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Nuclear Terrorism: A Brief Review of Threats and Responses

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Nuclear Terrorism: A Brief Review of Threats and Responses

Summary

It would be difficult for terrorists to mount a nuclear attack on a U.S. city, but such an attack is plausible and would have catastrophic consequences, in one scenario killing over a half-million people and causing damage of over \$1 trillion.

Terrorists or rogue states might acquire a nuclear weapon in several ways. The nations of greatest concern as potential sources of weapons or fissile materials are widely thought to be Russia and Pakistan. Russia has many tactical nuclear weapons, which tend to be lower in yield but more dispersed and apparently less secure than strategic weapons. It also has much highly enriched uranium (HEU) and weapons-grade plutonium, some said to have inadequate security. Many experts believe that technically sophisticated terrorists could, without state support, fabricate a nuclear bomb from HEU; opinion is divided on whether terrorists could make a bomb using plutonium. The fear regarding Pakistan is that some members of the armed forces might covertly give a weapon to terrorists or that, if President Musharraf were overthrown, an Islamic fundamentalist government or a state of chaos in Pakistan might enable terrorists to obtain a weapon. Terrorists might also obtain HEU from the more than 130 research reactors worldwide that use HEU as fuel.

If terrorists acquired a nuclear weapon, they could try many means to bring it into the United States. This nation has thousands of miles of land and sea borders, as well as several hundred ports of entry. Terrorists might smuggle a weapon across lightly-guarded stretches of borders, ship it in using a cargo container, place it in a crude oil tanker, or bring it in using a truck, a boat, or a small airplane.

The architecture of the U.S. response is termed “layered defense.” The goal is to try to block terrorists at various stages in their attempts to obtain a nuclear weapon and smuggle it into the United States. The underlying concept is that the probability of success is higher if many layers are used rather than just one or two. Layers include threat reduction programs in the former Soviet Union, efforts to secure HEU worldwide, control of former Soviet and other borders, the Container Security Initiative and Proliferation Security Initiative, and U.S. border security. Several approaches underlie multiple layers, such as technology, intelligence, and forensics.

Many policy options have been proposed to deal with nuclear terrorism, such as developing new detection technologies, strengthening U.S. intelligence capability, and improving planning to respond to an attack. Congress funds programs to counter nuclear terrorism and holds hearings and less-formal briefings on the topic. Several bills have been introduced in the 109th Congress related to nuclear terrorism.

This report is intended for background, not for tracking current developments. It will be updated occasionally. It does not cover radiological terrorism; see CRS Report RS21766, *Radiological Dispersal Devices: Select Issues in Consequence Management*, and CRS Report RS21528, *Terrorist ‘Dirty Bombs’: A Brief Primer*.

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Nuclear Terrorism: A Brief Review of Threats and Responses

Threats

It would be difficult for terrorists to attack a U.S. city using a nuclear weapon, but such an attack is plausible and would have catastrophic consequences. A report of June 2004 by the National Commission on Terrorist Attacks upon the United States found that even though an attempt by al Qaeda in 1994 to purchase uranium failed, “al Qaeda continues to pursue its strategic objective of obtaining a nuclear weapon.”¹ A book by the Center for Nonproliferation Studies emphasizes the urgency of taking steps to reduce the risk that terrorists could obtain nuclear weapons or materials.² A May 2004 report by Harvard University’s Project on Managing the Atom finds that a nuclear attack “would be among the most difficult types of attacks for terrorists to accomplish,” but that with the necessary fissile materials, “a capable and well-organized terrorist group plausibly could make, deliver, and detonate at least a crude nuclear bomb capable of incinerating the heart of any major city in the world.”³ An earlier report by the same group estimated the consequences of a ten-kiloton weapon (two-thirds the yield of the Hiroshima bomb) detonated at Grand Central Station in Manhattan as over a half-million people killed immediately, hundreds of thousands injured, the possibility (depending on wind direction) of having to evacuate all of Manhattan, much of lower Manhattan permanently destroyed, direct costs of well over \$1 trillion, indirect costs several times that, and the prospect for nationwide panic and economic chaos if terrorists subsequently claimed to have another bomb.⁴ The latter two reports, and a companion website,⁵

¹ U.S. National Commission on Terrorist Attacks upon the United States. “Overview of the Enemy,” Staff Statement No. 15, c. June 2004, p. 12. Available at [http://www.9-11commission.gov/hearings/hearing12/staff_statement_15.pdf].

² Charles Ferguson and William Potter, with Amy Sands, Leonard Spector, and Fred Wehling, *The Four Faces of Nuclear Terrorism*, Monterey, CA, Center for Nonproliferation Studies, Monterey Institute of International Studies, 2004, 378 p. Available at [<http://cns.miis.edu/pubs/week/040618.htm>].

³ Matthew Bunn and Anthony Wier, *Securing the Bomb: An Agenda for Action*, Project on Managing the Atom, Harvard University, May 2004, p. vii. Available at [http://www.nti.org/e_research/analysis_cnwmupdate_052404.pdf].

⁴ Matthew Bunn, Anthony Wier, and John Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, Project on Managing the Atom, Harvard University, March 2003, p. 18-23. Available at [http://www.nti.org/e_research/cnwm/cnwm.pdf].

⁵ Nuclear Threat Initiative, “Controlling Nuclear Warheads and Materials,” available at (continued...)

provide detailed data on U.S. threat reduction programs and argue that there is an urgent need to accelerate these programs.

This report divides the threat into two aspects, the acquisition of a bomb and its delivery to a target. The former could involve obtaining a nuclear weapon, or obtaining fissile material and making it into a bomb. Delivery involves more common and less sophisticated skills to move the weapon covertly to its target.

Weapon Acquisition

Experts have raised concerns that terrorists might try to acquire two types of nuclear weapons. In the simplest, a “gun-type” weapon, a mass of uranium highly enriched in the fissile isotope 235 (highly enriched uranium, or HEU) is shot down a tube (resembling an artillery tube) into another HEU mass, creating a supercritical mass and a nuclear explosion. The Hiroshima bomb used this approach; its designers had such high confidence in it that they did not test this type of weapon prior to using it. The second type, an implosion weapon, typically uses weapons-grade plutonium (WGPU, composed mainly of the isotope 239). A shell of WGPU is surrounded by chemical explosives arrayed to produce a symmetrical inward-moving (implosion) shock wave that compresses the plutonium enough to be supercritical. The Nagasaki bomb was of this type. It is much more complex in design and manufacture than a gun-assembly weapon. An implosion device was tested in New Mexico prior to use on Nagasaki. A National Academy of Sciences report asserts, “Crude HEU weapons could be fabricated without state assistance.”⁶ Some experts believe that terrorists could create an implosion weapon;⁷ others disagree.⁸

Terrorists or rogue states might acquire nuclear weapons or fissile materials in various ways. The source of greatest concern is Russia.⁹ It has much fissile material. A National Nuclear Security Administration (NNSA) document shows that

⁵ (...continued)

[http://www.nti.org/e_research/cnwm/overview/cnwm_home.asp].

⁶ National Academy of Sciences, *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, Washington, National Academies Press, 2002, p. 45. Available at [<http://books.nap.edu/books/0309084814/html/45.html>].

⁷ See, for example, Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman, and Jacob Wechsler, “Can Terrorists Build Nuclear Weapons?”, Nuclear Control Institute, n.d. Available at [<http://www.nci.org/k-m/makeab.htm>].

⁸ Robert Gallucci, Dean, School of Foreign Service, Georgetown University, wrote, “I do not believe that al-Qaida could build a nuclear weapon with a plutonium core, that is, a weapon with an implosion design.” Personal correspondence, August 26, 2002. For a detailed explanation of why it would be much harder for terrorists to build an implosion weapon than a gun-type weapon, see Ferguson et al., *The Four Faces of Nuclear Terrorism*, p. 135-138.

⁹ See CRS Report RL32202, *Nuclear Weapons in Russia: Safety, Security, and Control Issues*, by Amy Woolf.

considerable work remains for the disposition of this material,¹⁰ and a National Academy of Sciences report states that the risk of diversion of special nuclear material (SNM, or fissile material) from Russia is “high” because “large inventories of SNM are stored at many sites that apparently lack inventory controls, and indigenous threats have increased.”¹¹

A related concern is that Pakistan might be the source of nuclear weapons or materials for terrorists under several scenarios: (1) Islamists in the armed services might provide such assistance covertly under the current government; (2) if that government were overthrown by fundamentalists, the new government might make weapons available to terrorists; or (3) such weapons might become available if chaos, rather than a government, followed the overthrow.

Other nations are seeking nuclear weapons. President Bush, in his 2005 State of the Union Address, said, “Today, Iran remains the world’s primary state sponsor of terror, pursuing nuclear weapons ... it must give up its uranium enrichment program and any plutonium reprocessing ...”¹² According to a press report, Mohamed ElBaradei, Director General of the International Atomic Energy Agency, “says he is now certain that the nuclear material his agency once monitored there [in North Korea] has been converted into fuel for four to six nuclear bombs.”¹³ And in a statement of February 2005, North Korea declared that it had nuclear weapons.¹⁴

There is also evidence of transfers of nuclear weapon materials, designs, production equipment, and expertise to other nations. A.Q. Khan, the father of Pakistan’s atomic bomb, ran a covert operation for many years that reportedly provided Libya, North Korea, and Iran with equipment for making HEU and plans for making an atomic bomb.¹⁵ Reports of February 2005 pointed to evidence that strongly indicated that North Korea had provided Libya with uranium hexafluoride, a chemical used as the feedstock to produce HEU, though another report said that the “evidence ... could just as easily point to Pakistan.”¹⁶ Transfers to rogue states, or directly or indirectly to terrorist groups, are a source of concern.

¹⁰ U.S. Department of Energy. Office of Management, Budget and Evaluation/CFO. *FY 2005 Congressional Budget Request*. Vol. 1, National Nuclear Security Administration. DOE/ME-0032, February 2004, p. 477-490. Available at [<http://www.mbe.doe.gov/budget/05budget/content/defnn/nn.pdf>].

¹¹ National Academy of Sciences, *Making the Nation Safer*, p. 44.

¹² President George W. Bush, State of the Union Address; transcript in *New York Times*, February 3, 2005, p. 19.

¹³ David Sanger and William Broad, “North Korea Said to Expand Arms Program,” *New York Times*, December 6, 2004: 9.

¹⁴ James Brooke, “North Korea Says It Has Nuclear Weapons and Rejects Talks,” *nytimes.com*, February 10, 2005

¹⁵ David Sanger and William Broad, “Pakistani’s Nuclear Earnings: \$100 Million,” *New York Times*, March 16, 2004: 8.

¹⁶ David Sanger and William Broad, “Tests Said to Tie Deal on Uranium to North Korea,” *New York Times*, February 2, 2005: 1; and Glenn Kessler and Dafna Linzer, “Nuclear Evidence Could Point to Pakistan,” *Washington Post*, February 3, 2005: 18.

Nuclear research reactors offer still another route to obtaining a weapon. *Securing the Bomb* states, “More than 130 research reactors still use HEU as their fuel, in more than 40 countries. Most of these facilities have very modest security — in many cases, no more than a night watchman and a chain-link fence.”¹⁷ A more recent Government Accountability Office report stated that as of July 30, 2004, “39 of the 105 research reactors targeted by DOE [for conversion from HEU to low-enriched uranium, or LEU] have converted to LEU fuel.”¹⁸ Six of these reactors are reportedly on U.S. university campuses.¹⁹

A gun-assembly weapon need not be particularly large. The Hiroshima bomb, according to one source, weighed 8,900 pounds and was 10 feet long and 28 inches in diameter.²⁰ Much of that size and weight, however, was taken up by an armored steel shell and stabilizing fins, as well as by arming, fuzing, and firing devices.²¹ The gun barrel — the actual nuclear explosive device — measured 6 feet in length by over 6 inches in diameter and weighed about a half-ton.²² Simple improvements might shrink size and weight. A terrorist-made implosion weapon or a weapon stolen from a nation’s arsenal could be smaller. In short, a weapon could fit in a car, boat, or small airplane, and would occupy a small corner of a shipping container.

Weapon Delivery

The United States has many thousands of miles of land and water borders, as well as several hundred sea, land, and air ports of entry — 317 by one count — giving terrorists many pathways to smuggle a nuclear bomb into this nation.²³ There are many types of borders, as the following table shows — oceans (tropical to temperate to Arctic), land and river borders with Mexico and Canada, and the Great Lakes. Each poses its own set of opportunities for smugglers.

¹⁷ Bunn and Wier, *Securing the Bomb*, p. viii.

¹⁸ U.S. Government Accountability Office, *Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors*, GAO-04-807, July 2004, Highlights page.

¹⁹ Matthew Wald, “Uranium Reactors on Campus Raise Security Concerns,” *New York Times*, August 15, 2004: 19.

²⁰ Robert Duff, Director of Classification, DOE, letter to David Rosenberg, December 4, 1980, quoted in Thomas Cochran, William Arkin, and Milton Hoenig, *Nuclear Weapons Databook, Vol. 1: U.S. Nuclear Forces and Capabilities*, Cambridge, MA, Ballinger, 1984, p. 32. Another source uses slightly different figures: length 10.5 feet, diameter 29 inches, and weight 9,700 lb. Richard Rhodes, *The Making of the Atomic Bomb*, New York, Simon and Schuster, 1986, p. 701.

²¹ Rhodes, *The Making of the Atomic Bomb*, p. 701-703.

²² Duff, letter to David Rosenberg, quoted in Cochran et al., *Nuclear Weapons Databook, Vol. 1: U.S. Nuclear Forces and Capabilities*, p. 32.

²³ The figure was provided to CRS by the Customs and Border Protection Office of Congressional Affairs, April 22, 2004, and is referenced in CRS Report RL32399, *Border Security: Inspections Practices, Policies, and Issues*, by Ruth Ellen Wassem et al., p. 2 of update of August 2, 2004. See also CRS Report RL31539, *Nuclear Smuggling and International Terrorism: Issues and Options for U.S. Policy*, by Rensselaer Lee.

Legal and illegal crossings into the United States also present terrorists with different risks and opportunities. Legal crossings are points, such as seaports, airports, and border stations on roads entering the United States. Illegal crossings are lines — the thousands of miles of unguarded stretches of coasts and land borders. Securing points poses different requirements from securing lines. Points have an immense volume of traffic, almost all of it legal, and a corresponding concentration of people and resources of U.S. Customs and Border Protection (CBP). The task of CBP is to find the needle in the haystack while expediting legal traffic. Attempts to smuggle a nuclear weapon through a legal crossing would run the risk that the weapon might be detected by computerized screening of cargo manifests, imaging devices (similar to x-rays), neutron activation devices, or physical inspection, as discussed below. That risk is reduced by the need for CBP agents to process huge numbers of vehicles, vessels, and passengers, leaving little time or attention for those not raising suspicions, and by the low radioactivity of fissile uranium-235 — approximately one hundred-millionth that of radioactive material that might be used in a “dirty bomb.”²⁴

ABC News attempted to highlight the difficulty of detecting smuggled material. On September 11 of 2002 and 2003, that organization smuggled a 15-pound cylinder of depleted uranium (DU — natural uranium minus most of its uranium-235) into the United States in cargo containers; CBP did not detect it. ABC News said that DU is a good surrogate for HEU; CBP said that was not the case, and that there was no reason for CBP to have detected the DU because it is legal to import up to 15 pounds of DU as long as it is declared. The DHS Inspector General found “Improvements are needed in the inspection process to ensure that weapons of mass destruction ... do not gain access to the U.S. through oceangoing cargo containers. Detection equipment and search protocols and procedures are the two areas where improvements would enhance the effectiveness of the inspection process.”²⁵

²⁴ Half-life is the time it takes for half the atoms of a radioactive isotope to decay, by emitting radiation, into another isotope. As such, it is a rough measure of how radioactive an isotope is. The half-life of uranium-235 is about 700 million years, while the half-life of cobalt-60 is 5.3 years. That of plutonium-239 is about 24,000 years. U.S. Department of Energy. Office of Environmental Management. *Integrated Data Base Report — 1996: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, revision 13, December 1997, Table B.1, “Characteristics of Important Radionuclides,” available at [<http://web.em.doe.gov/idb97/tabbl.html>].

²⁵ U.S. Department of Homeland Security. Office of Inspector General. Office of Audits. *Effectiveness of Customs and Border Protection’s Procedures to Detect Uranium in Two Smuggling Incidents*. OIG-04-40, September 2004, p. 1.

Length of U.S. Borders (miles)			
Alaska coast	6,640	Atlantic coast	2,069
Hawaii coast	750	Great Lakes	970
Pacific coast excluding Alaska and Hawaii	1,293	Alaska-Canada border	1,538
Border with Mexico	1,933	Border with Canada excluding Alaska and Great Lakes	3,017
Gulf of Mexico coast	1,631	Total	19,841

Source: *The World Almanac and Book of Facts, 1998*. Mahwah, NJ, World Almanac Books, 1997. *World Book* page and source for each border segment are as follows: U.S. coasts, p. 541, U.S. Department of Commerce, National Oceanic and Atmospheric Administration; Great Lakes, p. 598, U.S. Department of Commerce, National Ocean Service; border with Canada excluding Alaska and Great Lakes, p.543, Department of the Interior, U.S. Geological Survey, and p. 598, U.S. Department of Commerce, National Ocean Service; Alaska-Canada border, p. 543, no source given; and U.S.-Mexico border, p. 543, listed as “approximately,” referenced to 1963 boundary agreement. Note that measurements of the U.S. coasts vary sharply, depending on such things as the length of the “yardstick” used and how far up inlets and rivers the seacoast is measured. See also CRS Report RS21729, *U.S. International Borders: Brief Facts*, by Marilyn Nelson and Barbara Salazar Torreon.

CBP resources are spread much more thinly along lines. Attempts to smuggle a nuclear weapon across an unguarded section of border would avoid the risk that the weapon might be detected, but CBP agents would only need to detect the smugglers, not the weapon: anyone or anything entering the United States across lines is illegal. On the other hand, risk to smugglers is reduced because CBP faces an immense task in patrolling the vast stretches of borders.²⁶

Terrorists could avoid the risks attendant to smuggling across both points and lines if they could place a weapon on board an airplane or ship bound for the United States and detonate it before it could be inspected, such as in the air above a city or as it entered a seaport.

Scenarios for smuggling a nuclear weapon across unguarded coasts or borders are similar to those for smuggling bales of marijuana, many of which are reportedly flown in, brought by small boats, or carried across land borders; the difficulty of patrolling the borders makes such scenarios feasible. A key difference between smuggling marijuana and a nuclear weapon is that in the former case, smugglers expect losses due to interception by CBP and view them as a cost of doing business. Terrorists attempting to smuggle a nuclear weapon into the United States, in contrast, would presumably have only one or a few weapons and would have to go to great lengths to succeed. Conversely, because of the great value of a nuclear weapon to terrorists, methods that create a substantial probability of detecting an attempt to smuggle a weapon into the United States might deter such an attempt.

²⁶ See CRS Report RL31019, *Terrorism: Automated Lookout Systems and Border Security Options and Issues*, by William Krouse and Raphael Perl.

Another scenario commonly discussed is smuggling a nuclear weapon in a shipping container.²⁷ These metal boxes, typically 8 by 8 by 20 feet or 8 by 8 by 40 feet, are used to transport vast quantities of goods ranging from clothes to computers to automobile engines. Nearly 9 million containers enter the United States by ship each year;²⁸ container ships may carry several thousand containers. From seaports, they are transported by truck or rail throughout the country. The concern is that if terrorists could place a bomb in a container overseas, they could ship it into the United States and transport it anywhere in the country. Under the Container Security Initiative (CSI), discussed below, CBP agents and their foreign counterparts screen containers being loaded onto container ships at certain foreign ports, and the foreign agents inspect containers that the screening identifies as suspicious, based on ports of call, manifest data, shipping company, etc. Terrorists, however, might try to circumvent CSI by acquiring a trusted shipping company to avoid suspicion, falsifying manifest data, infiltrating CSI ports, shipping from non-CSI ports. A nuclear explosion in a U.S. port from a bomb in a shipping container would have not only direct effects, but could also have far-reaching effects on the world economy because of its dependence on container traffic, an effect magnified by industry's use of "just-in-time" deliveries. According to Robert Bonner, Commissioner of Customs and Border Protection,

Simply put, the shipping of sea containers would stop. The American people, for one, would not likely permit one more sea container to enter the United States until there was a significantly greater assurance — such as 100% inspections — that no additional terrorist weapons would be smuggled into the country. Governments in other major industrial countries would no doubt adopt a similar policy, thus bringing the global economy to its knees.²⁹

Stephen Flynn, an authority on U.S. vulnerabilities to terrorist attack, cites John Meredith, a director of Hutchison Port Holdings, which Flynn describes as "the world's largest terminal operator," as "worried about the cascading consequences ... should the U.S. government close its ports for two to three weeks [after a terrorist attack], Meredith warned, the entire system would go into gridlock."³⁰

Another possible scenario is the use of an oil tanker to transport a nuclear weapon.³¹ The Middle East is the dominant source of anti-American terrorism, the

²⁷ See CRS Report RS21293, *Terrorist Nuclear Attacks on Seaports: Threat and Response*, by Jonathan Medalia.

²⁸ "Remarks by [CBP] Commissioner Robert C. Bonner, Council on Foreign Relations, New York, New York," January 11, 2005 [http://www.cbp.gov/xp/cgov/newsroom/commissioner/speeches_statements/01112005_foreign_rel.xml].

²⁹ [Then] U.S. Customs Commissioner Robert C. Bonner, Speech Before the Center for Strategic and International Studies, Washington, D.C., Jan. 17, 2002 [http://www.cbp.gov/xp/cgov/newsroom/commissioner/speeches_statements/archives/jan172002.xml].

³⁰ Stephen Flynn, *America the Vulnerable: How Our Government Is Failing to Protect Us from Terrorism*, New York, HarperCollins, 2004, p. 81, 83.

³¹ See U.S. Congress. Congressional Research Service. *Port and Maritime Security: Potential for Terrorist Nuclear Attack Using Oil Tankers*. CRS Report RS21997, by (continued...)

United States imports an average of more than 2 million barrels of crude oil a day from Persian Gulf nations,³² this crude oil is transported by ship, and it would be very difficult to detect a bomb inside a supertanker.

Part of the difficulty of detecting a bomb inside a floating vat of crude oil would arise from the sheer size of supertankers, which carry 100,000 deadweight tons or more of crude oil.³³ For example, two supertankers built in 2003 for COSCO (China Ocean Shipping) Group were 330 meters (almost a quarter-mile) long and 60 meters in beam, and had a capacity of about 300,000 deadweight tons.³⁴ There are even larger tankers that carry 500,000 deadweight tons of crude oil, and have a length of 396 meters and a beam of 71 meters.³⁵ On land, some detection devices use gamma rays (high-energy x-rays) to peer inside a shipping container and create an x-ray-type image, but the size of a supertanker and the thickness of the steel (especially with the use of double hulls) make this technique unworkable. Another possible means of detecting a nuclear weapon is neutron activation, in which a burst of neutrons is sent into the item to be examined, such as a shipping container; neutrons that strike uranium-235 (or other radioactive material) will cause some atoms to fission, releasing neutrons and gamma rays. Any neutron coming back as a result of neutron bombardment would be suspicious. The gamma rays produced by the disintegration of each isotope have a unique set of energies, creating a “fingerprint” that permits identification of the isotope. However, neutrons sent into the oil and any produced by fissioning of uranium would be absorbed (forming deuterium or tritium) or scattered by the hydrogen atoms in crude oil, and the large volume of oil would attenuate any gamma rays produced, defeating this form of detection. At the same time, designing a means to detonate a bomb inside a tanker could prove a technical challenge for terrorists.

A bomb in a tanker could devastate an oil port by the blast and by secondary fires in nearby refineries and oil storage tanks. A tanker bomb might be used against other maritime targets, such as the Panama Canal. And if a bomb in a shipping container could lead to the shutdown of container traffic, seriously damaging the

³¹ (...continued)
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³² U.S. Department of Energy. Energy Information Agency. “Table 3.7: United States — Oil Imports (Most Recent 12 Months)” for May 2003-April 2004. Available at [<http://www.eia.doe.gov/emeu/ipsr/t37.xls>].

³³ Schlumberger Corp., “Oilfield Glossary,” [<http://www.glossary.oilfield.slb.com/Display.cfm?Term=tanker>]. A deadweight ton is 2,240 pounds of carrying capacity.

³⁴ COSCO (China Ocean Shipping) Group, at [<http://www.cosco.com.cn/en/fleet/>] and click on “tanker”; statistics are for *Cosgreat Lake* and *Cosbright Lake*. For comparison, Nimitz-class aircraft carriers, the type currently under construction in the United States, have a length of 332.85 meters, a beam of 40.84 meters, and a displacement, fully loaded, of about 97,000 tons. U.S. Navy. “Fact File: Aircraft Carriers — CV, CVN,” updated January 14, 2004. [<http://www.chinfo.navy.mil/navpalib/factfile/ships/ship-cv.html>].

³⁵ Mark Huber, *Tanker Operations: A Handbook for the Person-in-Charge (PIC)*, fourth edition. Centreville, MD, Cornell Maritime Press, 2001, p. 20.

world economy, a tanker bomb might by the same token lead to the suspension of crude oil shipments, with similar results.

Responses

By now, over three years after the attacks of September 11, the components of the U.S. and global response have become clearer. The response is often termed “layered defense,” reflecting the idea that terrorists would have to proceed through many steps to acquire a nuclear weapon and smuggle it into the United States, and that attempting to thwart them at each step has a higher likelihood of success than trying to block one step only.³⁶ Whether layered defense is an overarching strategy, as is the case in ballistic missile defense, or simply a name given to what would have happened anyway as many agencies with different capabilities contribute in the ways each is able to, or some of both, is another matter. In any event, many programs have been established to deal with nuclear terrorism since 9/11, and others created well before then have acquired new urgency. The following six categories of programs are presented in the order in which they bear on a terrorist or rogue state effort to acquire and deliver a nuclear weapon.

Threat Reduction Programs in the Former Soviet Union. The Soviet Nuclear Threat Reduction Act of 1991 (P.L. 102-226, Title II), also known as the Nunn-Lugar Amendment, authorized a Department of Defense (DOD) program to assist in the destruction of Soviet nuclear and other weapons. The United States now funds threat reduction and nonproliferation programs through three agencies: DOD runs the Cooperative Threat Reduction program to secure and dismantle former Soviet nuclear and other weapons; the Department of Energy (DOE) runs several programs within its Defense Nuclear Nonproliferation account, such as International Nuclear Materials Protection and Cooperation and Elimination of Weapons-Grade Plutonium Production, to secure nuclear weapons materials and knowledge; and the Department of State runs such programs as Science and Technology Centers in Russia and Ukraine to provide weapons scientists with grant funding or employment on nonweapons projects.³⁷

Efforts To Secure HEU Worldwide. HEU is used in many research reactors around the world. The United States and the Soviet Union provided this material to many nations years ago. As noted above, much is said to be poorly guarded. It is a concern because acquiring a suitable quantity of HEU would be the most difficult step for terrorists intent on making a nuclear bomb. Efforts to secure some of this material have been ad hoc rather than part of a comprehensive plan. For example, in 1994 Project Sapphire reportedly removed from a “poorly guarded warehouse” in Kazakhstan enough HEU to make 20-50 nuclear weapons and brought

³⁶ For discussions of layered defense, see Flynn, *America the Vulnerable*, p. 68-71, and Ferguson et al., *The Four Faces of Nuclear Terrorism*, pp. 80-83.

³⁷ See CRS Report RL31957, *Nonproliferation and Threat Reduction Assistance: U.S. Programs in the Former Soviet Union*, by Amy Woolf.

it to the United States.³⁸ In August 2002, Project Vinca reportedly removed enough HEU for two nuclear weapons from a research reactor in Serbia and flew it to Russia, where it had originated.³⁹ *Securing the Bomb* asserts that the pace of securing fissile material has slowed since September 11, 2001, and suggests a “global cleanout” of HEU.⁴⁰ On May 26, 2004, responding to such concerns, Secretary of Energy Spencer Abraham announced a new Global Threat Reduction Initiative to secure Russian-origin fresh HEU by the end of 2005; to secure spent fuel of Russian/Soviet origin by 2010, and of U.S. origin within a decade; to convert the cores of civilian research reactors using HEU to be able to use uranium with a concentration of uranium-235 too low to be used in a nuclear weapon, and to try to identify and secure other nuclear and radiological materials that may pose a threat.⁴¹ For this effort, Secretary Abraham said, the United States plans to dedicate more than \$450 million. Other DOE personnel indicated that sum is the approximate cost to complete the program, that the funds would probably be spent over more than 10 years, and that most of the funds would be for already-existing programs.⁴²

There are also concerns about the security of any Iranian and North Korean HEU, as discussed above, and Pakistani HEU. A discussion of diplomatic efforts to secure such material goes beyond the scope of this report.⁴³

Control of Former Soviet and Other Borders. While some programs discussed earlier seek to secure former Soviet nuclear weapons and fissile materials, DOE’s Second Line of Defense (SLD) and the State Department’s Export Control and Related Border Security Assistance (EXBS) Program provide assistance to Russia and other countries to prevent nuclear materials from being smuggled out through their borders. DOE states that SLD “deploys radiation detection monitors at strategic transit and border crossings and at air and sea transshipment hubs.”⁴⁴

³⁸ Nuclear Threat Initiative, “Kazakhstan: Project Sapphire,” last updated September 28, 2001; available at [<http://www.nti.org/db/nisprofs/kazakst/fissmat/sapphire.htm>].

³⁹ Nuclear Threat Initiative, “International Response: Weapon-Grade Uranium Exits Yugoslavia,” *Global Security Newswire*, August 23, 2002. Available at [http://www.nti.org/d_newswire/issues/2002/8/23/3s.html].

⁴⁰ Bunn and Wier, *Securing the Bomb*, p. xii, 47. See also Bunn and Wier, “Faster Pace Needed on Uranium Removal,” *Boston Globe*, September 23, 2003, available at [http://www.ksg.harvard.edu/news/opeds/2003/uranium_removal_092303.htm].

⁴¹ U.S. Department of Energy. “Remarks Prepared for Energy Secretary Spencer Abraham,” International Atomic Energy Agency, Vienna, May 26, 2004. Available at [http://www.energy.gov/engine/content.do?PUBLIC_ID=15949&BT_CODE=PR_SPEECHES&TT_CODE=PRESSPEECH].

⁴² DOE briefing, July 8, 2004.

⁴³ Regarding efforts to control these nuclear programs, see CRS Report RS21592, *Iran’s Nuclear Program: Recent Developments*, by Sharon Squassoni; CRS Issue Brief IB91141, *North Korea’s Nuclear Weapons Program*, by Larry Niksch; and CRS Report RL31589, *Nuclear Threat Reduction Measures for India and Pakistan*, by Sharon Squassoni.

⁴⁴ Department of Energy, *FY 2005 Congressional Budget Request*, Volume 1, p. 454. Regarding EXBS, see U.S. Department of State. “The EXBS Program: Export Control and
(continued...)

Container Security Initiative. CSI was started in January 2002 by the former U.S. Customs Service, now a part of CBP in the Department of Homeland Security (DHS).⁴⁵ Shipping containers account for 90 percent of all world cargo; nearly 9 million are offloaded in U.S. seaports annually. Terrorists might attempt to ship a nuclear weapon to a U.S. port in a container and detonate it before the container was inspected. Accordingly, CSI screens containers in overseas ports before they are loaded onto U.S.-bound ships. CSI was operational in 34 ports, with another 13 possible, both as of February 2005.⁴⁶ Participating ports have U.S. CBP agents who work with host country officers to decide which containers to target for inspection; host country officers inspect suspicious containers using non-intrusive inspection devices such as gamma-ray imaging machines or using physical inspection. A portion of DOE's SLD program, Mega-Ports, supports CSI by equipping some foreign seaports that are part of CSI with radiation detection equipment, and providing the necessary training, to "screen cargo for nuclear and radioactive materials that could be used in a weapon of mass destruction or a RDD (dirty bomb) ..." ⁴⁷

Proliferation Security Initiative. PSI began in May 2003; by August 2004, 16 nations had joined,⁴⁸ and in his February 2005 State of the Union Address, President Bush said, "We are cooperating with 60 governments" in PSI.⁴⁹ The participants seek to interdict sea or air shipments of WMD or WMD-related materials to or by states "of proliferation concern" trying to acquire or transfer such items. Shipments could be interdicted at ports, in territorial waters, on the high seas, or in national airspace. According to press reports, the first interdiction under PSI was of the German ship *BBC China* in October 2003; the seizure of its Libya-bound cargo,

⁴⁴ (...continued)

Related Border Security Assistance," available at [<http://www.state.gov/t/np/export/ecc/20779.htm>].

⁴⁵ For information on CSI, see U.S. Department of Homeland Security. Customs and Border Protection. "Container Security Initiative (CSI)." Available at [http://www.cbp.gov/xp/cgov/enforcement/international_activities/csi/]. See also CRS Report RL31733, *Port and Maritime Security: Background and Issues for Congress*, by Jonathan Medalia. For DHS organization, see CRS Report RS21366, *Department of Homeland Security: Organization Chart*, by Sharon Gressle.

⁴⁶ U.S. Department of Homeland Security. Customs and Border Protection. "Ports in CSI." [http://www.cbp.gov/xp/cgov/border_security/international_activities/csi/ports_in_csi.xml]. Accessed February 9, 2005.

⁴⁷ Department of Energy, *FY 2005 Congressional Budget Request*, Volume 1, p. 454.

⁴⁸ See CRS Report RS21881, "Proliferation Security Initiative (PSI)," by Sharon Squassoni; CRS Report RL32097, *Weapons of Mass Destruction Counterproliferation: Legal Issues for Ships and Aircraft*, by Jennifer Elsea; and U.S. White House. Office of the Press Secretary. "Proliferation Security Initiative: Statement of Interdiction Principles," September 4, 2003; available at [<http://www.state.gov/t/np/rls/fs/23764.htm>].

⁴⁹ President George W. Bush, State of the Union Address; transcript in *New York Times*, February 3, 2005, p. 18.

thousands of parts for special centrifuges of value for enriching uranium, may have been influential in convincing Libya to abandon its WMD programs.⁵⁰

U.S. Border Security. The final line of defense tries to keep terrorists from smuggling a nuclear weapon across U.S. borders. It involves border patrols, barriers, remote sensors, radiation monitors, Customs inspections, seaport security, and the like, generally within the purview of CBP. Yet as noted in “Weapon Delivery,” above, there are great difficulties in securing the many “points” through which people and goods may enter legally, and the thousands of miles of “lines,” thinly-guarded stretches of coasts and land borders across which entry is illegal. These difficulties illustrate the importance of the other defensive layers noted earlier in this section and show why it would be unwise to rely solely on border security.

Supporting Capabilities. Technology, intelligence, and forensics cut across and support the foregoing steps to keep terrorists or rogue states from acquiring and delivering a nuclear weapon.

Technology Development. The Homeland Security Act of 2002 (P.L. 107-296, Sec. 302) makes the DHS Under Secretary for Science and Technology responsible for “coordinating the Federal Government’s civilian efforts to identify and develop countermeasures to” terrorist WMD threats. DHS is charged with coordinating efforts by many agencies, including DOE’s National Nuclear Security Administration and the Department of Commerce’s National Institute of Standards and Technology, to develop technology for homeland security. DHS has proposed various technology programs and organizations for FY2005-FY2006.⁵¹ U.S. national laboratories (including the three nuclear weapons labs, Los Alamos, Livermore, and Sandia), U.S. and foreign corporations, universities, and others have been conducting R&D for new technologies to detect smuggling of nuclear materials and weapons. Detection of HEU and WGPU is difficult because, as noted, they are not highly radioactive.⁵² Various technologies are in use,⁵³ such as radiation portal monitors,

⁵⁰ Robin Wright, “Ship Incident May Have Swayed Libya,” *Washington Post*, January 1, 2004: 19.

⁵¹ For FY2005, see Dr. Charles McQueary, Under Secretary for Science and Technology, Department of Homeland Security, “Statement for the Record Before the U.S. House of Representatives, Subcommittee on Cybersecurity, Science, and Research & Development,” February 25, 2004. Available at [<http://hsc.house.gov/files/Testimony%20McQueary.doc>]. For FY2005 accomplishments and FY2006 plans, see U.S. Department of Homeland Security. *Homeland Security Budget-in-Brief, Fiscal Year 2006*, chapter, “Science and Technology Directorate,” p. 73-77. Available at [http://www.dhs.gov/interweb/assetlibrary/Budget_BIBFY06_2-7-05.pdf].

⁵² For further information on detecting clandestine nuclear weapons, see Roger Byrd et al., “Nuclear Detection to Prevent or Defeat Clandestine Nuclear Attack,” *IEEE Sensors*, in press as of February 2005; “Detecting Nuclear Materials in International Container Shipping: Criteria for Secure Systems,” Stanford Study Group, Center for International Security and Cooperation, Stanford University, c. 2003; and Gabriele Rennie, “Radiation Detection on the Front Lines,” *Science and Technology Review*, September 2004: 4-11.

⁵³ See David Bodenheimer, “Technology for Border Protection: Homeland Security Funding (continued...)”

which passively detect radiation emitted by a source,⁵⁴ and active imaging systems, like the Vehicle and Cargo Inspection System (VACIS), which operate like x-ray machines.⁵⁵ More advanced systems are being developed. For example, Livermore is developing a neutron-interrogation system to screen containers. It bombards a container with neutrons, producing nuclear fissions in such material as HEU and WGPU.⁵⁶ The fissions produce gamma rays with specific energy levels unique to each substance, permitting identification. Detecting illegal movement across U.S. borders, in contrast, does not require detecting fissile material; relevant technologies include surveillance sensors and data analysis software.⁵⁷

The FY2006 DHS budget includes the establishment of a new Domestic Nuclear Detection Office (DNDO) within DHS:

The DNDO will develop, acquire and support the deployment and improvement of a domestic system to detect and report attempts to import, assemble, or transport a nuclear explosive device, fissile material or radiological material intended for illicit use.⁵⁸

Intelligence. The possibility that terrorists could evade any of the layers described above necessitates an enhanced intelligence capability to complement other means of detecting movement of nuclear materials and warheads. Such a capability could also focus the efforts of particular defenses, whether alerting a Russian facility that a smuggling plan was in the works or indicating that a particular cargo container might hold a nuclear weapon. Improving and organizing intelligence for homeland security have been sharply debated.⁵⁹

Nuclear Forensics. The ability to glean information from nuclear weapon debris and other radioactive material lies at the intersection of technology and intelligence. During the Cold War, the United States obtained much information by

⁵³ (...continued)

and Priorities,” *Journal of Homeland Security*, August 2003, [<http://www.homelandsecurity.org/journal/articles/displayArticle.asp?article=95>].

⁵⁴ See U.S. Department of Homeland Security, Bureau of Customs and Border Protection, “Radiation Portal Monitors Safeguard America from Nuclear Devices and Radiological Materials,” at [http://www.cbp.gov/xp/cgov/enforcement/port_activities/rad_portal1.xml].

⁵⁵ See Science Applications International Corporation, “Mobile VACIS Inspection System,” at [<http://www.saic.com/products/security/mobile-vacis/>].

⁵⁶ “Screening Cargo Containers to Remove a Terrorist Threat,” *Science and Technology Review*, May 2004: 12-15, at [http://www.llnl.gov/str/May04/pdfs/05_04.2.pdf].

⁵⁷ See also CRS Report RS21270, *Homeland Security and Combating Terrorism Research and Development: Funding, Organization, and Oversight*, by Genevieve Knezo, and CRS Report RL31914, *Research and Development in the Department of Homeland Security*, by Daniel Morgan.

⁵⁸ U.S. Department of Homeland Security. “Fact Sheet: U.S. Department of Homeland Security FY 2006 Budget Request Includes Seven Percent Increase.” February 7, 2005.

⁵⁹ See CRS Report RL31292, *Intelligence to Counter Terrorism: Issues for Congress*, and CRS Report RS21283, *Homeland Security: Intelligence Support*, both by Richard Best.

analyzing fallout from Soviet nuclear weapon tests. For example, analysis confirmed that the Soviet Union had conducted its first atomic bomb test, and analysis of fallout from the first Soviet hydrogen bomb test revealed many details about that weapon's design.⁶⁰ Even minute samples are of value.⁶¹ With the current moratorium on nuclear testing, forensic studies are applied to verifying the safety of U.S. nuclear warheads, detecting signs of nuclear proliferation, and thwarting illicit trafficking of nuclear materials.⁶² In the event of a terrorist nuclear attack, forensics might be able to identify the nation that originated the fissile material or weapon, and determine whether terrorists had fabricated the weapon on their own or obtained it from a nation's stockpile. This information would aid efforts to prevent further leakage. The ability to attribute a weapon or material to a nation might also deter a nation from providing such items to terrorists by holding the prospect of a military response. Further, if a terrorist nuclear weapon were found, forensic analysis could contribute to an understanding of the weapon's design, which could help determine whether it could be moved and how best to disable it.

Other issues that bear on nuclear terrorism include missile defense, export controls, and nuclear nonproliferation efforts more generally. Many organizations and other groups are involved, such as the U.N., the International Atomic Energy Agency, and the Group of Eight.⁶³

Options and Implications for U.S. Policy

In combating nuclear terrorism, the standard for success for the United States is daunting — zero nuclear detonations, which may require stopping every terrorist or rogue state attempt to acquire and deliver a nuclear weapon — while a single nuclear detonation in the United States would constitute a terrorist success. Measured against that binary standard, it is impossible to determine the extent to which, or even if, the initiatives discussed above have increased U.S. security.

⁶⁰ Richard Rhodes, *Dark Sun: The Making of the Hydrogen Bomb*, New York, Simon and Schuster, 1995, p. 372, 525.

⁶¹ Lawrence Livermore National Laboratory. Chemistry and Materials Science. Forensic Sciences. "Forensic Science Sleuthing." Available at [http://www-cms.llnl.gov/s-t/forensic_str.html] on September 10, 2004.

⁶² Regarding these applications, see Lawrence Livermore National Laboratory, "Forensic Science Sleuthing"; "Forensic Science Center," *Energy and Technology Review* [a publication of Lawrence Livermore National Laboratory], March 1994, p. 2 and European Commission, Joint Research Centre, "Developing Nuclear Forensic Science," *JRC in Action*, April 2002, [http://www/jrc.cec.eu.int/more_information/jrc-in-action/issue01/feature.htm]; respectively.

⁶³ For discussions of the topics in this paragraph, see CRS Report RL31111, *Missile Defense: The Current Debate*, by Steven Hildreth; "The Role of Export Controls," by Ian Fergusson, in the CRS Terrorism Electronic Briefing Book; CRS Issue Brief IB10091, *Nuclear Nonproliferation Issues*, by Carl Behrens; and CRS Report RL31559, *Proliferation Control Regimes: Background and Status*, by Sharon Squassoni, Steven Bowman, and Carl Behrens.

Nonetheless, studies have shown many potential weaknesses in U.S. ability to thwart nuclear terrorism. The main response of policymakers has been to strengthen, consolidate, coordinate, or initiate a wide array of programs. A Government Accountability Office report, for example, notes a number of recommendations that it and congressionally chartered commissions have made for defending against catastrophic threats.⁶⁴ Categories of recommendations include

- “Enhanced or clarified federal or state authority to manage a terrorist incident involving Weapons of Mass Destruction”
- “Improvements to incident planning, management, and response capabilities for dealing with a WMD terrorist incident”
- “Better management and more resources for research and development of technologies to prevent or respond to terrorist WMD incidents” and
- “Laws, cooperative agreements, and regulatory regimes to better control the precursors to WMD.”

A report by the House Policy Committee makes a number of recommendations for addressing nuclear proliferation, including:

- “Strengthen international regimes and controls to limit the legal spread of proliferation-enabling technology.”
- “Expand flexible, responsive multilateral activities to find, disrupt, and eliminate networks and trafficking.”
- “Engage multi- and bi-lateral initiatives to quickly secure materials and keep expertise off the market.”
- “Assure the credibility of consequences, as well as advantages of positive behavior.”
- “Advance technical and analytic tools and improve human assets to detect proliferation activities, networks and materials.”⁶⁵

Specific policy options available to counter nuclear terrorism include (1) accelerate the safeguarding of Russian fissile materials; (2) broaden that effort to a global cleanout of HEU, such as at research reactors; (3) expand CSI to more ports; (4) strengthen the Coast Guard, such as through its Integrated Deepwater Systems

⁶⁴ U.S. Government Accountability Office, *Homeland Security: Selected Recommendations from Congressionally Chartered Commissions and GAO*, GAO-04-591, March 2004, p. 15-16. Available at [<http://www.gao.gov/new.items/d04591.pdf>].

⁶⁵ U.S. Congress. House. House Policy Committee. Subcommittee on National Security and Foreign Affairs, Representative Heather Wilson, Chair. *All Tools at Our Disposal: Addressing Nuclear Proliferation in a Post-9/11 World*, January 2005, p. 5.

program, which would, among other things, improve its ability to conduct interdictions for PSI;⁶⁶ and (5) strengthen capabilities to detect and disable terrorist nuclear devices, such as Nuclear Incident Response Teams of DOE and the Environmental Protection Agency. Two books released in the summer of 2004 discuss policy options in detail.⁶⁷

Role of Congress

Congress funds programs to counter nuclear terrorism through several authorization and appropriations bills. The annual National Defense Authorization Act and Department of Defense Appropriations Act fund DOD Cooperative Threat Reduction programs; the annual National Defense Authorization Act and Energy and Water Development Appropriations Act fund DOE Defense Nuclear Nonproliferation and nuclear weapons programs. Regarding funding for DHS, bill referral patterns for authorizations may shift based on the changed jurisdictions of the new Homeland Security Committees and other related committees, and the subcommittee structures to handle DHS appropriations are in flux, both as of early February 2005. Other agencies, funded by other bills, also conduct R&D. The FY2006 requests for Cooperative Threat Reduction, Defense Nuclear Nonproliferation, and DHS Directorate of Science and Technology (S&T) are \$415.5 million, \$1,637.2 million, and \$1,368.4 million, respectively. (Much of DHS S&T is for programs in threat areas other than nuclear.) Congress also holds oversight hearings, establishes specific legislative requirements and restrictions on programs, and calls public attention to these issues.

Other bills introduced in the 109th Congress that bear on nuclear terrorism include the following. All entries show the latest major action as of February 10, 2005.

H.R. 173 (Millender-McDonald). Anti-Terrorism and Port Security Act of 2005. To prevent and respond to terrorism and crime at or through ports. Introduced January 4, 2005, and referred to the Committees on the Judiciary, Transportation and Infrastructure, Ways and Means, and Homeland Security.

H.R. 282 (Ros-Lehtinen). Iran Freedom Support Act. To hold the current regime in Iran accountable for its threatening behavior and to support a transition to democracy in Iran. Would codify sanctions related to WMD. Introduced January 6, 2005, and referred to the House Committee on International Relations.

H.R. 422 (Tauscher). 9-11 Commission Combating Proliferation Implementation Act. Would, among other provisions, establish an office for combating the

⁶⁶ See U.S. Department of Homeland Security, Coast Guard, "Integrated Deepwater System." Available at [<http://www.uscg.mil/hq/g-a/deepwater/default.htm>] and CRS Report RS21019, *Coast Guard Deepwater Program: Background and Issues for Congress*, by Ronald O'Rourke.

⁶⁷ Ferguson et al., *The Four Faces of Nuclear Terrorism*; and Graham Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, New York, Times Books, 2004.

proliferation of WMD, request that Russia form a similar office, authorize \$100 million a year for accelerating the removal or securing of fissile and radiological material (pursuant to P.L. 108-375, Ronald W. Reagan National Defense Authorization Act for FY2005, Section 3132), and authorize funds for Cooperative Threat Reduction programs. Introduced January 26, 2005, and referred to the House Committee on International Relations.

S. 3 (Gregg) Protecting America in the War on Terror Act of 2005. Among other provisions, criminalizes the transport by vessel of radioactive or nuclear material. Introduced January 24, 2005, and referred to the Senate Committee on Finance.

S. 21 (Collins) Homeland Security Grant Enhancement Act of 2005. Among other provisions, would bar any commercial motor vehicle carrying municipal solid waste from entering the United States until Customs and Border Protection can screen such waste for radiological and nuclear weapons. Introduced January 25, 2005, and referred to the Senate Committee on Homeland Security and Governmental Affairs