THE RISK OF NUCLEAR TERRORISM – AND NEXT STEPS TO REDUCE THE DANGER

TESTIMONY OF
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MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE: It is an honor to be here today to talk about what I believe is among the most urgent threats to America's security – the threat of nuclear terrorism. My message to you today is simple: the danger is real, but there are specific steps we can and must take that would greatly reduce the risk.

The Lessons of Pelindaba

On the night of November 8, 2007, two teams of armed men attacked the Pelindaba nuclear facility in South Africa, where hundreds of kilograms of weapon-grade highly enriched uranium (HEU) are stored. While one of the teams was chased off by site security forces, the other team of four armed men disabled the detection systems at the site perimeter, entered without setting off any alarm, and went to the emergency control center and shot a worker there in the chest. He then raised an alarm for the first time. This team spent 45 minutes inside the secured perimeter without ever being engaged by site security forces, and then disappeared through the same hole they had cut in the fence. No one on either team was shot or captured. South African officials later arrested three individuals, but soon released them without charge.[1] The South African government has not released important details of its investigation of the attack and refused earlier U.S. offers to remove the HEU at Pelindaba or to help improve security at the facility.

While we do not know that these attackers were after the HEU, this incident is nevertheless a potent reminder that inadequately secured nuclear material is a global problem, not one limited to the former Soviet Union. It is also a reminder that political heavy lifting will be needed to overcome the obstacles to sensitive nuclear security cooperation around the world. We urgently need a global campaign to ensure that every nuclear weapon and every cache of potential nuclear bomb material worldwide is secured against the kinds of threats terrorists and criminals have demonstrated they can pose – including two teams of armed attackers, possibly with cooperation from an insider.

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[1] Micah Zenko, "A Nuclear Site is Breached: South African Attack Should Sound Alarms," *Washington Post,* 20 December 2007. See also Rob Adam, "Media Briefing: Security Breach at Necsa on 08 November 2007," Nuclear Energy Corporation of South Africa, 13 November 2007; Graeme Hosken, "Officer Shot as Gunmen Attack Pelindaba," *Pretoria News,* 9 November 2007; Hosken, "Two Gangs of Armed Men Breach Pelindaba Nuclear Facility," *Pretoria News,* 14 November 2007; Joel Avni, Gertrude Makhafola, and Sibongile Mashaba, "Raid on Site Planned," *The Sowetan,* 14 November 2007.

Nuclear Terrorism Risks: The Bad News

Several basic questions can give us an understanding of the risk of nuclear terrorism.

Do terrorists want nuclear weapons? For a small set of terrorists, the answer is clearly "yes." Osama bin Laden has called the acquisition of nuclear weapons or other weapons of mass destruction a "religious duty."[2] Al Qaeda operatives have made repeated attempts to buy nuclear material for a nuclear bomb, or to recruit nuclear expertise – including the two extremist Pakistani nuclear weapon scientists who met with bin Laden and Ayman al-Zawahiri to discuss nuclear weapons. Before al Qaeda, the Japanese terror cult Aum Shinrikyo also made a concerted effort to get nuclear weapons. With at least two groups going down this path in the last 15 years, we must expect that others will in the future.

Is it plausible that a sophisticated terrorist group could make a crude nuclear bomb if they got HEU or separated plutonium? The answer here is also "yes." Making at least a crude nuclear bomb might well be within the capabilities of a sophisticated group, though a nuclear bomb effort would be the most technically challenging operation any terrorist group has ever accomplished. One study by the now-defunct congressional Office of Technology Assessment summarized the threat: "A small group of people, none of whom have 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."[3] Indeed, even before the revelations from Afghanistan, U.S. intelligence concluded that "fabrication of at least a 'crude' nuclear device was within al-Qa'ida's capabilities, if it could obtain fissile material."[4]

A terrorist cell of relatively modest size, with no large fixed facilities that would draw attention, might well be able to pull off such an effort – and the world might never know until it was too late.[5]

Could a terrorist group plausibly get the material needed for a nuclear bomb? Unfortunately, the answer here is also "yes." Nuclear weapons or their essential ingredients exist in hundreds of buildings in dozens of countries, with security measures that range from excellent to appalling – in some cases, no more than a night watchman and a chain-link fence. No specific and binding global standards for how these stockpiles should be secured exist.

Remarkably, another thing that does not exist is a comprehensive, prioritized list of which nuclear stockpiles around the world pose the highest risks of nuclear theft – though the

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[2] Rahimullah Yusufzai, "Interview with Bin Laden: World's Most Wanted Terrorist" (ABC News, 1999; available at http://www.islamistwatch.org/blogger/localstories/05-06-03/ABCInterview.html as of 27 March 2008).

[3] U.S. Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (Washington, D.C.: OTA, 1977; available at http://www.princeton.edu/~ota/disk3/1977/7705/7705.PDF as of 27 March 2008), p. 140.

[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 28 March 2008), p. 276.

[5] For discussions of official assessments of the complexity of the operation and the number of people required, see Matthew Bunn and Anthony Wier, "Terrorist Nuclear Weapon Construction: How Difficult?" *Annals of the American Academy of Political and Social Science* 607 (September 2006). For a particular scenario involving a cell of 19 people working for roughly a year (probably more than is actually required for some types of crude bomb), see Peter D. Zimmerman and Jeffrey G. Lewis, "The Bomb in the Backyard," *Foreign Policy*, no. 157 (November/December 2006), pp. 32-39.

Nuclear Material Information Program (NMIP), led by one of your earlier witnesses, Rolf Mowatt-Larsen, is working to create one. Based on the information we do have in the public domain, I believe the highest risks of nuclear theft today are in the former Soviet Union, in Pakistan, and at HEU-fueled research reactors around the world.

Nuclear security in Russia and the former Soviet Union has improved dramatically in the past 15 years; at many sites, the difference between the security in place today and the security in place in 1994 is like night and day. But Russia has the world's largest stockpiles of nuclear weapons and materials, scattered in the world's largest number of buildings and bunkers; some serious security weaknesses still remain, ranging from poorly trained, sometimes suicidal guards to gross under-funding of nuclear security; and the upgraded security systems must face huge threats, from insider theft conspiracies which are cropping up everywhere in Russia to large-scale outsider attacks. Within Russia, terrorist reconnaissance teams have been scoping secret nuclear weapon storage sites; a Russian businessman has been offering $750,000 for stolen weapon-grade plutonium; and the Beslan school massacre reconfirms the terrorists' ability to strike in force, without warning or mercy. As just one indicator of the insider threat, in 2006 President Putin fired Major General Sergey Shlyapuzhnikov, deputy chairman of the section of the MVD responsible for guarding the closed nuclear cities and other close territories, because (according to the Russian state newspaper), he was helping to organize smuggling in and out of these closed territories – in particular, giving out passes that allowed people to go in and out without being checked.[6]

Pakistan's nuclear stockpile is small, stored at a small number of sites, and is thought to be heavily guarded, with substantial security upgrades in recent years, in part with U.S. help. The recent unrest in Pakistan does not appear to have substantially increased the risks of theft, as it does not appear to have undermined the cohesion of the military and the security services. But Pakistani security systems face immense threats, from nuclear insiders with a demonstrated willingness to sell practically anything to practically anybody to armed attack potentially by scores or hundreds of jihadis. In at least two cases, serving Pakistani military officers working with al Qaeda came within a hair's breadth of assassinating Musharraf; if the military officers guarding the President cannot be trusted, how much confidence can we have in the military officers guarding the nuclear weapons?

HEU-fueled research reactors typically have comparatively modest stockpiles of material – but they have some of the world's weakest security measures for those stocks. And it is important to remember that much of the irradiated fuel from research reactors is still HEU, and is not radioactive enough to pose any significant deterrent to theft by suicidal terrorists. Some 130 research reactors around the world still use HEU as their fuel.[7]

While these are the highest-risk categories, virtually every country where these materials exist – including the United States – has more to do to ensure that these stocks are

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[6] "The President Issued a Decree To Dismiss Deputy Chairman of the MVD Department in Charge of Law and Order in Closed Territories and Sensitive Sites, Major General Sergey Shlyapuzhnikov," *Rossiyskaya Gazeta*, 2 June 2006 [translated by Anatoly Dianov].

[7] Tons of HEU exist at research, often – though not always – in forms that would require some chemical processing to use in a bomb. But any group that could pull off the difficult job of making a nuclear bomb from HEU metal would have a good chance of mastering the simpler job of getting HEU metal out of research reactor fuel. And many of these facilities have only the most minimal security measures in place.

effectively protected against the kinds of threats that terrorists and criminals have shown they can pose.[8]

Theft of HEU and plutonium is not a hypothetical worry, it is an ongoing reality. Most recently, in February 2006, Russian citizen Oleg Khinsagov was arrested in Georgia (along with three Georgian accomplices) with some 100 grams of 89% enriched HEU, claiming that he had kilograms more available for sale.[9] What we do not know, of course, is how many thefts may have occurred that were never detected; it is a sobering fact that nearly all of the stolen HEU and plutonium that has been seized over the years had never been missed before it was seized. [10]

The amounts required for a bomb are small. The Nagasaki bomb included some 6 kilograms of plutonium, which would fit easily in a soda can. A similar HEU bomb would require three times as much.[11] For a simpler but less-efficient gun-type design, roughly 50 kilograms of HEU would be needed – roughly the size of a six-pack. The world stockpiles of

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[8] For an overview of security for nuclear weapons and materials around the world, see Matthew Bunn, *Securing the Bomb 2007* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2007; available at http://www.nti.org/securingthebomb as of 28 March 2008).

[9] For a useful summary of this case, see Elena Sokova, William C. Potter, and Cristina Chuen, "Recent Weapons Grade Uranium Smuggling Case: Nuclear Materials Are Still on the Loose" (Monterey, Calif.: Center for Nonproliferation Studies, Monterey Institute of International Studies, 26 January 2007; available at http://cns.miis.edu/pubs/week/070126.htm as of 28 March 2008). For the International Atomic Energy Agency's most recent list of incidents confirmed by the states concerned, see *Incidents Involving HEU and Pu Confirmed to the ITDB, 1993-2006* (Vienna: IAEA, 2007, available as of 28 March 2008 at http://www.iaea.org/NewsCenter/Focus/NuclearSecurity/pdf/heu-pu_1993-2006.pdf). There are 18 total incidents on this list, but three of them appear to involve inadvertent losses rather than thefts. Some incidents that were previously on the list have been removed: one plutonium incident involved such a small amount of material it was reclassified as a radioactive source incident, and one incident previously tracked as an HEU case was confirmed to be LEU. (Personal communication from Richard Hoskins, IAEA Office of Nuclear Security, October 2006.) Other incidents are known to have occurred – the thieves were captured, tried, and convicted – but have nevertheless not been confirmed by the states concerned.

[10] The U.S. National Intelligence Council continues to assess that "it is likely that undetected smuggling has occurred, and we are concerned about the total amount of material that could have been diverted over the last 15 years." 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, April 2006; available at http://www.fas.org/irp/nic/russia0406.html as of 28 March 2008). Former CIA Director Porter Goss testified to Congress that sufficient material was unaccounted for that he could not provide assurances that enough material for a bomb had not already been stolen. See testimony in Select Committee on Intelligence, *Current and Projected National Security Threats to the United States*, U.S. Senate, 109th Congress, 16 February 2005 (available at http://www.fas.org/irp/congress/2005_hr/shrg109-61.pdf as of 28 March 2008). Goss was not saying that the CIA had definite information that enough material for a bomb was missing, only that the accounting uncertainties are large enough that he could not confirm that was not the case. The same is true in the United States; some two tons of U.S. plutonium, for example, enough for hundreds of nuclear bombs, is officially considered "material unaccounted for." See U.S. Department of Energy, *Plutonium: The First 50 Years: United States Plutonium Production, Acquisition, and Utilization from 1944 through 1994* (Washington, D.C.: DOE, 1996; available at http://www.fas.org/sgp/othergov/doe/pu50y.html as of 28 March 2007).

[11] The Department of Energy has officially declassified the fact that 4 kilograms of plutonium is in principle sufficient to make a nuclear weapon. U.S. Department of Energy, *Restricted Data Declassification Decisions 1946 to the Present (RDD-7)* (Washington, D.C.: DOE, 2001; available at http://www.fas.org/sgp/othergov/doe/rdd-7.html as of 27 March 2008). The amount of plutonium in the first nuclear bomb, at Trinity, was 6.1 kilograms. See Gen. Leslie R. Groves, Memorandum to the Secretary of War, 18 July 1945, reprinted as Appendix P in Martin Sherwin, *A World Destroyed* (New York: Knopf, 1975). The bare-sphere critical mass for 93% HEU metal is roughly three times the bare-sphere critical mass for delta-phase weapon-grade plutonium.

HEU and separated plutonium are enough to make roughly 200,000 nuclear weapons;[12] a tiny fraction of one percent of these stockpiles going missing could cause a global catastrophe.

Could a terrorist group likely deliver a bomb to Washington, New York, or other major cities around the world? Here, too, unfortunately, the answer is "yes." If stolen or built abroad, a nuclear bomb might be delivered to the United States, intact or in ready-to-assemble pieces, by boat or aircraft or truck. The length of the border, the diversity of means of transport, the vast scale of legitimate traffic across national borders, and the ease of shielding the radiation from plutonium or especially from HEU all operate in favor of the terrorists. Building the overall system of legal infrastructure, intelligence, law enforcement, border and customs forces, and radiation detectors needed to find and recover stolen nuclear weapons or materials, or to interdict these as they cross national borders, is an extraordinarily difficult challenge.

What would happen if terrorists set off a nuclear bomb in a U.S. city? Here, the answers are nothing short of terrifying. A bomb with the explosive power of 10,000 tons of TNT (that is, 10 "kilotons," somewhat smaller than the bomb that obliterated Hiroshima), if set off in midtown Manhattan on a typical workday, could kill half a million people and cause roughly $1 trillion in direct economic damage.[13] Terrorists – either those who committed the attack or others – certainly claim they had more bombs already hidden in U.S. cities (whether they did nor not), and the fear that this might be true could lead to panicked evacuations of major U.S. cities, creating widespread havoc and economic disruption. If the bomb went off in Washington DC, large fractions of the federal government would be destroyed, and effective governance of the country would be very much in doubt. Devastating economic aftershocks would reverberate throughout the country and the world – global effects that in 2005 then-UN Secretary-General,

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[12] The world stockpile of separated plutonium is roughly 500 metric tons (roughly half civilian and half military); the world stockpile of HEU is in the range of 1,400-2,000 tons (all but a few percent of which is military). See International Panel on Fissile Materials, *Global Fissile Material Report 2007* (Princeton: IPFM, 2007, available as of 28 March 2008 at http://www.fissilematerials.org/ipfm/site_down/gfmr07.pdf). The separated plutonium total includes both weapon-grade and reactor-grade plutonium. Reactor-grade plutonium is also weapons-usable. For a detailed unclassified official statement on this point see U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives*, DOE/NN-0007 (Washington, D.C.: DOE, 1997; available at http://www.osti.gov/bridge/servlets/purl/425259-CXr7Qn/webviewable/425259.pdf as of 27 March 2008), pp. 37-39.

[13] See 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/cnwm.pdf as of 28 March 2008), pp. 15-19. This was a rough estimate based on a relatively crude analysis. A number of more detailed analyses of the effects of a terrorist nuclear weapon in a U.S. city are available, though a surprising number of them either envision a bomb going off in an area with much lower population density than mid-town Manhattan, or envision the bomb being detonated at night (when the populations at the center of most cities are far lower, but easier to get information about from the U.S. census). For a recent official government analysis of such an event in Washington D.C., see, for example, U.S. Homeland Security Council, *National Planning Scenarios: Version 20.1 Draft* (Washington, D.C.: U.S. Homeland Security Council, 2005; available at http://media.washingtonpost.com/wp-srv/nation/nationalsecurity/earlywarning/NationalPlanningScenariosApril2005.pdf as of 28 March 2008). Recent detailed non-government analyses include Ira Helfand, Lachlan Forrow, and Jaya Tiwari, "Nuclear Terrorism," *British Medical Journal* 324 (9 February 2002; available at http://www.bmj.com/cgi/reprint/324/7333/356.pdf as of 28 March 2008); Charles Meade and Roger C. Molander, *Considering the Effects of a Catastrophic Terrorist Attack* (Washington, D.C.: RAND, 2006; available at http://www.rand.org/pubs/technical_reports/2006/RAND_TR391.pdf as of 28 March 2008).

Kofi Annan warned would push "tens of millions of people into dire poverty," creating "a second death toll throughout the developing world."[14] America and the world would be transformed forever – and not for the better.[15]

Nuclear Terrorism Risks: The Good News

Fortunately, there is good news in this story as well. First, there is no convincing evidence that any terrorist group has yet gotten a nuclear weapon or the materials needed to make one – or that al Qaeda has yet put together the expertise that would be needed to make a bomb. Indeed, there is some evidence of confusion and lack of nuclear knowledge by some senior al Qaeda operatives.[16]

Second, making and delivering even a crude nuclear bomb would be the most technically challenging and complex operation any terrorist group has ever carried out. There would be many chances for the effort to fail, and the obstacles may seem daunting even to determined terrorists, leading them to focus more of their efforts on conventional tools of terror – as al Qaeda appears to have done.[17] Both al Qaeda and Aum Shinrikyo appear to have encountered a variety of difficulties, demonstrating that getting a nuclear bomb is a difficult challenge, even for large and well-financed terrorist groups with ample technical resources.[18]

Third, the overthrow of the Taliban and the disruption of al Qaeda's old central command structure certainly reduced al Qaeda's chances of pulling off such a complex operation – though that capability may be growing again, as al Qaeda reconstitutes in the mountains of Pakistan.[19]

Fourth, nuclear security is improving. While there is a great deal yet to be done, the fact is that at scores of sites in Russia, the former Soviet Union, and elsewhere, security is dramatically better than it was fifteen years ago. Security upgrades are scheduled to be completed for most Russian nuclear warhead and nuclear material sites by the end of this calendar year. HEU is being removed from sites all around the world, permanently eliminating the risk of nuclear theft at those sites. An alphabet soup of programs and initiatives – Cooperative Threat Reduction (CTR), the Materials Protection, Control, and Accounting

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[14] Kofi Annan, "A Global Strategy for Fighting Terrorism: Keynote Address to the Closing Plenary," in *The 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 28 March 2008).

[15] For a recent meditation arguing that such an attack would lead the very notion of the sovereignty of nation-states in tatters, see Stephen D Krasner, "The Day After," *Foreign Policy*, no. 146 (January/February 2005), pp. 68-70.

[16] In particular, both Khalid Sheikh Mohammed and Abu Zubaydah are reported to have believed that uranium, which is only weakly radioactive, would be a good material for a dirty bomb – and there have been other al Qaeda operatives arrested for seeking uranium for dirty bombs as well. See discussion and sources in Matthew Bunn and Anthony Wier, with Joshua Friedman, "The Demand for Black Market Fissile Material," in *Nuclear Threat Initiative Research Library: Securing the Bomb* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2005; available at http://www.nti.org/e_research/cnwm/threat/demand.asp as of 27 March 2008).

[17] For the most comprehensive available account of this argument, seeMichael Levi, *On Nuclear Terrorism* (Cambridge, Mass.: Harvard University Press, 2007).

[18] Bunn and Wier, "The Demand for Black Market Fissile Material."

[19] See, for example, discussion in Hearing of the Senate Armed Services Committee, "Annual Threat Assessment," U.S. Senate, 110th Congress, February 27, 2007 available at http://www.dni.gov/testimonies/20070227_transcript.pdf as of 28 March 2007).

(MPC&A) program, the Global Threat Reduction Initiative (GTRI), the Global Initiative to Combat Nuclear Terrorism (GI), the International Atomic Energy Agency's Office of Nuclear Security, the Domestic Nuclear Detection Office (DNDO), and many more – are each making real contributions.[20] There can be no doubt that America and the world face a far lower risk of nuclear terrorism today than they would have had these efforts never been begun. These programs are excellent investments in U.S. and world security, deserving strong support; Americans and the world owe a substantial debt of gratitude to the dedicated U.S., Russian, and international experts who have been carrying them out. Securing the world's stockpiles of nuclear weapons and the materials needed to make them is a big job, and a complex job, but it is a doable one, as the progress already made demonstrates.

Fifth, hostile states are highly unlikely to consciously choose to provide nuclear weapons or the materials needed to make them to terrorist groups. Such a decision would mean transferring the most awesome military power the state had ever acquired to a group over which it had little control, and potentially opening the regime to overwhelming retaliation – a particularly unlikely step for dictators or oligarchs obsessed with controlling their states and maintaining power.

All of this good news comes with a crucial caveat: "as far as we know." The gaps in our knowledge remain wide. Some intelligence analysts argue that the lack of hard evidence of an extensive current al Qaeda nuclear effort simply reflects al Qaeda's success in compartmentalizing the work and keeping it secret. It is a sobering thought that a nuclear effort might not require a conspiracy larger than the one which perpetrated the 9/11 attacks and succeeded in remaining secret – and that Aum Shinrikyo was simply not on the radar of any of the world's intelligence agencies until *after* they perpetrated their nerve gas attack in the Tokyo subways.

Nuclear Terrorism: What is the Probability?

So, taking the good news with the bad, what are the chances of a terrorist nuclear attack? The short answer is that nobody knows. Former Secretary of Defense William Perry and former Assistant Secretary of Defense Graham Allison are among those who have estimated that chance at more than 50% over the next ten years.[21] In 2006, I published a mathematical model that provides a structured, step-by-step way of thinking through the problem. A set of plausible illustrative values for the input parameters resulted in a 29% 10-year probability estimate – by coincidence, the same as the median estimate of the 10-year probability of a nuclear attack on the United States in a survey of national security experts by Senator Lugar's office some years ago. Since there are large uncertainties in each of those inputs, however, the real probability could well be either higher or lower. But if these estimates are even within a factor of 3-5 of being correct, and if, as I believe, there is a large chance that such an attack would be directed at Manhattan or Washington D.C., then the danger of nuclear terrorism is high enough to have a significant effect on the life expectancy of everyone who lives and works in downtown Washington or midtown Manhattan.

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[20] See Bunn, *Securing the Bomb 2007*.

[21] See, for example, Graham T. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, 1st ed. (New York: Times Books/Henry Holt, 2004).

Even a 1% chance over the next ten years would be enough to justify substantial action to reduce the risk, given the scale of the consequences. No one in their right mind would operate a nuclear power plant upwind of a major city that had a 1% chance over ten years of blowing sky-high – the risk would be understood by all to be too great. But that, in effect, is what we are doing – or worse – by managing the world's nuclear stockpiles as we do today.

Next Steps to Reduce the Risk

In my view, these facts lead to an inescapable conclusion: we must do everything within our power to ensure that *all* caches of nuclear weapons and the materials needed to make them wherever they may be in the world, are secured and accounted for, to *standards* sufficient to ensure that they are defended against the threats that terrorists and thieves have demonstrated they can pose, in ways that will *work*, and will *last*. Improving nuclear security is the one step we can take that will most reduce the overall risk of nuclear terrorism – for once a nuclear weapon or nuclear material has left the facility where it is supposed to be, it could be anywhere, and all the subsequent layers of defense are variations on looking for needles in haystacks.

All the caches

Today, security upgrades in Russia are nearing completion, and there's significant progress in Pakistan, but the promising nuclear security dialogue with China does not yet appear to have led to major improvements in nuclear security there, and India has so far rejected offers of nuclear security cooperation. U.S. programs largely ignore caches in wealthy developed countries, though some of these, too, are dangerously insecure. Under current plans, GTRI will remove only about 2 tons of what it estimates are 15.9 tons of U.S.-origin HEU abroad. While GTRI is working to convert research reactors to use proliferation-resistant low-enriched uranium (LEU), scores of HEU-fueled reactors are not covered by that effort, and there is no program to give unneeded reactors incentives to shut down (an approach which may be cheaper and quicker, especially for difficult-to-convert reactors). There is currently no U.S. program to limit the production, use, and stockpiling of weapons-usable separated civilian plutonium. U.S. programs should focus on the total problem, eliminating these gaps.

In particular, we need to work with countries on drastically reducing the number of sites where nuclear weapons and the materials to make them exist, achieving higher security at lower cost. Our goal should be to remove all nuclear material from the world's most vulnerable sites and ensure effective security wherever material must remain within four years or less. Over time, the United States should seek an end to all civil use of HEU. And we should not encourage commercial reprocessing and recycling of plutonium, as proposed in the Global Nuclear Energy Partnership (GNEP); even the proposed GNEP processes that do not separate "pure plutonium" would tend to increase, rather than decreasing, nuclear theft and nuclear proliferation risks compared to not reprocessing this fuel.[22] We should also work to reduce the total stockpiles of

[22] See discussion in Matthew Bunn, "Risks of GNEP's Focus on Near-Term Reprocessing," testimony before the Committee on Energy and National Resources, U.S. Senate, 14 November 2007, available as of 28 March 2008 at http://belfercenter.ksg.harvard.edu/files/bunn-GNEP-testimony-07.pdf. The radioactivity of the plutonium-bearing materials that would be recovered in proposed GNEP processes is not remotely enough to deter theft by determined terrorists. See Jungmin Kang and Frank Von Hippel, "Limited Proliferation-Resistance Benefits from Recycling Unseparated Transuranics and Lanthanides from Light-Water Reactor Spent Fuel," *Science and Global Security* 13,

weapons and materials that must be guarded; if properly managed, serious pursuit of the steps toward a nuclear weapon free world advocated by Secretaries Shultz, Kissinger, and Perry and Senator Nunn could make a significant long-term contribution to reducing nuclear terrorism risks.[23]

While these programs must look beyond Russia to the world, Russia and the United States, with some 95% of the world's nuclear weapons and more than 80% of its stocks of weapons-usable nuclear material, clearly bear a special responsibility for nuclear security and have special experience. We should shift from a donor-recipient relationship to a true nuclear security partnership with Russia, including establishing joint teams that would help other states around the world upgrade security. The GI, co-led by the United States and Russia, is an important step in the right direction, as is President Bush's recent effort to work out a strategic framework to guide U.S.-Russian relations. But as the President and Congress consider actions which strongly affect Russian interests, from missile defense in Europe to the expansion of NATO to Russia's borders, they need to consider the potential impact on the prospects for effective nuclear security partnership as well.

Effective standards

As nuclear security is only as strong as its weakest link, the world urgently needs effective global nuclear security standards that will ensure that all nuclear weapons and weapons-usable materials are protected against the kinds of threats terrorists and criminals have shown they can pose – at a bare minimum, against two small teams of well-trained, well-armed attackers, possibly with inside help, as occurred at Pelindaba. (In some countries, protection against even more capable threats is required.) UN Security Council Resolution 1540 legally requires all countries to provide "appropriate effective" security and accounting for all their nuclear stockpiles. The time has come to build on that requirement by reaching a political-level agreement with other leading states on what the essential elements of appropriate effective security and accounting systems are, and then working to ensure that all states put those essential elements in place. Ultimately, effective security and accounting for weapons-usable nuclear material should become part of the "price of admission" for doing business in the international nuclear market.

Security that works, and that lasts

If the upgraded security equipment the United States is helping countries put in place is all broken and unused in five years, U.S. security objectives will not be accomplished. The Department of Energy (DOE) is working closely with Russia to try to ensure that Russia puts in place the resources, incentives, and organizations needed to sustain high levels of security for the long haul, and to build security cultures that will put an end to guards patrolling without

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no. 3 (2005).

[23] See George P. Shultz, William J. Perry, Henry A. Kissinger, and Sam Nunn, "Toward a Nuclear-Free World," *Wall Street Journal*, 15 January 2008, and Matthew Bunn, "Securing Nuclear Stockpiles Worldwide," in *Reykjavik Revisited: Steps Toward a World Free of Nuclear Weapons* (Palo Alto: Hoover Institution, forthcoming). For recent discussions of steps to reduce existing stockpiles of HEU and separated plutonium, see Matthew Bunn and Anatoli Diakov, "Disposition of Excess Highly Enriched Uranium," and "Disposition of Excess Plutonium," in *Global Fissile Materials Report 2007* (Princeton, NJ: International Panel on Fissile Materials, October 2007, available as of 28 March 2008 at http://www.fissilematerials.org), pp. 24-32 and 33-42.

ammunition or staff propping open security doors for convenience. But there is a long row yet to hoe, and similar efforts need to be undertaken wherever nuclear weapons and the materials to make them exist. As most nuclear managers only invest in expensive security measures when the government tells them they have to, effective regulation is essential to effective and lasting security, and there is far more to do to get effective nuclear security and accounting regulations in place around the world.

Beyond nuclear security

While securing nuclear weapons and materials at their source is the most effective tool to reduce the risk, we cannot expect it to be perfect. Most of the past successes in seizing stolen nuclear material have come from conspirators informing on each other and from good police and intelligence work, not from radiation detectors. We urgently need a substantially stepped-up effort to build police and intelligence cooperation focused on stopping nuclear smuggling in countries around the world, including additional sting operations and well-publicized incentives for informers to report on such plots, to make it even more difficult for potential nuclear thieves and those who would like to buy stolen material to connect. The United States should also work with key states around the world to ensure that they put in place laws making any participation in real or attempted theft or smuggling of nuclear weapons or weapons-usable materials, or nuclear terrorism, crimes with penalties comparable to those for murder or treason.

We also need an intense international focus on stopping the other elements of a nuclear plot – the recruiting, fundraising, equipment purchases, and more that would inevitably be required. Because of the complexity of a nuclear effort, these would offer a bigger and more detectable profile than many other terrorist conspiracies. The best chances to stop such a plot lie not in exotic new detection technologies but in traditional counter-terrorism – including addressing the anti-American hatred that makes recruiting and fund-raising easier, and makes it more difficult for governments to cooperate with us.

Steps within the United States

Homeland security begins abroad – it begins wherever there is a vulnerable cache of plutonium or HEU. I encourage the committee to hold joint hearings with the Armed Services or Foreign Relations committees to explore those critical issues. But there is much more than can and should be done within the United States itself as well. The incident last year in which six nuclear weapons were flown to Barksdale without anyone knowing it makes clear that there is more to be done even with respect to nuclear weapons themselves; Secretary of Defense Gate's recent direction to carry out a detailed inventory of weapons and related materials is commendable, but it seems clear that steps to strengthen organizational security culture are also needed.[24] We need to remember that convincing foreign countries to reduce and consolidate nuclear stockpiles, to put stringent nuclear security measures in place, or to convert their research reactors from HEU fuel to proliferation-resistant low-enriched uranium (LEU) will be far more difficult if we are not doing the same at home.

[24] For a useful discussion, see Defense Science Board Permanent Task Force on Nuclear Weapons Surety, *Report on the Unauthorized Movement of Nuclear Weapons* (Washington, DC: Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, February 2008).

- **Converting U.S. HEU-fueled reactors and upgrading their security.** DOE should be commended for its decision, after years of delay, to provide funding to convert U.S. research reactors to LEU, and Congress should provide adequate funding for this effort and insist it moves forward as rapidly as practicable.[25] At the same time, Congress should direct the Nuclear Regulatory Commission (NRC) to phase out the exemption from most security rules for HEU that research reactors now enjoy, and provide funding for DOE to help these reactors pay the costs of effective security.[26] Congress should also insist that NRC revise its rule exempting HEU emitting more than one Sievert per hour at one meter from almost all security requirements, as recent studies make clear that this level of radiation would pose little deterrent to theft by determined terrorists.[27]
- **Providing incentives to convert HEU medical isotope production.** Congress took a step in the wrong direction, in my view, when it modified the legislation limiting U.S. exports of HEU for medical isotope production. The revised law gives producers very little incentive to focus on the goal of converting to LEU for making these isotopes. Congress should use market forces to accomplish this objective, by imposing a roughly 30% tax on all medical isotopes made with HEU, with the funds used to help producers convert to LEU. This would give producers a strong financial incentive to convert, and since the isotopes are a tiny fraction of the costs of the medical procedures that use them, would not significantly affect the costs or availability of these life-saving procedures.
- **Closing the DOE-NRC security gap.** Currently, while there are still security issues to be addressed at DOE,[28] DOE sites with Category I nuclear materials – the most sensitive category – are required to put in place security systems capable of protecting against a very substantial design basis threat (DBT), while NRC-regulated sites that possess identical material are required to defend against much less. These can't both be the right answer, and

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[25] U.S. Congress, 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 10 July 2007).

[26] For a recent discussion of security rules at U.S. research reactors, focusing primarily on the sabotage threat, see U.S. Congress, Government Accountability Office, *Nuclear Security: Action May be Needed to Reassess the Security of NRC-Licensed Research Reactors*, GAO-08-403 (Washington, D.C.: January 2008). GTRI currently has a pilot program helping a few reactors voluntarily take security measures not required by the NRC; Congress should increase the budget for this effort, so that adequate upgrades can be made rapidly pending putting in place more stringent security rules.

[27] A recent Oak Ridge National Laboratory study concluded that a radiation level of 100 Sv/hr at one meter would be required to physically disable nuclear material thieves during the course of their theft. C.W. Coates et al., "Radiation Effects on Personnel Performance Capability and a Summary of Dose Levels for Spent Research Reactor Fuels," in *Proceedings of the 47th Annual Meeting of the Institute for Nuclear Materials Management, Nashville, Tenn., 16-20 July* (Northbrook, Ill.: INMM, 2006). An earlier Los Alamos study concluded that thieves stealing HEU fuel emitting 1 Sv/hr from a research reactor by picking it up with their bare hands and carrying it out to a waiting truck would not get a big enough dose even to make them feel immediately ill, though their long-term risk of cancer would be increased. J.J. Koelling and E.W. Barts, *Special Nuclear Material Self-Protection Criteria Investigation: Phases I and II*, vol. LA-9213-MS, NUREG/CR-2492 (Washington, D.C.: U.S. Nuclear Regulatory Commission, 1982; available at http://www.sciencemadness.org/lanl1_a/lib-www/la-pubs/00307470.pdf as of 28 March 2008).

[28] For a particularly recent discussion from a critical non-government organization, for example, see Project on Government Oversight, *U.S. Nuclear Weapons Complex: Livermore Homes and Plutonium Make Bad Neighbors* (Washington, DC: POGO, 17 March 2008, available as of 28 March 2008 at http://www.pogo.org/p/homeland/ho-080317-livermore.html).

Congress should act to close this gap.[29] Congress should also reverse NRC's position that reactors using plutonium fuels need no more security than other reactors do.[30]

- **Security against nuclear sabotage.** In this testimony, I have focused on terrorist use of actual nuclear explosives; although this would be the most difficult type of nuclear terrorism for terrorists to accomplish, and is therefore the least probable, its consequences would be so catastrophic that I believe it poses the highest risk.[31] Nevertheless, there are strong arguments that security requirements for U.S. nuclear power plants should be more stringent than they are, given the potentially large consequences of a successful sabotage.[32] Moreover, as a "security Chernobyl" anywhere could doom prospects for global nuclear growth to help respond to climate change, the U.S. government should work to ensure that countries around the world take adequate measures to protect against catastrophic nuclear sabotage.
- **Security for radiological materials.** There are also strong arguments for more stringent security arrangements for the most dangerous radiological sources that might be used in a "dirty bomb," taking not only the potential public health and safety impact but also the likely economic disruption and cleanup costs into account. Transports of the most dangerous sources are a particular concern, and regulations should require background checks for drivers, locks and barriers that would make removal of the source very difficult, and at least one armed guard. Here, too, GTRI is helping upgrade security for a few large sources beyond regulatory requirements, but with limited funding and authority. Congress should act to ensure that some government agency has the mission and funding to help domestic licensees that may have inadequate resources and expertise with providing security for dangerous sources. Most importantly, the Department of Homeland Security and the Nuclear Regulatory Commission must work closely with users of radiation sources to promote a change in thinking about security and raise awareness that these materials are a potential target for terrorists.[33]
- **A strengthened nuclear forensics effort.** Congress should also act to strengthen U.S. and international efforts in nuclear forensics (the science of examining characteristics of seized nuclear material or nuclear material collected after a nuclear blast for clues to where it came

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[29] See U.S. Congress, General Accounting Office, *Nuclear Security: DOE and NRC Have Different Security Requirements for Protecting Weapons-Grade Material From Terrorist Attacks*, GAO-07-1197R (Washington, DC: September 2007, available as of 28 March 2008 at http://www.gao.gov/new.items/d071197r.pdf).

[30] See discussion and sources in Matthew Bunn and Anthony Wier, *Securing the Bomb 2006* (Cambridge, Mass.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, 2006; available at http://www.nti.org/securingthebomb as of 28 March 2008), p. 137.

[31] For a useful discussion of the full spectrum of nuclear and radiological terrorist threats, see Charles D. Ferguson and William C. Potter, with Amy Sands, Leonard S. Spector, and Fred L. Wehling, *The Four Faces of Nuclear Terrorism*, ed. Amy Sands, Leonard S. Spector, and Fred L. Wehling (Monterey, Cal.: Center for Nonproliferation Studies, Monterey Institute of International Studies, 2004; available at http://www.nti.org/c_press/analysis_4faces.pdf as of 28 March 2008).

[32] For a recent critical assessment of NRC's rules for protecting power reactors from sabotage, see Lisbeth Gronlund, David Lochbaum, and Edwin Lyman, *Nuclear Power in a Warming World: Assessing the Risks, Addressing the Challenges* (Cambridge, MA: Union of Concerned Scientists, December 2007).

[33] For a brief discussion of these radiological issues, see Matthew Bunn and Tom Bielefeld, "Reducing Nuclear and Radiological Terrorism Threats," in *Proceedings of the Institute for Nuclear Materials Management 48th Annual Meeting*, Tucson, Arizona, 8-12 July 2007 (Northbrook, IL: INMM, 2007).

from). This should include both increased funding for R&D (currently so much of the funding is staying at the Department of Homeland Security that U.S. laboratories working on forensics of seized materials have had to lay off some of their staff) and expanded efforts to put together an international database of material characteristics. Congress should understand, however, that nuclear material has no DNA that can provide an absolute match: nuclear forensics will provide a useful but limited source of information to combine with other police and intelligence information, but will rarely allow us to know where material came from by itself.[34]

- **A modified approach to cargo scanning.** Congress should act to strengthen the approach to radiation scanning of cargo containers approved last year. By requiring 100% of containers coming into the United States to be scanned (an extraordinarily difficult target to meet), offering the possibility of a waiver, and setting no requirements for the quality of the scanning or for what should be done with the information from the scans, Congress may have inadvertently created a situation where the requirement will repeatedly be waived and the scanning put in place will be of low quality and lead to little action. Congress should approve a revised approach in which 100% of the containers would have a high *chance* of being scanned; the scans were done with the best available scanning technology; and the scans would be linked to immediate further search and other action in the event of unexplained detections. This would do more to keep terrorists from using containers to smuggle nuclear weapons and materials.
- **Stopping smuggling beyond official points of entry.** The countless pathways into the United States between official points of entry – from the hundreds of kilometers of unmarked forest between the United States and Canada to the thousands of fishing boats which return from the open ocean each day and could easily have loaded something into their cargo holds while at sea – pose a major nuclear smuggling vulnerability. This vulnerability will be extraordinarily difficult to address. In these cases, radiation detection is not likely to be central to the answer: we are more likely to catch the smugglers than to detect their nuclear materials. Congress should insist that the Department of Homeland Security provide a detailed assessment of this vulnerability and options for addressing it. Congress should also mandate an independent assessment of the cost-effectiveness of large investments in radiation detection at official points of entry when intelligent adversaries have options for going around them.[35]
- **Improved preparedness for the aftermath of an attack.** While some steps have been taken to prepare for the ghastly aftermath of a terrorist nuclear attack, we need a comprehensive plan and approach. We need a rapid ability to assess which people are in the greatest danger and to tell them what they can do to protect themselves. We need better capabilities to communicate to everyone, when TV, radio, and cell phones in the affected area may not be functioning properly, and we need much better public communication plans for the critical minutes and hours after such an awful attack. We need to do a much better job encouraging and helping people to take simple steps to get ready for an emergency. We

[34] See Nuclear Forensics Working Group (Michael May, chair), *Nuclear Forensics: Role, State of the Art, Program Needs* (Washington, DC: American Physical Society and American Association for the Advancement of Science, February 2008).
[35] For a more optimistic view on this part of the problem, see Levi, *On Nuclear Terrorism,* pp. 87-96.

also need a better ability – including making use of the military's capabilities – to treat many thousands of injured people. We need much better plans to keep our government and economy functioning while taking all the steps that will be needed to prevent another attack. (In particular, Congress has not yet acted to put a plan in place for reconstituting itself should most members of Congress be killed in a nuclear attack.[36]) Many of these steps would help us respond to any catastrophe, natural or man-made, and would pay off even if our efforts to prevent a terrorist nuclear attack succeeded.[37]

Leadership and commitment

None of these steps will be easy. They cut across multiple cabinet departments, and require cooperation in highly sensitive areas with countries across the globe. They will require sustained leadership, day-in and day-out, from the highest levels of the U.S. government – and other governments. Yet today, there is no one in the U.S. government with full-time responsibility for all of the disparate efforts to prevent nuclear terrorism. Last year, Congress acted to create a senior, full-time position in the White House solely focused on weapons of mass destruction nonproliferation and terrorism. Unfortunately, President Bush has not filled this position. The president who takes office in January 2009 should appoint some one who has the president's ear whose sole responsibility will be to see that everything that must be done to prevent a nuclear terrorist attack is being done, keeping these issues on the front burner at the White House every day. Congress should finally appoint the members of the WMD Commission it created in the same legislation, so the commission can make its recommendations in time for the next President to act.

Finally, the fundamental key to the success of such a global effort is to convince political leaders and nuclear managers around the world that nuclear terrorism is a real and urgent threat to *their* countries' security, worthy of a substantial investment of their time and money. If we succeed in building that sense of urgency, they will take the needed actions; if we fail, they will not. The United States and other countries should take several steps to build the needed sense of urgency and commitment, including:

- **Joint threat briefings.** Upcoming summits with political leaders of key countries should include detailed briefings for both leaders on the nuclear terrorism threat, given jointly by U.S. experts and experts from the country concerned. These would outline both the very real possibility that terrorists could get nuclear material and make a nuclear bomb, and the global economic and political effects of a terrorist nuclear attack.
- **Nuclear terrorism exercises and war games.** The United States and other leading countries should organize a series of exercises and war games with senior policymakers from key states, with scenarios tailored to the circumstances of each country or region where the

[36] For a discussion of the importance of a Congressional ability to reconstitute after a major attack, and specific recommendations, see Continuity of Government Commission, *Preserving Our Institutions: The Continuity of Congress* (Washington: American Enterprise Institute and Brookings Institution, May 2003).

[37] 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, MA: Preventive Defense Project, Harvard and Stanford Universities, May 2007, available as of 28 March 2008 at http://belfercenter.ksg.harvard.edu/files/dayafterworkshopreport_may2007.pdf)

exercises take place. Participating in such a war game can reach officials emotionally in a way that briefings and policy memos cannot.

- **Fast-paced nuclear security reviews.** The United States and other leading countries should encourage leaders of key states to pick teams of security experts they trust to conduct fast-paced reviews of nuclear security in their countries, assessing whether facilities are adequately protected against a set of clearly-defined threats. (In the United States, such fast-paced reviews after major incidents such as 9/11 have often revealed a wide range of vulnerabilities that needed to be fixed.)
- **Realistic testing of nuclear security performance.** The United States and other leading countries should work with key states around the world to implement programs to conduct realistic tests of nuclear security systems' ability to defeat either insiders or outsiders. (Failures in such tests can be powerful evidence to senior policymakers that nuclear security needs improvement.)
- **Shared databases of threats and incidents.** The United States and other key countries should collaborate to create shared databases of unclassified information on actual security incidents (both at nuclear sites and at non-nuclear guarded facilities) that offer lessons for policymakers and facility managers to consider in deciding on nuclear security levels and particular threats to defend against.

Congress has a responsibility and an opportunity to exercise in-depth and informed oversight of these efforts, through hearings such as this one and legislation. Congress should give the administration the funding and authority to get the job done, while holding the administration responsible for demonstrable results. In this year in particular, Congress should focus on laying the foundation of policy and authority that will allow the next President to hit the ground running. With a sensible strategy, adequate resources, and sustained leadership, the risk of nuclear terrorism can be dramatically reduced during the next president's first term. American security demands no less.