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BEFORE THE FIRST BOMB GOES OFF: DEVELOPING NUCLEAR ATTRIBUTION STANDARDS AND POLICIES

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Before the First Bomb Goes Off: Developing Nuclear Attribution Standards and Policies

Abstract:

Nuclear forensics and attribution are the new “deterrence” concepts against illicit use of fissile material. Although the science is being developed, the required systems of policies and processes have not been fully analyzed. This paper attempts to show how nuclear attribution can advance from theory to practice by establishing multilaterally coordinated policies and procedures and by replicating systems that have worked in other disciplines.

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Foreword Graham Allison

On the bottom-line question of whether a successful nuclear terrorist attack is more or less likely than it was when President George W. Bush entered office, the congressionally established Commission on the Prevention of WMD Proliferation and Terrorism offered a unanimous judgment in December 2008: “Our margin of safety is shrinking, not growing.” As President Obama stated at last April’s Global Nuclear Security Summit, nuclear terrorism is “the single biggest threat to U.S. security, short term, medium term and long term.”¹

Terrorists have no return address. But states do. And states have the nuclear material terrorists need to make a mushroom cloud. The international community’s best hope of preventing nuclear terrorism is to deny terrorists the means to achieve their deadliest aspirations. Here, happily, physics is on our side: no HEU or plutonium, no explosion, no nuclear terrorism. The big strategic question thus becomes: Could assured accountability for terrorist use of a nuclear weapon deter leaders from allowing weapons or weapons-usable material to fall into terrorists’ hands?

I believe the answer is “yes.” The key to a twenty-first-century deterrent is developing a capability to identify the “fingerprints” (contaminants and other markers) of the nuclear weapon or material from which it was constructed. After a terrorist nuclear event, or the seizure of material on the black market, governments must be able to backtrack to the source of the fissile material or the bomb.

Holding nations accountable for their fissile material offers the best prospect available to ensure the world’s most dangerous weapons and materials do not fall into the deadliest hands. A doctrine of nuclear accountability would mean any state found to have knowingly allowed terrorists to acquire nuclear weapons or materials would face consequences: from financial reparations to military retaliation. Such a system would put fear in the minds of potential proliferators and could cause countries to ensure that their nuclear weapons and materials are locked down to a “gold standard.”

Nuclear accountability would be assisted by the establishment of an international depository or a library of nuclear samples. If a nuclear explosion were to occur, such a

¹ Office of the Press Secretary, “Remarks by President Obama and President Zuma of South Africa before Bilateral Meeting,” Washington, D.C., April 11, 2010, <http://www.whitehouse.gov/the-press-office/remarks-president-obama-and-president-zuma-south-africa-bilateral-meeting>.

library could be used to increase the reliability and accuracy in tracking the material from that bomb to its original source. If nuclear weapons or materials should be stolen, states that had satisfied the requirements for assured nuclear security, met the established gold standard for securing their materials and made their safeguards sufficiently transparent to the international community would be judged less culpable. A state that was unwilling to take such steps would put itself on the list of suspect sources of a terrorist nuclear bomb.

Many questions arise about the feasibility of such a system. One key question: What incentive does a state have to classify and catalogue its unique nuclear material if that same material could potentially lead to a state's culpability in the event of an attack?

By assembling one of the most comprehensive reviews of a system of nuclear accountability and science of nuclear forensics, Belfer Center Associate Debra Decker provides an important advance in our understanding of this pressing question. Decker is right to highlight that a new set of policies must now be debated and implemented. As she notes, "A system of attribution needs to be consciously fostered that goes beyond the development of national capabilities and looks at how attribution can be more fully established to foster deterrence. Governments need to begin thinking cooperatively about the much longer term—*before* the first bomb goes off."

Before the First Bomb Goes Off: Developing Nuclear Attribution Standards and Policies

Nuclear terrorism is one of the most challenging threats to international security, and strong nuclear security measures are the most effective means to prevent terrorists, criminals, or other unauthorized actors from acquiring nuclear materials.

In addition to our shared goals of nuclear disarmament, nuclear nonproliferation and peaceful uses of nuclear energy, we also all share the objective of nuclear security. Therefore those gathered here in Washington, D.C. on April 13, 2010, commit to strengthen nuclear security and reduce the threat of nuclear terrorism. Success will require responsible national actions and sustained and effective international cooperation.

– Communiqué of the Washington Nuclear Security Summit
April 13, 2010²

² Office of the Press Secretary, “Communiqué of the Washington Nuclear Security Summit” (Washington, D.C.: White House, April 13, 2010), <http://www.whitehouse.gov/the-press-office/communiqu-washington-nuclear-security-summit>.

1. *Introduction: A System of Nuclear Accountability*

More than forty world leaders came together in Washington, D.C., at the Nuclear Security Summit in April 2010 to discuss a growing threat—nuclear terrorism—and a way to manage that threat—securing the world’s vulnerable nuclear material—that some analysts think too challenging to succeed. Yet leaders have little choice: they can either cooperate in trying to lock down dangerous fissile material or face the inevitable consequences when a nuclear explosion occurs.

The summit was a good start, but the next steps are crucial: individuals and countries need to understand both the enormous consequences of a nuclear incident as well as the high likelihood that it will occur (estimated at 29–50 percent over the next ten years)³ and set up a system of nuclear accountability before it is needed.

Apart from the death toll and direct physical destruction, a nuclear attack would have far-reaching consequences. The effect goes beyond those directly attacked. This would include not just nuclear fallout and generalized system outages with loss of some essential goods and services, but also indirect consequences such as disrupted commerce and travel, leading to major widespread economic losses. After the September 11 events, for example, other potential “target” states redirected funding into security improvements that not only inevitably slowed commerce but also reduced both short and long-term productivity; “nontarget” states also experienced substantial residual effects.⁴ A nuclear incident would result in unimaginable consequences beyond

³ Matthew Bunn, *Securing the Bomb, 2008* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, and Nuclear Threat Initiative, November 2008), p. 14, http://www.nti.org/e_research/Securing_the_bomb08.pdf. The material some consider most at risk is located in Russia, Pakistan, and in research reactors around the world that use highly enriched uranium.

⁴ After the terrorist attacks of September 11, 2001, many countries worldwide felt the effects of tourism losses from the immediate decline in both overseas and domestic travel. See World Travel and Tourism Council, “Travel and Tourism—One Year Later,” *Viewpoint* (4th Quarter 2002), p. 2, http://www.wttc.org/bin/pdf/original_pdf_file/viewpoint4q02.pdf. Also, the longer-term policy effects of increased security have been felt in increased costs of doing business, a redirection of development interests as well as in tourism losses. See Dr. Odeen Ishmael, Ambassador of Guyana, “The Impact Of The September 11 Terrorist Attack against the United States on the Caribbean Political Economy,” lecture sponsored by Clark Atlanta University, held at Spelman College, Atlanta, Georgia, November 28, 2001. Simple U.S. policy changes such as requiring Americans returning from Caribbean destinations to have valid passports could cost the Caribbean several billion dollars in tourism earnings. This is all beyond some broader policy effects of September 11, 2001, such as the opportunity cost of security-focused

those of September 11. And rightly or wrongly, some nations and people would be accused of the crime, and actions would be taken against them—with further negative consequences.

Few analysts expect states such as Russia, China, or even North Korea to stage an overt nuclear attack. States and regimes that do not face an existential threat can be deterred from launching a nuclear attack by fear of reprisal—the old “mutual assured destruction” (MAD) concept does appear to work. Terrorists and rogue actors, however, are not easily deterred. Furthermore, the distinct possibility that they could gain either the fissile material to make a nuclear bomb or a bomb itself should give pause, for their desire is evident and they are acting upon their intent.⁵ What they are missing is the capability. Their biggest challenge is obtaining the nuclear material from the governments that have control of it;⁶ yet even that challenge will be reduced if it becomes easier either to buy material from an all-too-active fissile materials market fueled by profit seekers,⁷ or to divert weapons-usable material from poorly protected

investments both domestically and overseas, including the wars in Afghanistan and Iraq. See Bob Woodward, *Plan of Attack* (New York: Simon and Schuster, 2004).

⁵ Rolf Mowatt-Larssen, “Al-Qaeda Weapons of Mass Destruction Threat: Hype or Reality?” (Cambridge, Mass.: Belfer Center for Science and International Affairs, January 2010), <http://belfercenter.ksg.harvard.edu/files/al-qaeda-wmd-threat.pdf>. Even more recently than the timelines included in that report, an al-Qaida leader in Afghanistan said the group would use Pakistani nuclear weapons against Americans if it could gain control of them. See Inal Ersan, “Al Qaeda Says Would Use Pakistani Nuclear Weapons,” Reuters, June 22, 2009, <http://in.reuters.com/article/worldNews/idINIndia-40495320090621?sp=true>. Although this possibility may be low, nuclear threats are growing. See Rolf Mowatt-Larssen, “Nuclear Security in Pakistan: Reducing the Risks of Nuclear Terrorism,” *Arms Control Today*, Vol. 39, No. 6 (July 2009), http://belfercenter.ksg.harvard.edu/publication/19191/nuclear_security_in_pakistan.html?breadcrumb=%2Fexperts%2F1961%2Frolf_mowattlarssen.

⁶ Note that fabricating fissile material (as opposed to buying or stealing it) is a complex process that only states are generally able to undertake, although new technologies might well change that calculation in the future. For a look at laser enrichment, see Mark Clayton, “Will Secret Technology Help Rogue Nations Get Nuclear Weapons?” *Christian Science Monitor*, May 28, 2010, <http://www.csmonitor.com/USA/2010/0528/Will-secret-technology-help-rogue-nations-get-nuclear-weapons>; and Marko Beljac, “SILEX Laser Uranium Enrichment and Nuclear Proliferation,” Nuclear Resonances blog, July 4, 2009, <http://scisec.net/?p=149>. For an overview of fissile materials and weapons, see Owen R. Coté Jr., “Appendix B: A Primer on Fissile Material and Nuclear Weapon Design,” in Graham Allison, Coté, Richard A. Falkenrath, and Steven E. Miller, *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge, Mass.: MIT Press, 1996), reprinted in “Loose Nukes,” *Frontline*, <http://www.pbs.org/wgbh/pages/frontline/shows/nukes/readings/appendixb.html>.

⁷ According to the International Atomic Energy Agency (IAEA), since 1993 there have been 18 reported incidents involving highly enriched uranium (HEU) or plutonium, the material used in nuclear weapons. Note that IAEA only reports confirmed incidents. See especially the annex to IAEA, “IAEA Illicit

civilian storage sites⁸ or from the nine to ten countries with active weapons development/possession and uncertain historic/current materials accounting and controls.⁹

As nuclear expertise spreads with the expansion of nuclear power, the question becomes how to provide incentives to governments to reduce their current levels of fissile material so that there are “no new nascent nukes” and to protect nuclear stockpiles so that there are “no loose nukes.”¹⁰ International relations theorists and policymakers are looking to nuclear attribution as a way to assign responsibility to countries—and individuals—for managing fissile material and its proliferation and use.¹¹

“*Attribution* refers to the ability to identify the perpetrators of an act (by typing an anthrax culture, for example, or performing radiochemical analysis of nuclear bomb debris) and is key to the choice of responses, such as retaliation or prosecution.”

– National Research Council (NRC), *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, (Washington, D.C.: National Academies Press, 2002), p. 28,
http://www.nap.edu/openbook.php?record_id=10415&page=R1 (emphasis in original).

Tracking Database (ITDB): Fact Sheet,”

http://www.iaea.org/NewsCenter/Features/RadSources/PDF/fact_figures2007.pdf. For a description of the nuclear bazaar, see International Institute for Strategic Studies (IISS), *Nuclear Black Markets: Pakistan, A.Q. Khan, and the Rise of Proliferation Networks: A Net Assessment* (London: IISS, 2007).

⁸ For a description of the break-in at Pelindaba, South Africa, see, for example, Bunn, *Securing the Bomb*, 2008, pp. 3–4. Note that several dozen countries possess highly enriched uranium, the material most easily used for terrorist production of a bomb. This paper does not address the scenario of nuclear facilities being attacked or sabotaged and radioactive material being released.

⁹ For an estimate of current stocks of fissile material, see International Panel on Fissile Materials (IPFM), *Global Fissile Material Report, 2010: Balancing the Books: Production and Stocks* (Princeton, N.J.: IPFM, 2010), http://www.fissilematerials.org/ipfm/site_down/gfmr10.pdf.

¹⁰ See Graham Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe* (New York: Holt, 2004).

¹¹ Daniel H. Chivers, Bethany F. Lyles Goldblum, Brett H. Isselhardt, and Jonathan S. Snider, “Before the Day After: Using Pre-Detonation Nuclear Forensics to Improve Fissile Material Security,” *Arms Control Today*, Vol. 38, No. 6 (July/August 2008),

http://www.armscontrol.org/act/2008_07-08/NuclearForensics; William Dunlop and Harold Smith, “Who Did It? Using International Forensics to Detect and Deter Nuclear Terrorism,” *Arms Control Today*, Vol. 36, No. 8 (October 2006), http://www.armscontrol.org/act/2006_10/CVRForensics; and Jonathan Medalia, *Nuclear Terrorism: A Brief Review of Threats and Responses*, CRS Report for Congress (Washington, D.C.: Congressional Research Service, Library of Congress, September 22, 2004), Order Code RL32595, <http://www.fas.org/irp/crs/RL32595.pdf>.

The basic hypothesis is that countries will reduce and better protect stocks of fissile material and work to deter illicit transfers if they can be held accountable for the effects of that material,¹² and that individuals working within countries to produce and secure such material may likewise be dissuaded from diverting it for financial gain if they are held jointly and/or severally responsible for the material they handle. Nuclear attribution is thus a critical element of deterrence in a world where the threat of attack is not from state actors but from nonstate actors who are not as easy to deter.

To act as an effective deterrent, an attribution capability must provide reliable information and an expectation of an assured response, i.e., a response that is sufficiently harsh to deter rogue or negligent actors from fissile material production, proliferation, or use. Attribution ideally would identify not only the original source of the fissile material but also its chain of custody, so that system “holes” could be identified. Proportionate responses would then have to be developed and communicated ahead of time to fit conceived acts of negligence, diversion, and use.

Nuclear attribution poses some questions, however. What would motivate a state to cooperate in nuclear attribution if the illicit material in question originated in or transited that state (with or without its complicity), and, as a result, it might face punishment? Further, if a state has already been identified as the source of material for one incident and additional nuclear materials/weapons may be at large, what is the incentive for the state to cooperate in order to find and eliminate additional illicit acts? Such dilemmas, however, are not unique. Comparable situations exist where evidenced wrongs do not preclude cooperation. Lessons can and need to be applied from these situations to develop frameworks today for the cooperation in nuclear attribution and response that will be needed tomorrow.

The Washington Nuclear Security Summit called for states to “explore ways to work together” to further capabilities in the area of nuclear forensics, “such as the creation of national libraries and an international directory of points of contact.”¹³ These are small but important steps, because states need reliable data on their own fissile material inventories, but determining what to do with the forensic evidence also must be considered. The goal of forensics and attribution—how to obtain the information, how

¹² Debra Decker, “Who Pays when the Bomb Goes Off?” *Foreign Policy*, December 19, 2006, http://www.foreignpolicy.com/articles/2006/12/18/who_pays_when_the_bomb_goes_off.

¹³ Office of the Press Secretary, “Work Plan of the Washington Nuclear Security Summit” (Washington, D.C.: White House, April 13, 2010), <http://www.whitehouse.gov/the-press-office/work-plan-washington-nuclear-security-summit>.

it will be used, and how it will be used best to deter and compel certain state and individual behaviors—must be debated. U.S. and international policymakers must decide how best to pursue such a discussion, with whom, and when. A system of attribution must take all these components into account. This paper explores the requirements for that system of attribution.

The second section discusses a system for developing attribution reliability. That is the ability of scientific and other evidence to determine the sources and pathways of smuggled or detonated fissile material with some degree of precision and to do so with a process that produces trust in the conclusions.

Section three puts attribution reliability in the context of the larger question of guilt, that is, it looks at ways to assess the degree of guilt of offenders and their accomplices to guide appropriate responses. Whether someone is guilty or not may be fairly clear—but how guilty they are of a particular act is a more subtle question that assesses not only the action of the accused but also their intent as well as the effect of the action.

The fourth section grapples with the assessment of states' intent, which requires measuring their intent against a standard of conduct that reflects certain specific intentions. I explore international nuclear standards as well as concepts of negligence as they apply to intent. I also discuss how to come to some agreement on what reflects intent—both in declaring and protecting stockpiles of fissile materials and in their transfer.

Section five examines the next step after assessment and judgments are passed. How should “assured responses” be crafted, agreed, and communicated so that they successfully deter undesired behaviors?

In the sixth section, the paper looks to other fields for applicable lessons to create a successful system of nuclear accountability. It focuses on ways to mitigate penalties and increase rewards so that even the guilty cooperate. Insights are gained from considering agreements or situations in domestic laws and regulations and international agreements where cooperation is obtained despite initial admitted wrongs. Lessons are taken from consumer product safety issues, medical liability, and other areas.

The concluding section explores next steps to further develop a system of nuclear attribution.

This paper notes the many difficulties that exist to achieve this vision and hopes to demonstrate possible paths to manage those challenges. As the 2010 National

Academies nuclear forensics study chaired by Al Carnesale concludes, “ [E]ven if intelligence and law enforcement were to successfully identify culprits associated with smuggling¹⁴ or detonating a weapon or material, they would have to provide supporting evidence for their conclusions, not just in a prosecutorial context but even in a national security context, domestically and internationally. Allies and adversaries alike must be persuaded.”¹⁵ Thus, a system of attribution needs to be consciously fostered that goes beyond the development of national capabilities and looks at how attribution can be more fully established to foster deterrence. Governments need to begin thinking cooperatively about the much longer term—*before* the first bomb goes off.

¹⁴ The term smuggling is used in most of this paper to connote the broad range of acts short of using the material and includes theft, purchase, transit.

¹⁵ Committee on Nuclear Forensics, National Research Council of the National Academies, *Nuclear Forensics: A Capability at Risk (Abbreviated Version)* (Washington, D.C.: National Academies Press, 2010), http://www.nap.edu/catalog.php?record_id=12966.

2. *Developing Attribution Reliability*

WHERE DID THE MATERIAL COME FROM?

Establishing some certainty around “who did it” is critical for any responsive action to be taken with assurance against those accused of aiding, abetting, or performing an illicit act. Regarding a nuclear incident, it is necessary to be highly confident of concluding judgments and to have others in the international community accept those judgments—or at least understand and respect the process that was undertaken to come to that judgment. Establishing credibility of the process helps to rally international support for subsequent actions.

The U.S. experience during the period leading up to the invasion of Iraq in 2003 demonstrates the difficulties inherent in reaching and acting on a judgment. One lesson is that having and then abandoning an ostensible process can make matters worse. A second lesson is that multiple contingencies must be considered, such as agreeing on acceptable time frames, levels of cooperation, what needs to be proven (is intent sufficient?), and appropriate consequences. Therefore any process for nuclear attribution must carefully consider a full range of scenarios across which the process would work.

When determining fault, consideration should include the original source of the illicit material (e.g., what reactor and when it was produced) down to the last person who handled it. Identifying the ownership chain helps to apportion responsibility, but it can be difficult.¹⁶ Cooperation is also challenging, but U.S. and international scientists, law enforcement specialists, and the International Atomic Energy Agency (IAEA) are working to increase the reliability of attribution through improved nuclear forensics¹⁷

¹⁶ One analyst, Cristina Hansell, with the James Martin Center for Nonproliferation Studies in California, says that fissile material can be traced to a nation “with 60 to 75 percent likelihood.” See “Scientists Urge U.S. to Gather Nuclear Forensic Background Data,” Global Security Newswire, June 15, 2009, http://www.globalsecuritynewswire.org/gsn/nw_20090615_6208.php.

¹⁷ Nuclear forensics is a science that looks at material that has been captured, including post-blast fragments, and determines the material characteristics, including type, age, and provides other information in order to help determine the material’s source and transit history. I limit the discussion here to fissile material and do not consider radioactive dispersal through radiological dispersal devices or through sabotage of sites containing/transporting other radioactive materials. Although attribution for other radioactive materials incidents can help alert law enforcement authorities to patterns of smuggling and of reduced controls, nuclear explosive devices and fissile material for improvised devices are of most concern.

and law enforcement cooperation.¹⁸ This is not a new science—nuclear forensic techniques have been used by the IAEA as part of its safeguards program and by many countries to acquire information about the nature of other states’ weapons, beginning with the first atom bombs.¹⁹ Nuclear forensics has received increasing attention, however, not only as nuclear smuggling has increased, but also as a method to help in monitoring treaty compliance, e.g., by the Preparatory Commission of the Comprehensive Nuclear Test-Ban Treaty or by a prospective Fissile Material Cutoff Treaty.²⁰

“Nuclear forensics is the analysis of intercepted illicit nuclear or radioactive material and any associated material to provide evidence for nuclear attribution...[N]uclear forensic analysis includes the characterization of the material and correlation with its production history.”

– IAEA, Nuclear Forensics Support: Technical Guidance Reference Manual (Vienna: International Atomic Energy Agency, 2006), p. 3,
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1241_web.pdf (emphasis in

Many challenges exist in effecting an attribution capability, including simply hiring the personnel needed and organizing the attribution responsibilities and procedures even within the United States.²¹ And for timely analyses, much needs to be done, including

¹⁸ INTERPOL, “Nuclear and radiological terrorism (Project Geiger),” August, 8, 2010, <http://www.interpol.int/public/nuclearterrorism/default.asp>; FBI National Press Office, “FBI and Savannah River National Laboratory Put Science to Work to Protect the Nation” (Washington, D.C.: Federal Bureau of Investigation, June 3, 2010), <http://www.fbi.gov/news/pressrel/press-releases/fbi-and-savannah-river-national-laboratory-put-science-to-work-to-protect-the-nation>; and Rachel Oswald, “Distrust Mires Effort to Develop International Nuclear Forensics Database,” Global Security Newswire, December 24, 2009, http://www.globalsecuritynewswire.org/gsn/nw_20091223_9450.php.

¹⁹ About a dozen countries have laboratory facilities that are part of the IAEA safeguard network labs. See International Atomic Energy Agency, “Safeguards Analytical Laboratory,” <http://www.iaea.org/OurWork/ST/NA/NAAL/sal/salCLnwal.php>.

²⁰ For more detailed information on some uses of nuclear forensics, see Vitaly Fedchenko, “Appendix 8D: Nuclear Forensic Analysis,” in Stockholm International Peace Research Institute (SIPRI), *SIPRI Yearbook 2008: Armaments, Disarmament, and International Security* (Oxford: Oxford University Press, 2008), <http://www.sipri.org/yearbook/2008/files/SIPRIYB0808D.pdf>.

²¹ International Atomic Energy Agency, “Wanted: More Atomic Sleuths to Trace Seized Nuclear Material: Countries Are Working with the IAEA to Reinforce Nuclear Forensics,” February 20, 2008, <http://www.iaea.org/NewsCenter/News/2008/atomsleuths.html>; and U.S. Government Accountability Office (GAO), “Nuclear Forensics: Comprehensive Interagency Plan Needed to Address Human Capital Issues,” GAO-09-527R, April 30, 2009, <http://www.gao.gov/products/GAO-09-527R>.

developing and acquiring more basic field and lab equipment.²² For the United States, the recent report of the National Academies' Committee on Nuclear Forensics noted the extensive need for better organization, clearer alignment of authorities, and the establishment of good standardized operating procedures and modeling and simulation in national labs.²³ Most important, an extensive reference databank of sources is needed to enable "nuclear fingerprinting" so that the materials obtained can be more accurately matched to their sources. Elemental and isotopic characteristics of source materials, including impurities, need to be catalogued in such databanks.

HOW MUCH MATERIAL IS THERE?

Accounting for the whereabouts and the extent of existing stocks of fissile material is one of the first challenges, as only a small amount is needed to construct a nuclear device—about 8 kg (18 pounds) of plutonium or 25 kg (55 pounds) of highly enriched uranium (HEU).²⁴

²² See "Improving the State of the Art," in Joint Working Group of the American Physical Society (APS) and the American Association for the Advancement of Science (AAAS), *Nuclear Forensics: Role, State of the Art, Program Needs* (Washington, D.C.: AAAS, revised 2008), pp. 23–25, http://cisac.stanford.edu/publications/nuclear_forensics_role_state_of_the_art_program_needs/.

²³ Committee on Nuclear Forensics, National Research Council of the National Academies, *Nuclear Forensics*, p. 2.

²⁴ Highly enriched uranium is defined as uranium with 20 percent or more of the isotope U-235—although for countries' weapons, enrichment is typically more than 90 percent U-235. IAEA considers just 25 kg of uranium enriched to 20 percent or more with U-235 or 8 kg plutonium containing less than 80 percent Pu-238 to be a "significant quantity." This is "the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded." See IAEA, *IAEA Safeguards Glossary*, p. 23. Much lower amounts than these quantities can be used to produce a nuclear device with the appropriate reflectors and other technological enhancements. For a representation of how much material is needed for critical mass depending on the enrichment levels, see the first report of the International Panel on Fissile Materials, *Global Fissile Material Report, 2006* (Princeton, N.J.: IFPM, 2006), p. 9, <http://www.fissilematerials.org/blog/gfmr06.pdf>. Note that the IAEA also classifies uranium 233 as special fissionable material and may deem other materials as such. See International Atomic Energy Agency, *IAEA Safeguards Glossary: 2001 Edition*, International Nuclear Verification Series, No. 3 (Vienna: IAEA, 2002), http://pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf; for the draft update see IAEA, "Nuclear Security Glossary," rev. 3E (Vienna: IAEA, March 17, 2010), <http://www-ns.iaea.org/downloads/security/security-series-drafts/nuclear-security-glossary-ver-3e.pdf>. For terrorist nuclear scenarios, see Charles D. Ferguson and William C. Potter, "Improvised Nuclear Devices and Nuclear Terrorism," No. 2 (Stockholm: Weapons of Mass Destruction Commission, <http://www.blixassociates.com/wp-content/uploads/2011/03/No2.pdf>). For more technical details, see J. Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman, and Jacob Wechsler, "Can Terrorists Build Nuclear Weapons?" paper prepared for the International Task Force on the Prevention of Nuclear Terrorism, (Washington, D.C.: Nuclear Control Institute, 1987), <http://www.nci.org/k-m/makeab.htm>.

In contrast, the amount of fissile material that needs to be tracked is large—and this material is not just found in weapons. Russia and the United States possess well over 90 percent of the world’s nuclear weapons, with China, France, India, Israel, Pakistan, and the United Kingdom and accounting for the remaining approximately 1,000 weapons.²⁵ According to a National Academies Report, however, “Enough additional NEM [nuclear-explosive material] exists in military and civil nuclear facilities worldwide to make something like 100,000 additional nuclear weapons.”²⁶ Other estimates put this number at 120,000 additional nuclear weapons.²⁷ The International Panel on Fissile Materials estimated in 2010 the total stock of HEU in all sources at about 1,600 tons and the total stock of separated plutonium (Pu) at about 500 tons.²⁸ Estimates, however, are only best guesses, and the accuracy of material accounting has been questioned, particularly in the early years of the nuclear age.²⁹

Dangerous civil nuclear activities occur in many states. Some have research reactors that use highly enriched uranium, some undertake nuclear power–related activities such as reprocessing (e.g., in France and Japan), and many engage in the transport of nuclear materials.³⁰ In addition, several countries produce medical isotopes using highly enriched uranium.³¹ The greatest nonweapon use of HEU is for naval

²⁵ Robert S. Norris and Hans M. Kristensen, “Nuclear Notebook: Worldwide Deployments of Nuclear Weapons, 2009,” *Bulletin of the Atomic Scientists*, Vol. 65, No. 6 (November 2009), p. 87.

²⁶ Committee on International Security and Arms Control, *Monitoring Nuclear Weapons and Nuclear-Explosive Materials: An Assessment of Methods and Capabilities* (Washington, D.C.: National Academies Press, 2005), p. 2, http://books.nap.edu/openbook.php?record_id=11265&page=2.

²⁷ Fissile Materials Working Group, “Preventing Nuclear Terrorism,” *Bulletin of the Atomic Scientists*, March 30, 2010, <http://www.thebulletin.org/web-edition/columnists/fissile-materials-working-group/preventing-nuclear-terrorism>. Assumptions on yields and material requirements to achieve those yields can differ.

²⁸ IFPM, *Global Fissile Material Report, 2010*.

²⁹ Matthew L. Wald, “Analysis Triples U.S. Plutonium Waste Figures,” *New York Times*, July 10, 2010.

³⁰ World Nuclear Transport Institute, “Nuclear Transport Facts,” <http://www.wnti.co.uk/nuclear-transport-facts>. For a listing of nuclear fuel cycle–related facilities, see World Nuclear Fuel Facilities, updated November 27, 2010, <http://www.wise-uranium.org/efac.html>; and International Atomic Energy Agency, Integrated Nuclear Fuel Cycle Information Systems, <http://www-nfcis.iaea.org>.

³¹ Note that companies report using about 85 kilograms of HEU annually to produce the medical isotope molybdenum 99, but they actually use less than 5 percent of this, stockpiling the rest as “waste.” See Laura H. Kahn, “The Potential Dangers in Medical Isotope Production,” *Bulletin of the Atomic Scientists*, March 16, 2008, <http://www.thebulletin.org/web-edition/columnists/laura-h-kahn/the-potential-dangers-medical-isotope-production>. Most of the production comes from Canada, Belgium, France, the Netherlands, and South Africa, with the United States using one-third of the isotope supply. See Nuclear Energy Institute, “Medical Isotopes in Short Supply,” *Nuclear Energy Insight*, Web Extra, November 9, 2009, <http://www.nei.org/resourcesandstats/publicationsandmedia/insight/insight-web-extra/medical-isotopes-in-short-supply>. Cristina Hansell, “Nuclear Medicine’s Double Hazard: Imperiled Treatment and the Risk of Terrorism,” *Nonproliferation Review*, Vol. 15, No. 2 (July 2008), pp. 185–208.

propulsion, with the United States alone using two tons each year.³² More than 20 tons of HEU, albeit not weapons-grade, are in nonnuclear weapons states, with about 25 states—from South Africa to Kazakhstan—possessing more than 1 kg.³³ Civilian HEU is generally of more concern than nuclear weapon or naval HEU, which some may consider to be better protected.

Another challenge in accounting for fissile materials is that the stocks of separated plutonium and HEU continue to change—for example, as global threat reduction programs convert HEU research reactors to low enriched uranium (LEU), as Russia and the United States rid themselves of excess inventory, as more HEU is produced in Pakistan, and as plutonium reprocessing increases in Japan as part of its energy program. In addition, as nuclear power extends, the possibility for increasing weapons material grows. For a state wanting to acquire nuclear weapons capability, plutonium sufficient for making a bomb could be reprocessed from one ton of light water reactor spent fuel.³⁴ South Korea, with its 20 nuclear reactors, for example, generates about 700 tons of spent fuel each year, already has 11,000 tons of spent fuel stored,³⁵ and is interested in reprocessing—as are others.³⁶ Today about 440 nuclear power reactors operate in more than 30 countries, and another 15 countries are planning or proposing to have power reactors.

WHO CAN TRACK ALL OF THIS?

Even within the United States, the government's record of tracking nuclear materials is imperfect. Six nuclear missiles were not even reported missing after they had been inadvertently put on a B-52 bomber that traversed the United States.³⁷ Commercially, U.S. material control and accountability (MC&A) efforts are part of the Nuclear

³² Ole Reistad and Styrkaar Hustveit, "HEU Fuel Cycle Inventories and Progress on Global Minimization," *Nonproliferation Review*, Vol. 15, No. 2 (July 2008), pp. 265–287. HEU used in naval fuel is typically enriched to no more than 20 percent rather than the higher enrichment levels preferable for weapons. About 400 kg of HEU enriched at 20 percent is needed to produce a critical mass (see n. 24).

³³ IFPM, *Global Fissile Material Report, 2010*, pp. 15, 137–138.

³⁴ IFPM, *Global Fissile Material Report, 2009*, p. 106. Because of its high radioactivity and weight, spent fuel requires special handling that makes clandestine diversion unlikely. Thus, it would generally take a conscious state decision to divert and reprocess the fuel for weapons use.

³⁵ Park Seong-won, Miles A. Pomper, and Lawrence Scheinman, "The Domestic and International Politics of Spent Nuclear Fuel in South Korea: Are We Approaching Meltdown?" Korea Economic Institute, Academic Paper Series, Vol. 5, No. 3 (March 2010), p. 2,

<http://www.keia.org/Publications/AcademicPaperSeries/2010/APS-ParkPomperScheinman.pdf>.

³⁶ "Triple Push for Reprocessing," *World Nuclear News*, April 15, 2010, <http://www.world-nuclear-news.org/newsarticle.aspx?id=27532&terms=South%20Korea>.

³⁷ Thom Shanker, "2 Leaders Ousted from Air Force in Atomic Errors," *New York Times*, June 6, 2008, <http://www.nytimes.com/2008/06/06/washington/06military.html>

Materials Management and Safeguards System (NMMSS), in which specific individuals at facilities must be designated as having responsibility for nuclear materials. However, a 2009 report of the Inspector General of the Department of Energy, which shares authority with the U.S. Nuclear Regulatory Commission over domestic licensing for nuclear material, stated:

Our review disclosed that the Department could not always accurately account for, and, had not adequately managed, significant quantities of nuclear material that had been provided to domestic licensees. For about 37 percent (15 of 40) of the domestic facilities we reviewed, the Department could not accurately account for the quantities and locations of certain nuclear materials. In a number of cases, the Department had also agreed to write-off large quantities without fully understanding the ultimate disposition of these materials.³⁸

A forthcoming study of the National Academies calls for a more systemic approach to the United States' method of securing its nuclear weapons and special nuclear material, especially using scenario analysis.³⁹ If the United States, which has such an intrinsic interest in securing fissile materials, has problems doing so, other countries must also. That it is difficult to calculate and track stocks of fissile material, however, should not lead to abandonment of such actions but to more robust efforts, with the United States admitting it also has more to do.

Owners of fissile material can be encouraged to quicken their accounting efforts, as technology is improving in its ability to detect nuclear weapons and material.⁴⁰ This will help lead to better attribution capabilities overall. A databank of nuclear stocks and associated fingerprints and a monitoring system could become a veritable source tracking system.⁴¹ Starting in 2006, the United States took steps to establish a Nuclear

³⁸ Office of the Inspector General, "The Department's Management of Nuclear Materials Provided to Domestic Licensees," Audit Report, DOE/IG-0813 (Washington, D.C.: U.S. Department of Energy, February 2009), p. 1, <http://www.ig.energy.gov/documents/IG-0813.pdf>.

³⁹ Committee on Risk-Based Approaches for Securing the DOE Nuclear Weapons Complex, National Research Council, *Understanding and Managing Risk Security Systems for the DOE Nuclear Weapons Complex* (Washington, D.C.: National Academies Press, forthcoming). For a summary, see http://books.nap.edu/catalog.php?record_id=13108.

⁴⁰ For an excellent overview of current detection technologies, see Jonathan Medalia, *Detection of Nuclear Weapons and Materials: Science, Technologies, Observations*, CRS Report for Congress (Washington, D.C.: Congressional Research Service, Library of Congress, June 4, 2010), No. R40154, <http://www.fas.org/sgp/crs/nuke/R40154.pdf>.

⁴¹ The United States started a National Source Tracking System in 2009 to track radioactive sources that pose high risks for safety in terms of exposure and that could be used malevolently in a radiological device. See U.S. Nuclear Regulatory Commission, "National Source Tracking System," October 20, 2010, <http://www.nrc.gov/security/byproduct/nsts.html>. For one proposal on monitoring HEU and other

Materials Information Program (NMIP),⁴² whose goal is “to consolidate information from all sources pertaining to worldwide nuclear materials holdings and their security status into an integrated and continuously updated information management system.”⁴³ Other groups, such as the International Atomic Energy Agency, the European Commission Joint Research Centre’s Institute for Transuranium Elements, and some individual countries also maintain data. States such as India are starting to develop nuclear forensic capabilities.⁴⁴ Some intergovernmental cooperation has begun between the United States and others.⁴⁵ An internationally accepted framework for a databank, its management, and access rights would allow for broader agreement on material sources and pathways and therefore better verification.

The idea of an international nuclear databank is not without problems, however. Countries do not want to share nuclear fingerprints that would disclose information about their weapons’ characteristics; some countries would not want to share that they may have clandestinely obtained information about other states’ weapons and production facilities; and commercial fuel manufacturers would not want to disclose proprietary information (although only selected information related to fissile materials or their immediate precursors would be of interest to the databank). To resolve these issues, information could be maintained in classified and unclassified forms, and some access to encrypted national or multinational databanks in emergencies could be prearranged.⁴⁶ Participants could use a trusted third party to maintain overall system collaboration if samples are independently maintained in different countries.

Indeed, the Joint Working Group of the American Physical Society and the American Association for the Advancement of Science, which convened to assess the state of nuclear forensics, concluded that despite the technical difficulties, an international

shipments, see M. Schanfein and P.C. Durst, “A National Tracking Center for Monitoring Shipments of HEU, MOX, and Spent Nuclear Fuel: How Do We Implement?” paper prepared for the 50th annual meeting of INMM (Idaho Falls: Idaho National Laboratory, U.S. Department of Energy, July 2009), INL/CON-09-16106, <http://www.inl.gov/technicalpublications/Documents/4284994.pdf>.

⁴² Rolf Mowatt-Larssen, testimony before the U.S. Senate Homeland Security and Governmental Affairs Committee, 110th Cong., 2d sess., April 2, 2008,

http://www.congressional.energy.gov/documents/April_2_-_Homeland_Sec-Larssen%281%29.pdf.

⁴³ Federation of American Scientists, “Nuclear Materials Information Program,” NSPD-48/HSPD-17, August 28, 2006, in George W. Bush Administration, *National Security Presidential Directives*, <http://www.fas.org/irp/offdocs/nspd/nspd-48.html>.

⁴⁴ M.K. Madhusoodan, “Dirty Bomb: Forensic Lab to Take Lead in Fighting Nuclear Terrorism,” *Daily News and Analysis*, March 6, 2011.

⁴⁵ “Japan, U.S. to Launch Talks on Cooperation in Nuclear Forensics,” *Associated Press*, January 30, 2010.

⁴⁶ See suggestions in Michael May, Jay Davis, and Raymond Jeanloz, “Preparing for the Worst,” *Nature*, October 26, 2006, pp. 907–908.

database would be useful and should include not only fissile material characteristics but also other information needed to trace the material, including information on storage sites, related nuclear material, and production and processing.⁴⁷ The report acknowledged the difficulties involved in attempting to establish such a database but noted that “the potential for nuclear forensics to play a crucial role in analysis of both pre- and post-detonation materials is enormous.”⁴⁸ In addition, it noted that attempts to “spooft” the database would likely be costly and indicative of a country’s intent, when the erroneous information was detected.⁴⁹

Some important past work has been done on nuclear information sharing. As part of the 1996–2002 Trilateral Initiative, the United States, Russia, and the IAEA discussed levels and types of verification procedures for nuclear weapon dismantlement, including a process for sharing weapons-origin fissile material with the IAEA. New U.S. and Russian administrations, however, were less interested in this process, and it was abandoned. Lessons can be drawn, however, from reflecting back both on these discussions and on how data classification issues were resolved.⁵⁰ Russia and the United States have a long history of developing (or trying to develop) mechanisms for sharing sensitive information, from strategic arms reduction verification to missile launches.⁵¹

Even with excellent scientists, state-of-the-art equipment, and a complete and accurate database of all fissile material, the ability to determine the source and path of fissile material obtained pre- or post-detonation would still not be completely reliable, given the imperfect nature of nuclear forensics. It would be possible, however, to narrow the number of sources and paths. And by complementing nuclear forensics with traditional law enforcement techniques, attribution accuracy increases. In addition, new technological developments are expected to help improve attribution confidence in the future—indeed, the technology already exists to successfully tag nuclear material. At the very least, attribution techniques could help determine where the material did *not* originate, i.e., in a nuclear weapons state or a nonnuclear weapons state. Being able to

⁴⁷ APS and AAAS, *Nuclear Forensics*.

⁴⁸ *Ibid.*, p. 4.

⁴⁹ *Ibid.*, p. 30.

⁵⁰ Thomas E. Shea, “The Trilateral Initiative: A Model for the Future?” *Arms Control Today*, Vol. 38, No. 4 (May 2008), http://www.armscontrol.org/act/2008_05/PersboShea.asp%2523Sidebar1.

⁵¹ I thank Martin Malin for pointing out the past work of the Joint Data Exchange Center and its problems. For an update on new U.S.-Russian efforts on sensitive cooperation in this area, see Tom Z. Collina, “Russia, U.S. Working on Joint Launch Notification,” *Arms Control Today*, Vol. 40, No. 6 (July/August 2010), http://www.armscontrol.org/act/2010_07/JointLaunch.

more definitively lay or clear blame for an incident is the driving attractiveness of attribution.

Forensics and attribution's potential ability to more confidently rule out illicit material sources could indeed spur interest in standardized material tagging protocols, which would need further exploration.⁵² Taggant use in plastic explosives has already become standard for purposes of detection.⁵³ After the Pan Am Lockerbie bombing, with the UN's urging, the International Civil Aviation Organization (ICAO) drafted the "Convention on the Marking of Plastic Explosives for the Purpose of Detection," which requires plastic explosives to be marked with detectable chemical tags.⁵⁴ Taggant use for purposes of identification and attribution in chemical explosives are more controversial, given the costs involved.⁵⁵

THE ATTRIBUTION PROCESS

Beyond the complex science involved in forensics and attribution, the process for establishing attribution is critical—both internationally and intranationally. On the science side, the Nuclear Smuggling International Technical Working Group has established a subgroup called the Nuclear Forensic Laboratories (INFL)—an association of forensic scientists—to assist states in the attribution process. Ideally, that process should follow some internationally accepted standards and procedures, which so far are merely suggestions, not imperatives.⁵⁶ On the political side, the process for states to

⁵² Author's phone conversation with scientist who had explored the possibility of adding tags under a Defense agency contract, Cambridge, Massachusetts, September/October 2006.

⁵³ I thank Dr. Kent Myers for this point.

⁵⁴ "Convention on the Marking of Plastic Explosives for the Purpose of Detection," Montreal, Canada, March 1, 1991 (Monterey, Calif.: Center for Nonproliferation Studies, Monterey Institute for International Studies, updated April 23, 2010), <http://cns.miis.edu/inventory/pdfs/pexplo.pdf>. Note that as of April 2010, China, Iran, Iraq, Venezuela, and several other states have not acceded to this convention. See "UN Conventions on Terrorism," pt. 2 (Monterey, Calif.: Center for Nonproliferation Studies, Monterey Institute for International Studies, updated April 27, 2010), <http://cns.miis.edu/inventory/pdfs/apmunterII.pdf>.

⁵⁵ Institute of Makers of Explosives (IME), "Taggants in Explosives," February 2007, http://www.ime.org/tmp_downloads/TaggantsExplosives07_pdf.pdf.

⁵⁶ See, for example, APS and AAAS, *Nuclear Forensics*; and International Atomic Energy Agency, *Nuclear Forensics Support*, IAEA Nuclear Series No. 2 (Vienna: IAEA, 2006), http://www-pub.iaea.org/MTCD/publications/PDF/Pub1241_web.pdf. The International Technical Working Group (ITWG) is nonetheless moving forward with best practice development. See David K. Smith, Klaus Mayer, Tamas Biro, Bernard Chartier, Bruno Jouniaux, Paul Thompson, Carey Larsson, Michael Kristo, and Richard Hanlen, "ITWG: A Platform for International Cooperation in Nuclear Forensics," presentation at the IAEA symposium on nuclear security, Vienna, Austria, March 30–April 3, 2009,

agree on attribution has not been thoroughly addressed—and politics will undoubtedly hinder any attempt to reach agreement after a blast occurs if it is not addressed before.

Domestic political and international strategic considerations may well necessitate a quick response to a deadly event, which is why establishing and ensuring adherence to an international process standard for dealing with interdicted fissile material is crucial.

A more robust response to interdiction, attribution, prosecution, and punishment today could help support the development of international postincident cooperative mechanisms, and those mechanisms need to be formulated sooner rather than later. International deliberations take time. Consultations that take the “right” amount of time would allow policymakers the cover time needed to develop more assured attribution and more considered responses.

Time is indeed of the essence as a second attack could well follow a first, as the Harvard-Stanford Preventive Defense Project workshop on “The Day After” notes in its report. The report recognizes the likely delay in attribution but stresses its importance, “The U.S. should aspire to have the capability to attribute a nuclear detonation to its source—credibly and unambiguously—and state clearly as a matter of national policy that it will demand the cooperation of governments that might have been the source in proving or disproving their complicity.”⁵⁷

The U.S. Congress has supported an international framework for determining “the source of any confiscated nuclear or radiological material or weapon, as well as the source of any detonated weapon and the nuclear or radiological material used in such a weapon” and called for “expedited protocols for the data exchange and dissemination of sensitive information needed to publicly identify the source of a nuclear detonation.” This was part of the Nuclear Forensics and Attribution Act signed into law in February 2010.⁵⁸

One consideration is whether a state would indeed need international support in attributing blame and communicating effectively that it would respond to a nuclear

http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2009/cn166/CN166_Presentations/Session%204/021_D%20Smith.pdf. For more on standards, see section 4 (ibid.).

⁵⁷ Ashton B. Carter, Michael M. May, and William J. Perry, “The Day After: Action in the 24 Hours Following a Nuclear Blast in an American City,” April 19, 2007, <http://iis-db.stanford.edu/pubs/21872/DayAfterWorkshopReport.pdf>, p. 17.

⁵⁸ “Nuclear Forensics and Attribution Act,” Public Law 111-140, February 16, 2010, 111th Cong., 2d sess., http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_public_laws&docid=f:publ140.111.pdf.

incident in a way that is punitive enough to deter illicit acts and promote security but flexible enough to promote cooperation. If a country wants an excuse to attack another state or to insist on reparations and does not face any appreciable negatives from acting on its own, then it has little incentive to involve others in the attribution process. It might want to be able to assert simply that it knows “who did it and how” and to seek appropriate recompense. The United States, for example, might well be tempted to take such an approach, given the sophisticated state of its science and technology on attribution.⁵⁹ In today’s interconnected world, however, unilateral state actions may be more self-satisfying than effective. If a state is the accused rather than the accuser, then it certainly would prefer the protection associated with a fully developed process. Therefore, given that the United States owns much of the world’s fissile material—with some of it possibly errant—it might well like to have such a process in place.

Thus, to gain international support for response to a nuclear event and to validate innocence, states would need to have instituted a process for proving the validity of accusations about those responsible for an event. Although state leaders will always reserve the right to respond in a way that best serves their national interest, having a prearranged process in place for gaining international acceptance of attribution and an assured response could help deter some thefts and illicit use and could help move states toward improved security of their materials and even reductions in that material. Indeed, the establishment of such a process with assured repercussions might help convince a seemingly irrational state such as North Korea that it could not tie up the world community in never-ending UN Security Council deliberations with incremental sanctions.

An evidentiary and internationally cooperative process for prosecuting individuals is likewise needed. Although the question of whether it is possible to deter individuals from trafficking nuclear material is a complicated one, given the lack of agreed penalties and the relative ineffective prosecutions to date, prosecutions and penalties for smuggling must become part of the state framework discussions and accused smugglers must be tried more effectively and publicly. In the first instance, a multilaterally accepted if not internationally agreed process for controlling and assessing chains of forensic evidence is needed—just as it would be in developing accusations against a state.

Most immediately, an attribution framework could be pursued as a subset of the Russian and American Global Initiative to Combat Nuclear Terrorism (GICNT) begun

⁵⁹ The United States has a National Technical Nuclear Forensics Program to sort out its internal process responsibilities—but perhaps not its policy ones.

in 2006 to combat nuclear terrorism. In this initiative, the United States and Russia invited other nations to cooperate in pursuing “determined and systematic efforts to:

- improve accounting, control, and physical protection of nuclear material and radioactive substances, as well as security of nuclear facilities;
- detect and suppress illicit trafficking or other illicit activities involving such materials, especially measures to prevent their acquisition and use by terrorists;
- respond to and mitigate the consequences of acts of nuclear terrorism;
- ensure cooperation in the development of technical means to combat nuclear terrorism;
- ensure that law enforcement takes all possible measures to deny safe haven to terrorists seeking to acquire or use nuclear materials;
- strengthen our respective national legal frameworks to ensure the effective prosecution of, and the certainty of punishment for, terrorists and those who facilitate such acts.”⁶⁰

This was translated into a related statement of principles to which more than eighty nations now subscribe.⁶¹ The 2010 meeting of partner states set out a work plan for the coming year that prioritized nuclear detection and forensics.⁶² This should be coordinated with the IAEA’s Nuclear Security Plan.⁶³

As the GICNT pursues its work plan, it should endeavor to establish a process for accepting the forensic information in a timely and reliable manner.⁶⁴ That means

⁶⁰ Office of the Spokesman, “U.S.-Russia Joint Fact Sheet on the Global Initiative to Combat Nuclear Terrorism” (Washington, D.C.: U.S. Department of State, July 15, 2006), <http://2001-2009.state.gov/r/pa/prs/ps/2006/69016.htm>. The initiative, however, specifically noted that it does not address issues related to nuclear weapons safeguards.

⁶¹ Note that the parties to the initiative, as of the March 2011 U.S. State Department website, did not include countries such as Indonesia, Iran, Malaysia, North Korea, and South Africa, but did include China, India, Israel and Pakistan. See U.S. State Department, Global Initiative to Combat Nuclear Terrorism (GICNT), <http://www.state.gov/t/isn/c18406.htm>. See also GICNT, “Statement of Principles,” <http://www.state.gov/t/isn/c37071.htm>.

⁶² Office of the Spokesman, U.S. Department of State, “Joint Co-Chair Statement Regarding the 2010 Global Initiative to Combat Nuclear Terrorism Plenary Meeting,” Abu Dhabi, United Arab Emirates, June 29, 2010, <http://www.state.gov/r/pa/prs/ps/2010/06/143754.htm>.

⁶³ IAEA Director General, “Nuclear Security Plan 2010-2013,” report prepared for the Board of Governors General Conference, August 17, 2009, <http://www-ns.iaea.org/downloads/security/nuclear-security-plan2010-2013.pdf>.

⁶⁴ Sarah Fendrich “International Nuclear Forensics Cooperation” (Washington, D.C.: Office of WMD Terrorism, U.S. Department of State, n.d.), www.stcu.int/nf2009/download/download.php?id=124.

refraining from developing unwieldy procedures with many participants but identifying key partners who need to be involved or represented in dual processes:

- a. the scientific forensic and traditional law enforcement forensic process to attribute sources of material and their pathways with a specific degree of confidence; and
- b. a political process to accept those findings and announce and/or promote action on them.

The GICNT is currently developing these processes to support states. At some point, however, once the processes for supporting states in criminal prosecutions of individuals become institutionalized, the processes will inevitably be applied to civil prosecutions and for pressing states for claims. Thought should be given to these processes now. The point is not only to establish attribution with confidence but also to ensure acceptance by those who might want to oppose (or to impose) retribution and requirements for reparations and would therefore want to dispute the veracity of the findings. And those involved in the forensic process need not always be involved in the political process.

This two-step process is one that is currently followed regarding states' compliance with the Nonproliferation Treaty (NPT). The IAEA issues findings of fact regarding a state's conformity to its safeguards agreement, an agreement that has been specifically negotiated between the IAEA and the state. The IAEA board can then refer a noncompliant country to the Security Council, where a political process then decides repercussions. Yet IAEA board's decision to refer a state to the Security Council is political also, because a finding of noncompliance does not automatically necessitate a referral.⁶⁵ The difficulty of dealing with NPT issues in a formal international treaty context highlights the reason for establishing less formal/comprehensive but nonetheless standardized mechanisms for the attribution system, at least to start.

For the first part of the attribution process (forensic/law enforcement), for example, the United States and Russia, the other major holder of fissile material, might agree on standard and precise operating procedures. Then they together could consider how to involve others in that process. All countries holding fissile material of significant quantity might nominate trusted experts to be involved in or observe the analyses; this would in effect constitute the pool of "jurors." Countries could challenge for cause each

⁶⁵ Pierre Goldschmidt, "Safeguards Noncompliance: A Challenge for the IAEA and the UN Security Council," *Arms Control Today*, Vol. 40, No. 1 (January/February 2010), http://www.armscontrol.org/act/2010_01-02/Goldschmidt.

other's nominations to the pool in the same way that a defense attorney and a prosecutor assess prospective jurors in the *voir dire* process and present challenges for cause; preemptory challenges (i.e., vetoing a selection) might or might not be allowed given the small number of experts from which to select in some areas, preventing preemptory challenges from being used often. The United States and Russia might decide on the validity of the challenges for cause, with recommendations coming from a peer group such as the INFL. Once the juror pool was established, a formulaic basis could be used for selecting further participants, based on where an event occurs and what capabilities are needed.

Establishing such a transparent process to respond to smuggling would help elevate today's low-key handling of illicit fissile material trading into a broader international context. Engaging more international actors in the process would not only help legitimize it for subsequent use post-blast but would also help to publicize any negative events and would pressure states tangentially involved to be more cooperative.⁶⁶

The role of the IAEA in this attribution framework would also need to be clarified. Today, the IAEA plays two major roles: promoting the safe and peaceful uses of atomic energy and helping to monitor that such uses are truly peaceful. In this capacity, the IAEA has assisted in forensic analyses.

"The IAEA is responsible for ensuring that the advantages of nuclear technology are used to benefit human well-being and sustain socio-economic development, while also seeking to ensure that the risks associated with nuclear technology are minimized."

– 20/20 Vision for the Future: Background Report by the Director General for the Commission of Eminent Persons, p. 11, http://www.iaea.org/NewsCenter/News/PDF/20-20vision_220208.pdf.

An independent, international commission considered the future role of the IAEA and concluded, among other things, that:

Though nuclear security is fundamentally the responsibility of individual states, the IAEA has an important role to play in addressing the threat of nuclear terrorism. It is the only global body with relevant competence and expertise

⁶⁶ Germany's attempts at prosecuting the German engineer Gotthard Lerch, part of the A.Q. Khan smuggling network, extended from 1987 until 2008 and took years longer than necessary because of uncooperative Swiss rules and authorities and Germany's own earlier restrictive Federal statutes. See Sandy Spector, guest editor, "Special Report: The A. Q. Khan Network: German Case Highlights Difficulties of Prosecuting Nuclear Smugglers," *WMD Insights*, January 2010.

relied on by a wide range of countries. States should negotiate binding agreements that set effective global nuclear security standards. They should agree to give the IAEA an important role in developing those binding standards and assisting in and confirming their implementation.⁶⁷

The final document of the 2010 NPT Review Conference noted (as do IAEA documents) that “nuclear safety and nuclear security are national responsibilities,” but agreed that the “IAEA should play the key role in the development of safety standards, nuclear security guidance and relevant conventions based on best practice.”⁶⁸ Today, no single document covers all nuclear security requirements.⁶⁹ Most nuclear security standards are voluntary and apply to civil nuclear facilities.⁷⁰ The requirements that are imposed—e.g., by Security Council Resolution 1540⁷¹—call for taking “appropriate effective” measures without defining those measures. The IAEA does provide integrated nuclear security support plans for states wanting assistance in improving nuclear security;⁷² it has a new security knowledge-sharing effort;⁷³ and it has produced

⁶⁷ Independent Commission, “Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond” (Vienna: IAEA, May 2008), p. vii, <http://www.iaea.org/NewsCenter/News/PDF/2020report0508.pdf>.

⁶⁸ United Nations, “2010 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons: Final Document,” Vol. 1 (New York: United Nations, 2010), [http://www.un.org/ga/search/view_doc.asp?symbol=NPT/CONF.2010/50%20\(VOL.I\)](http://www.un.org/ga/search/view_doc.asp?symbol=NPT/CONF.2010/50%20(VOL.I)).

⁶⁹ For the IAEA’s requirements, see International Atomic Energy Agency, “Adherence to International Legal Instruments,” http://www-ns.iaea.org/security/legal_instruments.htm.

⁷⁰ Nuclear security requirements are incorporated into several instruments, including: United Nations Security Council Resolution 1540 and its extensions; the Convention on Physical Protection of Nuclear Material and its amendments; and the International Atomic Energy Agency’s Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. For details on nuclear authorities/standards, see Justin Alger, *A Guide to Global Nuclear Governance: Safety, Security and Nonproliferation*, Nuclear Energy Futures Special Publication (Waterloo: Centre for International Governance Innovation, September 23, 2008), <http://www.cigionline.org/sites/default/files/A%20Guide%20to%20Nuclear%20Power.pdf>; and Aaron Shull, “The Global Nuclear Safety and Security Regimes,” Nuclear Energy Futures Papers, No. 2 (Ontario: Centre for International Governance Innovation, November 2008), <http://www.cigionline.org/publications/2008/11/global-nuclear-safety-and-security-regimes>.

⁷¹ United Nations, “Security Council Decides all States Shall Act to Prevent Proliferation of Mass Destruction Weapons,” Resolution 1540 (New York: United Nations, adopted 2004), <http://www.un.org/News/Press/docs/2004/sc8076.doc.htm>.

⁷² International Atomic Energy Agency, “Integrated Nuclear Security Support Plan (INSSP),” <http://www-ns.iaea.org/security/inssp.asp>. The agency has various security activities, including the International Security Advisory Services, which are based on INFCIRC/225/Rev.4 and other best practices, as well as technical and regulatory advisory assistance.

⁷³ International Atomic Energy Agency, “Nuclear Security Information Portal (NUSEC),” <http://www-ns.iaea.org/security/nusec.asp?s=4&l=31>.

and is updating its nuclear security series documents.⁷⁴ The NPT supported the update of IAEA's INFCIRC/225/Rev.4, which provides general instructions for "The Physical Protection of Nuclear Material and Nuclear Facilities."

The role of IAEA as an advisor on improving security, however, could conflict with its role as an overseer of state's stocks of fissile material. This is especially true as the information gathered by IAEA safeguards inspectors is supposed to remain confidential between the IAEA and the client, with the inspectors also sometimes taking on an advisory role with client states.⁷⁵ Missing material could, therefore, reflect on the work of the IAEA advisors, representing an organizational conflict of interest.

Nonetheless, the IAEA's statute also authorizes it to apply legally binding health and safety standards. Given that the statute was written when nuclear security was considered only in terms of diversion for state military use and not for terrorist use, the safety provisions of the statute might well be inferred to apply to security today as public safety has now become a function of that security. The IAEA, therefore, could simply take on the role of setting and monitoring security standards as authorized by its statute covering safety. The IAEA's safeguards role could also support its forensics validation role. Given the obvious synergies, this blending of the safety, security, and safeguards functions is something that IAEA's former Director General Mohamed ElBaradei suggested be considered for the future.⁷⁶

Such a validation role could evolve for the agency in other areas. A recent IAEA Director General report noted that the IAEA might well be asked to help verify fissile material from weapons dismantling or within the context of a prospective fissile material cutoff treaty.⁷⁷ The IAEA's role, however, could become too complex: if it oversees a nuclear fuel bank⁷⁸ or takes ownership of significant quantities of nuclear material, which its current statute allows,⁷⁹ then it will have to monitor its own sites and report on itself.

⁷⁴ International Atomic Energy Agency, Nuclear Security Series, <http://www-pub.iaea.org/mtcd/publications/>.

⁷⁵ Bunn, *Securing the Bomb*, 2008, p. 87 n. 239.

⁷⁶ Director General for the Commission of Eminent Persons, "20/20 Vision for the Future," Background Report (Vienna: IAEA, February 2008), p. 17, http://www.iaea.org/NewsCenter/News/PDF/20-20vision_220208.pdf.

⁷⁷ *Ibid.*, p. viii..

⁷⁸ The IAEA Board of Governors voted in December 2010 to authorize the IAEA to establish a reserve sufficient for one full reactor core. See International Atomic Energy Agency, "Factsheet: IAEA Low Enriched Uranium Reserve," http://www.iaea.org/Publications/Factsheets/English/iaea_leureserve.html.

⁷⁹ See International Atomic Energy Agency, "Article XVI: Relationship with other Organizations," in *Statute of the IAEA*, http://www.iaea.org/About/statute_text.html#A1.16; see also "Article III: Functions."

More formally separating the regulatory/safeguards role of the IAEA from its technical cooperation and nuclear development role (and any future nuclear operating role it might have) would make sense as a tighter security regime develops. Regulatory commissions should be properly separated from any services advising on compliance.⁸⁰ Some organizations, especially those opposing nuclear power, have accused the two basic roles of the IAEA of already being inherently in conflict.⁸¹ The IAEA 2010 technical meeting of experts to discuss the safety and security of radioactive sources recognized that within countries regulatory bodies needed to be independent of other functions,⁸² and the same could be said for the IAEA's efforts.

It is clear that the science part of the forensic science and attribution process needs more international attention. With an appropriate system of attribution established, however, the next question then becomes "to what end?" And there the political process to accept the scientific findings and announce and act on them takes center stage.

⁸⁰ Best practices separate advisory services from auditing. Consider, for example, the problems found with U.S. accounting firms performing audits while offering accounting and consultancy.

⁸¹ Greenpeace International, "A Call to Reform the UN International Atomic Energy Agency (IAEA) Mandate," April 11, 2006, <http://www.greenpeace.org/international/press/reports/IAEAmandatereform>.

⁸² International Atomic Energy Agency Secretariat, "Open-ended Meeting of Technical and Legal Experts for Sharing of Information on States' Implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and Its Supplementary Guidance on the Import and Export of Radioactive Sources," Report of the Chairman, Vienna, Austria, May 17–21, 2010, p. 3,

3. *Measuring Degree of Guilt*

Knowing with some certainty where to lay relative responsibility for a smuggling incident or a nuclear blast is the first part of the equation. The second part is convincing those who would undertake such acts that they would likely be discovered (preferably preemptively) and judged and would then confront consequences severe enough to prevent them from acting and to convince them to cooperate.

A key part of an assured response is the system for judging the degree of guilt necessary to trigger the appropriate assured response. Even if the source and path of the errant fissile material are agreed, the question of where to assign guilt still must be decided.

Questions of who has jurisdiction and how to proceed arise. As with the scientific forensic and traditional law enforcement processes, a political process for accepting the findings and acting on them must be considered. These two processes may be related (e.g., in formal judicial proceedings in which standards of evidence apply), but they may well have different actors (as in the case of IAEA Safeguards presenting evidence to the IAEA Board, which then does nothing, informs, or refers a state to the Security Council). In practice, states generally require no formal processes to justify their acts against others. The offended state may and can act alone on any judgment it makes, but in an interconnected world the benefits of doing so recede, especially when public opinion holds sway in not only the offended state but internationally. The question then is how best to come to some type of collective judgment against a state and/or an individual. A transparent, respected process for judging culpability and penalties is needed.

Today, the International Court of Justice, which can review states' conduct, and the International Criminal Court (ICC), which can prosecute individuals for certain crimes, are still evolving as venues for handling grievances.⁸³ Indeed, the International Court of Justice issued a nuanced decision on the legality of the use of nuclear weapons for the survival of the state and found that no treaties specifically forbade state possession of

⁸³ Formal adjudication of interstate grievances has not occurred often (although this is changing), but having a forum in which to negotiate settlements has been valued. See Abram Chayes and Antonia Handler Chayes, *The New Sovereignty: Compliance with International Regulatory Agreements* (Cambridge, Mass.: Harvard University Press, 1995), pp. 201–227.

nuclear weapons or threat of their use.⁸⁴ If the Global Zero movement's efforts ever succeed, "a legally binding international agreement for eliminating all nuclear weapons ('global zero accord')" may transpire.⁸⁵ Then nuclear weapons may become illegal, and the Westphalian prerogative allowing states to use or threaten the use of force may not extend to nuclear weapons, just as chemical and biological weapons have been circumscribed. Such a nuclear agreement would include methods for dispute resolution—including, for example, agreed referral to the International Court of Justice—and would help to establish new norms that could lead to easier agreement among Security Council members on appropriate penalties for nuclear weapons-related actions—including, one would hope, a state's lack of protection of its fissile material.

As for assessing blame and imposing sanctions on individuals, the International Criminal Court would be able to try terrorists who used a nuclear weapon, which would no doubt be considered a "crime against humanity" — over which the court has jurisdiction. Although states⁸⁶ and this court could prosecute crimes after a nuclear incident, it is up to states to criminalize and enforce penalties for smuggling. UN Security Council Resolution 1540 requires states to adopt legislation to criminalize nonstate WMD proliferation. It also calls for states to enforce criminal and civil penalties for violations of export control laws and regulations.⁸⁷ Its limited scope and the wide varieties of penalties that states impose (or do not impose) on smugglers have led some to suggest universalizing jurisdiction over illicit transfers.

Princeton University Professor Anne-Marie Slaughter and her colleague Thomas Wright recommended that illicit nuclear transfers be deemed a "crime against humanity."⁸⁸

⁸⁴ I thank Dr. Libby Turpen for raising this point. For a layman's analysis of the court's considerations, see "International Court of Justice Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons," Wikipedia, last updated February 11, 2011, http://en.wikipedia.org/wiki/International_Court_of_Justice_advisory_opinion_on_the_Legality_of_the_Threat_or_Use_of_Nuclear_Weapons#Court.27s_analysis_of_illegality_of_nuclear_weapons.

⁸⁵ Global Zero Commission, "Global Zero Action Plan" (Washington, D.C.: Global Zero, World Security Institute, February 2010), p. 2, http://static.globalzero.org/files/docs/GZAP_6.0.pdf.

⁸⁶ I thank Sam Witten for pointing out aspects of the International Convention for the Suppression of Terrorist Bombings, Art. 1(3), that cover devices that release radiation or radioactive material. See: United Nations, "Measures to Eliminate International Terrorism," Report of the Sixth Committee, November 25, 1997, <http://www.un.org/law/cod/terroris.htm>. For additional background information, see United Nations, "International Convention for the Suppression of Terrorist Bombings," <http://cns.miis.edu/inventory/pdfs/bomb.pdf>.

⁸⁷ The original resolution, adopted in 2004, was extended in UNSCR 1673 (2006) for two years, and in UNSCR 1810 (2008) for an additional three years. For the text of these resolutions, see United Nations Security Council, "1540 Committee," <http://www.un.org/sc/1540/>.

⁸⁸ Anne-Marie Slaughter and Thomas Wright, "Punishment to Fit the Nuclear Crime," *Washington Post*, March 2, 2007, <http://www.washingtonpost.com/wp->

This would give jurisdiction to the International Criminal Court to indict and prosecute suspects. Slaughter and Wright write, “Even if the United States cannot bring itself to join the ICC, it could work with allies to empower the ICC to act, just as the Bush administration has done on Darfur.” U.S. Senator Bob Casey (D-PA) and Congressman Adam Schiff (D-CA) introduced in the 111th Congress the Nuclear Trafficking Prevention Act that would instruct the United States to press the United Nations General Assembly to establish illicit transfer of nuclear material for terrorist purposes a crime against humanity and that would amend the U.S. Code to establish a fine of \$2 million and a prison term of at least 25 years for those convicted of transferring or assisting in the transfer of nuclear material to a terrorist organization.⁸⁹ However, this bill never progressed.

Even if the International Criminal Court and the International Court of Justice have effective jurisdiction, they often take too long to act and a reliable threat of swift penalties is needed. In addition, the United States and Russia have not ratified the Rome Statute for the Criminal Court, and the permanent members of the Security Council may veto the enforcement of judgments of the International Court of Justice.⁹⁰ Therefore, individual states that want to ensure more immediate, harsh penalties must find an alternative way to legitimately do so. The International Convention for the Suppression of Acts of Nuclear Terrorism and other conventions such as the International Convention for the Suppression of the Financing of Terrorism allow for some broadening of jurisdictions over cases, for example, if an offense is committed against a national of a state or against a state facility abroad—and do not exclude criminal jurisdiction under national laws.⁹¹ The Convention for the Suppression of Acts of Nuclear Terrorism significantly strengthens possible enforcement by “the possibility of *ad hoc* extradition, treating the Convention as the basis for extradition in the absence of a treaty, and the modification of provisions of existing extradition treaties to the extent that they were incompatible with the provisions of the Convention.”⁹² After a nuclear blast, wherever it occurs, inevitably foreign nationals will be killed or injured,

dyn/content/article/2007/03/01/AR2007030101326.html. Professor Slaughter served as U.S. State Department Director of Policy Planning from 2009–11.

⁸⁹ “Sen. Casey and Rep. Schiff Introduce Legislation to Safeguard Nuclear Weapons Material,” July 16, 2009, <http://casey.senate.gov/newsroom/press/release/?id=3FED9270-45BE-4022-A723-ADF4E236F446>.

⁹⁰ See International Court of Justice—Further Readings, <http://law.jrank.org/pages/7737/International-Court-Justice.html>.

⁹¹ For more on UN conventions, see United Nations, Treaty Collection, http://treaties.un.org/Pages/DB.aspx?path=DB/studies/page2_en.xml&menu=MTDSG.

⁹² Rohan Perera, “International Convention for the Suppression of Acts of Nuclear Terrorism” (New York: United Nations Audiovisual Library of International Law, April 13, 2005), <http://untreaty.un.org/cod/avl/ha/icsant/icsant.html>.

and additional countries can claim jurisdiction.⁹³ In terms of smuggling, however, both claiming jurisdiction and subsequently prosecuting the case are challenging and expensive, especially for states facing more pressing issues than their position as transit stations for nuclear materials. Actual enforcement, therefore, is lax.

Thus, some states could well become interested in establishing a separately agreed system of rules and penalties. If the UN Security Council is not conditioned to take swift action, penalties may be legally applied by states or cooperating groups of states invoking Article 51 of the UN Charter⁹⁴ or defensibly applied by states coming to a new agreement on collective responses. The two states whose participation is most important are arguably the two with the most fissile material—the United States and Russia. Other major holders of fissile material such as Canada and nuclear weapon states such as France would no doubt also be interested. Material from their stocks could be found to be involved in an incident, so they can claim standing and likewise may end up being inadvertently if not directly complicit.

The United States and Russia could agree on standard operating procedures that each or together they would follow to reach judgment on degrees of guilt—establishing a consultative mechanism that could be instituted when needed or maintaining a system of continuous consultation. They could discuss ways to involve others in aspects of the process, these might be stakeholders impacted by the incidents (e.g., possible perpetrators, unwitting accomplices, transit states for the material, or potential victims), or they could be neutral third parties (e.g., Norway, Sweden—renown jurists). Call this a “Russia-U.S.-Plus” process. Then, just as for the scientific attribution process, the political process for coming to judgment on responses could be understood, if not agreed, for fissile materials smuggled or used.

Such an informal system could evolve much as the Proliferation Security Initiative (PSI) has—from a concept that a few states followed to principles of actions that nearly 100 countries now have adopted.⁹⁵ The United States started the voluntary initiative to

⁹³ I thank Gary Peters for this point. The Convention could be interpreted even more broadly, but issues arise in applying extradition. For an excellent discussion of this Convention and principles for state jurisdiction over alleged offenders, see Christopher C. Joyner, “Countering Nuclear Terrorism: A Conventional Response,” *European Journal of International Law*, Vol. 18, No. 2 (2007), pp. 225–251, <http://www.ejil.org/pdfs/18/2/225.pdf>.

⁹⁴ United Nations, “Chapter VII: Action with Respect to Threats to the Peace, Breaches of the Peace, and Acts of Aggression,” in *Charter of the United Nations* (New York: United Nations, January 1985), <http://www.un.org/en/documents/charter/chapter7.shtml>.

⁹⁵ Emma Belcher, “The Ties That Bind Are Not Always Best,” *Huffington Post*, April 27, 2010, http://www.huffingtonpost.com/emma-belcher/the-ties-that-bind-are-no_b_552095.html.

develop procedures among willing countries for the interdiction of ships suspected of transporting weapons of mass destruction or their means of delivery.⁹⁶ A similar system for actually prosecuting smuggling incidents should be considered, including the acceptance of sentencing guidelines.

The best way to develop an effective system of judgment is an area for more research, e.g., what are the characteristics of informal agreements that have led to successful and enduring norms covering state and individual accountability? New ideas should be considered. For example, could special local courts and a special international prosecutor be established to assist in speedy, effective prosecutions of smuggling incidents? The possibility of establishing a special prosecutor with specific venue and of obtaining countries' agreement for possible extradition of accused smugglers to that venue could be considered.⁹⁷ Even without any new agreements, the existing framework of nuclear-related agreements and laws could be interpreted broadly to allow for expanded jurisdiction and prosecutions.⁹⁸ Such a system might also allow states to more easily comply with parts of their UNSCR 1540 requirements by simply letting others effect prosecutions.

Whatever the forum for the judgment, careful judgments are typically made with an estimation of the degree of certainty surrounding the action. If one is certain of guilt, if the effect of the action was heinous, and if the intent of the accused was clear (with no remorse shown), then the penalties imposed are defensibly most severe. Otherwise the penalties are moderated –how much moderation will depend on the degree of certainty/uncertainty surrounding those three factors: the action of the accused, the effect of that action, and the intent of the accused.

THE ACTION OF THE ACCUSED

Difficulties in attributing the action to specific states and/or individual actors have already been covered in the earlier discussion of the science and the process for

⁹⁶ U.S. Department of State, Proliferation Security Initiative, <http://www.state.gov/t/isn/c10390.htm>.

⁹⁷ In the United States, some communities have established “drug courts” that prioritize substance abuse crimes for special treatment with experienced judges and some pre-planned treatment/oversight and penalty options. In infrequently tried, complex legal cases such as ones involving the death penalty, some states have looked to establish a specifically competent base of prosecutors and defense attorneys.

⁹⁸ See for example, the far-reaching prosecutions of the U.S. Attorney's office in the Southern District of New York in Benjamin Weiser, “A New York Prosecutor with Worldwide Reach,” *New York Times*, March 27, 2011,

http://www.nytimes.com/2011/03/28/nyregion/28prosecutor.html?_r=1&scp=3&sq=southern%20district%20of%20new%20york&st=cse. Any system with expanded nuclear prosecutorial powers would have to ensure adequate defense and human rights protections.

attribution reliability. (Clear acts of war fall outside of this discussion.) Some degree of uncertainty may always exist, given the current state of forensic science, but other evidence, testimony, and insights resulting from traditional law enforcement investigation techniques may result in more certainty. The question of certainty often arises when assessing guilt in both judicial proceedings and regulatory enforcement. The lack of perfect certainty surrounding forensic science should not inhibit the establishment of an attribution system that can deter offenders.

THE EFFECT OF THE ACTION

What weight to give to certainty of effect may also be debated. Even if the fissile material has been interdicted before a blast, one could still argue that smuggling or facilitating the smuggling of illicit material should equate with actually using the material. The smugglers should be treated as accomplices in the ultimate crime, even if they are not the ones pulling the trigger. More difficult questions arise regarding the degree of responsibility of the material owner to protect the material and of those who know about the smuggling to report on it.

Regarding the smuggler, one could argue that smuggling even small amounts of fissile material should not equate to a smaller penalty, as small amounts accumulate to large amounts, which have effect. The effect under consideration should be the potential effect of the material (perhaps, as Slaughter and Wright suggest, making illicit transfer equivalent to a crime against humanity). By demonstrably prosecuting cases of these small amounts of fissile material and imposing severe penalties, the potential smuggler will know to recalculate his interests. This could deter individuals motivated by money or prestige from selling material, and it could deter, to a lesser extent, individuals acting in quasi-state groups from facilitating the transfer of material. Such penalties would likely not deter all individuals motivated by ideology, but it could cause some to pause, including due to the new difficulty of finding accomplices. That pause could increase the probability of the smuggler getting caught—because he might undertake further actions that could be unveiled and because authorities would have more time to discover the plot.

Regarding the material owners, a larger question is their degree of liability given their responsibility to protect their material. A state that does not control its nuclear material may be held responsible for the effect of that material, including the most extreme potential effect—a nuclear blast. Even inadvertent facilitation of dangerous acts would be considered a state liability. Indeed, in civil nuclear law, operators of nuclear plants face what is known as “strict liability,” whereby they are considered liable for damages whether or not they were at fault; the designated plant operator is thereby held

responsible for plant safety.⁹⁹ States could similarly be held liable for fissile material security—moderated by the lethality of the material. Thus, if the origin of enriched uranium with a content of 85 percent or more U-235 is identified, then the accused state theoretically could be liable for stricter penalties than if the same amount of uranium but with a content of 20 percent U-235 were illicitly taken from that state. This might interest states in reducing their stocks, production, and/or use of highly enriched uranium. Rather than waiting for a negative event and then establishing new requirements or penalties, the international community should consider devising predetermined ranges of severe penalties.¹⁰⁰

If the effect is an actual nuclear blast, the penalties on those involved should be, of course, the most severe. That includes the penalties for the smugglers, the terrorists, the state owners, and the states/persons who facilitated transit. In addition, those with prior knowledge or suspicions of the illicit act also bear responsibility for the outcome.

The responsibility to report crimes or even suspected possible criminal behavior exists in many areas. For example in the United States, jurisdictions have passed laws requiring reporting of suspected child abuse. Jurisdictions vary to some extent in the triggers for reporting requirements by the level of suspicion and the position of trust of the person (e.g., with teachers and caregivers having higher levels of reporting requirements). The passage of such mandatory reporting laws was not just good public policy but was spurred by communities only becoming eligible for federal funding if they passed mandatory reporting laws with certain minimum provisions.¹⁰¹

Communities also typically have confidential hotlines to report suspected abuse. The very public prosecution of some persons who were in a position to know of child abuse but did not report it would reasonably cause other persons in similar situations to

⁹⁹ For an overview of civil nuclear law, see World Nuclear Association, “Liability for Nuclear Damage,” updated November 2010, <http://www.world-nuclear.org/info/inf67.html>.

¹⁰⁰ For example, Pierre Goldschmidt, former head of IAEA Safeguards, notes that it was the discovery of Iraq’s nuclear weapon program in the early 1990s that led to the development of IAEA’s Additional Protocol standards, which allow the IAEA not to restrict its inspectors to declared nuclear sites. He suggests a process to facilitate automatic escalation of obligations and actions on states that the IAEA determines are not in compliance with its agreed safeguard obligations, ranging from increasing IAEA access rights in the country to suspending military cooperation with the state. See Goldschmidt, “IAEA Safeguards: Dealing Preventively with Non-Compliance” (Washington, D.C., and Cambridge, Mass.: Carnegie Endowment for International Peace, and Belfer Center for Science and International Affairs, Harvard Kennedy School, July 12, 2008), http://belfercenter.ksg.harvard.edu/publication/18456/iaea_safeguards.html?breadcrumb=%2Fexperts%2F1492%2Fpierre_goldschmidt.

¹⁰¹ See Susan K. Smith, “Mandatory Reporting of Child Abuse and Neglect,” July 12, 2009, http://www.smith-lawfirm.com/mandatory_reporting.htm.

report their suspicions.¹⁰² Ultimate responsibility is therefore shared among all parties. The potential parallels to nuclear smuggling/detonations are obvious. Those with knowledge or suspicions regarding possible illicit nuclear acts have a responsibility to report. Therefore international reporting mechanisms need to be put in place, international rewards for reporting instituted, and penalties imposed for nonreporting. The concept of societal verification in the nuclear field is not new. Joseph Rotblat, a prominent nuclear scientist and founder of the Pugwash movement to eliminate nuclear weapons, and others support this.¹⁰³ Legal protections, including asylum, would need to be established to protect whistleblowers including protections from prosecution for any self-incrimination.¹⁰⁴

THE INTENT

In considering individuals or groups of illicit nonstate actors, measuring intent is fairly straightforward. Those who might detonate a nuclear device would be hard pressed to argue they did not mean to do so. Although countries' laws may vary, the Nuclear Terrorism Convention states: "unlawfully and intentionally" possessing radioactive material or a device "[w]ith the intent to cause death or serious bodily injury" or "[w]ith the intent to cause substantial damage to property or to the environment" is an offense.¹⁰⁵ If one is smuggling and selling material, it can be argued that intentions are sufficiently nefarious to be offensive even if that person is not the one intending to use the material. In smuggling materials, some do get caught and prosecuted under countries' own laws, albeit with difficulty and without harsh sentencing. And accomplices to smuggling, thus far, have received only light sentences, if any at all.¹⁰⁶

State intent, however, is where arguments have tended to falter on attribution as a deterrent. Policymakers who support retribution would argue for equating lax ownership with actual use of the fissile material to cause harm. Others argue that "threatening retaliation against countries like Russia and Pakistan in response to terrorist attacks stemming from lax security practices is unwise. It undercuts efforts to

¹⁰² See, for example, Jim O'Hara, "Lawyer Claims Day Care Provider Is Prosecution 'Scapegoat' in Imani Jennings' Death," *Post-Standard*, August 6, 2009,

http://www.syracuse.com/news/index.ssf/2009/08/lawyer_claims_day_care_provide.html.

¹⁰³ See IPFM, "Societal Verification," in *Global Fissile Material Report, 2009*, chap. 9.

¹⁰⁴ See suggestions in Dieter Deiseroth, "Societal Verification: Wave of the Future?" in Trevor Findlay, ed., *Verification Yearbook 2000* (London: VERTIC, 20010), http://oldsite.vertic.org/assets/VY00_Deiseroth.pdf.

¹⁰⁵ United Nations, "International Convention for the Suppression of Nuclear Material" (New York: United Nations, 2005), <http://treaties.un.org/doc/db/Terrorism/english-18-15.pdf>.

¹⁰⁶ A 1993 incident of accomplices to nuclear smuggling being sentenced to a few years in prison is noted, although there may be other cases. See Central Intelligence Agency, "Appendix A: Chronology of Nuclear Smuggling Incidents," March 27, 1996, https://www.cia.gov/news-information/speeches-testimony/1996/go_appendixa_032796.html.

work cooperatively with those states to improve their nuclear security; dissuades those states from informing others if they discover that their nuclear weapons or materials are ever stolen, thus undermining any efforts to recover them; and makes it difficult to work with those states in the aftermath of an attack to prevent further detonations.”¹⁰⁷ This argument against retribution has been applied to countries such as Russia and Pakistan who own fissile materials and who also could be threatened by terrorists using that material domestically.

This is where standards are important. Intent can be equated with willingness to protect and control material by compliance with standards, including standards for protection, controls, enforcement, and penalties. Noncompliance could be deemed willful negligence. For those who do not have the capacity on their own to effect standards, interested third parties can and have provided assistance both financially and operationally.¹⁰⁸ But clear standards have to be developed in the first place.

¹⁰⁷ Michael A. Levi, *Deterring State Sponsorship of Nuclear Terrorism*, Council Special Report, No. 29 (New York: Council on Foreign Relations Press, 2008), p. 4.

¹⁰⁸ See, for example, the U.S. State Department’s efforts, including the Nuclear Smuggling Outreach Initiative, <http://www.nsoi-state.net/>; the Export Control and Related Border Security (EXBS) program, <http://www.exportcontrol.org/>; and the 1540 Committee’s efforts to match states requesting help with states willing to provide assistance.

4. *Standards, Stockpiles, and States' Intent*

CURRENT STANDARDS

To measure state intent as part of culpability, some standards of conduct are needed so that deviation can be deemed a form of negligence. Some nuclear standards exist, but not all states participate in the various agreements, and the results are generally more “guidance” documents than standards. These standards include IAEA safeguards agreements with states, but these are confidential. And they are not fully followed—nonnuclear weapons states that are required to report materials under their control have at times not immediately informed the IAEA when they have interdicted nuclear material—at times the IAEA has found out via press reports.¹⁰⁹ Finally, not all states participate in the Illicit Nuclear Trafficking Database program.

The Convention on the Physical Protection of Nuclear Material is the only legally binding instrument protecting nuclear material—and it only applies to peaceful material in international transport and to those who have accepted the convention. According to the U.S. State Department, the concept was a U.S. initiative begun in 1974,¹¹⁰ taking more than a decade to become reality. The Convention entered into force in 1987 and was amended in 2005 to expand coverage to include domestic transport and nuclear facilities. Only 45 Convention members signed on to the amendment, but about half of those states accepted the amendment over the last 18 months, perhaps due to reinvigorated interest in nuclear security after the Nuclear Security Summit.¹¹¹ The amendment requires two-thirds of the 144 state parties to the underlying convention to accept the amendment for it to go into force, which means an additional 51 need to accept it.

Surprisingly, the United States is among those who have lagged in depositing its instruments of ratification of the amendment. Although the Senate gave its advice and

¹⁰⁹ IAEA officials, conversations with author, 2006.

¹¹⁰ Bureau of International Security and Nonproliferation, U.S. Department of State, “Convention on the Physical Protection of Nuclear Material,” February 8, 1987 (entered into force), <http://www.state.gov/t/isn/5079.htm>.

¹¹¹ International Atomic Energy Agency, “Amendment to the Convention on the Physical Protection of Nuclear Material,” updated December 30, 2010, http://www.iaea.org/Publications/Documents/Conventions/cppnm_amend_status.pdf. See also IAEA Director General, “Nuclear Security Report 2010: Measures to Protect against Nuclear Terror,” report prepared for the Board of Governors General Conference, August 12, 2010, http://www.iaea.org/About/Policy/GC/GC54/GC54Documents/English/gc54-9_en.pdf.

consent, the United States will not ratify the amendment until the implementing legislation is passed. As of this writing, this legislation has been held up for political reasons.¹¹²

Other issues exist with the Convention. The Convention has a dispute resolution mechanism that favors negotiation followed by arbitration by the International Court of Justice (to which all UN members belong), or otherwise as agreed by the disputing state parties. If no agreement can be reached, then a disputant “may request the President of the International Court of Justice of the Secretary-General of the United Nations to appoint one or more arbitrators”¹¹³—with the Secretary-General getting priority in conflicting requests. Many states, however, expressed certain technical reservations to the convention, including Pakistan, for example, which opted out of this formula for dispute resolution.

The one standard required of all states today is in UN Security Council Resolution 1540, which falls under UN Chapter VII and is therefore a requirement of all UN members. But it is vague, involving undefined “appropriate effective” methods. Although it is “required,” there are no specific legal requirements, penalties or enforcement. UNSCR 1540 says that states should not support WMD proliferation and should adopt legislation to criminalize nonstate proliferation. The resolution requires states to:

[A]dopt and enforce appropriate effective laws which prohibit any non-State actor to manufacture, acquire, possess, develop, transport, transfer or use nuclear, chemical or biological weapons and their means of delivery, in particular for terrorist purposes, as well as attempts to engage in any of the foregoing activities, participate in them as an accomplice, assist or finance them; ...to take and enforce effective measures to establish domestic controls to prevent the proliferation of nuclear, chemical, or biological weapons and their means of delivery, including by establishing appropriate controls over related materials and to this end shall:

- (a) Develop and maintain appropriate effective measures to account for and secure such items in production, use, storage or transport;
- (b) Develop and maintain appropriate effective physical protection measures;
- (c) Develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat, including through international cooperation when necessary, the illicit trafficking and brokering in

¹¹² The political reasons have to do with the penalties being proposed in the legislation. U.S. government official, telephone conversation with author, Washington, D.C., September 2010.

¹¹³ International Atomic Energy Agency, “The Convention on the Physical Protection of Nuclear Material,” Information Circular (Vienna: IAEA, May 1980), article 17, para. 2 <http://www.iaea.org/Publications/Documents/Infcircs/Others/inf274r1.shtml>.

such items in accordance with their national legal authorities and legislation and consistent with international law;

(d) Establish, develop, review and maintain appropriate effective national export and trans-shipment controls over such items, including appropriate laws and regulations to control export, transit, trans-shipment and re-export and controls on providing funds and services related to such export and trans-shipment such as financing, and transporting that would contribute to proliferation, as well as establishing end-user controls; and establishing and enforcing appropriate criminal or civil penalties for violations of such export control laws and regulations....¹¹⁴

The presumption is that each state operates in a unique environment with distinct threats that need to be assessed for what would constitute “appropriate effective measures” for security. The 1540 Committee has established working groups to assist states, including in the implementation of legislation, and it will monitor state compliance. The process, however, has been slow.¹¹⁵ Some states such as China have amended their domestic legislation to include penalties but not all states have fulfilled requirements, and many have done so in a limited way. Whether these laws are actively and effectively enforced is a separate problem. A recent report of the Committee notes that “owing to a wide range of obligations derived from resolution 1540 (2004), some States still have some lacunae in addressing all of them in their legislation, including the adoption of penalties and preventive enforcement measures.”¹¹⁶

The 1540 Committee is scheduled to report in April 2011 on state compliance—and some have suggested that when the UN passes a resolution extending the resolution that it consider putting the work under the UN Office of Disarmament Affairs (ODA), as it has larger staffing and could coordinate multiple Security Council requirements to better ensure compliance.¹¹⁷ Another option is to have a centralized coordinator for UNSCR 1540, not just the small group of expert advisors.¹¹⁸ Further, an excellent report

¹¹⁴ See United Nations Security Council, “1540 Committee.”

¹¹⁵ See *ibid.* For an analysis of that report, see Peter Crail, “UN Report Urges Progress on WMD Controls,” *Arms Control Today*, Vol. 38, No. 7 (September 2008), http://www.armscontrol.org/act/2008_09/UNreport.

¹¹⁶ See United Nations 1540 Committee, “Comprehensive Review of the Status of Implementation of Security Council Resolution 1540 (2004),” p. 3, http://www.un.org/sc/1540/comprehensive_review.shtml.

¹¹⁷ The 1540 Committee and ODA already work together. See United Nations Office for Disarmament Affairs (UNODA), “The Role of the Office for Disarmament Affairs (ODA) in Support of the Committee Established Pursuant to Security Council Resolution 1540 (2004),” <http://www.un.org/disarmament/WMD/1540/index.shtml>.

¹¹⁸ Regarding UNSCR 1540, which is up for renewal in April, some policy analysts and governments have suggested establishing best practices on a “regional or sub regional basis,” renewing the committee’s life for a 10-year period, and establishing a committee coordinator. See Stanley Foundation, “Policy Memo:

from a workshop sponsored by the Center for International Trade and Security and the Nuclear Law Association has rightly noted the need for coordination among all the various initiatives.¹¹⁹ More centralized coordination of 1540 with terrorism-related Security Council resolutions and within IAEA also should be considered, but these processes must not become overly bureaucratized. Also, the 1540 Committee has already made some progress. It developed a matrix of information that states must provide to show progress in complying with the resolution. For the nuclear-related parts of the matrix, see the appendix. The publication of these documents on the internet is a major step toward transparency and can allow better civil society oversight.¹²⁰ Although the Committee protests otherwise (see the Committee statement in the appendix), the matrix requirements can be viewed as the beginnings of a standard measure of conduct. And although today states only report on whether they have acted to effect a condition of the matrix (as in yes, the state has a law that does x) and are asked to supply action plans, one hopes that the next step will be some evaluation of the information the states provide. A March 2011 Stanley Foundation policy memo also recommends feedback on country reports.¹²¹

The 1540 matrix data include the Code of Conduct on the Safety and Security of Radioactive Sources and various conventions and protocols. The matrix specifies Safeguards Agreement with the IAEA but does not specify as part of that the Additional Protocol, which broadens the IAEA's authority to verify a country's compliance with the Nuclear Nonproliferation Treaty and better allows the IAEA to check on diversions of or illicit development of fissile materials. The matrix also does not specifically refer to the amendment to the Convention on the Physical Protection of Nuclear Material, which broadens that agreement from international transit of materials to covering domestic peaceful uses. The latest work program of the 1540 Committee

Perceptions, Resources Challenge Implementation of UN Security Council Resolution 1540 ahead of April Renewal," March 1, 2011, http://www.stanleyfoundation.org/1540/UNIssues_PM_3-11.pdf. Although all points are valid, the last point in particular is salient so that the inevitable changes in UN country delegations don't disrupt longer term plans for progress in implementation of the resolution.

¹¹⁹ Igor Khripunov and Carlton Stoiber, eds., "Nuclear Security and Nuclear Counterterrorism: Streamlining and Updating the Legal Framework" (Athens, Ga.: Center for International Trade and Security, University of Georgia, 2010), http://www.uga.edu/cits/Events/ViennaWorkshop/Vienna%20Executive%20Report_03Mar2010.pdf. For good overviews of agreements and mechanisms affecting nuclear security, see this document and also Elizabeth Turpen, "Policy Analysis Brief: Global Lockdown: Moving the Needle on Nuclear Security," The Stanley Foundation, October 2010, <http://www.stanleyfoundation.org/policyanalysis.cfm?id=434>.

¹²⁰ United Nations 1540 Committee, "The 1540 Matrix Template," <http://www.un.org/sc/1540/matrixtemplate.shtml>.

¹²¹ Stanley Foundation, "Policy Memo: Perceptions, Resources Challenge Implementation of UN Security Council Resolution 1540 ahead of April Renewal."

calls for “improving” the matrix.¹²² The Additional Protocol and the Amendment are two necessary additions. Other groups and organizations have also proposed sets of indicators of compliance with UNSCR 1540 and other agreements.¹²³

IMPROVING STANDARDS

The 1540 matrix is only one incentive toward the formation of standards of nuclear material protections. Industry standards develop when groups—such as insurers or investors and even operating entities—perceive a benefit from reducing risks through use of standards. Typically in control regimes, the sharing of “best practices” advances to informal standards and then to formally adopted standards. Those standards typically advance from self-reporting of compliance to the other extreme of independent certification of compliance with formally adopted standards. Oversight of self-reporting regimes is provided through “whistleblower” protections and through nongovernmental organization and/or media investigations. At the other extreme, standards certification, organizations seek certification to accrue benefits such as reduced insurance rates and better investor ratings. Licensing is a further form of standards requirements that may even be required to allow operation.

The 1986 Chernobyl explosion sparked the need for standard setting in the nuclear world, but it still took three years to establish the World Association of Nuclear Operators (WANO) to share operating information and best practices for safety in the civil arena. WANO focuses mainly on safety and less on security. To focus on security of civilian nuclear facilities, former Senator Sam Nunn, co-chair of the Nuclear Threat Initiative, recently helped found the World Institute of Nuclear Security (WINS), a partnership of government and industry professionals patterned on WANO. He noted, “The world cannot afford what I call a security Chernobyl.”¹²⁴

In WANO, members engage in technical exchanges and share lessons learned from operating events. WANO facilitates voluntary peer reviews (including at nuclear fabrication and processing facilities), emphasizes the individual and collective

¹²² “Letter dated 26 February 2010 from the Chairman of the Security Council Committee Established Pursuant to Resolution 1540 (2004) Addressed to the President of the Security Council,” March 2, 2010, http://www.un.org/ga/search/view_doc.asp?symbol=S/2010/112 An improved matrix, however, could become an overly simplified one.

¹²³ See, for example, Allen S. Weiner, Chaim Braun, Michael May, and Roger Speed, “Enhancing Implementation of U.N. Security Council Resolution 1540” (Stanford, Calif.: Center for International Security and Cooperation, Stanford University, September 2007), http://iis-db.stanford.edu/pubs/22070/1540_Final_Report_w_cvr.pdf.

¹²⁴ William J. Broad, “New Security Organization Will Try to Prevent Nuclear Theft,” *New York Times*, September 29, 2008.

responsibility of members to plant safety, presents awards for excellence and publishes collective safety performance reports.¹²⁵ Although plant operators have an interest in avoiding an accident, not all are equally accepting of their responsibilities.¹²⁶ Nonetheless, all commercial nuclear power plants have now received WANO reviews.¹²⁷

WINS has made great strides since its inception in late 2008. It has held workshops and issued guidance on best practices. Its work complements that of the Institute of Nuclear Materials Management (INMM), which contributed to WINS' establishment. In the commercial arena, some security standards do exist. Professional organizations like the Institute of Electrical and Electronics Engineers (IEEE) have promulgated standards as has the American National Standards Institute (ANSI).¹²⁸ Indeed security standards in the private sector are sure to continue to evolve as investors look to better assess all their risks. But in the noncommercial area, among government-owned enterprises, the press for standards can only come about if threats and resulting risks are perceived as being sufficiently high to spur some standardization—even if modified based on threat.

Governments are starting to recognize that they have a vested interest in good security, as groups such as WINS, the IAEA, and the North Atlantic Treaty Organization are looking at standardization of all nuclear security practices.¹²⁹ The IAEA does provide Integrated Nuclear Security Plans for states that want assistance in improving nuclear security, and as of 2008 it has been working with 44 states on implementation.¹³⁰ The United States, working with Russia and other countries, has also undertaken an effort to establish comprehensive “model guidelines for nuclear detection architectures” that

¹²⁵ See World Association of Nuclear Operators, <http://www.wano.info/>.

¹²⁶ This biannual WANO conference noted, for example, how safety rhetoric does not always match performance. See “Conference Report; Minding The Gap,” *Nuclear Engineering International*, November 5, 2007. The article also questioned the design performance standards for the nuclear power plant that was affected by the July 2007 earthquake in Japan.

¹²⁷ “Safety Milestone for WANO,” World Nuclear News, February 4, 2010, http://www.world-nuclear-news.org/RS-Safety_milestone_for_WANO-0402108.html. Reviews are expected to be done every six years with even more frequent peer reviews.

¹²⁸ See, for example, IEEE, “Standard Criteria for Security Systems for Nuclear Power Generating Stations,” No. 692-2010, February 12, 2010; and Institute of Nuclear Materials Management (INMM), “Nuclear Materials Management–Measurement Control Program– Nuclear Materials Analytical Chemistry Laboratory,” ANSI N15.51-2007.

¹²⁹ I. Khripunov, N. Ischenko and J. Holmes, eds., *Nuclear Security Culture: From National Best Practices to International Standards* (Amsterdam: IOS Press, September 2007).

¹³⁰ International Atomic Energy Agency, “Integrated Nuclear Security Support Plan (INSSP),” <http://www-ns.iaea.org/security/inssp.htm>. For more specific details on some resulting actions, see International Atomic Energy Agency, “International Nuclear Security Advisory Service (INSServ),” <http://www-ns.iaea.org/security/insserv.htm>.

offer a layered system of controls from materials protection, controls, and accounting (MPC&A) to interdiction at sea and protection at borders,¹³¹ starting with civilian nuclear materials.

Certainly, there is no shortage of UN directives, IAEA security guidelines, and supporting organizations to promote responsible civilian nuclear behavior.¹³² Furthermore, recent technical group discussions “acknowledged” that binding legal agreements might be considered in the future for all radiological sources, with national registers of sources and possible mechanisms for an international system of continuous control.¹³³ Coming to agreement, however, on specific standards, including defining “design basis threat” and how to secure against it, is yet to be achieved.¹³⁴

Developing standards for military nuclear stocks is quite different. Restrictions exist among nuclear supplier states and within U.S. law regarding the sharing of nuclear technologies, including protective technologies, with states that have not signed the NPT.¹³⁵ This restriction on sharing protective technologies, i.e., security mechanisms, is not an insurmountable problem. More problematic are the concerns over the internal security of the states that would be accepting and adapting these technologies because of the risk of malevolent insiders using their knowledge to subvert that technology in their state or others. Nothing is without risks, but such exchanges of security expertise have taken place to protect nuclear materials, even between the United States and

¹³¹ Mark Wittrock, “Model Guidelines for Nuclear Detection Architecture,” (Washington, D.C.: Domestic Nuclear Detection Office, Department of Homeland Security, April 1, 2009), http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2009/cn166/CN166_Presentations/Session%206/INV-19%20Wittrock.pdf; and C.S. Elliot Kang, “Enhancing International Partnerships,” remarks at the 2009 plenary meeting of the Global Initiative to Combat Nuclear Terrorism, The Hague, Netherlands, June 16, 2009, <http://www.state.gov/t/isn/rls/rm/125349.htm>.

¹³² See U.S. Department of State, “Nuclear Security Summit Work Plan Reference Document,” April 13, 2010, <http://fpc.state.gov/documents/organization/140357.pdf>.

¹³³ See the excellent report of the chairman, Steven McIntosh, in IAEA Secretariat, “Open-ended Meeting of Technical and Legal Experts for Sharing of Information on States’ Implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and Its Supplementary Guidance on the Import and Export of Radioactive Sources,” Report by the Chairman, pp. 8–10.

¹³⁴ Matthew Bunn and E.P. Maslin, “All Stocks of Weapons-Usable Nuclear Materials Worldwide Must Be Protected against Global Terrorist Threats,” *Journal of Nuclear Materials Management*, Vol. 39, No. 2 (Winter 2011), pp. 21–27.

¹³⁵ See Sharon Squassoni, *Nuclear Threat Reduction Measures for India and Pakistan*, CRS Report for Congress (Washington, D.C.: Congressional Research Service, Library of Congress, updated February 17, 2005), Order Code RL31589, <http://www.fas.org/sgp/crs/nuke/RL31589.pdf>; and Sharon Squassoni, *Globalizing Cooperative Threat Reduction: A Survey of Options*, CRS Report for Congress (Washington, D.C.: Congressional Research Service, Library of Congress, updated October 5, 2006), Order Code RL32359,

Pakistan.¹³⁶ Furthermore, certain basic requirements, such as protective fencing to secure command authorities, are not proprietary technological concepts but simply good operating procedures. States willing to adopt such standards in their civilian and military programs might be deemed less culpable under intent.

Simple adoption of standards is necessary but insufficient as an indicator of intent. Verification and implementation of those standards are also required—and are elements in the 1540 Matrix. Self-assessment and reporting, including the declaration of existing stockpiles, are the necessary first steps, but verification is next, which would be an important component of any nuclear attribution regime.

VERIFICATION

Nonnuclear weapons states who have signed the NPT are obliged to declare their nuclear facilities to the IAEA, which relies on a state's material accounting systems to verify nondiversion of these stocks. Thus, although the IAEA already monitors fissile material, it only covers a small portion of the stocks worldwide, because most stocks are held by nuclear weapons states that are not required to report stocks and by states that are not signatories to the NPT.¹³⁷ Also, the IAEA safeguards system is designed to monitor declared stockpiles (not actually to safeguard them), and the IAEA has limited ability to check for undeclared stocks. One simple measure of intent, for example, would be the willingness of a state to adopt the Additional Protocol that would allow IAEA more leeway in searching for undeclared facilities in nonnuclear weapons states, and as noted earlier this should be part of an enhanced 1540 matrix.¹³⁸

The declaration of existing stocks from nuclear weapons states will be difficult. The extent to which states can account for their stockpiles of material is uncertain. Some stocks have been lost already—either in reality or simply in accounting. For these states, fissile material verification could be undertaken in a staged approach. The first step

¹³⁶ Matthew Bunn, *Securing the Bomb 2010: Securing All Nuclear Material in Four Years* (Cambridge, Mass., and Washington, D.C.: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, and Nuclear Threat Initiative, April 2010), pp. vii, 32 n. 16, http://www.nti.org/e_research/Securing_The_Bomb_2010.pdf.

¹³⁷ India and Pakistan have not signed the NPT but have some civil facilities under IAEA safeguards. Likewise, some civil facilities in nuclear weapons states have been put under IAEA safeguards. The amount of fissile material monitored by the IAEA is small. Siegfried S. Hecker, "Toward a Comprehensive Safeguards System: Keeping Fissile Material Out of Terrorists' Hands," *Annals of the American Academy of Political and Social Science*, Vol. 607 (September 2006), pp. 121–132, http://iis-db.stanford.edu/pubs/21247/Toward_a_Comprehensive_Safeguards_System.pdf.

¹³⁸ The IAEA already has authority to undertake "special inspections" given some interpretations. See Chayes and Chayes, *The New Sovereignty*, pp. 180–181, 216.

would comprise self-auditing, which has already been undertaken by several states¹³⁹; the United States and Russia could also develop cooperative processes and transparent reporting, which could serve as a prototype for others' reporting.¹⁴⁰ A second step might consist of developing graduated application of independent verification of fissile material production cutoff (e.g., from remote monitoring to random verification) before further verification of stockpiles is undertaken.¹⁴¹ Verification of actual dismantlement of existing nuclear devices and production facilities might be the final step, which is already under discussion.¹⁴²

States "cheating" by not declaring all stocks of material is something that has been a concern within the Biological and Toxin Weapons Convention, which has not developed a protocol on verification. For fissile materials, lessons could be taken from the Chemical Weapons Convention (CWC), where stocks of material are declared and destroyed with verification mechanisms in place. The Organisation for the Prohibition of Chemical Weapons (OPCW) implements the terms of the convention, which allows challenge inspections.

¹³⁹ See International Panel on Fissile Materials, "Declaration of Fissile Material Stocks and Production," http://www.fissilematerials.org/ipfm/pages_us_en/inventories/declarations/declarations.php; and additional briefings by the International Panel on Fissile Materials, http://www.fissilematerials.org/blog/ipfm_news_and_publication/briefings/.

¹⁴⁰ Matthew Bunn, Anthony Wier, and John P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass., and Washington, D.C.: Belfer Center for Science and International Affairs, Harvard Kennedy School, and Nuclear Threat Initiative, March 2003), pp. xvi, 6, 97, 147–150, http://www.nti.org/e_research/cnwm/cnwm.pdf

¹⁴¹ See, for example, International Panel on Fissile Materials, "A Fissile Material Cutoff Treaty," 2006, http://www.fissilematerials.org/ipfm/pages_us_en/fmct/fmct/fmct.php. See also the suggestions of Dr. Bruno Pellaud, former Deputy Director General of the IAEA, in Bruno, "Revisiting the FM(C)T," presentation at the Geneva Centre for Security Policy, January 27, 2006.

¹⁴² See, for example, the recent simulations that Norway and the United Kingdom undertook to verify onsite dismantlement of nuclear bombs. "How to Dismantle a Nuclear Bomb," *BBC News*, July 16, 2009, <http://news.bbc.co.uk/2/hi/europe/8154029.stm>.

“Under Article IX of the [Chemical Weapons] Convention any State Party can request the Secretariat to conduct an on-site challenge inspection anywhere in the territory (or under the jurisdiction or control) of any other State Party. States Parties are not granted the right to refuse a challenge inspection, regardless of the nature of the location at which it is to take place. Article IX encourages, but does not oblige, States Parties to try to clarify and resolve non-compliance concerns through consultations before requesting a challenge inspection. Challenge inspections are characterised by the “any time, any place” concept; they are to be launched at very short notice and can be directed at declared or undeclared undeclared [sic] facilities and locations.... Part X of the Verification Annex of the Convention contains extremely detailed guidelines for the conduct of challenge inspections. Only specifically designated inspectors can participate in challenge inspections. Nationals of the inspected State Party (ISP) and the requesting State Party (RSP) are excluded from the team.”
– Organisation for the Prohibition of Chemical Weapons, “Challenge Inspections,” <http://www.opcw.org/our-work/implementation-support/routine-tasks/challenge-inspections/> .

The Chemical Weapons Convention is also not without problems, which include tight budgets, the absence of any state requests for challenge inspections, states’ slow adoption of domestic laws compliant with the convention, and the delayed reduction in chemical weapon stockpiles.¹⁴³ But such CWC issues can also prove instructive, and the overlap of requirements among conventions can help to reinforce standards for fissile materials.

Indeed in 2005, a National Academies panel concluded that “[c]urrent and foreseeable technological capabilities exist to support verification at declared sites, based on transparency and monitoring, of declared stocks of all categories of nuclear weapons—strategic and nonstrategic, deployed and nondeployed—as well as for the nuclear-explosive components and materials that are their essential ingredients. Many of these capabilities could be applied in existing bilateral and international arrangements without the need for additional agreements beyond those currently in force.”¹⁴⁴

¹⁴³ WMD411, “Key Challenges and the Road Ahead” (Monterey, Calif.: James Martin Center for Nonproliferation Studies, updated July 2010), http://www.nti.org/f_wmd411/f2o3.html.

¹⁴⁴ Committee on International Security and Arms Control, *Monitoring Nuclear Weapons and Nuclear-Explosive Materials*, p. 218.

How to account for already lost material is another problem. If policymakers start a public attribution discussion, states might work harder to locate any lost material. States might confidentially inform other significant parties of the lost material, with those parties joining the effort to find that material. Or states might issue a public announcement detailing the lost material, with a reward for its return. Although this may appear somewhat farfetched, it could also lead to a refreshed interest in civil defense and public resilience.

How and whether states would be held accountable for past misplaced material needs to be discussed. New understandings need not apply retroactively. For example, when the International Criminal Court came into being it could only prosecute “crimes committed after the entry into force of this Statute” or after a state acceded to the statute unless it declares otherwise.¹⁴⁵ The United States itself has had some historical accounting problems,¹⁴⁶ as well as recent confused reporting.¹⁴⁷ Innovative solutions, such as current material tagging, could be instituted, so material from a specific date could be tracked.¹⁴⁸

¹⁴⁵ United Nations, “Rome Statute of the International Criminal Court,” (Rome: United Nations, July 17, 1998), article 17, http://untreaty.un.org/cod/icc/statute/99_corr/cstatute.htm. Some NGOs argued against statutory limitations on prosecuting war crimes and crimes against humanity, per other agreements. See American Association of Jurists, “Independence of the Judiciary: Statute of the International Criminal Court,” submitted to United Nations Economic and Social Council, February 11, 2000, [http://www.unhcr.ch/huridocda/huridoca.nsf/AllSymbols/705EE910C3154B5F802568B0004B7F98/\\$File/G0010861.pdf?OpenElement](http://www.unhcr.ch/huridocda/huridoca.nsf/AllSymbols/705EE910C3154B5F802568B0004B7F98/$File/G0010861.pdf?OpenElement).

¹⁴⁶ Hecker, “Toward a Comprehensive Safeguards System.” The *New York Times* also published reports describing both how technicians discovered several pounds of missing plutonium, and how workers found over sixty pounds of plutonium in air ducts at a plant. See, for example, James Brooke, “Plutonium Stockpile Fosters Fears of ‘a Disaster Waiting to Happen,’” *New York Times*, December 11, 1996, <http://www.nytimes.com/1996/12/11/us/plutonium-stockpile-fosters-fears-of-a-disaster-waiting-to-happen.html?scp=2&sq=missing%20plutonium&st=cse&pagewanted=2>; and Matthew L. Wald, “38-Year Plutonium Loss at Plant Equals 7 Bombs,” *New York Times*, March 29, 1990, <http://www.nytimes.com/1990/03/29/us/38-year-plutonium-loss-at-plant-equals-7-bombs.html?scp=16&sq=missing%20plutonium&st=cse>, respectively.

¹⁴⁷ See Office of the Administrator, National Nuclear Security Administration, U.S. Department of Energy, letters to Arjun Makhijani, February 28, 2006, <http://www.ieer.org/pu/nnsa0602.pdf>

¹⁴⁸ Tagging might range from radio frequency tagging of nuclear devices to elemental tagging. See Argonne National Laboratory, “New RFID Technology Tracks and Monitors Nuclear Material,” insciences.org, March 24, 2009, http://insciences.org/article.php?article_id=363;1 and G.P. Gilfoyle and J.A. Parmentola, “Using Nuclear Materials To Prevent Nuclear Proliferation,” *Science and Global Security*, Vol. 9, No. 2 (2001), pp. 81–92.

Another concern is that states could display an interest in falsely declaring some material lost in order to ensure that future material losses are not attributed to them. Part of the declaration of material stocks could include annual production histories. Age dating of materials found and verification of some sites could help detect some falsehoods.¹⁴⁹ In addition, a finding of intentional spoofing would itself lead to revelations about intent.

ACHIEVING AGREEMENT

A state's intent could be measured therefore by gradations of compliance with standards—with the heaviest burden to prove intent-to-protect placed on the states that have fissile material in their possession. Intent could be evidenced by ranges of actions:

- from the simplest regarding laws and physical protections, such as ratification of relevant international agreements, self-reporting of the state's stockpiles and its characteristics, and domestic legislation to provide for criminal penalties for nonstate proliferation;
- to the more complex, such as having independent validation of effective legislation with evidence of enforcement and some confidential verification of specific effective lockdown of fissile material and their facilities and protections for all fissile materials and border/transport controls;
- to the most intense, such as independent verification of enforcement of or willingness to extradite those who support proliferation and over whom the state has purview, and independent verification of the destruction and nonproduction of fissile material. This latter effort could be part of a Fissile Material (Cut-Off) Treaty (FMCT), which if it gets agreed with verification, would help control and attribution efforts.¹⁵⁰ The FMCT is under consideration in the UN Conference on Disarmament.¹⁵¹

¹⁴⁹ For example, inspection of graphite moderators in plutonium-production reactors can help reveal the reactors' production history.

¹⁵⁰ The Fissile Material Treaty would prohibit production of fissile material for weapon uses and put all civilian materials under safeguards. The International Panel on Fissile Materials has recommended that it be a verifiable treaty. See International Panel On Fissile Materials, "A Fissile Material (Cut-Off) Treaty (FMCT): A Treaty Banning the Production of Fissile Materials for Nuclear Weapons or Other Nuclear Explosive Devices," February 5, 2009, http://www.fissilematerials.org/blog/fmct-ipfm_feb2009draft.pdf.

¹⁵¹ Pakistan, however, has impeded the work program as it feels it needs to develop additional fissile material to have some balance against India. See: Zia Mian and A.H. Nayyar, "Playing the Nuclear Game: Pakistan and the Fissile Material Cutoff Treaty," April 2010, http://www.armscontrol.org/act/2010_04/Mian.

At each of these levels, the nature of the threat could determine the levels of controls, including border controls for states known as transit venues for illicit trafficking of goods. Just as the IAEA has negotiated distinct country-specific Safeguards Agreements, eventually it or another independent entity could do the same regarding overall fissile material security requirements for a country.

Spurring the development of standards will be a gradual process. It has worked, however, when importance has been placed on the outcome and a small group of committed countries have initiated change, such as in the G7's development of the Financial Action Task Force (FATF) and its work developing and promulgating financial standards to deter money laundering and terrorist financing. As researchers noted about FATF, "It simply built upon legislative and regulatory instruments already in place...[and] constitutes a positivist problem-solving approach, tweaking the existing system to overcome new challenges."¹⁵² Building on existing agreements, the proposed "Russia-U.S.-Plus" initiative can lead the way.

Regional organizations, NGOs, and civil society can also play a crucial role in helping to promote UNSCR 1540 compliance, for example, as well as successful standards development and auditing. The European Union, the Organization for Security and Cooperation in Europe, and the Organization of American States are just a few helping to promote the development of local laws, regulations and states' capacity to comply with UNSCR 1540 imperatives. The issue of consistency of approaches arises, however, when help comes from disparate groups—such as regional or subregional organizations and various states volunteering to help those requesting assistance. Coordination across efforts will require centralized leadership for efforts, a challenge as country diplomatic representation changes. But the question of whether a government-affiliated organization could even develop timely standards also remains.

NGOs and civil society could help spur faster standard-setting. The new WINS, for example, has helped to publicize the importance of standards. But broader civil society can also be rallied to assist the effort in innovative ways. For example, George Washington University Law School representatives met with the 1540 Committee's eight expert advisors to discuss ways in which U.S. and international law students could provide volunteer research support to further the Committee's efforts. The associate dean of the school will soon be submitting a protocol to the Committee on

¹⁵² Yee-Kuang Heng and Ken McDonagh, "The Other War on Terror Revealed: Global Governmentality and the Financial Action Task Force's Campaign against Terrorist Financing," *Review of International Studies*, Vol. 34, No. 3 (2008), p. 556.

how the research will be conducted and presented to the committee.¹⁵³ This pilot project, if successful, is expected to be expanded to other schools and will serve as a way both to support the committee and to educate upcoming international civil society leaders.

One idea that needs further development is whether a small group of civil society experts could actually develop a template for regulatory and legal standards if governments do not lead in this area. These standards would be circulated for comment and further discussion—much as the International Panel on Fissile Material, comprising experts from many disciplines and countries, developed a draft fissile material treaty for states to consider. Indeed many standards exist and are already accepted as guidance,¹⁵⁴ but standards required by states and facilities might vary, as noted, regarding “appropriate effective” based on what fissile materials the state possesses, if any, and other considerations, such as past/likely future smuggling incidents.¹⁵⁵ Standards have and are being developed that go beyond the official UN 1540 matrix, including a checklist on the nuclear security culture of facilities and some model state legislation.¹⁵⁶ Certain situations, such as verifying standards’ application to military fissile material, would be difficult, but other measures such as transparency and the verification of the destruction of materials could be used. (The work of the Trilateral Initiative could be used as a model once governments became directly involved.) Then the civil society group could rank states according to intent and publicly post the information. States could use this to do their own self assessment. The civil society group developing the standards protocol could be an off-shoot of the Fissile Materials Working Group but broadened with more international representation. Such a group might complement the suggested “Russia-U.S.-Plus” effort. Lessons could be learned

¹⁵³ Susan L. Karamanian, Associate Dean for International and Comparative Legal Studies, George Washington University Law School, email correspondence with author, August 8, 2010.

¹⁵⁴See, for example, IAEA, “Guidance on the Import and Export of Radioactive Sources,” Austria, 2005, http://www-pub.iaea.org/MTCD/publications/PDF/Imp-Exp_web.pdf.

¹⁵⁵ This could be determined formulaically including such factors as proximity to states’ with fissile materials, past border incidents, and so on. See also Bunn and Maslin, “All Stocks of Weapons-Usable Nuclear Materials Worldwide Must Be Protected against Global Terrorist Threats.”

¹⁵⁶ Based on survey questions, it provides both objective and subjective tests of rules and attitudes and is designed for management self evaluation. Igor Khripunov, Nikolay Ischenko, and James Holmes, *Nuclear Security Culture: From National Best Practices to International Standards* (Amsterdam: IOS Press, 2007), appendix III. Note that other organizations such as VERTIC, the Verification Research Training and Information Center, a UK-based NGO, also have worked to develop guidelines, including model legislation. See <http://www.vertic.org/>.

from private sector efforts to develop governance standards where similar challenges over conflicts of interest have occurred.¹⁵⁷

Country performance against nuclear standards could be tracked and publicized, in general terms to avoid presenting security risks. The information could be published online. This would follow the IAEA practice of completing safety regulatory reviews and making some of the findings available.¹⁵⁸ Nuclear security rating standards would not purport to be comprehensive—especially at first—but could at least be the start of a standard rating system. Careful thought would have to go into the composition of the rating group and the process for rating (e.g., blind ratings based on objective characteristics or on verifiable measures). To spur this effort, a proliferation watchdog or a foreign policy–interested media organization could participate as an independent oversight panel to develop standards and rate countries on security standards, which could be equated to evidenced intent. This would be similar to economists’ deciphering revealed preferences among consumers from their choices, i.e., a system not without flaws but at least a way to gain insights. The alliance of a media outlet and a research group can help publicize the effort. *Foreign Policy* magazine, for example, allied with the Fund for Peace to produce a “Failed States Index,” which helps bring attention to that issue.¹⁵⁹ The new World Justice Project’s Rule of Law Index provides similar

¹⁵⁷ For example, in the early part of this decade, concerns about executive compensation, lack of independent board oversight with friendly cross-board director appointments, problematic accounting, and other issues led several groups to develop corporate governance standards. One of those groups, the Conference Board—an independent, international organization composed mainly of private business executives—established a task force that issued recommendations on good governance practices. See, for example, Kenneth N. Gilpin, “Expert Business Panel Puts Stock Options on a List of Reforms,” *New York Times*, September 18, 2002, <http://www.nytimes.com/2002/09/18/business/expert-business-panel-puts-stock-options-on-a-list-of-reforms.html?scp=7&sq=conference%20board%20corporate%20governance&st=cse>. The Conference Board then tracked the performance of the S&P 500 regarding some of the recommendations. (Frank Tortorici, Director of Public and Media Relations, the Conference Board, telephone conversation with author, August 13, 2009; email follow-up forwarded from retired Conference Board governance expert Carolyn Brancato, August 15, 2009).

¹⁵⁸ A 2010 IAEA review of U.S. safety practices suggested, among other things, that the U.S. Nuclear Regulatory Commission develop a “fully integrated management system” and consider incorporating IAEA safety standards. See International Atomic Energy Agency, “Safety Experts Complete IAEA Nuclear Regulatory Review of the United States,” October 29, 2010, <http://www.iaea.org/newscenter/pressreleases/2010/prn201013.html>. The IAEA points out that these are “peer reviews, not inspections or audits.” See International Atomic Energy Agency, “Safety Experts Review U.S. Nuclear Safety Regulations,” November 3, 2010, <http://www.iaea.org/newscenter/news/2010/ussafetyreg.html>.

¹⁵⁹ Fund for Peace, “The Failed States Index, 2010,” *Foreign Policy.com*, http://www.foreignpolicy.com/articles/2010/06/21/the_failed_states_index_2010.

aspirational standards for countries interested in general good governance.¹⁶⁰ A civil society group and media outlet could join together to lend attention to “intent” measures based on a synthesis of IAEA, WINS, and others’ security recommendations.

Of course, punitive actions against alleged perpetrators could not be taken simply on civil society’s assessments—but having even informal civil society standards could spur more governmental agreements on the same. With such a system established first by civil society organizations, a group of interested countries—e.g., potential victims of a nuclear attack—might then agree to consider state nuclear security against these rating standards and could limit relations with failing countries. As Harvard Professor Matthew Bunn and Colonel-General E.P. Maslin, former Russian commander overseeing security of Russia’s nuclear weapons, have suggested, “Ultimately, effective nuclear security should be part of the ‘price of admission’ for doing business in the international nuclear market.”¹⁶¹ The standards are sure to find not just developing countries falling short of standards but also major owners of fissile material, such as Russia and the United States as well.

A lesson can also be taken from attempts at better corporate governance in the private sector; new rules over the last decade have limited privileges and defined personal responsibilities and possible penalties. These are crucial steps for nuclear attribution as well. For example, world stock exchanges began requiring tighter rules of companies for the privilege of being listed. Companies adopting International Financial Reporting Standards have easier access to a wider investor audience. Responsibilities and penalties became more defined. In the United States, for example, the 2002 Sarbanes-Oxley Act instituted a public company accounting oversight board to police auditors and required specific individuals to sign off personally on the company’s financial reports. Such lessons as these can be applied to nuclear stockpile governance and evidence of intent. It is noteworthy, however, that the new corporate rules did not conceive of every threat to the larger system of corporate performance—and the world indeed experienced financial implosion. It is crucial, then, to examine systemic risk and build resilience into the system. Personal certification of both nuclear stockpiles and civilian fissile material and their safety should be considered.

Short of being able to require standards and enforce compliance with them, a regime also gains from voluntary accreditation. In U.S. healthcare, for example, the Joint Commission on Hospital Accreditation is a nonprofit organization whose accreditation

¹⁶⁰ See World Justice Project, “Rule of Law Index,” <http://worldjusticeproject.org/rule-of-law-index>.

¹⁶¹ Bunn and Maslin, “All Stocks of Weapons-Usable Nuclear Materials Worldwide Must Be Protected against Global Terrorist Threats.”

allows hospitals to obtain Medicare and Medicaid reimbursements. Accredited hospitals pay fees for being evaluated for regulatory compliance. Core measures for standards of care are set. Some review visits are unannounced. Initial findings of noncompliance may not be publicly announced. A related but separate entity advises on processes to ensure accreditation. In nuclear attribution, having facilities and personnel “accredited” could increase confidence in nuclear security as well as safety and indicate intent.

This is a broader system of standards with levels of requirements and standards than could now be applied. With so much fissile material available, however, and with nuclear handling increasing worldwide, longer term system needs become more important—and measures of intent will be needed. Thus, if standards are clearly established¹⁶² and well communicated, and if assistance is forthcoming to those without the capacity to achieve those standards on their own, then some measure can be taken of state intent.

When all this transpires, states can make defensible, if not certain, judgments. As demonstrated, however, mechanisms can be established for determining the guilty party, norms can be voiced if not developed on the definition of the effect,¹⁶³ and the intent can be weighted based on adherence to standards.¹⁶⁴ Then responses can be rationally conceived and defensibly undertaken.

¹⁶² Some analysts argue for rule-based systems, in which every eventuality is taken into account and inevitably some are not, or for a principles-based system, in which the spirit of the agreement is indicated. One should argue for both—with the spirit applying where the rules do not. Ambiguity may have some benefits in agreements (see Chayes and Chayes, *The New Sovereignty*, pp. 10-13), but its benefits must be closely questioned when it comes to national security standards.

¹⁶³ This could even be mechanistic, with dollar values attributed to property destroyed and to human lives. See Lisa A. Robinson, James K. Hammitt, Joseph E. Aldy, Alan Krupnick, and Jennifer Baxter, “Valuing the Risk of Death from Terrorist Attacks,” *Journal of Homeland Security and Emergency Management*, Vol. 7, No. 1 (January 2010), .

¹⁶⁴ By definition and in order to gain agreement, a principle could be applied that greater culpability would be placed on states whose material was used (as these are fewer in number) than on other states who may have or whose citizens may have facilitated the illicit act.

5. *Assured Responses—How to React?*

The point of threatening consequences is to coerce certain behaviors, which means that the consequences must be negative enough to deter certain actions or positive enough (if only by avoiding the negative) to compel certain others behaviors. Communicating the consequences is key. Should a fissile material event require an immediate and automatic response, as in the “Doomsday Device”? Probably not, given the many uncertainties involved.

“Deterrence is the art of producing in the mind of the enemy the fear to attack, and so because of the automated and irrevocable decision-making process, which rules out human meddling, the doomsday machine is terrifying and simple to understand—and completely credible and convincing....But the whole point of the doomsday machine is lost if you keep it a secret.”

—Dr. Strangelove (Peter Sellers) explains the flaw in the Soviet Union not revealing it had installed a “Doomsday Device” that would automatically annihilate the world if the Soviets were attacked by a nuclear weapon. From the 1964 movie: “Dr. Strangelove, or How I learned to stop worrying and love the Bomb.”

It is unacceptable, however, to continue with no clear, public communication or expected responses. The range of responses needs to be explored, decided upon, and communicated. How a state acts need not be what it says it will do — a state can always diplomatically redirect its response. Some response must be anticipated, however, by states and by individual actors, if attribution is to act as a deterrent.

A debate has begun on whether threatening punishments against states or individuals would work. For individuals the calculus is complicated by the degree of their financial need, ideological commitment, and risk aversion. For states, according to one former IAEA official, penalties would certainly make states at least think twice about letting material—intentionally or unintentionally—out of their control. And if a state has already been identified as the source of material for one incident and additional nuclear materials/weapons may be at large, the cooperation of that state would certainly be needed to find and eliminate additional illicit acts. Would the threat of punishment deter that cooperation?

This proposed dichotomy between retaliation and cooperation, however, is false—for states and individuals. The concepts are not mutually exclusive in life or in law. Cooperative actions are often undertaken with prescribed consequences for noncompliance when the larger basis for cooperation is valued. Lessons from other areas can be well applied for framing resilient cooperation in nuclear attribution. For example, expected penalties may be negotiated; liabilities may be previously agreed as limited under certain conditions; responsibilities may be jointly shared. And if the offending state or person could expect to be eventually discovered with even harsher penalties resulting due to the delay in admission of the offense, then cooperation can be elicited earlier rather than later.

Three concepts need development. First, the range of penalties that would deter acts needs to be explored. Second, the means for establishing alternatives to the full penalties and means for providing rewards need to be explored as a way to induce cooperation. Again, lessons can be learned from looking at similar situations. Third, consideration needs to be given to how to inspire confidence that judgments will actually be made and actions effected.

Penalties are related to the judgment of guilt, earlier discussed regarding the act, its effect and the intent of the actor and of the certainty regarding all these judgments.

Issues of judgment are addressed in U.S. courts by establishing different trial standards that can prove instructive for nuclear cases where the certainty of attribution and the intent can vary, and the importance of the effect can be debated. The burden of proof for criminal cases has to reach the threshold of “beyond a reasonable doubt,” but in civil cases, the threshold is lower and can range from “preponderance of the evidence” to “clear and convincing evidence.” The range of penalties then differs. Criminal penalties include fines, imprisonment and (in some states) the death penalty. Civil penalties are generally restricted to fines but sometimes including punitive damages. Public contrition may also be required.¹⁶⁵

Similarly the degree of conviction achieved in the so-called trial phase can lead to certain levels of responses in the “sentencing” phase. In U.S. domestic law, sentences are handed down not just as penalties to deter others from doing the same but also for

¹⁶⁵ Former Texas Judge Ted Poe, now U.S. Congressman (and serving on the House Subcommittee on Terrorism, Nonproliferation, and Trade, among others), often went further and required the convicted to publicly apologize for their behaviors, e.g., by carrying signs about their acts.

societal protection (through incarceration of dangerous persons) and to exact societal retribution.¹⁶⁶

Specific procedures are followed because society buys into the system, thereby making it effective. Buy-in is both literal, in terms of financially paying for it, and figurative, in terms of helping to enforce it. For nuclear cases, the lesson is that societal agreement on the appropriate penalties for different levels of egregious acts is an important tenet that should not be overlooked—as most penalties related to illicit fissile material will also need societal agreement to be effectively enacted. Likewise, rewards for cooperative behaviors need to be socially accepted as well as commonly understood.

As noted, two types of actors commit the illicit acts: the state (with individuals acting in a national capacity) and the individual (and/or group of individuals) acting for their own benefit, financial or ideological. States and individuals knowing that a framework is already in place can itself help deter some illicit acts.

REPRISALS AND REWARDS THAT ENCOURAGE POSITIVE BEHAVIOR

Some possible reprisals against states include physical attack, forced reparations, sanctions, and exclusions from certain activities. States that cooperate can face positive responses, such as reduced penalties, limitations of liabilities, and societal accolades or financial gains.

To the state who must be compelled to cooperate in locking down its material and assisting in attribution, the obvious threat is one of physical reprisal. Although President Obama's National Security Strategy is more tempered,¹⁶⁷ his predecessor's strategy was openly threatening of harsh reprisals. Former President George Bush's national security advisor Stephen Hadley stated, "[T]he United States...reserves the right to respond with overwhelming force to the use of weapons of mass destruction against the United States, our people, our forces and our friends and allies. Additionally, the United States will hold any state, terrorist group, or other nonstate actor fully accountable for supporting or enabling terrorist efforts to obtain or use

¹⁶⁶ Jurists and social scientists debate the effectiveness of harsh penalties in deterring crimes, especially given the unpremeditated nature of many criminal acts. However, fissile material diversions and use would likely be very premeditated.

¹⁶⁷ "Military force, at times, may be necessary to defend our country and allies or to preserve broader peace and security..." Barack Obama, *The National Security Strategy of the United States of America* (Washington, D.C.: White House, May 2010), p. 22,

http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.

weapons of mass destruction, whether by facilitating, financing, or providing expertise or safe haven for such efforts.”¹⁶⁸

To validate such a threat of physical reprisal, the possibility of escalation and further reprisals by the initial offending state must be addressed. An escalation of hostilities can threaten allies or U.S. territories, further exacerbating the situation. The threat of reprisal could therefore ring false unless allies and Americans were prepared for possible retaliation by the offending state and unless other potential adversaries were also consulted to help ensure a conflict does not broaden. For example, South Korea would have to accept the possibility of a North Korean attack if the United States attacked North Korea as retribution for the use or facilitation of use of a nuclear weapon against U.S. interests. China would also need to be consulted. These types of considerations would have to be addressed ahead of time to establish the range of possible plausible outcomes. Scenarios need to be developed and played out that call for physical reprisals and the cascading effects anticipated and accepted.¹⁶⁹ Here regional specialists and track-two players can be used to test reactions.

The other threat, which may be more likely today, is forced reparations from the state whose fissile material was used or that otherwise facilitated transfers of fissile material or support for such illegal development, transfer, and use. As noted earlier, greater responsibility may be assigned to the official owner of the material, so guilt may weigh more heavily upon those states with fissile material stocks, placing a great burden on the United States and Russia. This could, however, dissuade other states from pursuing fissile material development or ownership, which could be well worth these two countries agreeing to the possible financial exposure of a reparations agreement. States would likely not cheat the system, that is, steal material and self-inflict an attack to obtain a payout from any international reparations regime.

A standard system could be developed whereby the claims for reparations are made and another state's assets blocked and diverted once judgment is passed. The claims could be made through existing international accords or expanded agreements as occurred with the Financial Action Task Force. These actions are not without difficulty, but the legal frameworks available for reprisals need full review to determine the ability

¹⁶⁸ Stephen Hadley, “Remarks by the National Security Advisor, Stephen Hadley, to the Center for International Security and Cooperation,” Stanford, California, February 8, 2008, <http://georgewbush-whitehouse.archives.gov/news/releases/2008/02/20080211-6.html>. For further context, see the analysis by Wade Boese, “U.S. Issues Broad Threat to WMD Accomplices,” *Arms Control Today*, Vol. 38, No. 6 (July/August 2008), <http://www.armscontrol.org/print/3109>.

¹⁶⁹ Michael Levi also notes the importance of conferring with Japan and South Korea to credibly threaten North Korea. See Levi, *Deterring State Sponsorship of Nuclear Terrorism*.

of alternative, existing institutions to provide methods for recourse. The Cuban Missile Crisis is a case in point: the United States looked to the Organization of American States to provide the basis for a naval embargo instead of approaching the UN Security Council, where the Soviet Union would have vetoed any actions. Existing charters and legal rulings need to be reviewed with an eye to expanding interpretations, and then the need for additional understandings should be considered.

Unilateral actions put a country's own financial system at risk. The International Criminal Court, however—despite the United States, Russia, and China not being participants—provides a model for reparations to victims of crime and a trust fund (articles 75 and 79 of the Rome Statute). On the state level, declaratory statements by groups of states who agree to hold others accountable for fissile material could establish general expectation of some financial accountability. A state paying reparations for terror-related incidents is not without precedent.¹⁷⁰ Applicable case laws would have to be further investigated and new laws could be devised to facilitate such claims. Legal scholars could apply some innovative thinking.

Developing countries that are aid recipients often find ways, nonetheless, to spend money on armaments and other so-called state necessities, such as missile systems. Pre-agreement on blocking funds for such purchases and diverting those funds to reparations could be sought.¹⁷¹ This would mean states that sell military supplies or technologies to offending countries could lose their export earnings. The exporting country's interest would then also lie in ensuring that the state importing its arms had its fissile material locked down and had sufficiently blocked possible illicit transfers. In addition, state leaders tend to be wealthy and could be assigned responsibility for the material's security; thus, the possible blocking of personal accounts could be explored.

Taxing fissile material is another possibility. The tax could be used not only to dissuade fissile material ownership but also to pay into a reparations fund. The idea of using tax or tariff incentives has already been discussed to reduce reliance on the medical isotope molybdenum, which is produced using highly enriched uranium.¹⁷² The idea of taxing

¹⁷⁰ For example, Libya compensated the family of victims in the Lockerbie bombing. "Libya Pays \$1.5 Billion to Settle Terrorism Claims," *CNN.com*, November 21, 2008, <http://www.cnn.com/2008/WORLD/africa/10/31/libya.payment/index.html>.

¹⁷¹ Following on recommendations of Pierre Goldschmidt. See Goldschmidt, "IAEA Safeguards: Dealing Preventively with Non-Compliance."

¹⁷² See, for example, Edwin S. Lyman, "Making Domestically Produced Medical Isotopes a National Priority," *Bulletin of the Atomic Scientists*, December 18, 2008, <http://www.thebulletin.org/web-edition/oped/making-domestically-produced-medical-isotopes-national-priority>; and National Research Council, *Medical Isotope Production without Highly Enriched Uranium* (Washington, D.C.: National Academies

all fissile material through a “proliferation tax/user fee” has also been raised.¹⁷³ The tax would have definite appeal to the vast majority of states who do not own any material themselves. If taxes were not instituted for fissile materials but insurance premiums were required to be paid, the holders of less secure fissile material would likely be forced to pay more. Whether the funds would truly be available for their intended use, i.e., repayment for the cost of any incident, would have to be discussed and assured.¹⁷⁴ Terrorism risk insurance and catastrophe risk markets have emerged to help manage new types of challenges¹⁷⁵; the role of the private sector in helping to manage nuclear terrorism risks should not be ignored.

Sanctions against the state and targeted sanctions against individuals or entities in a state are also penalties that can be applied.¹⁷⁶ Allied effort to impose trade penalties or conditions must be studied further. Noted scholars (and now policymakers) have called for “proscribing foreign assistance to a state that the [IAEA] cannot certify to be in full transparency and safeguard obligations under the NPT.”¹⁷⁷ Heavy diplomatic lifting is needed today to even convince nuclear supplier states to agree on the need for the Additional Protocol as well as added controls on enrichment and reprocessing activities.¹⁷⁸ Getting states to agree to stricter rule within the NPT also needs to be

Press, 2009), p. 139, <http://books.nap.edu/openbook.php?isbn=0309130395&page=139>. Approximately 40–50 kg of HEU is used worldwide each year to produce molybdenum (Bunn, *Securing the Bomb*, 2008, p. 110).

¹⁷³ Stanley Foundation, “Growing Nuclear Stockpiles Require New Security Measures,” press release, October 30, 2007, <http://www.stanleyfoundation.org/press.cfm?id=14>.

¹⁷⁴ U.S. nuclear operators pay \$0.001 per kilowatt generated to a nuclear waste fund with the unrealized promise of the U.S. Department of Energy accepting used nuclear fuel and have paid, including interest, about \$33 billion into the fund as of 2009. See Glen Schweitzer and Kelly Robbins, eds., *Setting the Stage for International Spent Nuclear Fuel Storage Facilities*, International Workshop Proceedings (Washington, D.C.: National Academies Press, 2008), <http://books.nap.edu/openbook.php?isbn=0309119618&page=77>; and Nuclear Energy Institute, “Nuclear Waste Disposal,” <http://www.nei.org/resourcesandstats/documentlibrary/nuclearwastedisposal/graphicsandcharts/nuclearwastefundpaymentinformationbystate/>.

¹⁷⁵ See, for example, some of the work of the Center for Risk Management and Decision Processes, Wharton School of the University of Pennsylvania.

¹⁷⁶ These have had mixed results in the past, with sanctions levied by individual countries not working well and group sanctions working only somewhat better. For an overview of the effectiveness of sanctions, see Brendan Taylor, *Sanctions as Grand Strategy*, Adelphi Papers, No. 411 (London: International Institute for Strategic Studies, 2010).

¹⁷⁷ George Perkovich, Jessica T. Mathews, Joseph Cirincione, Rose Gottemoeller, and Jon B. Wolfsthal, “Universal Compliance: A Strategy for Nuclear Security,” Carnegie Endowment Report (Washington, D.C.: Carnegie Endowment for International Peace, 2005), p. 55.

¹⁷⁸ Mark Hibbs, “Nuclear Suppliers Group and the IAEA Additional Protocol,” Nuclear Energy Brief (Washington, D.C.: Carnegie Endowment for International Peace, August 18, 2010), <http://carnegieendowment.org/publications/index.cfm?fa=view&id=41393>.

reviewed for sanction measure possibilities. Leaving the NPT is allowed with simply three months notice, with no requirements made for the return of nuclear technologies or material to the state parties that provided them.¹⁷⁹ As of December 2008, nuclear supplier states had not even agreed on the need for the Additional Protocol to apply to certain sales and transfers.¹⁸⁰ No timetable even has been instituted for states to come into compliance with the very weak requirements of UNSCR 1540—so no penalties for noncompliance can even be applied.

In addition to holding states liable for illicit fissile material-related acts, individuals must also be held accountable for their actions. Furthermore, state acts are perpetrated by individuals. These individuals may not necessarily be acting in their own interest, but (or also) in what they perceive to be the state's interests. If the penalties on the individual are great enough and internationally agreed upon, then the individual may be likely to change his perception of the state's interests given the public opprobrium.

“In many countries, stealing nuclear material is no more of a crime than stealing a car....A more ambitious international legal regime would strengthen deterrence against illicit activities, and also strengthen states' basis for prosecuting proliferation activities.”

—Perkovich et al, *Universal Compliance*, pp. 53-54.

Individuals can be assessed criminal or civil penalties. International precedent exists for holding individuals accountable, with special tribunals established to prosecute war/humanitarian crimes and local courts that seek extradition for individuals responsible for accidents as well as intentional violations of law.¹⁸¹

Regarding individuals acting supposedly without state complicity, one concern is that some states have not imposed sufficient consequences considered to deter illicit nuclear acts. Former Pakistani President Pervez Musharraf pardoned the infamous nuclear

¹⁷⁹ See Article X, “Treaty on the Nonproliferation of Nuclear Weapons,” Federation of American Scientists, <http://www.fas.org/nuke/control/npt/text/npt2.htm>.

¹⁸⁰ Miles A. Pomper, “Nuclear Suppliers Make Progress on New Rules,” *Arms Control Today*, Vol. 38, No. 10 (December 2008), http://www.armscontrol.org/act/2008_12/NSG_progress.

¹⁸¹ See, for example, the claims sought by the Indian courts against the Union Carbide chief executive during the Bhopal chemical incident that killed 10,000. Associated Press, “Company Defends Chief in Bhopal Disaster,” *New York Times*, August 2, 2009, http://www.nytimes.com/2009/08/03/business/global/03bhopal.html?_r=1&scp=2&sq=bhopal%20&st=cse. The U.S. Environmental Protection Agency (EPA) presses cases on environmental crimes and seeks out “environmental fugitives”—e.g., those charged with selling ozone depleting substances in contravention of the U.S. obligation under the Montreal Protocol. See, for example, “EPA Fugitives,” <http://www.epa.gov/fugitives/index.html>.

proliferator A.Q. Khan, who was celebrated in his home country despite having shared nuclear wares and knowledge not only with Pakistan but also with Iran, Libya, and North Korea.¹⁸² Although he was not distributing fissile material, he was facilitating the means of producing those materials. In addition, even when states do press nuclear-related cases, they have found prosecutions difficult given the sensitivity of the information being handled.¹⁸³ Some individuals have been tried successfully, albeit still with some controversy.¹⁸⁴ Too often, however, penalties are low and not always enforced.¹⁸⁵

As U.S. science policy advisors Sid Niemeyer and David Smith point out:

[T]he United States and other states that have declared countering nuclear terrorism as a priority should seek to establish a new international norm that places far greater importance on conducting nuclear forensic investigations for interdictions of illicit nuclear materials. In a majority of past incidents, the investigation was conducted in the context of local government laws, often from the customs perspective that places a premium on the monetary value of the interdicted material, i.e., if you cannot sell it for much, we do not care much.

¹⁸² He was confined to his home but recently released. Joby Warrick, "Nuclear Scientist A.Q. Khan Is Freed from House Arrest," *Washington Post*, February 7, 2009, <http://www.washingtonpost.com/wp-dyn/content/article/2009/02/06/AR2009020603730.html>.

¹⁸³ The Swiss government destroyed documents that could have been helpful in the prosecution of the Tinner family members who had been linked to A.Q. Khan's nuclear technology export activities; the CIA has been mentioned as being involved also. See William J. Broad, "Swiss Release Suspect in Nuclear Case," *New York Times*, January 24, 2009, <http://query.nytimes.com/gst/fullpage.html?res=9405E4DB1E31F937A15752C0A96F9C8B63&scp=1&sq=Urs+Tinner&st=nyt>.

¹⁸⁴ See, for example, the earlier cited case of Gotthard Lerch in Spector, "Special Report: The A.Q. Khan Network." Trials of terrorists may differ from trials of nuclear smugglers. Consider the long prison sentences originally given to Abdel Basset Ali al-Megrahi, the Lockerbie bomber who was sentenced to a minimum of twenty-seven years and released from a Scottish prison after only serving eight years, according to government officials, because of health considerations. See "Abdel Basset Ali al-Megrahi," *New York Times*, updated August 24, 2009, http://topics.nytimes.com/top/reference/timestopics/people/m/abdel_basset_ali_al_megrahi/index.html. The movie *Countdown to Zero* offers some interesting interviews related to smuggling and other issues. For the trailer, see <http://www.youtube.com/watch?v=pQG4oA66uzI>.

¹⁸⁵ In Georgia, for example, the HEU smuggler, Dadaian, is said to have bribed local officials for his release. He was subsequently tried in Armenia and sentenced to several months in prison but was then granted amnesty. Alexander Kupatadze, "Organized Crime and the Trafficking of Radiological Materials: The Case of Georgia," *Nonproliferation Review*, Vol. 17, No. 2 (July 2010), p. 225. In 2010 Georgia also granted early release to Oleg Khintsagov, a Russian convicted of attempting to sell HEU. See Molly Corso, "Tbilisi Grants Early Release to Weapons-Grade Uranium Smuggler," *Eurasianet.org*, June 22, 2010, <http://www.eurasianet.org/node/61374>.

New policies are necessary that emphasize threats to international and national security.¹⁸⁶

Currently there is little confidence that judgments will be made and appropriate penalties applied. In the short term, developing a consensus among the willing "Russia-U.S.-Plus" states on a common and severe approach in national courts to dealing with illicit transfers would prove useful. As already mentioned, the possibility of establishing a special nuclear prosecutor to assist such international enforcement should be considered.¹⁸⁷ A mechanism for states to cooperate in prosecution would need to be explored. In any event, there is a need for a more thorough and coordinated consideration of nuclear law, with states entering into bilateral, if not multilateral, agreements for prosecution where treaties and conventions have proved lacking.¹⁸⁸

In addition to tangible penalties, exclusion from participation in a group or an event is another possibility. States and their leaders want recognition and prestige; their citizens want economic development and participation in international events, from the Olympics to the World Cup. The moral pressure that comes from potential "shunning" can be great—but has been seldom used, or at least not very effectively. Coercing another state is difficult. International attempts to stop Iran from enriching uranium have not met with success, and attempts to dissuade North Korea from going nuclear have also been unsuccessful, despite a mix of incentives and increasing penalties.

The threat of applying the penalties described in this paper may be more effective than the penalties themselves. Public diplomacy around the offenses and penalties has great value; if penalties actually have to be levied, they may cost the state(s) levying them more than they might cost the accused. Achieving early agreement on the penalties can increase the expectation that they may be applied and thereby reduce the actual likelihood of having to apply them. Thus, to be cost effective, the penalties may be better framed in the context of positive acts that a state, its leaders, and citizens need to do now to avoid being in a position to have these negative acts befall them later. The key is credibly defining or agreeing on the conditions required to have reduced penalties or to receive rewards. States and individuals often enter into agreements that

¹⁸⁶ Sidney Niemeyer and David K. Smith, "Following the Clues: The Role of Forensics in Preventing Nuclear Terrorism," *Arms Control Today*, Vol. 37, No. 6 (July/August 2007), <http://www.armscontrol.org/print/2449>.

¹⁸⁷ A leading statesman such as former IAEA Director, joint winner of the 2005 Nobel Peace Prize, and lawyer by training Mohamed ElBaradei would be a likely contender for this position. Or a lower-profile technical expert can be elevated to more international prominence and put in this role.

¹⁸⁸ See Khripunov and Stoiber, "Nuclear Security and Nuclear Counterterrorism: Streamlining and Updating the Legal Framework."

require cooperation and impose penalties for noncompliance, with penalties adjusted for performance.

A system of rewards and penalties has not yet been fully laid out in the nuclear area—it needs to be. UNSCR 1887 calls on all states to adopt the IAEA Additional Protocol as part of agreed safeguards, calls for adherence to relevant conventions, and supports a voluntary fund to help implement UNSCR 1540. It also provides hope for collective action when it calls attention to “ongoing discussions in the course of the NPT review on identifying modalities under which NPT States Parties could collectively respond to notification of withdrawal, and affirms that a State remains responsible under international law for violations of the NPT committed prior to its withdrawal.”¹⁸⁹ But it ignores rewards for positive actions. Although at the state level many threat reduction initiatives have been undertaken very successfully to reduce stocks of fissile material, at the individual level programs have been more wanting and generally focused (and then in a very modest way) on diversion of nuclear scientific talent to positive pursuits.¹⁹⁰ The extension of these programs and new programs should be considered, such as offering rewards for whistleblowers or informants and offering to buy back nuclear materials. This could help surface some long missing materials.¹⁹¹ Discussion must start around possible cooperative penalties and rewards as well as the conditions for each. We cannot afford to wait for a nuclear catastrophe to spur action and debate.

¹⁸⁹ United Nations Security Council, Resolution 1887, September 24, 2009, <http://www.america.gov/st/texttrans-english/2009/September/20090924173226ihecuor0.5509411.html>.

¹⁹⁰ See for example, Nuclear Threat Initiative, “Past and Current Efforts to Reduce Civilian HEU Use,” <http://www.nti.org/db/heu/pastpresent.html>.

¹⁹¹ For example, some fuel elements with 19 percent HEU may still be missing from a Congo research reactor. See “Congo Special Weapons,” in Weapons of Mass Destruction (WMD), *GlobalSecurity.org*, <http://www.globalsecurity.org/wmd/world/congo/index.html>. Researchers argue whether such buyback programs cause more theft, however, in this case, if fissile materials can be stolen and do get turned in to authorities, then authorities will know where additional security measures are needed.

6. *Learning from Other Regimes*

A system of rewards and penalties can be developed. To achieve a successful regime, certain conditions are generally met:

- Universalize the threat—even without a crisis. The universal threat caused by the lack of cooperation and the urgency of addressing this deficit is the first order of business. Although parties may want different things out of cooperating,¹⁹² they must understand the possible negative effects of not participating.
- Establish responsibility—precisely. The different responsibilities accruing to different parties need to be defined with precise standards.
 - Owners of fissile material have responsibility for securing that material, including reporting on material stocks and controls which will need verification, and individuals must be held accountable at each facility and in transport;
 - States have responsibility for not allowing illicit transfers; for apprehending and penalizing those who do such transfers or allow others to do so; and for educating their citizens on compliance; and
 - Individuals have a responsibility not only to know and follow the law but also to report on illicit incidents they know or suspect may have occurred.
 - To have responsible parties be responsible, they must have not only the incentive to be but also the capacity. Many countries lack the financial and expert capacity to effect compliance. Augmenting their resources is key. Doing this in a standardized way is also important. One issue, for example, with simply matching donor countries with countries needing assistance is that the standard of assistance will not be consistent, the rules that the donor country provides (in export regulations, civil/criminal penalties, code writing) may well vary. Quality control is important. The 1540 Voluntary Fund to provide

¹⁹² For an assessment of what different states wanted from participating in the Nuclear Security Summit, see Kayvan Farzaneh, Andrew Swift, and Peter Williams, “Guess Who’s Coming to Dinner?” *Foreign Policy*, April 9, 2010, http://www.foreignpolicy.com/articles/2010/04/09/guess_whos_coming_to_dinner. For an analysis of how states can be motivated to increase their compliance with UNSCR 1540, see Brian Finlay and Elizabeth Turpen, “The Next 100 Project: Leveraging National Security Assistance to Meet Developing World Needs” (Washington, D.C.: Stimson Center and Stanley Foundation, February 2009), <http://www.stanleyfoundation.org/resources.cfm?id=372>.

country assistance must also define some quality control measures—and, much as the UN might not like it—guidelines if not standards for outcomes.

- Establish penalties and incentives—in broad ranges. A group of willing states (Russia-U.S.-Plus) needs to agree on the ranges of penalties and incentives so that new negotiations do not have to take place in the UN Security Council with each incident of smuggling or nuclear event. Quick action will be needed particularly in a post-blast environment to coerce some states' actions; premeditating the possible scenarios will help establish the plausible ranges of outcomes and encourage states to explore their interests. Track-two discussions and scenario games can help states realize and test various options without having to commit to a course immediately.
- Clarify ways to mitigate penalties and to increase rewards—imaginatively. Lessons from other areas, including from other government programs and the private sector, can be applied.

The first points have already been explored elsewhere in this paper. The last two points need further reflection.¹⁹³

REWARDS AND PENALTIES FROM OTHER SYSTEMS

In all cases, rewards for complying with regulations must be satisfying enough and penalties must be severe enough to justify early cooperation to avoid later catastrophe. To some extent, this is already the situation in an interconnected world. States interact constantly whether they want to or not. A future unavoidable coexistence means that cooperation will be the starting norm.

The joint effect of individual state behavior and the recognition of its effect on the global commons serve as a starting point.¹⁹⁴ Experts in environmental agreements suggest combining rewards with penalties, which tend to be used infrequently internationally, to prompt desired behaviors.¹⁹⁵ Nonetheless, on the domestic front, countries such as the United States have instituted stiff enforcement and compliance mechanisms for agreements such as the Montreal Protocol on Substances That Deplete the Ozone

¹⁹³ The University of Georgia's Center for International Trade & Security recognized the importance of individuals acting within security cultures and held a half-day panel on "The Human Dimensions of International Security," Washington, D.C, March 30, 2011.

¹⁹⁴ The responsibility to the global commons of individual state actions has been recognized in fishing, pesticide use, hazardous waste, illegal timbering, and ozone depletion, to name a few areas.

¹⁹⁵ See, for example, U.S. Government Accountability Office, "Summary," in "International Environment: Experts' Observations on Enhancing Compliance with a Climate Change Agreement," August 23, 1999, <http://www.gao.gov/products/RCED-99-248>.

Layer.¹⁹⁶ To have credence in negotiating reduced penalties, there must be an agreed system for imposing penalties in the first place. A legal, regulatory, or common code of practice (some norms) must be identified with fairly clear outcomes expected.

It is beyond the scope of this paper to go into detail about what motivates states to comply and what penalties and rewards might be effective to drive that cooperation. A body of literature exists on this topic, from the effectiveness of sanctions to preventive force¹⁹⁷—and still more research is needed. The system discussed here is even more complex than convincing a state to act or not act in a certain way—it involves compelling a state to act seemingly not in its own interest in the short run—to risk cooperating in the short term given the possibility of punishment in the long term.

Although establishing a full nuclear liability regime will not be easy and could take decades to achieve, it is useful to consider some parallel examples in other systems where penalties are reduced and rewards are increased through short-term, seemingly non-self-interested compliance. This could help provide insights into ways in which incentives have worked—successfully or not—in other systems so that the nuclear liability regime can be constructed with these lessons in mind. When a system of rewards and penalties is not only established but also fairly well communicated, cooperation can be elicited by mitigating penalties or increasing rewards. The following examples are not comprehensively developed for a nuclear liability regime but are mentioned to start creative discussion around the possibilities for such.

In the international area, the World Trade Organization (WTO) is a prime example of a system that evolved after many decades, and survived the defeat of its originating institution, working now as an effective organization that facilitates trade and penalizes transgressions. The original idea after World War II for an international trade organization proved impossible to effect, but the General Agreement on Tariffs and Trade (GATT) was agreed upon within a multilateral framework, eventually evolving into the WTO. In negotiations, sometimes packages of agreements were negotiated that allowed trade-offs among concessions.¹⁹⁸ The lesson for a nuclear liability regime is to

¹⁹⁶ Phyllis P. Harris, “Combining Legal Mandates with Economics in the Application of Environmental Law,” paper presented at the Global Forum for Sustainable Development, Organisation for Economic Cooperation and Development, Paris, France, December 1–2, 2004, http://www.inece.org/conference/7/vol1/07_Harris.pdf.

¹⁹⁷ See, for example, Taylor, *Sanctions as Grand Strategy*; and Martin B. Malin, “The Effectiveness and Legitimacy of Using Force to Prevent Nuclear Proliferation,” in Christopher Daase and Oliver Meier, eds., *Coercive Arms Control* (New York: Routledge, forthcoming).

¹⁹⁸ World Trade Organization, “The GATT Years: From Havana to Marrakesh,” in “Understanding the WTO: Basics,”

consider the possibility of putting a debate within a larger framework for agreement—one in which benefits are clearly perceived for concessions (e.g., broad development funding, nuclear trade preferences, or concessions). That framework can include benefits for members, penalties for those who break the rules, and mechanisms for ensuring enforcement within a specified timeframe.¹⁹⁹ Revelations of noncompliance are initiated, however, not by self-revelation of transgressions but by others accusing a member of violating the trade rules. Additional examples need to be researched of what induced admissions of culpability and quicker resolution of disputes.²⁰⁰

Another international example is the Mine Ban Treaty. A “de facto monitoring regime” for the treaty has arisen in civil society to support treaty implementation; this includes the Landmine & Cluster Munition Monitor, which is “a civil society-based program providing research and monitoring on progress made in eliminating landmines, cluster munitions, and other explosive remnants of war.”²⁰¹ The treaty requires transparency and self-reporting, but the Monitor basically audits country performance.

Additional research is needed on examples of international treaties/agreements where compliance has been effectively encouraged even though short-term culpability in agreement violation is admitted. Within domestic legal/regulatory frameworks, however, many examples exist.

State criminal procedures offer a very clear example. In criminal procedure, a prosecutor may offer a plea agreement for not pursuing a capital punishment conviction and offer only a very long prison term to a defendant who is suspected of a series of murders, but has only one pending murder charge, if the alleged murderer reveals the locations of other victims’ graves. In a nuclear agreement, the agreement could provide for a range of penalties that might be negotiated based on the culpable state’s assistance in resolving any crisis. A state may waive certain penalties if a state and/or individual cooperates in identifying the source of nuclear material being smuggled or the location of another device set to blast. Prosecutorial procedures, however, are time consuming, whereas a nuclear negotiation would likely involve greater urgency. Standard operating procedures for multiple scenarios would have to be developed ahead of time. The certainty of “getting caught,” being pronounced guilty, and having some penalty assessed in the first place has to be reasonably assured,

¹⁹⁹ World Trade Organization, “A Unique Contribution,” in “Understanding the WTO: Settling Disputes,” http://www.wto.org/english/thewto_e/whatis_e/tif_e/displ_e.htm.

²⁰⁰ See, for example, Chad P. Brown, “On the Economic Success of GATT/WTO Dispute Settlement,” *Review of Economics and Statistics*, Vol. 86, No. 3 (August 2004), pp. 811–823.

²⁰¹ Landmine and Cluster Munition Monitor, “About Us: What is the Monitor?” <http://www.the-monitor.org/index.php/LM/About-Us/What-is-the-Monitor>.

as already noted. In addition, positive incentives for “informing” on smuggling can be instituted, including cash rewards, with penalties instituted for not reporting (such as being deemed “an accomplice”). Good intelligence cooperation and communication of the system of penalties and rewards would be required. Those who smuggle for financial gain will cooperate more than ideologues. Just as penalties are not always deterrents in standard criminal cases, they may well not work fully to deter actions here—but they should help.

Civil law situations also provide some precedent in terms of pre-agreeing on limitations of liability, which detail exactly who has the liability and how much liability one has. The United Nations International Law Commission submitted recommendations for an international agreement on “Prevention of Transboundary Harm from Hazardous Activities” relating to lawful actions.²⁰² Discussion has been continuing on the principles of liability for lawful acts²⁰³ but could be used as a basis for discussion of unlawful acts and international liability and appropriate remedies.

In the nuclear energy field, the operator of a facility has exclusive liability no matter what causes an incident; however, the liability is limited both in amount and time. The operator is required to maintain evidence of ability to meet this liability—and typically buys insurance. The method for dispute resolution is detailed, including court jurisdiction.²⁰⁴ The state provides some backup in case the liability exceeds the operator’s liability. In real estate and other contracts, a party can offer to indemnify another party against certain specified claims or judgments resulting from a transaction (i.e., agree to hold the other party harmless and assume all responsibility for the purchase or transfer). This typically occurs after due diligence reveals the potential extent and likelihood of the risk that such claims or judgments will arise in relation to the contracting parties’ business dealings. In terms of nuclear attribution, the United States and Russia, for example, each could account for the material that it knows is missing and measure the material it now retains. An accounting of stocks would generally be required under the FMCT in any event. Liability might then only be expected for the material under current accurate control and joint effort can be undertaken to “find” the missing material.

²⁰² United Nations International Law Commission, “Prevention of Transboundary Damage from Hazardous Activities,” updated June 30, 2005, http://untreaty.un.org/ilc/summaries/9_7.htm.

²⁰³ For some Chinese comments, see, for example, Jielong Duan, “Statement on Diplomatic Protection, International Liability for Injurious Consequences Arising Out of Acts Not Prohibited by International Law,” *Chinese Journal of International Law*, Vol. 6, No. 1 (March 2007), pp. 189–194.

²⁰⁴ World Nuclear Association, “Liability for Nuclear Damage.”

Standards organizations provide mechanisms for accruing rewards from compliance. Nuclear technology standards already exist under ASTM International (formerly American Society for Testing and Materials), a voluntary standards development organization.²⁰⁵ In the private sector, meeting or exceeding (in a positive sense) agreed industry standards can lead to decreased liability claims and decreased insurance rates, and may be required for insurance or other benefits. Although requiring standards may not be possible at first for nuclear security, best practices can be determined and compliance with these practices might be independently verified, as discussed in the first sections of this paper. Adherence to these standards then would offer reduced liability, for example, in the event of eventual loss of nuclear materials. Independent monitoring of adherence to the standards—or some indicators related to the standards—would be part of IAEA’s or another group’s effort. VERTIC, for example, is an NGO that has developed extensive checklists of verification measures related to export controls and other measures.²⁰⁶

The insurance world also offers insights into ways to incite cooperative behaviors. For this comparison to hold, owners of fissile material would be required to have liability insurance. Materials stocks and facilities in different countries could be risk-rated just as in the Federal Emergency Management Agency’s (FEMA’s) National Flood Insurance Program, which has developed flood maps with risk premium zones based on coverage type and flooding risk, with consideration given to community mitigation efforts such as levees. FEMA has established administrative processes for corrections to designations on the maps; similarly, countries can dispute their facilities’ and stocks’ designations.

In the insurance world, liability can be shared. Prior agreement can be reached to share liability if certain agreed standards of operating conditions exist; risk can be allocated through differentiating premiums for *pro rata* liability based on a negotiated or independently certified risk assessment. Early designation of a violation (e.g., loss of material) would be required to trigger the insurance mechanism. Once a negative event occurs, the individual facility responsible absorbs some costs, and then the group (or government) absorbs the residual. The party responsible for the negative event, however, may be subsequently subject to higher insurance premiums. U.S. nuclear utilities pay annual premiums for \$300 million in off-site liability insurance and obtain secondary coverage in which the nuclear facilities share nuclear accident costs on a *pro rata* basis. Premiums under one pool, American Nuclear Insurers (ANI), are on average

²⁰⁵ American Society for Testing and Materials (ASTM), “Nuclear Technology Standards,” <http://www.astm.org/Standards/nuclear-technology-standards.html>.

²⁰⁶ See VERTIC, <http://www.vertic.org/>.

\$400,000 per reactor, with discounts on additional reactors at the same site. ANI, a group of large insurers, evaluates risks for underwriting and ratings independent of the Nuclear Regulatory Commission and the Institute of Nuclear Power Operators; the evaluations are based on technical inspections, although for some overseas reinsurance, a portfolio approach is taken and individual facilities are not examined. ANI is a secondary insurer to Nuclear Electric Insurance Limited (NEIL), a mutual insurance company that provides nuclear plants with on-site liability insurance and some business interruption coverage. Under the Price Anderson Act, the federal government backstops nuclear liability. Utilities need insurance because they know victims' compensation would be required under U.S. laws. Similarly, forensics and attribution can lead to compensation/reparations requirements as already discussed; with some certainty of such liabilities, offering a liability limitation scheme or risk insurance pools can compel cooperative behavior.

Medical malpractice is another field from which lessons can be learned. Just as an auto insurer advises its clients not to admit liability in an accident, medical insurers often advise their insured doctors against any confession or confirmation of medical errors. With medical malpractice awards sometimes being quite costly, insurance companies and doctors (who jointly suffer the high premiums resulting from costs associated with a few individual cases) have lobbied for tort reform that imposes caps on the total amount of damages that plaintiff medical patients may recover. Many U.S. states now impose dollar limits on damage awards in medical malpractice cases, in varying amounts based upon the nature of the damages (e.g., economic losses, pain and suffering, medical expenses).²⁰⁷ Nonetheless, the concept is still to assign responsibility to individuals for security and hold them liable for performance. If compliance with certain standards are achieved (e.g., one is a board-certified operator and follows good practices consistently), it might be useful to cap damages if early disclosure is obtained and possible subsequent damages are thereby reduced.

Medical malpractice liability in itself has not been shown to deter errors.²⁰⁸ Although individual liability and liability protection appear to be important, the resulting

²⁰⁷ See the website for the Medical Malpractice Directory, <http://www.medical-malpractice-directory.com/info/damage-awards.htm>. Some states prohibit caps; some assess damages based on "condition of misconduct."

²⁰⁸ Michelle M. Mello, "Malpractice Liability and Medical Error Prevention: Strange Bedfellows?" paper prepared for the Council on Health Economics and Policy Conference on Medical Malpractice Practice in Crisis: Health Policy Options, March 2003, p. 3, http://www.kaisernetwork.org/health_cast/uploaded_files/Malpractice_and_Errors_-Mello_Paper.pdf.

outcomes in terms of affecting behaviors in the medical field are still questionable.²⁰⁹ The personal associations with “doing good,” however, are much greater in the medical field than in the nuclear security field, perhaps simply by self-selection among those choosing the profession. Thus, the addition of liabilities in the medical field may be less of a factor in individual performance than in other fields (where even factory workers now put their individual labels in the pieces they make or check). Thus, states need to have their nuclear security professionals be held more individually accountable. They may be trained and internationally certified, and that would require a yet-to-be-fully-developed security professional certification organization. The importance of establishing training and certification in the nuclear security field should not be underestimated. In a field where some nuclear security personnel may have low general education levels and be poorly paid, establishing a career path with international professional standards could easily help elevate the profession and increase security.

Other lessons can be learned from the ongoing medical malpractice discussion. Legal protections for reporting errors are important.²¹⁰ The possibility of providing incentives for reporting errors by discounting penalties to hospitals (the enterprise) based on physicians’ reporting efforts has also been considered²¹¹ (albeit not highly persuasively). Most persuasive for reducing negative incidents was: Medicare not reimbursing hospitals for error events; the existence of automated processes and checklists to ensure good practices; and the incidence of basic hand washing, which patients should request.²¹² Thus, for nuclear security, the lessons are in some positive approaches: provide incentive payments conditioned on performance, automate the compliance system, and put some burden for requesting security performance on those involved directly or indirectly.

If doctors/hospitals (or nuclear security officials) expect to be ousted for errors, they will be more compliant. Attempts to effect change may occur through broad media efforts but must eventually be individualized. For example, the Institute of Medicine report on

²⁰⁹ According to one researcher, “no evidence exists” that the liabilities imposed reduce medical errors. See Mimi Marchev, “Medical Malpractice and Medical Error Disclosure: Balancing Facts and Fears” (Portland, Maine: National Academy for State Health Policy, December 2003), p. 11, http://www.nashp.org/sites/default/files/balancing_facts_fears.pdf.

²¹⁰ Mello, “Malpractice Liability and Medical Error Prevention: Strange Bedfellows?” pp. 8–11.

²¹¹ Joshua Graff Zivin and Alexander S.P. Pfaff, “To Err on Humans Is Not Benign: Incentives for Adoption of Medical Error Reporting Systems,” *Journal of Health Economics*, Vol. 23, No. 5 (September 2004), pp. 935–949.

²¹² ASQ, “Hospitals Examining Error Prevention Methods,” Milwaukee, Wisconsin, October 17, 2008, <http://asq.org/qualitynews/qnt/execute/displaySetup?newsID=4888>.

patient deaths from medical error spurred public and legislative interests when it came out in 2000.²¹³ Twenty states have instituted mandatory reporting of medical errors—yet a recent report on medical mistakes says that such deaths may have increased to 200,000 per year.²¹⁴ More than official reporting mandates on medical errors, empowering “unofficial” additional oversight of behaviors, such as by patients or by nurses, has been proven to increase surgeon hand washing and reduce infections.²¹⁵ Nurses in some hospitals are regularly asked to inform on the compliance of surgeons with certain presurgery procedures. Likewise, law enforcement regularly uses undercover informants who are motivated by money, reduced/waived penalties or nonarrest for other violations to provide insights into instances of noncompliance. Expanding this concept further to include nonsecurity management being able or incentivized to ensure security should be considered. Empowering such additional, “nonofficial,” oversight is a lesson to be embraced. Broadening responsibility to the citizenry for reporting on illicit nuclear acts could be important. Even at the state level, for nuclear attribution, if a state knows that it will be “outed” then it may be less likely to attempt initial denial. A system to encourage information disclosure should be established at the outset of any attribution agreements.

In terms of mitigating penalties, environmental law enforcement offers some precedents:

Where a criminal case is filed, for many years it also has been the policy of national prosecutors and many national judges to encourage environmental auditing. A guilty environmental offender may receive a reduced sentence where there was already in effect a good faith environmental auditing or compliance program. Similarly, an offender can expect some leniency when, reasonably promptly after becoming aware of the crime, the offender reports it to government authorities, cooperates and accepts responsibility. Also, when sentencing an environmental offender, leniency may be shown to the offender who agrees to begin an effective environmental auditing program to prevent and

²¹³ Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, eds., *To Err Is Human: Building a Safer Health System* (Washington, D.C.: Institute of Medicine, National Academies Press, 2000), <http://www.nap.edu/openbook.php?isbn=0309068371>.

²¹⁴ Cathleen F. Crowley and Eric Nalder, “Within Health Care Hides Massive, Avoidable Death Toll,” *Hearst Newspapers*, August 10, 2009, <http://www.chron.com/disp/story.mpl/deadbymistake/6555095.html>.

²¹⁵ Deborah Schoch, “Pronovost Shows How Checklists Can Slash Infections,” *Center for Health Reporting*, California HealthCare Foundation, December 20, 2010, <http://www.centerforhealthreporting.org/article/pronovost-shows-how-checklists-can-slash-infections>.

detect future violations. In this way, criminal punishment, like civil penalties, is reduced to encourage and reward environmental auditing.²¹⁶

In short, managing the liability regime is important.

Finally, and applicable to the establishment of responsibility as well as the validity of the imposition of penalties, the role of public relations is important in any effort. Media power and public interest can be used to help apportion general responsibility and require changes in performance. Consumer safety rules are a classic example. The U.S. Consumer Product Safety Commission cannot possibly oversee all potential consumer threats, but nongovernmental organizations' independent oversight and individual reporting have assisted the effort. Whistleblower protections exist in virtually every U.S. state. Concerted public pressure can force actors to do the right thing. Although domestic public pressure may have less sway in nondemocratic societies, and in all societies national interests may impel leaders not to act in global interests, instituting a system to encourage high-visibility reporting of nuclear smuggling incidents and government responses could encourage more responsible behaviors and discourage smuggling for financial gain. The potential for "getting found out" either by nuclear forensics or by informants can help establish responsibility and lead to a system of incentives and reduced penalties that will support a nuclear attribution process to reduce risks.

The idea of having a special nuclear security prosecutor—at first, even perhaps with no power to prosecute except in the eye of the public— might go a long way toward encouraging nuclear accountability once some legitimate, broad security rules are established.

"States will obey the rules because they see such rules and their institutional framework as possessing a high degree of legitimacy....Legitimacy will depend upon four specific properties, it is suggested: determinacy (...'transparency'); symbolic validation (or authority approval); coherence (or consistency or general application) and adherence (or falling within an organized hierarchy of rules)."

– Malcolm Nathan Shaw, *International Law*, 5th Ed. (New York: Cambridge University Press, 2003), p. 60.

²¹⁶ Harris, "Combining Legal Mandates with Economics in the Application of Environmental Law," p. 35.

7. *Conclusion: Next Steps*

The Nuclear Security Summit produced a work plan with some immediate goals, such as achieving universality of existing conventions. The plan document closes by noting the importance of the work in the field of nuclear detection and forensics and calls for greater cooperation “nationally, bilaterally, or multilaterally” in this area.²¹⁷ The UN Security Council is also primed for concerted action.²¹⁸

The need for better coordination in nuclear incidents is starkly evident. The March 2011 nuclear reactor crisis in Japan provides unfortunate lessons on the importance of having established support mechanisms in place prior to a disaster. As the IAEA Director General Yukiya Amano remarked, “It is already clear that arrangements for putting international nuclear experts in touch with each other quickly during a crisis need to be improved.”²¹⁹

Technical cooperation on forensics and attribution is only an initial step. The reason for this cooperation needs to be understood and further considered both in policy terms and in the procedures that should support those policies. This paper details some of those resulting challenges and ways to address them.

Disputing the nuclear forensic and attribution critics, this paper attempts to demonstrate that a system of nuclear forensics and attribution could be developed to deter nuclear smuggling and to help lockdown nuclear materials. Multiple liability regimes exist and are managed to induce positive behaviors from illicit or negligent actors. The nuclear community needs to take lessons from these other regimes to establish a workable system of nuclear attribution to deter proliferation. A new deterrence system can indeed be developed. The new U.S. National Security Strategy is predicated on the development of international frameworks and cooperation, including work on nuclear nonproliferation.

²¹⁷ Office of the Press Secretary, “Work Plan of the Washington Nuclear Security Summit.”

²¹⁸ UN Security Council, “Speakers in Security Council Call for Unified, Global Counter-Terrorism Effort, following Briefings by Chairs of Committees Set Up to Spearhead Fight,” May 11, 2010, <http://www.un.org/News/Press/docs//2010/sc9923.doc.htm>.

²¹⁹ Yukiya Amano, Introductory Statement to Board of Governors, March 21, 2011, IAEA Board of Governors meeting, Vienna, Austria, <http://www.iaea.org/newscenter/statements/2011/amsp2011n007.html>

“Constructive national steps on issues ranging from nuclear security to climate change must be incentivized, so nations that choose to do their part see the benefits of responsible action. Rules of the road must be followed, and there must be consequences for those nations that break the rules—whether they are nonproliferation obligations, trade agreements, or human rights commitments. This modernization of institutions, strengthening of international norms, and enforcement of international law is not a task for the United States alone—but together with like-minded nations, it is a task we can lead.”

–*National Security Strategy*, May 2010, p. 3,

http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.

More research needs to be done on a mechanism for institutionalizing standards—the hardest hurdle for the international community to accept—and on ways for those standards to be developed and formally accepted first by the United States and Russia and then by others, just as the Proliferation Security Initiative has spread in adoption.²²⁰ The Global Initiative to Combat Nuclear Terrorism needs to be energized. A key element will be a verification mechanism and a broad system of rewards and penalties to induce cooperation. A fresh look at nuclear law is needed to determine what areas for enforcement can be more assiduously pursued and how best to do that.²²¹ Consideration should be given to the successes and failures of other liability regimes, including international regimes in particular, and applying those insights to a system of nuclear attribution.

More assessment is needed of the risks associated with various countries’ fissile material stockpiles and what positive incentives or penalties might be needed to alter those countries’ actions. Thus far, the NPT reviews have not addressed more stringent withdrawal conditions.²²² As of December 2008, nuclear supplier states had not agreed on the need for the Additional Protocol to apply to certain sales and transfers.²²³ No timetable has been given for compliance with UNSCR 1540. Some of these important issues will not be soon resolved. Scenario development and gaming need to be

²²⁰ I thank Graham Allison for his sharing his insightful ideas on this topic.

²²¹ See, for example, the discussion of the provisional application of existing conventions in Khripunov and Stoiber, “Nuclear Security and Nuclear Counterterrorism: Streamlining and Updating the Legal Framework,” pp. 2–3.

²²² Article X, “Treaty on the Nonproliferation of Nuclear Weapons.”

²²³ Pomper, “Nuclear Suppliers Make Progress on New Rules.”

undertaken to test alternative policies and optimal processes so that the desired levels of cooperation and outcomes can be achieved—or so that responses can be pre-planned to minimize risks when actions are required.

Further consideration also needs to be given to certain points raised in this paper such as the possibility of a specialized nuclear prosecutor and coordinated standard operating procedures for nuclear incidents including prosecution among states willing to come into agreement on extradition and prosecution.

A more structured understanding of what nuclear forensics and attribution can and should bring to international relations is needed. The scientific capability is emerging for better forensics and attribution but more political analysis is needed to maximize use of that information to encourage reduction and better protection of stocks of fissile material and to deter illicit transfers. A strategic vision of what forensics and attribution can and cannot do needs to be discussed and debated.

A subset of the members of the Global Initiative to Combat Nuclear Terrorism—led by Russia and the United States—should now develop this broader vision for forensics and attribution. Certain countries have special responsibilities. Spain has been selected as the first coordinator of a new Implementation and Assessment Group to provide strategic oversight for the Global Initiative’s activities. Parts of the problem can be put to others with demonstrated ability and interest in these issues and may be spread wider than the G-8, given the questionable funding to continue the Global Partnership against the Spread of Weapons and Materials of Mass Destruction beyond 2012 and the need to better organize international efforts.²²⁴ South Korea, the host of both the next Nuclear Security Summit in 2012 and a plenary meeting of the Global Initiative to Combat Nuclear Terrorism in 2011, will open an International Nuclear Security Training Center in 2012;²²⁵ other states are also looking to be regional centers of security excellence. Some Global Initiative states such as Turkey have been working hard to resolve nuclear issues with Iran and North Korea and are willingly taking on important leadership roles. South Africa currently chairs the 1540 Committee; the members of the committee also hold special responsibility to demonstrate progress.

²²⁴ Chris Schneidmiller, “G-8 Nonproliferation Program Faces Uncertain Future,” Global Security Newswire, August 16, 2010, http://gsn.nti.org/gsn/nw_20100815_3867.php.

²²⁵ The Center comes as South Korea undertakes major efforts to export nuclear reactors. See Statement by Dr. Ju-Ho LEE, Republic of Korea, at the 54th General Conference of IAEA, Vienna, September 20, 2010, <http://www.iaea.org/About/Policy/GC/GC54/Statements/rok.pdf>.

Much can and needs to be accomplished before the 2012 Nuclear Security Summit. Part of these state leaders' task must be to take nuclear forensics and attribution to the next level—to develop policy and actual operational plans for resolving the technical and political issues involved in the development of nuclear attribution. Developing the science alone is not enough. This paper offers many suggestions for ways forward. Given what is at risk, we cannot afford to delay.

APPENDIX
1540 Matrix Relating to Nuclear Materials
[Below are direct excerpts from the 1540 Committee Website]

The information in the matrices originates primarily from national reports and is complemented by official government information, including that made available to intergovernmental organizations. The matrices are prepared under the direction of the 1540 Committee.

The 1540 Committee intends to use the matrices as a reference tool for facilitating technical assistance and to enable the Committee to continue to enhance its dialogue with States on their implementation of Security Council Resolution 1540.

The matrices are not a tool for measuring compliance of States in their non-proliferation obligations but for facilitating the implementation of Security Council Resolutions 1540 and 1673.

They do not reflect or prejudice any ongoing discussions outside of the Committee, in the Security Council or any of its organs, of a State's compliance with its non-proliferation or any other obligations.²²⁶

OP 1 and related matters from OP 5, OP 6, OP 8 (a), (b), (c) and OP 10				
	Did you make one of the following statements or is your country a State Party to or Member State of one of the following Conventions, Treaties and Arrangements ?	YES	if YES, indicate relevant information (i.e. signing, accession, ratification, entering into force, etc)	Remarks
1	General statement on non-possession of WMD			
2	General statement on commitment to disarmament and non-proliferation			
3	General statement on non-provision of WMD and related materials to non-State actors			
6	Nuclear Non-Proliferation Treaty (NPT)			
7	Comprehensive Nuclear Test Ban Treaty (CTBT)			
8	Convention on Physical Protection of Nuclear Material (CPPNM)			
9	Hague Code of Conduct (HCOC)			

²²⁶ United Nations Security Council, "1540 Committee," <http://www.un.org/sc/1540/>.

10	Geneva Protocol of 1925					
11	International Atomic Energy Agency (IAEA)					
12	Nuclear Weapons Free Zone/ Protocol(s)					
13	Other Conventions/Treaties					
14	Other Arrangements					
15	Other					
OP 2 - Nuclear Weapons (NW)						
Does national legislation exist which prohibits persons or entities to engage in one of the following activities ? Can violators be penalized ?		<u>N</u>ational legal framework		<u>E</u>nforcement: civil/criminal penalties and others		Remarks
		YES	if YES, indicate source document of national implementation law	YES	if YES, indicate source document	
1	manufacture/produce					
2	acquire					
3	possess					
4	stockpile/store					
5	develop					
6	transport					
7	transfer					
8	use					
9	participate as an accomplice in a.m. activities					
10	assist in a.m. activities					
11	finance a.m. activities					
12	a.m. activities related to means of delivery					
13	involvement of non-State actors in a.m. activities					
14	Other					

OP 3 (a) and (b) - Account for/Secure/Physically protect NW including Related Materials							
Are any of the following measures, procedures or legislation in place to account for, secure or otherwise protect NW and Related Materials? Can violators be penalized ?		National legal framework		Enforcement: civil/criminal penalties, and others		Remarks	
		YES	if YES, indicate source document	YES	if YES, indicate source document		
1	Measures to account for production						
2	Measures to account for use						
3	Measures to account for storage						
4	Measures to account for transport						
5	Other measures for accounting						
6	Measures to secure production						
7	Measures to secure use						
8	Measures to secure storage						
9	Measures to secure transport						
10	Other measures for securing						
11	Regulations for physical protection of facilities/materials/ transports						
12	Licensing of nuclear installations/entities/use of materials						
13	Reliability check of personnel						
14	Measures to account for/secure/ physically protect means of delivery						
15	National regulatory authority						
16	IAEA Safeguards Agreements						
17	IAEA Code of Conduct on Safety and Security of Radioactive Sources						

18	IAEA Database on Illicit Trafficking of Nuclear Materials and other Radioactive Sources					
19	Other Agreements related to IAEA					
20	Additional national legislation/regulations related to nuclear materials including CPPNM					
21	Other					
OP 3 (c) and (d) and related matters from OP 6, and OP 10 - Controls of NW including Related Materials						
Which of the following legislation, procedures, measures, agencies exist to control border crossings, export/import and other transfers of NW and Related Materials ? Can violators be penalized ?		<u>N</u> ational legal framework		<u>E</u> nforcement: civil/criminal penalties, and measures of implementation, etc		Remarks
		YES	if YES, indicate source document	YES	if YES, indicate source document	
1	Border control					
2	Technical support of border control measures					
3	Control of brokering, trading in, negotiating, otherwise assisting in sale of goods and technology					
4	Enforcement agencies/authorities					
5	Export control legislation in place					
6	Licensing provisions					
7	Individual licensing					
8	General licensing					
9	Exceptions from licensing					
10	Licensing of deemed export/visa					
11	National licensing authority					
12	Interagency review for licenses					

13	Control lists					
14	Updating of lists					
15	Inclusion of technologies					
16	Inclusion of means of delivery					
17	End-user controls					
18	Catch all clause					
19	Intangible transfers					
20	Transit control					
21	Trans-shipment control					
22	Re-export control					
23	Control of providing funds					
24	Control of providing transport services					
25	Control of importation					
26	Extraterritorial applicability					
27	Other					
OP 6, 7 and 8 (d) - Control lists, Assistance, Information						
Can information be provided on the following issues ?		YES				Remarks
1	Control lists - items (goods/ equipment/ materials/ technologies)					
2	Control lists - other					
3	Assistance offered					
4	Assistance requested					
5	Assistance in place (bilateral/plurilateral/multilateral)					
6	Information for industry					
7	Information for the public					

Legend: a.m. = aforementioned

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