiracies of al-Qaeda-linked insiders, might not be remotely sufficient for a site located in Pakistan, where both outsider and insider threats are dangerously high. (However, as will be discussed later, in a world of terrorists with global reach, at least a minimum level of security must be maintained for stockpiles of nuclear weapons and the materials needed to make them, even in the safest countries.) Unfortunately, the approaches in use today are not providing accurate and nuanced global assessments of any of these three critical parameters, leaving dangerous uncertainties over where nuclear security efforts should be targeted.

Assessing which nuclear sites and transport routes have the weakest security is not easy. Most countries regard the specific measures they have in place to protect nuclear weapons or nuclear materials from theft as closely guarded secrets, and any test or assessment that revealed particularly urgent vulnerabilities would be especially closely held. In Pakistan, to take one urgent example, U.S.-Pakistani nuclear security cooperation has been greatly constrained by Pakistan's fear that the United States might be tempted to snatch Pakistan's nuclear weapons if it could. As a result, U.S. experts are not allowed to visit the Pakistani nuclear sites to assess what problems need to be fixed, or even to know where the sites are. Thus cooperation focuses on offering advice to Pakistan on how best to assess such vulnerabilities and design security systems to fix them, and on helping Pakistan buy and install security equipment. (The Pakistanis generally regard U.S.-provided equipment with suspicion, fearing it might somehow be bugged.) Even in Russia, where the United States has invested billions of dollars in nuclear security and achieved dramatic improvements as a result, it remains illegal for Russian experts to give their American counterparts the results of detailed assessments of remaining vulnerabilities at Russian sites.

As a result, no country or institution in the world has a comprehensive global database assessing the effectiveness of the security measures for each nuclear site and transport route handling nuclear weapons or weapons-usable materials. Despite these obstacles, however, much more can be done to collect and assess information about key indicators of nuclear security effectiveness in countries around the world, as the U.S. intelligence community's Nuclear Materials Information Program (NMIP), launched in 2006, is now beginning to do. Information to inform such assessments can be gleaned from published nuclear security regulations; from a wide variety of "open source" literature (journalistic accounts, legislative hearings, papers presented at conferences, and the like); from confidential exchanges of information among particular countries; from visits to nuclear sites; from international nuclear security reviews, such as those organized by the IAEA for the small fraction of the key sites with weapons-usable materials where such reviews have been conducted;[2] and from intelligence information.

Ultimately, a combined all-source analysis is needed, drawing on the partial information available about each particular site or transport route and making judgments about what types of threats the security measures there could protect against effectively. Today, by contrast, the assessments guiding some key U.S. programs are based on simple yes/no estimates of whether sites comply with a particular rule or not; some of the assessments simply exclude all sites in advanced developed countries from any possibility of posing urgent issues.

While we live in a world with terrorists with global reach, and organized thieves are present in every country, there is no doubt that the threat is higher in some countries than in others. How can we assess what outsider and insider capabilities nuclear security systems should be designed to protect against?

Such an assessment should start from experience – from the kinds of capabilities and tactics terrorists and thieves have actually used against high-value guarded targets in recent years (whether nuclear or non-nuclear). In some countries, these include large, well-planned forcible attacks; the use of multiple coordinated teams (such as the four teams that struck on 9/11); sophisticated covert attacks that defeat alarm and detection systems; the use of unusual routes (such as tunneling into bank vaults); deception attacks (for example, using real-looking uniforms, identification, and paperwork to get through the security system); and the use of sophisticated weapons such as armor-piercing rocket-propelled grenades and platter charges to blow through security doors.

Most importantly, perhaps, such crimes and attacks frequently have insiders as participants. All but one of the documented cases of theft of HEU or plutonium appear to have been perpetrated by insiders (and the exception involved insider help to an outsider).[3] Security managers who believe that all of *their* personnel are trustworthy should remember that insiders may be coerced: in a 2004 case, for example, thieves apparently linked to a splinter faction of the Provisional Irish Republican Army (IRA) made off with £26 million from the Northern Bank after kidnapping the families of two of the bank's managers to force the managers to use their keys together to open the vault.

A wide variety of indicators can be used to judge how likely it is that outsiders or insiders could bring particular types of capabilities to bear in different countries or regions of countries. (Al Qaeda clearly can bring more force to bear in the mountainous regions near Pakistan's Afghan border than in the rest of the country, though the militants' ability to strike throughout the country is clearly greater than it was three years ago; it is a good bet that none of Pakistan's nuclear assets is located in this conflict zone.) The most important indicators would be the kinds of capabilities terrorists and thieves have demonstrated in that country (or similar neighboring countries) in recent times, from the number of people involved to the tactics and weapons used. The frequency of terrorist incidents and of crimes involving theft of valuable items from heavily guarded facilities or transports would be additional important indicators, as would the level of insider corruption and theft in the country.[4] The level of pay and morale among nuclear staff and guards, and the procedures in place to screen and monitor individuals before giving them access to nuclear materials or roles in protecting them, are also critical factors that should be examined in considering the scale of insider threat. In integrating assessments of these factors, governments can work with insurance companies, which have already had to assess risks of theft in different countries to determine how much they should charge to insure against bank robbery, for example.

Unfortunately, despite the creation of NMIP, much of this kind of information is not being systematically collected and analyzed, though in many cases it is not difficult to get. Some years ago, for example, two researchers then at American University documented key elements of insider corruption, organized crime presence, and the potential for Islamic extremism among some insiders worshipping at recently established nearby Wahabbi mosques in one of Russia's closed nuclear cities that stores and processes enough plutonium and HEU for thousands of nuclear weapons.[5] Prior to this study, the U.S. government was unaware of these circumstances. Similar in-depth studies of other facilities around the world have not been done, despite the modest level of effort required.

A building with nuclear material that terrorists could readily make into a nuclear bomb needs more security than a building with lower-quality material that would be very difficult for adversaries to use to make a bomb. But this sensible "graded safeguards" approach, used in national regulations and international recommendations around the world, must avoid slipping into what might be called "cliffed safeguards," in which security falls off catastrophically if nuclear material is beyond some arbitrary threshold that has little relation to real risk. For example, under current Nuclear Regulatory Commission (NRC) rules in the United States, nuclear material that would normally require security measures costing millions of dollars a year requires none of that if it is radioactive enough to cause a radiation dose of one Sievert per hour at one meter – a level considered radioactive enough to make the material "self-protecting." But studies at the national laboratories have shown that at this level of radiation, thieves who carried the material out to a waiting truck with their bare hands would not even receive a big enough dose of radiation to make them feel sick. In a world of suicidal terrorists, these rules – and similar, though less extreme, international rules – urgently need to be revised.

More broadly, in-depth assessments of how different chemical, physical, isotopic, and radiological properties of a material affect the odds that adversaries would succeed in making a bomb from it should be used to determine how much security can be relaxed for particular types of material while keeping overall risks low. In making these assessments, it is important to remember that HEU at enrichment levels far below the 90 percent U-235 level considered "weapons grade" can still readily be used in a bomb, at the cost of using somewhat more material. So past policies that have focused cooperative security upgrades only on sites whose HEU is at least 80 percent U-235 should certainly be revised. Similarly, while weapons designers prefer weapons-grade plutonium, produced specifically to contain 90 percent or more Pu-239, the "reactor grade" plutonium produced in the spent fuel from typical power reactors can also be used to make fearsome explosives, despite the extra neutrons, heat, and radiation generated by the less desirable plutonium isotopes it contains. Indeed, repeated government studies have concluded that any state or group capable of making a bomb from weapons-grade plutonium would also be able to make a bomb from reactor-grade plutonium.[6]

Based on the limited data publicly available about these factors, three categories of facilities stand out as posing the highest risks of nuclear theft: facilities in Russia, facilities in Pakistan, and research reactors fueled with HEU in dozens of countries.[7]

Russia still has the world's largest stocks of nuclear weapons and weapons-usable nuclear materials, stored in the world's largest number of buildings and bunkers. The egregious security weaknesses of the 1990s – gaping holes in fences, lack of any detectors to set off an alarm if someone was carrying plutonium out in a briefcase – have, in general, been fixed, but important security weaknesses remain. And the threats these facilities must protect against – not only possible large-scale terrorist assaults, but widespread insider corruption and theft – are substantial. In 2008, for example, a colonel in the Ministry of Interior troops that guard Russia's nuclear sites was reportedly arrested for soliciting thousands of dollars in bribes to overlook violations of security rules in the closed nuclear city of Snezhinsk. Earlier, the chief of security at Seversk, a huge plutonium and HEU processing facility, described a stunning array of weaknesses in his site's guard forces, from patrolling with no ammunition in their guns to widespread corruption, calling the guards "the most dangerous internal adversaries."[8]

By contrast, Pakistan has a small nuclear stockpile, in a small number of locations. Pakistan's stockpile is believed to be heavily guarded, but it faces immense threats, from possible attacks by huge numbers of well-armed extremists to insiders with extremist sympathies. At least two Pakistani nuclear weapon scientists sat down with Osama bin Laden to discuss nuclear weapons, and while General Pervez Musharraf was president, at least two near-miss assassination attempts involved serving Pakistani military personnel in league with al Qaeda. If the people guarding the president cannot be trusted, how much confidence can one have in the people guarding the nuclear weapons?

Finally, there are some 130 research reactors around the world that still use HEU as their fuel, and many of these have only the most minimal security measures in place. Many of these do not have enough material for a bomb at one site, but some do; and the 1998 embassy bombings as well as the 9/11 attacks are painful reminders of terrorists' ability to strike in more than one place at the same time.

In each of these cases, and in others throughout the world, urgent actions are needed to improve security, constrain the plausible threats (through actions that make it more difficult to put together large outsider attacks or to infiltrate insiders without detection), and remove weapons-usable nuclear material entirely (such as by converting research reactors to fuels that cannot be used in a nuclear bomb, or shutting down little-used reactors entirely).

In the last 15 years, the United States and other countries have put together a patchwork quilt of programs and initiatives to address these issues. The Nunn-Lugar Cooperative Threat Reduction program and related efforts have dramatically improved security at scores of sites in the former Soviet Union and elsewhere, and removed the potential bomb material entirely at dozens more. New treaties have been negotiated, such as the Convention on the Suppression of Acts of Nuclear Terrorism and the amendment to the Convention on Physical Protection of Nuclear Materials and Facilities. The UN Security Council unanimously approved Resolution 1540, which legally requires all states to pass legislation making it a grave crime to help non-state actors with nuclear, chemical, or biological weapons, and also requires all states to provide "appropriate effective" security for any stockpiles of nuclear weapons or related materials they may have. In 2006, the United States and Russia announced the launch of the Global Initiative to Combat Nuclear Terrorism, providing a new forum for discussion and capacity-building among like-minded states.

Nevertheless, global nuclear security institutions and standards remain far weaker than the task demands – and certainly far weaker than global *safety* institutions. Nuclear security has never had a

Three Mile Island or a Chernobyl to focus the world's attention, and as a result, complacency is widespread, with many policy-makers and nuclear managers around the world dismissing the danger of nuclear terrorism or assuming that existing security measures are more than sufficient. Unlike safety, where information can be widely shared, nuclear security measures are shrouded in secrecy, inhibiting international cooperation. (As one French official put it: "In safety, transparency is an obligation. In security, it is an offense.") And secretive nuclear security establishments are simply not in the habit of cooperating with each other.

Hence, while there are established mechanisms for reporting and analyzing nuclear *safety* incidents around the world and ensuring that reactor operators act on their lessons, and there is an industry organization to which all power reactors belong that reviews the *safety* of these plants, nothing comparable exists for nuclear security. The IAEA Office of Nuclear Security makes recommendations (which states can choose to adopt or ignore) and only organizes nuclear security reviews when states request them (which most states have not done). An independent organization to exchange best practices among operators, the World Institute for Nuclear Security (WINS), was only established in 2008.

Remarkably, years after the 9/11 attacks, with overwhelming evidence that terrorists are seeking stolen nuclear weapons material, the world has still been unable to agree on any specific and binding minimum standards for how well nuclear weapons or the materials to make them should be secured. Despite the danger that insecure plutonium or HEU in any state poses to all other states, security for these stockpiles is left almost entirely to the discretion of each country where these weapons and materials exist. Even more remarkably, no effort to put specific and binding global standards in place is now under way.

The nuclear Non-Proliferation Treaty (NPT) does not contain any provisions requiring states to secure nuclear material from theft. Similarly, IAEA "safeguards" are only inspections to ensure that nuclear material is still in civil use, and do not involve any form of international guarding or even international review of the quality of security. No one has yet defined what essential elements must be in place for a nuclear security and accounting system to meet the "appropriate effective" requirement of UNSCR 1540. Neither the new nuclear terrorism convention nor the amended physical protection convention includes any specific requirements for how secure nuclear material should be; the amended physical protection treaty requires every party with nuclear facilities to enact and enforce a national rule on that subject, but it does not specify what that rule should say. IAEA recommendations on nuclear security are more specific, but still quite vague: they specify, for example, that significant amounts of weapons-usable nuclear material should be stored in a place with a fence and intrusion detectors, but they say nothing about how strong the fence should be or how difficult to defeat the intrusion detectors should be. More fundamentally, they say nothing about what level of threat nuclear weapons and the materials needed to make them should be protected against.

These international approaches need urgent steps to strengthen them. All nuclear weapons and all stocks of the materials needed to make them, whether at fixed sites or during transport, should be effectively protected against the kinds of threats that terrorists and criminals have demonstrated they can pose in the countries where those stocks exist.

While terrorist and criminal capabilities vary from one country to the next, in an age of global terrorism, there are no countries so safe that substantial security measures are not needed when handling materials that could be used to make a nuclear bomb. Every facility or transport route anywhere in the world where there is a nuclear weapon or a stash of plutonium or HEU should be protected against a family of potential types of theft attempts, including attempts by insiders with authorized access to a facility, forcible outsider attack, or a variety of other outsider scenarios, such as attempts to enter the facility covertly (such as by tunneling into a vault, as often occurs in bank robberies), or attempts to deceive the facility security forces with fake uniforms, forged documents, and the like. At a minimum, such facilities and transport routes must be well protected against one well-placed insider; two small teams of well-armed, well-trained outsiders; or both working together. This corresponds to the threat revealed in the attack on the Pelindaba site in South Africa in November 2007, when two armed teams attacked from opposite sides of the site. One of the teams got through a 10,000-volt security fence, disabled intrusion detectors without detection (apparently with insider knowledge of the security system), proceeded to the emergency control center (where they shot a site worker in the chest), and spent 45 minutes inside the guarded perimeter without ever being engaged by site security forces. As far as is known, they never entered the area of the site where hundreds of kilograms of weapons-grade HEU are stored; but nevertheless, this is the kind of lapse that simply should not be allowed to occur at sites handling the essential ingredients of nuclear weapons.

Today, there are many facilities with plutonium or HEU that are *not* effectively protected against this level of threat. Gaining agreement that all states with nuclear weapons or enough plutonium or HEU to provide a substantial fraction of the material needed for a bomb will protect these stocks, at least against such a minimum level of threat, should be a high priority for the Obama administration. Such an accord, if followed through, would lead to major improvements at the world's most vulnerable nuclear sites, greatly reducing the risk of nuclear theft and terrorism. Of course, in countries where adversaries can pose more capable threats, additional protection should be provided. In Pakistan, in particular, the most stringent attainable security measures against both outsider and insider threats are clearly required.

A strong argument can be made that UNSCR 1540's requirement for "appropriate effective" security already obligates states to provide something like this level of security. If the words "appropriate effective" mean anything, they should mean that nuclear security systems would effectively protect against the threats that terrorists and criminals have shown they can pose.

While effective security for nuclear stockpiles is the most important step to reduce the danger of nuclear terrorism, a multilayered defense is needed – not least because some weapons-usable material may already have been stolen, but may not yet be in the hands of terrorists or proliferating states.

First, counterterrorist measures focused on detecting and disrupting those groups with the skills and ambitions to attempt nuclear terrorism should be greatly strengthened, and new steps should be taken to make raising funds and recruiting nuclear experts more difficult (including addressing some sources of radical Islamic violence and hatred and challenging the moral legitimacy of the mass slaughter of civilians – already a matter of debate even among violent Islamic jihadists).

Second, a broad system of measures to detect and disrupt nuclear smuggling and terrorist nuclear-bomb-acquisition efforts should be put in place, including expanded international police and intelligence cooperation, increased emphasis on intelligence operations such as stings (that is, intelligence agents posing as buyers or sellers of nuclear material or nuclear expertise), and targeted efforts to encourage participants in such conspiracies to blow the whistle.

Radiation detectors such as those now being installed at ports and border crossings in the United States and dozens of other countries have a role to play in this effort, but there is a limit to what can be done with large, readily observable detectors that adversaries can easily bypass by taking other routes. (And it is important to understand that neither the detectors now being installed nor the proposed Advanced Spectroscopic Portals would have any significant chance of detecting HEU metal with even modest shielding.) Congress would be well advised to abandon the current legislated requirement that 100 percent of cargo containers be scanned for radiation before entering the United States, focusing instead on requiring the administration to develop an integrated approach that places as many barriers in the path of an intelligent adversary trying to get nuclear material into the United States on *any* pathway as can be done at reasonable cost.

Third, while the danger of conscious state decisions to transfer nuclear weapons or materials to terrorists is only a small part of the overall risk of nuclear terrorism, more can be done to reduce that danger. This is yet another motivation for putting together international strategies that can convince the governments of North Korea and Iran that it is in their own national interests to constrain their nuclear ambitions in a verifiable way. And the United States should make one "red line" clear: any transfer to terrorists of nuclear weapons or the materials to make them would provoke a swift and sure response.

Fourth, while the focus must be on preventing nuclear terrorism from ever occurring, there is also much to be done to prepare for the ghastly aftermath should these efforts fail, from better preparations to keep the government and the economy functioning to a strengthened ability to treat tens or hundreds of thousands of injured people, including making use of the military's capabilities.[9] Many of the needed steps would help respond to any catastrophe, natural or man-made, and would pay off even if efforts to prevent a terrorist nuclear attack succeeded.

Fortunately, there is good news in this story as well. The initial overthrow of the Taliban government in Afghanistan and the death or capture of many of al Qaeda's top leaders have made it more difficult for al Qaeda to carry out the large, complex operation of getting and using a nuclear bomb. As noted earlier, at scores of sites that once posed particular dangers of nuclear theft, security has been dramatically upgraded or the dangerous nuclear material removed, as a result of cooperative threat reduction programs and countries' own efforts.

Moreover, the expected growth and spread of nuclear energy need not increase the chance that terrorists could get their hands on the material for a nuclear bomb. Today, most nuclear power reactors run on low-enriched uranium fuel that cannot be used in a nuclear bomb without further enrichment, which is beyond plausible terrorist capabilities. These reactors produce plutonium in their spent fuel, but that plutonium is 1 percent by weight in massive, intensely radioactive spent-fuel assemblies that would be extraordinarily difficult for terrorists to steal and process into material for a bomb. In some countries, the plutonium is removed from the spent fuel (an approach known as "reprocessing") for recycling into new fuel; that process requires extraordinary security measures to ensure against terrorist access to the separated plutonium. Fortunately, economics and counterterrorism point in the same direction in this case: because reprocessing is much more expensive than simply storing spent fuel pending disposal, few countries that do not already reprocess their fuel are interested in starting, and some of the existing plants are running far below capacity or will soon be shut down.

Many more nuclear power reactors in many more countries *would* mean more potential targets for terrorist sabotage – and more chances that some reactor's security would be weak enough that a terrorist attack would succeed. Sabotage would not cause the kind of massive, instantaneous destruction a nuclear bomb would cause, but in the worst case, successful sabotage might cause a massive radiation release – a "security Chernobyl." Such an event would be a catastrophe for the country where it occurred, and for its downwind neighbors; but unlike readily transported nuclear weapons or materials, it would not pose a threat to countries thousands of kilometers away. It would, however, pose a threat to the global nuclear power industry, for the public reaction to such an event would almost surely doom any prospect for nuclear growth on the scale needed to play a significant role in mitigating the threat of climate change.

The bottom line: nuclear terrorism remains a real and urgent threat. The way to respond is through international cooperation, not confrontation and war. Immediate action is needed around the world to improve security for nuclear weapons and the materials needed to make them, focusing on those sites and transport routes that pose the highest risks. The job is big and complex, but finite and doable. With sufficient high-level leadership and political will, the world can meet the four-year target for achieving effective nuclear security that President Obama has laid out. The clock is ticking.

ENDNOTES

1 For comprehensive recommendations for meeting this objective, see Matthew Bunn, *Securing the Bomb* 2008 (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, November 2008), and Matthew Bunn and Andrew Newman, "Preventing Nuclear Terrorism: An Agenda for the Next President" (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, November 2008); http://www.nti.org/securingthebomb.

2 It is important to understand that IAEA "safeguards," which cover all nuclear material in non-nuclear-weapons states, involve inspectors visiting every few weeks or months to

check that nuclear material is where the state says it is; they do not protect the material from theft. The IAEA only reviews a state's arrangements for protecting against theft if the state in question asks for such a review, and the states with nuclear weapons and most of the world's weapons-usable nuclear materials have not asked for such reviews.

3 The exception was a 1993 case at a Russian naval base in which the perpetrator was an outsider who was informed of how to steal the nuclear material by a relative who worked at the base. See Oleg Bukharin and William Potter, "Potatoes Were Guarded Better," *Bulletin of the Atomic Scientists* 51 (3) (May/June 1995): 46 – 50.

4 See Matthew Bunn, "Corruption and Nuclear Proliferation," in *Corruption, Global Security, and World Order*, ed. Robert I. Rotberg (Washington. D.C.: Brookings Institution Press, 2009).

5 For a summary of part of their results, see Robert Orttung and Louise Shelley, "Linkages Between Terrorist and Organized Crime Groups in Nuclear Smuggling: A Case Study of Chelyabinsk Oblast," PONARS Policy Memo No. 392 (Washington, D.C.: Program on New Approaches to Russian Security, Center for Strategic and International Studies, December 2005).

6 For the most detailed authoritative, unclassified statement on this point, see *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives*, DOE/NN-0007 (Washington, D.C.: Department of Energy, January 1997), 37 – 39.

7 For a more detailed assessment, see Bunn, *Securing the Bomb* 2008, 7 – 10, 21 – 44.

8 Report of the Snezhinsk incident is from "An Employee of the Department of Classified Facilities of the MVD Was Arrested in Snezhinsk: What Incriminates the 'Silovic,'" trans. Jane Vayman; reported on www.ura.ru, May 29, 2008. The Seversk description is from Igor Goloskokov, "Refomirovanie Voisk MVD Po Okhrane Yadernikh Obektov Rossii (Reforming MVD Troops to Guard Russian Nuclear Facilities)," trans. Foreign Broadcast Information Service, *Yaderny Kontrol* 9 (4) (Winter 2003).

9 For an especially useful recent discussion, see Ashton B. Carter, Michael M. May, and William J. Perry, *The Day After: Action in the 24 Hours Following a Nuclear Blast in an American City* (Cambridge, Mass.: Preventive Defense Project, Harvard and Stanford Universities, May 2007); http://belfercenter.ksg.harvard.edu/files/dayafterworkshopreport_may2007.pdf (accessed May 29, 2009).