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Integrating Prevention with Detection and Response

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Progressive Ideas for a Strong, Just, and Free America

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Among the unconventional weapons that a terrorist could use to attack the United States, a radiological weapon, or "dirty bomb," is the most likely. The materials needed to build a bomb are relatively common and the required technical skills are minor, compared to other unconventional weapons. Perhaps most critically, evidence found in Afghanistan demonstrates terrorists' intent to build a radiological weapon.

Reasonably sophisticated terrorists have a number of options for acquiring the necessary materials. They could procure the materials from one of thousands of locations in the United States. They could also acquire materials from overseas and smuggle them into the United States. A successful attack could sever the arteries of our global economy, render entire city blocks virtually uninhabitable for decades, and cause widespread panic.

Despite the clear threat, the Bush administration has not given the issue high enough priority. Major gaps remain in efforts to control devices that house radiological materials, known as "radiological sources." There is no domestic mechanism for reliably tracking the location and condition of all radiological sources, and the situation is often worse in other countries. Efforts to identify and intercept illicit shipments need better coordination and more resources. The United States lacks the capacity to effectively respond to an attack.

The United States must develop and implement a layered, risk-based strategy to defend against the threat posed by radiological weapons. The strategy must:

- Secure the entire life-cycle of new and existing radioactive sources by acting to strengthen licensing requirements; develop a mechanism to track down and catalogue all sources; and refine incentives for safely and securely disposing of unwanted sources.

- Develop more effective measures to detect and intercept illicit shipments of materials from overseas by improving radiation detection technology.

- Implement an emergency response plan that includes measures to facilitate continuity of economic operations; a medical surge capacity for treating radiation wounds; and a plan for educating the public about radiation and radiological weapons.

The Radiological Weapons Threat

So-called "dirty bombs" are made by packing conventional explosives around radioactive materials. When detonated, the explosion disperses radioactive material into the environment. A dirty bomb is not a nuclear weapon and cannot be equated to the catastrophic effects of one.

Nevertheless, a radiological weapon has the potential to massively disrupt society by contaminating economic infrastructure, causing panic, and exposing people to elevated levels of radiation. The most likely targets are densely populated urban areas or vital economic infrastructure, such as ports.

The amount of damage that a radiological weapon can cause varies widely, depending on the type of radioactive material used and local environmental factors such as wind and geography. A bomb made with weak or virtually harmless materials could cause little to no direct harm to people or the environment beyond the force of the conventional explosion. The bomb could, however, exploit the public's fear of radiation and induce wider panic, causing significant psychological trauma and putting enormous stress on the emergency response. Thus, a weapon made with less potent or even relatively harmless radioactive materials could still have a major financial and psychological impact.

A bomb made with the most radioactive materials would be very difficult to construct, but could be devastating. For instance, a radiological weapon made with a foot-long, one inch diameter rod of cobalt-60 detonated at the lower tip of Manhattan would render most of the borough virtually uninhabitable for decades and raise the risk of dying from cancer from one person in five hundred to one per one hundred.[1] The attacks on the World Trade Center cost New York City an estimated $82.8-$94.8 billion gross city product loss over four years.[2] In addition to destroying buildings in the vicinity, the attacks also shut down most financial activities in lower Manhattan for several days. A

Riskiest Materials for a Radiological Weapon

There at least eight powerful radioactive elements that pose the most serious threat, if sufficient quantity were used. These elements can be found in factories, hospitals, or abandoned in locations around the world. What makes these elements especially risky is their combination of radioactivity and relative prevalence.[i]

Element	Examples of common industrial uses[ii]
Americium-241	To detect petroleum deposits and calibrate instruments, and in industrial gauges.
Californium-252	To detect petroleum deposits.
Cesium-137	Used in industrial gauges and to treat diseases, sterilize food and medical equipment, detect petroleum deposits, and in industrial gauges.
Cobalt-60	Used in industrial gauges and to treat diseases, sterilize food and medical equipment, and detect hidden flaws in structures.
Iridium-192	To detect hidden flaws in structures and treat diseases.
Plutonium-238	To generate low-levels of power
Radium-226	Used in industrial gauges and to produce radon for cancer treatment.
Strontium-90	To generate low-levels of power

[i] Charles D. Ferguson & William C. Potter (with Amy Sands, Leonard S. Spector, and Fred L. Wehling), *The Four Faces of Nuclear Terrorism* (2005), p.8.

[ii] IAEA, Categorization of Radioactive Sources, IAEA TECDOC-1344 (July 2003), *available at* http://hps.org/documents/IAEATecDoc1344.pdf.

radiological attack that effectively shuts down most of Manhattan for weeks, months, or even years would likely increase the damage by several orders of magnitude.

Ports are an especially vulnerable target. The Center for Homeland Security and Defense estimates that a terrorist attack on major U.S. ports could result in losses of $1.5-2.7 billion per day for the first several days, $5 billion a day for the next two weeks, and then the rise exponentially after that. The Center estimates that after 45 days—a plausible amount of time for a port to be shut down after a well-executed radiological attack—"the U.S. economy would collapse into an unprecedented depression due to a severe energy crisis, widespread shortages and rampant price gouging by the energy industry."[3] The damage could reach into the trillions of dollars.

The greatest challenge to guarding against a radiological attack is the sheer prevalence of radioactive sources throughout the world, which makes securing them difficult, combined with the relative ease of building a dirty bomb once radiological materials are acquired.

Both these factors distinguish radiological weapons from other unconventional weapons, such as nuclear and biological weapons. Potential radiological weapons materials exist in hundreds of thousands of locations worldwide. By contrast, the fissile materials needed to make nuclear weapons and the weaponized pathogens required for catastrophic bioweapons are much rarer and far more concentrated geographically. Building one of these weapons also requires considerable technical skills.

Radiological weapons are different. There are an estimated ten million radioactive sources in existence around the world, with several hundred thousand radioactive enough to pose a potential threat. These sources are used to help keep food safe, treat diseases like cancer, and detect flaws in metal parts and welds. In industrialized countries, the most radioactive sources tend to be well-guarded. In less developed nations, however, security is uneven.

After radiological materials are acquired, it takes comparatively little specialized knowledge or skill to build a crude radiological weapon, beyond an understanding of how to build conventional bombs and skills in handling radioactive materials. A radiological weapon made with comparatively weak radiological materials would be easier to assemble than a device using powerful materials, but still be disruptive by exploiting public fear of radiation and rousing a disproportional emergency response.

Building a device with stronger materials capable of causing enormous damage would be much more difficult. Many of these materials are so radioactive that handling them without the protection of extensive shielding could result in death within minutes of exposure. These materials also tend to be more valuable, and therefore relatively well-protected. Finally, they are so radioactive that there is some chance that existing radiation detection technology could detect attempted shipments of them. These risks and challenges, however, would be acceptable to sophisticated terrorists willing to give their lives in order to carry out a devastating attack.

Control of Radioactive Sources Falling Short

Today, there is no effective mechanism in the United States, at either the federal or state level, for tracking throughout their lifecycle the number and location of the estimated two million radioactive sources in the United States.[4]

The Nuclear Regulatory Commission (NRC) has regulatory authority over radiological sources in the United States. At the request of 33 states – so-called "agreement states" – the NRC has delegated its regulatory authority to them. It retains authority over sources in the remaining seventeen states. The NRC stopped tracking sources by serial number more than twenty years ago and has had a difficult time locating the majority of those licensed to use radiological sources, known as "general licensees."[5] A Government Accountability Office (GAO) study found serious gaps in agreement states' regulatory practices—almost one-half were unable to identify the number of radioactive sources in their jurisdictions.[6]

In July 2005, the NRC announced plans to implement a National Source Tracking System to track potentially dangerous materials, though it is unclear how quickly it will be implemented.[7]

Not surprisingly, lost and stolen radioactive sources pose a major problem. As many as one radioactive source is "orphaned" in the United States every day because legitimate disposal options are limited and physical security is uneven.[8] The U.S. Off-Site Source Recovery Project, run by the National Nuclear Security Administration (NNSA), has made major progress in tracking down orphan or unwanted sources in the United States, collecting more than 10,000 since 1997.[9] Experts at NNSA estimate that this represents more than two-thirds of the sources believed to be at risk through 2010, and are confident that the remaining sources can be secured within 2-5 years.[10] The sources are safely and securely stored at DOE facilities, which have plenty of space to store these sources.[11]

Since 9/11, the NRC has taken some action to increase physical security for radioactive sources, focusing primarily on mandating additional security at facilities where food and medical equipment are irradiated against microbial contamination. These are positive steps, although in addition to being relatively well-guarded, the intense radioactivity of these sources offers some inherent security against theft, since the materials are difficult to transport and dangerous to handle.

Spent fuel from a nuclear reactor would make an enormously powerful dirty bomb. This fuel, however, is so radioactive that terrorists would find it virtually impossible to remove from storage and handle before being overcome by radiation. On the other hand, a recent study by the National Research Council could not rule out the contingency of a terrorist breaching security and draining the spent fuel ponds that store these materials, which could ignite a fire that disperses radioactive material into the environment.

Physical security measures for other sources vary widely. The security of sources in hospitals and those used by industrial radiographers have been identified by the GAO as particularly worrisome.[12] These sources are often portable, making them particularly vulnerable to theft.

Finally, the NRC and many states lack adequate measures for rigorously enforcing existing security standards. The NRC and many states, for example, do not carry out inspections before licenses are granted for sophisticated devices that require skill to use safely and securely – devices for which specific license is required – and they wait up to a year after licensing a user to carry out an inspection of the user's facility. In practical terms, this gives users a full year to use or transfer the source before authorities discover any illicit activity.

Thousands of potentially dangerous materials also exist in other countries, and more than one-half of all countries lack even minimum regulatory safeguards for these materials.[13] Terrorists could travel to countries where rules against illicit transfers are weakest, acquire the necessary radioactive materials, and then use commercial shipping channels to transport the materials to the United States.

The "orphan source" problem reaches well beyond the United States. There are believed to be thousands of orphaned sources in the former the Soviet Union, many of them dumped by the Russian Army as it withdrew its forces from the Newly Independent States. These sources often employed some of the most potent radioactive materials, and pose an especially severe risk. For example, during the Cold War the Soviet Union conducted a secret research project known as Gamma Kolos that sought to understand the effects of radioactive fallout from nuclear war on plant growth and crop yields. To replicate the effects of nuclear fallout, it built hundreds of compact, transportable devices designed to disperse intense radiation onto crop fields. Each device contains enough cesium-137—a talc-like substance—to contaminate an entire city. After the experiment ended, the devices were abandoned in Soviet republics such as Georgia and Moldova. Only a handful has been recovered so far.

Two Types of Licenses

There are two categories of licenses to procure and use radioactive sources: general licenses and specific licenses.

General licenses typically apply to sealed radioactive sources that are surrounded by shielding to contain radioactivity and are considered safe for use by those with no specialized expertise. General licensees comprise the largest category of legitimate users of radioactive sources, with an estimated 40,000 general licensees owning approximately 600,000 devices.[i] The NRC automatically grants such licenses. The licensee commits to certain safety, security, and self-reporting standards, while manufacturers of the device must submit quarterly sales reports to the NRC.[ii]

A **specific license** is available to users that want to operate a device in a manner that does not qualify for a general license, but who demonstrate their compliance with the rules on safety and security in an application to the NRC or relevant state regulatory agency. There are approximately 20,000 specific licensees in the United States.[iii]

[i] GAO, U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening, p.15.

[ii] *See* 10 C.F.R. Section 31.5.

[iii] GAO, U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening, p.10.

A global approach is vital to protecting the American people. But these efforts are just getting off the ground, and have not yet fulfilled their promise. At the 2003 G8 meeting in Evian, France, leaders agreed to an Action Plan on Securing Radioactive Sources that called for stronger measures to prevent potentially dangerous sources from falling into the wrong hands.[14] Leaders agreed to support global implementation of the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources, which identifies minimum standards for regulating radioactive sources.[15] One year later,

at the Sea Island meeting, they agreed to limit the export of sources to legitimate end-users in states that have an adequate capacity to regulate them by the end 2005, as called for by the Code. Adherence to the Code is voluntary, however, and as noted earlier, most countries lack the regulatory capacity to implement them.
The United States has spearheaded promising joint efforts with the Russian Federation and the International Atomic Energy Agency (IAEA) to track down and secure former Soviet orphan materials. This effort, known as the Tripartite Initiative, is a significant contribution to security against the radiological threat. At the 2003 G8 Summit, leaders called on countries to locate and secure orphan sources in their territory—but failed to identify concrete measures that would enable countries with marginal regulatory capacity to take on this difficult task.

There have been positive developments in efforts to improve controls over the import and export of radioactive sources. Effective December 31, the United States will require "specific licenses" for importing and exporting high-risk radiological sources. The Congressional Energy Conference Committee has reportedly approved provisions in the energy bill that would further strengthen oversight over the domestic and international sale of radiological sources, but as of this writing the Committee has not yet reported a final bill.[16]

Weaknesses in Efforts to Intercept Illicit Shipments

Due to the volume of potential radiological weapons materials in the world coupled with the minimal expertise required to build a bomb, a layered strategy must include measures to identify and intercept illicit shipments of these materials.

The IAEA has confirmed more than 300 examples of illicit trafficking in radioactive materials since 1993. For example, in May 2004 Ukrainian authorities seized two 190-pound containers containing an unspecified quantity of cesium-137. The containers were destined for sale on the nuclear black market. This highly radioactive element was among the deadliest substances dispersed by Chernobyl's meltdown in 1986, and is also a component of fallout from nuclear weapons explosions.

The most likely route for a terrorist to smuggle a high-risk source into the United States is via a container through one of our ports. An American port is also a potential target of an attack, due to the enormously disruptive effects an attack could have on our economy.

While port security is better today than it was before 9/11, it is still weak. The Department of Homeland Security (DHS) has installed more than 470 radiation portal monitors at key transit points in and around the United States, at a cost of $300 million.[17] But these monitors are typically not sensitive enough to detect radiological materials that have been shielded in lead or other metal.[18] Increasing the effectiveness of radiation detection technology is not simply a matter of making equipment more sensitive; the equipment must also be capable of discriminating between normal background radiation and the radiation given off by potential radiological weapons components. It must also do so quickly in order to avoid costly delays.

Efforts to improve the performance of the monitors have been hampered by unproductive competition and poor coordination between DHS and technical experts at the Department of Energy (DOE).[19] The Bush administration has just begun to take action to remedy these defects. In April 2005, it announced the creation of a Domestic Nuclear Detection Office at DHS to coordinate efforts to develop and deploy radiation monitors. In June 2005, DHS and DOE broke ground on a joint "Radiological/Nuclear Countermeasures Test and Evaluation Complex" to develop better plans and technologies for detecting and intercepting illicit shipments of radiological materials.

The U.S. is also working to strengthen global capacity to detect illicit shipments by installing radiation detectors at key ports and other transit points around the world. Congress has appropriated approximately $500 million for the Departments of Energy, Defense and State for these efforts from FY 1994 through FY 2005.[20] Many of these programs, however—including the Department of Defense's International Counterproliferation Program and DOE's Megaports Initiative—have been hampered by insufficient staffing, incomplete global participation, and weak coordination among national customs services.[21] The Bush administration only recently developed a coordinated strategy to improve global capacity to detect illicit shipments of radiation.[22]

Insufficient Domestic Preparedness

The United States needs a reliable national emergency response system that integrates federal, state and local capabilities, provides clear policy guidance, and matches resources to responsibilities.

The United States has a National Response Plan that includes specific guidance on federal responsibilities for a radiological incident.[23] But agencies do not necessarily have the capacity to effectively implement their responsibilities. For instance, the United States does not have an adequate supply of certain drugs—such as DTPA and Prussian Blue—that may be crucial to help treat or mitigate the effects of certain kinds of radiation exposure in the event of a large-scale attack.[24] The Environmental Protection Agency, the Nuclear Regulatory Commission and the Department of Energy all have expertise and equipment for scrubbing contaminated areas, but none have the capability to clean-up a potentially large amount of territory quickly.

There are other shortcomings in emergency preparedness. Federal decontamination rules are based on unrealistic assumptions and could inflate clean-up costs, hinder continuity of economic operations, and feed panic over the attack.[25] Insurance companies will not cover damage from radiation in their policies. Thus, unlike the 9/11 attacks, there is no insurance available to cushion the blow of an attack.[26]

A Strategy for Reducing the Threat of Radiological Terrorism

A strategy to minimize the radiological threat must integrate prevention with detection and response. First, the United States must dramatically improve security at each point in the lifecycle of a radioactive source, from its initial purchase, through its service life, and finally to its safe and secure disposal. Second, the United States must enhance and expand on our limited capacity to reliably detect and intercept illicit shipments of radiological materials. Finally, the United States must develop a strong capability for rapidly responding to a radiological attack.

The United States must implement a layered, risk-based strategy that directs resources to where they are likely to have the greatest impact. Securing the most dangerous materials wherever they exist and promoting more effective control over them should be the highest priority, since these materials have the potential to cause the greatest damage. Vital economic infrastructure—especially ports and other key transit routes—should be outfitted with the means to detect attempted shipments of these materials. To respond effectively to an attack of any magnitude, the United States should take steps now to eliminate or reduce conditions that would needlessly amplify the costs of an attack, and develop measures to contain the damage.
These efforts should build upon the International Atomic Energy Agency's Code of Conduct on the Safety and Security of Radioactive Sources.

Protect Radiological Sources Throughout Their Lifecycle

- **Strengthen regulatory oversight of radioactive sources using a risk-based approach.** Consistent with the IAEA Code of Conduct on the Safety and Security of Radioactive Sources, the Bush administration should develop or propose to Congress new licensing, inspection and enforcement measures to mitigate the risk of radiological attacks. The measures should include a national mechanism for tracking the location and owner of a source from its initial sale to any subsequent transfers to its final disposal. Requests for specific licenses should only be granted after the NRC (or appropriate authorities in so-called "agreement states") inspects the site where the source will be housed. A new interagency Task Force on radiation source protection chaired by the NRC should coordinate interagency efforts and work with relevant nuclear control authorities to assess whether the current balance of responsibilities between agreement states and the federal government for regulating radiological sources is appropriate in light of the threat.

- **Fully implement the National Research Council's recommendations on spent fuel security.** The recommendations would severely restrict terrorists' already limited capacity to use spent fuel ponds as a radiological weapon.[27]

- **Develop tighter controls on the export of radiological sources.** The United States should work with other leading exporters of high-risk sources to achieve universal adoption of this practice. Fewer than ten countries produce most high-risk sources, so export controls and effective licensing requirements by the exporting country would cover a large proportion of global commerce in radiological materials and greatly reduce the chances that high-risk radiological devices fall into the wrong hands. Limited exceptions to this requirement should be granted on an *ad hoc* basis for vital medical equipment, but alternative arrangements for ensuring the safety and security of the source must be made.

- **Strengthen cooperation among domestic regulatory authorities.** Working with the IAEA, the United States should strengthen information-sharing and cooperation among relevant regulatory authorities around the world to further ensure that radiological sources are only exported to legitimate end users. The United States should also work with the IAEA and other countries to develop a mechanism for sharing information about orphan sources and enable radiation control offices to confirm with their foreign counterparts that a prospective user meets all regulatory requirements.

- **Help countries that have vulnerable sources implement the IAEA Code of Conduct.** The Code of Conduct should become the global standard on the safety and security of radiological sources, as called for by the United States and other G8 countries in the 2004 Action Plan on Nonproliferation. The United States should continue to support the U.S.-IAEA Radiological Security Partnership, which has helped nearly forty countries improve security over potentially dangerous radioactive materials since its launch in March 2003.[28] The G8 and other donor countries should institute mechanisms to address regulatory vulnerabilities in countries that are not members of the IAEA.

- **Track down and secure orphan sources at home and abroad, focusing on the former Soviet Union.** The United States should fully support joint U.S.-Russian-IAEA efforts under the Tripartite Initiative. To facilitate the identification and recovery of sources around the world, the United States should also work with the IAEA and other countries to launch an international effort modeled on the U.S. Off-Site Source Recovery Project that addresses sources in countries that lack the capacity to safely and securely dispose of them. It is the responsibility of the country with possession of a scaled radiological source to dispose of it. In the event that no such option is available, however, the United States should work with the IAEA and other countries to take the sources they exported back and properly dispose of them.

- **Ensure safe and secure disposal of radioactive sources.** The Department of Energy should refine and enforce incentives and disincentives for users to safely and securely dispose of sources. At a minimum, it should actively publicize the Off-Site Recovery Project, and offer incentives to use the service.

- **Research and develop safer alternatives to current industrial uses of radioactive sources.** The Congress should request that the National Academy of Sciences prepare an assessment of current industrial uses of radioactive sources, focusing particularly on the most dangerous ones, to identify uses for which safer alternatives can be developed.

Enhance Ability to Detect Illicit Shipments

- **Adopt a risk-based approach to port security that makes detecting radiation a priority.** Efforts to improve security should be based on the actual threat and likely consequences of an attack, and not according to universal requirements that may be too weak or stringent for a particular facility.[29]

- **Speed and expand research, development, and deployment of radiation detectors.** The Congress should grant the administration's request for $227 million in FY 2006 to launch the Domestic Nuclear Detection Office (DNDO) at the Department of Homeland Security. The office is described as "a single accountable organization with dedicated responsibilities to develop the global nuclear detection architecture, and acquire, and support the deployment of the domestic detection system to detect and report attempts to import or transport a nuclear device or fissile or radiological material intended for illicit use."[30] Training personnel in the proper use of equipment should be a high priority of DNDO.

- **Fully integrate radiological proliferation into the Proliferation Security Initiative.** The Proliferation Security Initiative was launched in May 2003 in order to strengthen international cooperation to halt illicit shipments of weapons and materials of mass destruction, and the means for delivering them. Identifying and intercepting illicit shipments of radioactive materials for use in radiological weapons should be one of the Initiative's priorities.

Strengthen Emergency Preparedness

- **Ensure that radiological incident response is fully integrated into a national emergency response strategy.** The plan should identify clear policy goals and enable local emergency response personnel to rapidly acquire assistance from federal authorities.

- **Ensure an adequate stockpile of anti-radiation drugs.** The United States should have a large enough stockpile to treat at least 10,000 victims of a radiological attack for a minimum of one month. The stockpiles should be deployed in a manner ensuring that medicine is available to high-risk locales on 2-4 hours of notice.[31]

- **Develop measures to minimize economic disruption following an attack.** Since a dirty bomb is primarily an economic and psychological weapon, a national emergency response plan should make continuity of economic activity a central goal. Key measures include developing and deploying advanced clean-up technology and rationalizing clean-up standards to avoid unnecessary costs.[32] In addition, the United States should condition renewal of the Terrorism Risk Insurance Act—set to expire at midnight on December 31, 2005—on the insurance industry offering coverage for radiological terrorism.

- **Educate the public about the realities and myths of radiation and radiological weapons.** DHS should develop credible, targeted education campaigns in areas at particularly high risk for attack and host briefings for the media on the consequences of an attack. The emergency response plan should communicate the risks and realities of an attack in a clear, concise manner.

Endnotes

[1] Michael Levi and Henry Kelly, Dirty Bombs Continued, FAS Public Interest Report, Vol. 55 (May 2002), *available at* http://www.fas.org/faspir/2002/v55n2/dirtybomb.htm. The baseline cancer estimate comes from the National Cancer Institute, *Table I-4: Age-Adjusted SEER Incidence and U.S. Death Rates and 5-Year Relative Survival Rates*, SEER Cancer Statistics Review 1975-2002, *available at* http://seer.cancer.gov/cgi-bin/csr/1975_2002/search.pl#results.

[2] *See* Gail Makinen, The Economic Effects of 9/11: A Retrospective Assessment, Congressional Research Service RL31617, Sept. 27, 2002, citing New York City Comptroller, *Trade Center Attack Could Cost City Economy More Than $100 Billion Over 2 Years: City Will Need Additional Federal Aid To Recover*, press release (Oct. 4, 2001).

[3] Joseph F. Bouchard, New Strategies to Protect America: Safer Ports for a More Secure Economy, Center for American Progress Critical Infrastructure Protection Series (Spring 2005), pp.3-4, *available at* http://www.americanprogress.org/atf/cf/{E9245FE4-9A2B-43C7-A521-5D6FF2E06E03}/port_security.pdf.

[4] Government Accountability Office (GAO), U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening, GAO-03-638 (August 2003), p.9.

[5] Statement of Jim Wells, Director, Natural Resources and Environment, Challenges Facing NRC in Effectively Carrying Out Its Mission, Testimony Before the Subcommittee on Clean Air, Climate Change, and Nuclear Safety, Committee on Environment and Public Works, U.S. Senate, GAO-05-754T (May 26, 2005), p.5.

[6] Ibid.

[7] A day before the NRC announced its plans, Congressman Markey (D-MA) announced that the Congressional Energy Conference Committee approved provisions in the pending energy bill mandating the creation of such a system within one year of the bill's enactment.

[8] *See* R.A. Meserve, Chairman, Nuclear Regulatory Commission, Effective Regulatory Control of Radioactive Sources, in *National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials*, proceedings of IAEA International Conference held in Buenos Aires, Argentina, December 11-15, 2000, p.11, cited in Charles D. Ferguson, Tahseen Kazi & Judith Perera, *Commercial Radioactive Sources: Surveying the Security Risks*, Center for Nonproliferation Studies Occasional Papers, #11 (2003), p.17.

[9] *See* http://osrp.lanl.gov.

[10] Author conversation with NNSA officials.

[11] Ibid.

[12] GAO, U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening, p.21.

[13] Ibid, p.3 (quoting IAEA estimate).

[14] Nonproliferation of Weapons of Mass Destruction: Securing Radioactive Sources: A G8 Action Plan (June 2003), *available at* http://www.fco.gov.uk/Files/kfile/Art%2007%20radioAction-.pdf.

[15] The Code defines a set of minimum standards that all countries should adopt to ensure the safety and security of radiological sources under their control. According to the Code, all states should develop and implement an "effective national legislative and regulatory system of control over the management and protection of radioactive sources." This should include effective licensing procedures, including for exported sources, and a mechanism for tracking the location of the highest-risk sources. The Code does not define specific legislation or regulatory practices; individual countries are to promulgate rules according to their specific national requirements. Countries can request assistance in this endeavor from the IAEA's International Nuclear Security Advisory Service.

[16] Press Release, Office of Representative Ed Markey (D-MA), Energy Conference Committee Adopts Markey Measure to Protect Nuclear Facilities and Secure Dirty Bomb Materials, July 19, 2005, *available at* http://www.house.gov/markey/Issues/iss_energy_pr050719.pdf.

[17] Gene Aloise, GAO, Combating Nuclear Smuggling: Efforts to Deploy Radiological Detection Equipment in the United States and Other Countries, GAO-05-84OT (June 21, 2005).

[18] Ibid, p.3.

[19] Ibid, p.3.

[20] Ibid, p.2.

[21] *See* Flynn; Aloise; GAO, Preventing Nuclear Smuggling: DOE Has Made Limited Progress in Installing Radiation Detection Equipment at Highest Priority Foreign Seaports, GAO-05-375 (March 31, 2005), Customs Service: Acquisition and Deployment of Radiation Detection Equipment, GAO-03-235T (October 17, 2002), Nuclear Nonproliferation: U.S. Efforts to Help Other Countries Combat Nuclear Smuggling Need Strengthened Coordination and Planning, GAO-02-426 (May 16, 2002).

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[23] Department of Homeland Security, National Response Plan (December 2004), *available at* www.dhs.gov/interweb/assetlibrary/NRP_FullText.pdf.

[24] *See* Report of the Medical Preparedness and Response Sub-Group, Department of Homeland Security Working Group on Radiological Dispersal Device (RDD)Preparedness (December 2003), p.59; 66, *available at* http://www1.va.gov/emshg/docs/Radiological_Medical_Countermeasures_Indexed-Final.pdf.

[25] Peter D. Zimmerman & Cheryl Loeb, Dirty Bombs: The Threat Revisited, *Defense Horizons*, No.38 (January 2004), pp.8-9.

[26] Ibid, p.9.

[27] Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report, Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage, National Research Council (2005). Executive summary available at http://www.nap.edu/execsumm_pdf/11263.pdf.

[28] Global Threat Reduction Initiative Fact Sheet, *available at*

http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2004/cn139fact.pdf.

[29] *See* Bouchard, pp.13-16.

[30] Department of Homeland Security, Fact Sheet: Domestic Nuclear Detection Office, *available at* http://www.dhs.gov/dhspublic/display?content=4474.

[31] Zimmerman & Loeb, p.10.

[32] Zimmerman & Loeb, pp.9-10.

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