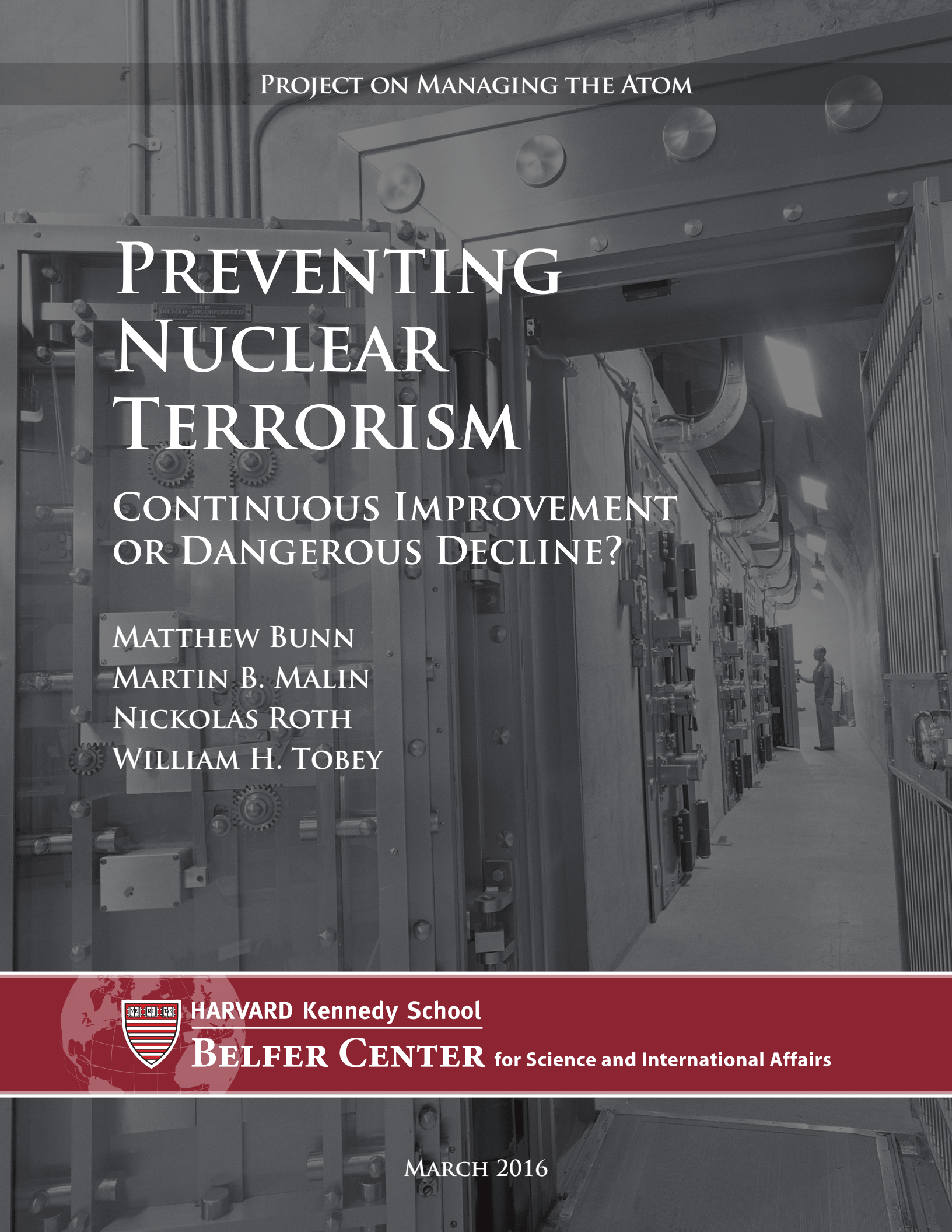

Project on Managing the Atom

Preventing Nuclear Terrorism

Continuous Improvement or Dangerous Decline?

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The "Tunnel Vault" nuclear materials storage facility at Technical Area 41, Los Alamos National Laboratory, as seen in October, 1964. (Los Alamos Archive).

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6. Recommendations: Getting to Continuous Improvement in Nuclear Security

Nuclear security efforts should have a clear goal: ensuring that all nuclear weapons and all the materials that could be used to make them, wherever they are in the world, are effectively and sustainably secured against the full spectrum of threats that terrorists and thieves might plausibly pose. All the various nuclear security policy tools should be assessed for their contribution to that goal.[193]

Many actions by many different parties will be needed to achieve this goal. Action will be needed from:

- Nuclear facility operators and transporters handling nuclear weapons, HEU, and separated plutonium;
- Governments of the countries where these stocks reside;
- The broader international community, and international organizations such as the IAEA; and
- Civil society, including industry associations, nonprofit organizations, academia, and the media.

Given the central role the United States has played in nuclear security initiatives, actions to be taken by the next U.S. president will be particularly critical. Hence, in this section, each category of recommendations includes steps the next U.S. president should take.

Indeed, the work has no fixed end date: nuclear security must continually evolve and adapt in the face of evolving threats, changing technology, and improved understanding of vulnerabilities. Yesterday's security may not be adequate to meet tomorrow's threat. Hence, past U.S. approaches that focused on finishing a fixed set of activities by a specific date will need to be modified for the nuclear security efforts of the future. For nuclear security, even more than for nuclear safety, the focus must be on continual improvement,

[193] Similar goals could and should be established for preventing nuclear reactor sabotage and controlling dangerous radiological sources (see Box: "Protecting Against Nuclear Sabotage," p.114). The recommendations in this section draw in part on previous work by the authors, including Bunn et al., *Advancing Nuclear Security*, pp. 61–78.

in the never-ending search for excellence. Effective security measures that are regularly assessed, probed, and tested will continue to be needed as long as terrorists seeking mass destruction and the materials needed to make nuclear weapons both exist in the world.

While there are many steps that should be taken to improve security for nuclear weapons and weapons-usable nuclear materials around the world, we believe that actions in six categories would be most important in filling existing gaps:

1. Committing to stringent nuclear security principles;
2. Revitalizing programs to implement such principles;
3. Expanding efforts to strengthen security culture and combat complacency;
4. Broadening efforts to consolidate nuclear weapons and materials to the minimum number of sites;
5. Developing approaches to confirm that effective nuclear security is in place; and
6. Continuing an effective nuclear security dialogue after the summits end.

We will discuss recommendations in each of these areas in turn. We also provide brief recommendations on strengthening other lines of defense against nuclear terrorism (see Box: "Preventing Nuclear Terrorism: Tools Beyond Nuclear Security," p. 130) and on protecting against and responding to sabotage of nuclear facilities and attacks with radiological "dirty bombs" (see Box: "Protecting Against Nuclear Sabotage" p. 114, "Reducing the Risk of Radiological Dirty Bombs," p. 98).

Reducing the Risks of Radiological Dirty Bombs

Tens of thousands of radiological sources are used all around the world for a variety of commercial purposes, from food sterilization to cancer treatment. By one estimate, radiological sources big enough to pose a serious danger exist in over 13,000 buildings in more than 100 countries.[i] A "dirty bomb" used to disperse such radioactive material could cause widespread fear and disruption, and necessitate costly evacuation and cleanup. The consequences of this type of attack, while substantial, would be utterly unlike those of a nuclear explosive: rather than incinerating the heart of a major city and killing tens or hundreds of thousands of people, a dirty bomb would create an expensive and disruptive mess, probably not killing anyone beyond those killed by the explosives that might be used to disperse the material.[ii]

Given the huge numbers of radioactive sources in use, it is hopeless to try to provide highly effective security for all of them. Instead, global radiological security efforts have focused primarily on the largest radioactive sources that could contaminate substantial areas if used as a dirty bomb—mainly those designated by the IAEA as "Category I" or "Category 2" sources.[iii]

Every country using such sources should:[iv]

- Require operators to provide appropriate security measures—including alarms that would notify police or other response forces if the source were removed or tampered with; appropriate locks and equipment designs to increase the time and effort required to remove a source (such as making it impossible to remove without explosives or special tools); and armed personnel where appropriate.[v]
- Provide training programs to inform operators of the best ways to secure sources—and to highlight the ongoing danger these sources pose.

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i Estimate provided by NNSA, July 2013.

ii See, for example, Ji Young Park, "The Economic Impacts of Dirty Bomb Attacks on the Los Angeles and Long Beach Ports: Applying the Supply-Driven NIEMO (National Interstate Economic Model)," *Journal of Homeland Security and Emergency Management,* Vol. 5, No. 1, 2008, http://www.degruyter.com/view/j/jhsem (accessed March 8, 2014), pp.1-20. See also Peter D. Zimmerman with Cheryl Loeb, "Dirty Bombs: The Threat Revisited," *Defense Horizons,* No. 38 (January 2004), pp. 1–11.

iii For a description of which sources fall in which category, see International Atomic Energy Agency, "Code of Conduct on the Safety and Security of Radioactive Sources" (Vienna: IAEA, 2004).

iv See Matthew Bunn and Tom Bielefeld, "Reducing Nuclear and Radiological Terrorism Threats," in *Proceedings of the Institute for Nuclear Materials Management 48th Annual Meeting,* Tucson, Arizona, July 8–12, 2007 (Northbrook, IL: INMM, 2007).

v For example, NNSA's Global Threat Reduction Initiative has worked with manufacturers to create new designs that make it far more difficult for adversaries to remove radioactive sources from machines that use them, and kits to modify machines already in use. Such "in-device delay" technology had been installed on more than 200 cesium chloride irradiators (some of the most dangerous sources in use) in the United States by April 2013. See "NNSA: Securing Domestic Radioactive Material" (*NNSA Media Room Fact Sheet,* April 12, 2013), http://nnsa.energy.gov/mediaroom/factsheets/gtri-protect (accessed March 9, 2014).

- Require transporters to provide appropriate security measures, including continuous tracking of vehicles carrying such sources, use of genuinely safe "safe havens" when drivers are sleeping or stopping, armed escorts where appropriate, a "panic button" allowing drivers to signal if trouble comes up, and engineered vehicle features that would make the vehicle and its contents more difficult to steal (as armored cars for transporting valuables routinely have—such as a button that effectively stops the vehicle from being driven). This should include improved security training for all drivers of dangerous radioactive sources.
- Maintain a cradle-to-grave register tracking the location and use of each source.
- Provide safe and secure options for disposing of such sources when they are no longer needed, with requirements for users to send them there.
- Establish a program for finding and securing lost and orphan sources, potentially including through effective use of radiation detection equipment.
- Shift quickly to non-radioactive alternatives wherever practicable—such as the linear accelerators now used in the United States and other developed countries instead of the type of teletherapy source stolen in the incident in Mexico.[vi]

In addition, because a great deal of the impact of a radiological dirty bomb would come from the public fear of radiation, it is crucial to begin preparing public communication strategies and broader emergency response and cleanup approaches to mitigate the disruption and fear that might result as much as practicable.

The United States, the IAEA, and other donors have been helping countries take such steps, and have made significant progress, removing thousands of unneeded sources around the world and installing security upgrades for sources in more than 2,000 buildings, within the United States and elsewhere. To date, however, neither the United States nor any other country has been willing to provide the funding needed to upgrade security for or replace all of the world's most dangerous sources. It may be that most of the job should be accomplished by convincing countries to require operators to provide adequate security themselves, rather than most of the job being paid for by U.S. taxpayers. But there are clearly some circumstances where international funds will be needed if security is to be provided at a reasonable pace. The United States has reduced its budget for radiological security assistance, even though the task was far from complete: at the U.S. program's current pace, it would take another 17 years to meet its much-reduced target of helping to secure just under 4,400 buildings with dangerous radioactive material—down from a target of 16,000 a few years ago.[vii]

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vi Rafael Romo. Nick Parker, and Mariano Cas, "Mexico: Stolen Radioactive Material Found," *CNN*, December 4, 2013, http://www.cnn.com/2013/12/04/world/americas/mexico-radioactive-theft/ (accessed March 11, 2016).

vii U.S. Department of Energy, *FY 2017 Congressional Budget Request: National Nuclear Security Administration*.

1. Commit to Stringent Nuclear Security Principles

The time has come to seek to build a common understanding that wherever nuclear weapons, HEU, or plutonium exist, certain key security and accounting elements are needed.[194] There should not be a "one size fits all" approach, as countries legitimately have somewhat different approaches to implementing and regulating nuclear security, and face different adversary threats to their nuclear stocks. A nuclear security system capable of reducing the risk of nuclear theft to a very low level in Canada might not be remotely adequate in Pakistan, where both outsider and insider threats are far more substantial. Hence, what is needed is a set of principles specific enough to be meaningful, but broad and flexible enough to permit each country to implement nuclear security in its own way.

Governments will not negotiate a treaty establishing stringent nuclear security principles in the near term. But it is quite possible that a group of like-minded states with substantial stocks of nuclear materials could work together to draft a political commitment to a set of principles that they were each willing to implement. They could invite all other states with plutonium and HEU on their soil to join them in the commitment, and offer help to those countries wishing to implement the principles but needing technical or financial help to do so. Such a commitment could potentially be worked out in experts' meetings of the permanent five members of the UN Security Council, within a new working group of GICNT, or in a grouping established for this purpose.

The initial participants in such a commitment will have to work out what the specific principles would be.[195] One approach would be to look to the goals in areas such as physical protection, material control, and material accounting that Russian and U.S. experts agreed to work toward in their technical cooperation.[196] We suggest that such an arrangement include commitments to:

194 We use the terms "key elements" and "principles" here, rather than "standards," as many countries interpret the word "standard" to mean that the implementation should be identical, as in a technical standard for high-definition television or something of that kind.

195 Such an initiative would be a substantial complement to the nuclear security implementation initiative announced at the 2014 Nuclear Security Summit, offering substantially stronger nuclear security commitments, and clearly extending to both military and civilian stocks.

196 William Tobey, Building a Better International Nuclear Security Standard (Cambridge, MA.: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, March 2012), http://uskoreainstitute.org/wp-content/uploads/2012/03/USKI_NSS2012_Tobey.pdf (accessed March 17, 2016). For other ideas on approaches to building stronger commitments on military stockpiles in particular, see Des Browne, Richard Lugar, and Sam Nunn, co-chairs, *Bridging the Military Nuclear Materials Gap* (Washington, D.C.: Nuclear Threat Initiative, November 2015), http://www.nti.org/media/pdfs/NTI_report_2015_e_version.pdf (accessed March 17, 2016); and Fissile Materials Working Group, *The Results We Need in 2016: Policy Recommendations for the Nuclear Security Summit* (Washington, D.C.: FMWG, June 2105), http://www.fmwg.org/FMWG_Results_We_Need_in_2016.pdf (accessed March 17, 2016).

- Require facility operators and transporters to protect nuclear weapons, HEU, and separated plutonium against the full range of plausible adversary capabilities and tactics—including, at a minimum, a modest group of well-armed and well-trained outsiders; a well-placed insider; and both outsiders and an insider working together.[197] Given the global reach that terrorists have demonstrated, it seems clear that such a baseline level of security is essential wherever nuclear weapons and their essential ingredients exist, even in the safest countries.
- Accept that national leaders have a responsibility they cannot delegate to others to ensure effective and continually improving security for all nuclear weapons or weapons-usable nuclear materials under their country's control.
- Provide on-site armed guard forces that are well equipped, well trained, professional, and have sufficient capabilities to defeat adversary threats.
- Put in place a comprehensive suite of measures to protect against insider threats.
- Implement material control and accounting systems adequate to detect and localize any theft of weapons-usable nuclear material.
- Ensure that protection against cyber threats is strong and fully integrated with other nuclear security measures.
- Require facility operators and transporters to institute programs to assess and improve security culture, and to exchange and learn from security best practices.
- Put in place effective nuclear security and accounting rules, and give regulators the authority, independence, expertise, and resources to ensure that operators implement them effectively.
- Carry out regular, realistic tests of the performance of nuclear security systems, including force-on-force exercises.
- Ensure that all facility operators and transporters have the resources and plans to sustain effective nuclear security and accounting for as long as they are handling these items and materials.
- Review each site where stocks of nuclear weapons or weapons-usable materials exist and remove these items from any site where the costs and risks of their presence outweigh the continuing benefits.

197 For a more detailed rationale for this suggestion, see Matthew Bunn and Evgeniy 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.

- Regularly host international nuclear security peer reviews, such as the IPPAS reviews led by the IAEA.
- Regularly review and update nuclear security requirements and approaches in the face of changing technology, accumulating experience, and the evolving threat.

Such a commitment would be, in effect, the strongest nuclear security "gift basket" yet—a joint commitment entered into by a substantial group of countries. Assuming that no such commitment emerges from the upcoming summit, it could be developed later, in forums for ongoing nuclear security discussion, discussed below.

Beyond these commitments focused on protecting nuclear weapons, HEU, and separated plutonium, the initiative (or parallel initiatives) could also include pledges to develop similar measures to protect nuclear power reactors and other major nuclear facilities from sabotage, and to provide effective security for radiological sources that might be used in a "dirty bomb." It could also include agreements to work together to stop nuclear smuggling and bring such smugglers to justice, along with expanded cooperation among law enforcement and intelligence agencies.

The participating states should agree to have experts and senior officials meet regularly, with the participation of the IAEA, to review progress in implementing these principles, and to discuss ways in which the initial principles should be modified or expanded, based on evolving threats, experiences with implementation, changing technology, and more. They should also agree to have experts work together to develop means to build confidence between states that these commitments are being fulfilled, without compromising secret information.

Finally, the participants should commit to work together to strengthen the nuclear security role of the IAEA and ensure that it has sufficient, predictable funds to implement its nuclear security activities.

Steps Along the Path

There are other sets of existing commitments that are quite important, though they do not include the stringent nuclear security principles just discussed. States interested in promoting stronger nuclear security around the world should use their diplomatic efforts to encourage more countries to:

- Ratify the 2005 amendment to the Convention on Physical Protection of Nuclear Materials (CPPNM) and the International Convention on the Suppression of Acts of Nuclear Terrorism (ICSANT).
- Participate in the nuclear security "implementation initiative" announced at the 2014 Nuclear Security Summit, in which states commit to meet the objectives of IAEA nuclear security recommendations and accept regular peer review of their nuclear security arrangements. Participation by key holders of substantial stocks who are not yet participating, such as Russia, China, Pakistan, and India, would be particularly important.
- Participate in other important nuclear security "gift baskets" developed in the nuclear security summit process.
- Provide funding, experts, and political support to strengthen the IAEA's nuclear security role.
- Participate in and support the best practice exchanges and other activities of WINS.

Some nuclear security experts have advocated expressing such commitments in a new treaty on nuclear security, arguing that such an agreement could provide an overarching framework for the many elements of global nuclear security governance and plug the holes in the existing nuclear security framework.[198] Unfortunately, it appears very unlikely that states would be able to reach agreement on a convention that really imposed stringent security requirements in the near term. The experience of the amendment to the CPPNM is instructive. The amendment was first proposed by the United States in 1998, and it took seven years to negotiate an agreed text. Even though most of those negotiations occurred after the 9/11 attacks, the negotiators firmly rejected including any requirements that states implement specific nuclear security measures, any verification provisions, or even requirements for national reporting on implementation. Even so, as of early 2016, 18 years after it was first proposed, the amendment had still not entered into force.

198 See, for example, Kenneth C. Brill and John H. Bernhard, "A Convention on Nuclear Security: A Needed Step Against Nuclear Terrorism," *Arms Control Today,* June 2015. For a proposed text of such a convention, with explanatory material, see John H. Bernhard, Kenneth C. Brill, Anita Nilsson, and Shin Chang-Hoon, *International Convention on Nuclear Security* (Washington, D.C.: Nuclear Security Governance Experts Group, March 2015), http://www.nsgeg.org/ICNSReport315.pdf (accessed March 15, 2016).

Recommendations for the Next U.S. President

The next U.S. president should:

- Clearly establish as national policy the goal of effective and sustained protection against the full range of plausible outsider and insider threats for all stocks of nuclear weapons and weapons-usable nuclear materials worldwide.

- Order the implementation of the principles at home, shoring up vulnerabilities at U.S. sites, including through programs for improving and assessing security culture in relevant organizations.

- Work with other countries to launch an initiative on nuclear security principles such as that described above.

- In parallel, work to convince countries with stocks of weapons-usable nuclear materials who have not yet done so to join in the 2014 nuclear security implementation initiative.

- Declare as administration policy that nuclear security is an undelegatable executive responsibility and hold other heads of state and government colleagues to that standard.

2. Revitalize Programs to Implement Effective and Sustainable Nuclear Security

Achieving and sustaining excellent nuclear security will require both actions within individual countries and revitalized international cooperation. Particular attention should be focused on protecting against insider threats and cyberattacks, and on strengthening security at bulk-handling facilities, which appear to have been the source of most nuclear thefts to date.

Much of the job of achieving excellence in nuclear security, and sustaining and improving it over time, rests with operators—the organizations that actually run nuclear facilities and transport nuclear weapons and materials. These organizations should establish excellence in nuclear security as their goal, with approaches based on continuous improvement, just as in nuclear safety. They should be focused on safety, security, and successful operations

as co-equal goals, each necessary for the organization to be successful.[199] This should be communicated clearly throughout the organization, by word and deed.

In particular, these organizations will need to:

- Implement the nuclear security commitments described above.
- Develop and implement plans to provide the funding and the trained and certified personnel needed to achieve and sustain effective nuclear security.
- Motivate their employees to achieve strong nuclear security performance.
- Implement effective security practices, including those outlined in guidance from the IAEA and WINS. Operators should also participate in and support good practice exchanges.
- Ensure that all personnel responsible for nuclear security, at all levels of relevant organizations, are well trained and demonstrate competence through professional certification.
- Continuously assess their security programs and look for vulnerabilities, in order to improve security over time in the face of evolving threats.

Governments, of course, must help with the implementation of these goals, providing policy direction, funding where appropriate, threat information, additional response forces where needed, regulation and oversight, and other forms of support.

Three areas in particular will need to be the focus of attention, both for these organizations and for their governments: insider threats, bulk processing facilities, and cyber protection.

199 For those operations subject to international safeguards, effective safeguards must also be integrated with safety, security, and successful operations – making a "4S" concept. For a discussion of the "3S" approach—safety, security, and safeguards—see, for example, Kenneth E. Sanders, R.B. Pope, Y.Y. Liu, and J.M. Shuler, "Interfaces among Safety, Security, and Safeguards (3S)—Conflicts and Synergies," *Proceedings of the 56th Annual Meeting of the Institute for Nuclear Materials Management, Indian Wells, CA, July 12–16* (Northbrook, IL: INMM, 2015), https://rampac.energy.gov/docs/default-source/transportation/INMM56_3S.pdf (accessed January 18, 2016).

Protecting Against Insider Threats. Insiders appear to have carried out or assisted in all or nearly all of the known thefts of HEU or separated plutonium.[200] Protecting against insiders who have authorized access to the material, are trusted by the other staff, and may be well informed about the weaknesses of the security measures in place is particularly challenging. Operators handling nuclear weapons, plutonium, or HEU—working closely with the governments of the states in which they operate—should put in place comprehensive insider protection programs, combining effective screening and monitoring of personnel; storage of all material in secure vaults whenever it is not in use; strong material controls that ensure that material is monitored at all times and any removal would be rapidly detected; a two-person or three-person rule whenever relevant materials are handled, to ensure that no one is ever alone with a nuclear weapon or weapons-usable nuclear material; accounting of nuclear material that is accurate and timely enough to notice either a rapid or a protracted theft and help identify where the loss is occurring and who might have had access; portal monitors at all potential entrances and exits to set off an alarm if any material is being removed; and regular tests, assessments, and inspections to ensure the effectiveness of the insider protection program in place.[201]

Improved Security for Bulk-Processing Facilities. When nuclear material is being processed in bulk, it is far easier for insiders to steal small amounts at a time without anyone noticing. Nearly all of the seizures of stolen HEU and separated plutonium that have occurred have been of bulk material such as powders, apparently stolen from bulkprocessing facilities. All countries operating such facilities should: ensure that advanced material control and accounting systems are in place that are capable of detecting and localizing both abrupt and protracted thefts; minimize direct human access to bulk material; ensure that all pathways in and out of such facilities are carefully monitored for nuclear material; and take other measures to make it very difficult to remove weapons-usable nuclear material from these facilities.

Protecting Against Cyber Threats. As noted earlier, every aspect of nuclear operations and of nuclear security systems is increasingly digital. This is an area where the threat evolves and changes particularly rapidly and unpredictably. Operators must ensure that effective cyber protections are in place; establish programs to test and probe their systems

200 In many cases, how exactly the theft occurred is not known—but since the material has been bulk material stolen without anyone noticing, it seems very likely that the thefts were perpetrated by insiders.

201 World Institute for Nuclear Security, *Managing Internal Threats: A WINS International Best Practice Guide for Your Organization*, Rev. 1.0 (Vienna: WINS, 2010); International Atomic Energy Agency, *Preventive and Protective Measures Against Insider Threats*, IAEA Nuclear Security Series No. 8 (Vienna: IAEA, 2008). See also Matthew Bunn and Kathryn M. Glynn, "Preventing Insider Theft: Lessons from the Casino and Pharmaceutical Industries," *Journal of Nuclear Materials Management* 41.3 (Spring 2013): 4–16; and Matthew Bunn and Scott Sagan, "A Worst Practices Guide to Insider Threats: Lessons From Past Mistakes" (Cambridge, MA: American Academy of Arts and Sciences, March 2014).

for vulnerabilities; and integrate cyber protection with their traditional security measures, to protect against coordinated cyber and physical intrusions.

Strengthen International Nuclear Security Cooperation

The chances for achieving and sustaining nuclear security excellence worldwide will be far higher if countries work together, exchanging ideas and experiences and pooling the best experts to address difficult problems. But nuclear security cooperation is moving into a new era, focused less on donor states providing equipment and training and more on convincing (and helping) states to do more themselves. The approach will focus much more on genuine partnerships, with ideas and resources from all participants, rather than donor-recipient relationships. As one U.S. official put it, the role for the United States and other countries working to strengthen nuclear security will be as "an evangelist and a consultant," working through multiple channels to convince other countries to take additional nuclear security actions, and exchanging ideas about how best to do so—along with some continuing effort at providing help where needed.

This new era will still require experts in the disciplines of nuclear security, from physical protection system design to material control and accounting to security leadership and management. Such experts bring a better understanding of what needs to be done and what the difficulties are in doing it, and more credibility with their international counterparts; indeed, personal relationships among international experts can be a key intangible factor driving progress in nuclear security. But the new era will require fewer skills in managing construction programs and negotiating contracts, and more skills at energetic but sensitive diplomacy to push for additional action—the "evangelist" part of the equation.

It will also require in-depth analysis and assessment of what new steps are most needed. Countries cooperating to strengthen nuclear security should find ways to exchange more information – protected as appropriate to its sensitivity – about what their nuclear security arrangements actually are. For example, to assess progress toward the goal of protecting nuclear weapons and weapons-usable materials against the full spectrum of adversary threats would require an understanding of what kinds of threats countries are seeking to protect their stocks against. But U.S. officials report that in general they have little idea what DBTs other countries have established (and do little sharing of comparable U.S. information)– and in the case of U.S.-Japan cooperation, the participants have found that there is not an obvious legal basis for exchanging such sensitive information.[202]

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202 Interviews with U.S. National Security Council and National Nuclear Security Administration officials, April 2013, and February 2016.

Establish Funds to Finance Unexpected Nuclear Security Needs

Occasionally, nations attempting to provide effective nuclear security confront a funding shortfall relative to need. This can occur because of a financial or budgetary emergency, an urgent and unexpected security requirement, or the need for a capital investment too large to be accommodated in an annual budget.

The classic example of the first problem would be the nuclear security crisis caused by the dissolution of the Soviet Union, when guards went unpaid and fences were left unmended for a lack of funds. Today, Russia again faces severe budgetary constraints—with two successive across-the-board 10 percent federal budget cuts, and a federal budget depending on hydrocarbon revenues for half its income when oil and gas prices remain a fraction of what they were a few years ago.

The extraordinary funds that were required to guard the plutonium left over in the former Soviet nuclear test tunnels in Kazakhstan provide an example of the second type of problem. After weapons-usable fissile material was discovered in the tunnels, Astana (with U.S. assistance) provided guards and fencing at considerable cost on a temporary basis, until the tunnels could be permanently closed and the material immobilized. With respect to the third type of problem, capital expenditures for improved fencing and sensors or armored guard posts can easily match or exceed the annual security budgets for many facilities. Two policy options might address these needs.

First, the IAEA could administer a Nuclear Security Revolving Fund, initially capitalized by member states through voluntary contributions. Any member state could apply to the fund for a loan to improve the security of civil fissile or radiological material under extraordinary circumstances—financial or budgetary crisis, urgent and unexpected security exigencies, or requirements for large capital expenditures. The IAEA and the borrower would negotiate a term for repayment of the loan, perhaps 5-10 years, and the IAEA would verify both the security need and the implementation of the security improvements, with appropriate protection of sensitive information, including use of alternative measures such as trusted agents if needed. This service could be offered in connection with IPPAS missions. An initial fund of $20-$30 million would probably suffice. Such a fund could help overcome

political sensitivities that can impair cooperation between states on nuclear security, such as the currently fraught U.S.-Russian relationship. It could also provide a flexible and agile means to deal with extraordinary circumstances. Consistent with the IAEA's overall mission, it would be limited to civil material.

Second, to cover both civil and military material and facilities, the United States and Russia, despite changed political and economic circumstances, could establish a similar revolving fund that they would jointly administer. A board with equal numbers of U.S. and Russian experts could review and decide on applications to the fund and oversee implementation of funded projects. The United States and Russia have considerable experience they could draw on to work out arrangements to confirm that projects were implemented as agreed without compromising sensitive information. Facilities in either the United States or Russia, or in other countries, could apply for funding, or experts on the board could suggest projects for discussion.

This type of fund would advance several purposes. It would provide funding for urgent nuclear security requirements in a partnership-based approach rather than one based on a donor-recipient relationship. It could relieve some of the pressure that leadership at certain facilities may feel to cut corners on security in hard times. It would maintain valuable relationships between technical experts built over decades at great cost in time and money. It would also maintain a focus on the need for continual improvement in nuclear security in both countries. Moreover, it would serve as the basis for sharing insight and best practices, to improve both countries' security techniques. Finally, it would demonstrate that the United States and Russia could still work together on important security issues of mutual interest, even as their policies and interests in other realms diverge.

The effort to build continuously improving nuclear security systems will involve cooperation with many partners. The United States should seek renewed cooperation with Russia (see below); continued and deepened cooperation with Pakistan; a much broader set of cooperative activities with India; a broader agenda of cooperation with China; and ongoing cooperation to ensure that security is sustained and continues to improve where needed for research facilities with HEU around the world, from South Africa to Belarus. The United States should also expand its discussions with developed countries, to make the case for needed nuclear security actions, develop agreed-upon principles such as those discussed above, exchange good practices, discuss approaches to addressing remaining challenges, and more. For example, the United States should pursue joint workshops on topics such as strengthening security culture, protecting against insider threats, and cybersecurity with all of the countries where nuclear weapons or weapons-usable exist, regardless of whether they are developing or developed countries.[203]

Rebuild Nuclear Security Cooperation with Russia, Based on a New Approach

Rebuilding broad U.S.-Russian nuclear security cooperation is especially important. As the Russian government itself put it in early 2015, "Russia and the United States of America bear a special responsibility for ensuring safety and security of nuclear materials and their reliable physical protection, preventing them from falling into the hands of terrorist organizations."[204]

Despite current tensions at the political level, U.S. and Russian nuclear experts still respect each other and many would be eager to return to working together. Russia and the United States should each take actions to unravel this knot and revitalize their cooperation. It should be possible to cooperate in areas of mutual interest even while confronting each other where interests conflict—as the two countries did in Soviet times. For the United States, work on nuclear security is of particular interest; Russia is especially interested in nuclear energy cooperation.[205] Ultimately, the two countries should agree to a package of cooperation that includes both nuclear energy initiatives and a broader agenda of nuclear

203 Participation in such cooperation will never be universal. It is unlikely, for example, that North Korea will be willing to participate in nuclear security cooperation in the near term, or that Israel would be willing to have detailed discussions of security for whatever nuclear stocks it may have (since it does not acknowledge possessing such stocks).

204 Rosatom, "In 2015 Russia and the USA Will Continue Cooperation in Ensuring Global Nuclear Safety," *Rosatom Press Centre,* January 22, 2015, http://www.rosatom.ru/en/presscentre/news/1268ed0047075a019f90bff60e8e8c2a (accessed February 11, 2016). For discussion, see Matthew Bunn, "Russia Puts a Positive Spin on Nuclear Security Cooperation—Which is Good," *Nuclear Security Matters Blog*, Project on Managing the Atom, January 23, 2015, http://nuclearsecuritymatters.belfercenter.org/blog/russia-puts-positive-spin-nuclear-security-cooperation-—-which-good (accessed January 18, 2016).

205 Bunn, "Russia Puts a Positive Spin on Nuclear Security Cooperation—Which is Good."

security cooperation than is currently under way. Track II dialogues in which non-government experts explore ideas may help to lay the groundwork for such renewed cooperation.[206]

It is unlikely that U.S.-Russian cooperation will ever again resemble the Nunn-Lugar approach of old, in which the United States financed large-scale equipment installation and training programs in Russia and U.S. experts were permitted to visit a wide range of Russian nuclear facilities, many of them highly sensitive.[207] Cooperation in the future, if it can be rebuilt, will be based on a partnership approach, including ideas and resources from both sides, designed to serve both sides' interests.

Joint efforts could include:

- Establishing working groups in key technical areas, from vulnerability assessment to material accounting. These groups could carry out activities ranging from good practice exchanges and discussions of remaining challenges to jointly developing guides and training courses.
- Developing joint nuclear security principles, such as those suggested above.
- Conducting joint R&D to develop the next generation of more effective, lower cost, security and accounting technologies.
- Minimizing the number of sites with nuclear weapons, HEU, or separated plutonium. Each country, for example, should draw up a strategic plan to accomplish its remaining military and civilian missions with the minimum number of locations where these stocks exist.
- Strengthening nuclear security regulation, inspection, and testing.
- Exchanging technical visits to particular sites, to review implementation and exchange ideas.
- Working together to strengthen nuclear security in other countries.
- Working together to strengthen efforts to interdict nuclear smuggling, including development of improved detection technologies and strategies, sharing of intelligence, and more.

206 Several of the authors recently participated in a Track II dialogue on these topics sponsored by the Nuclear Threat Initiative and the Center for Energy and Security Studies in Moscow.

207 It is worth noting that while U.S. visits to Russian facilities were more extensive, the United States also invited Russian experts to visit U.S. facilities. These visits included all three of the U.S. nuclear weapons labs, the main U.S. plutonium-handling and HEU-handling facilities, and the U.S. nuclear weapons assembly and disassembly facility (a type of facility U.S. experts did not visit in Russia), so these visits were not as one-sided as they are sometimes made to seem in Russia.

- Conducting joint exercises to strengthen coordinated response in the event of a nuclear terrorism or nuclear smuggling event.
- Expanding cooperation against the IS and other terrorists who may combine the capabilities and intent to pose a nuclear threat in the future.[208]

Recommendations for the Next U.S. President

The next U.S. president should:

- Seek to revitalize nuclear security cooperation programs and adapt them to focus on convincing countries to take the actions needed to achieve nuclear security excellence, and helping them to do so.
- Work with Russia to rebuild and reform U.S.-Russian nuclear security cooperation, including being willing to restart U.S.-Russian nuclear energy cooperation as part of a larger nuclear cooperation package that includes nuclear security.

3. Expand Efforts to Strengthen Security Culture and Combat Complacency

To combat the complacency that undermines effective nuclear security, two interrelated sets of actions are needed: steps to strengthen nuclear security culture, and steps to broaden international understanding of the evolving threat and the remaining vulnerabilities that need to be addressed.

A New Nuclear Security Culture Initiative

Most nuclear organizations do not have any focused program to strengthen their nuclear security culture. They should. Countries interested in strengthening nuclear security should join together and commit to working with their operating organizations to take a series of steps to strengthen security culture.

208 For an existing set of recommendations for unilateral, bilateral, and multilateral work from a set of U.S. and Russian experts, see Matthew Bunn Matthew Bunn, Valentin Kuznetsov, Martin B. Malin, Yuri Morozov, Simon Saradzhyan, William H. Tobey, Viktor I. Yesin, and Pavel S. Zolotarev, *Steps to Prevent Nuclear Terrorism: Recommendations Based on the U.S.-Russia Joint Threat Assessment* (Cambridge, MA: Belfer Center for Science and International Affairs, Harvard Kennedy School, and Institute for U.S. and Canadian Studies, September, 2013), http://belfercenter.hks.harvard.edu/files/JTA eng web2.pdf (accessed January 18, 2016), pp. 19–22.

This would begin with the participating countries agreeing on the goal of excellence in nuclear security, with approaches based on the principle of continuous improvement, and on the importance of strong security culture to achieving that objective. Specific steps in such an initiative might include committing to:

- Ensure that all organizations managing high-consequence nuclear materials or facilities have programs in place to (a) assess their security culture, and (b) continuously strengthen it;
- Ensure that these organizations implement security culture recommendations of the IAEA and WINS;
- Ensure that all security-relevant managers and staff at such organizations receive regularly updated information on nuclear security threats, at levels of detail appropriate to their particular roles;
- Ensure that all such organizations establish programs of incentives for strong nuclear security performance (for individuals, teams, and organizations, as appropriate);
- Develop mechanisms for sharing good practices in strengthening security culture among nuclear organizations, and ensure that as many organizations as practical participate in these (including, as appropriate, through the IAEA and WINS); and
- Establish a joint working group charged with discussing progress and lessons learned, and developing additional suggestions for action.

Such an initiative could be one part of the broader nuclear security principles initiative suggested above, or it could be developed independently.[209]

209 For another account of the importance of security culture initiatives and potential actions leaders might take, see Igor Khripunov, "A Culture of Nuclear Security: Focus for the Next Nuclear Security Summit?" *Bulletin of the Atomic Scientists*, June 26, 2015, http://thebulletin.org/culture-security-focus-next-nuclear-security-summit8428 (accessed March 17, 2016).

Protecting Against Nuclear Sabotage

The disaster at the Fukushima Daiichi nuclear power plant in 2011 vividly demonstrated the terror, disruption, and costs that could be caused by a major nuclear accident—which could be caused by purely accidental events or by sabotage.[i] The sabotage of the Doel-4 reactor described in this report is only one of a number of sabotage events over the years, ranging from an insider bringing explosives into a plant and detonating them directly on the reactor's steel pressure vessel to terrorists overwhelming a plant's guards and seizing control of the facility before off-site response forces arrived.[ii] While none of these events released radiation, the danger of a major nuclear sabotage—a "security Fukushima"—is very real.

Preventing and responding to sabotage requires both deterring and delaying adversaries and providing effective safety and emergency response measures for coping with any emergency, whether caused by accident or terrorism. Steps such as ensuring that electric power to nuclear plants can quickly be restored and water can be provided to keep reactor cores and spent fuel stores adequately cooled can help reduce the chance of radioactive releases in any emergency, and steps such as filtered events can reduce the scale of radioactive releases if an emergency nevertheless occurs.[iii] For similar reasons, it would be more difficult for terrorists to cause a major radioactive release by sabotaging a new-generation reactor that relies more on passive systems to achieve safety, such as the AP-1000, than an older-design system more dependent on quick action of pumps and electrical systems; it would be still more difficult to cause a major radioactive release from an even more passive small modular reactor design, with less energy contained in its core to cause overheating.

To date, U.S. nuclear security programs have focused almost exclusively on security for materials that might be picked up and moved to the United States for an attack, rather than on helping countries protect against nuclear sabotage, which was seen as more their problem than a U.S. issue. Similarly, CPPNM did not include sabotage until its 2005 amendment, and the 2011 revision to the IAEA's nuclear security recommendations was the first that included specific recommendations for preventing and coping with sabotage. While the nuclear security summits have not focused in detail on sabotage, the 2012 communiqué noted the importance of the

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i For a discussion of both safety and security lessons from Fukushima, see Matthew Bunn and Olli Heinonen, "Preventing the Next Fukushima," *Science*, Vol. 333 (September 16, 2011), pp. 1580–1581.

ii The first of these incidents occurred at the Koeberg plant in 1982. For a useful summary, see Noah Gale Pope and Christopher Hobbs, *Insider Threat Case Studies at Radiological and Nuclear Facilities* (London: King's College and Los Alamos National Laboratory, April 13, 2015), http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-15-22642 (accessed February 29, 2016).The second incident mentioned occurred at the Atucha Atomic Power Station in Argentina in 1973. For a brief account of that incident (and many others) see Konrad Kellen, "Appendix: Nuclear-Related Terrorist Activities by Political Terrorists," in Paul Leventhal and Yonah Alexander, *Preventing Nuclear Terrorism* (Lexington, MA: Lexington Books, 1987), pp. x–xv. In both of these cases, the reactors were under construction and not yet loaded with fuel, so radioactive releases were not possibilities.

iii International Atomic Energy Agency, *Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage* (Vienna: IAEA, 2007), http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1271_web.pdf (accessed March 6, 2016).

safety-security link, and the 2014 communiqué included preventing sabotage as one of the fundamental nuclear security responsibilities of all states. A strong argument can be made that U.S. nuclear security programs should also begin including an expanded focus on sabotage: while it would not be in any way comparable to a nuclear detonation in a U.S. city, a foreign nuclear reactor sabotage could devastate the countries concerned and the global nuclear industry, seriously undermining any hope of expanding nuclear energy enough to play an important role in mitigating climate change.

There is clearly more to be done in many countries to provide adequate protection against sabotage.[iv] The protections that were in place in Belgium in 2014 were clearly inadequate to prevent a major sabotage—and Belgium (which has since upgraded security to prevent a recurrence) was not alone. Some countries have no armed guards at all at nuclear facilities, relying on offsite response forces some distance away; others have no background checks before allowing employees access to reactor vital areas or nuclear security systems. Experts in many countries unduly downplay the risk: in a recent survey of experts from 18 countries with HEU or plutonium on their soil, most respondents did not consider insider sabotage as a really credible threat, and some similarly downplayed the credibility of outsider sabotage.[v] Most individual country statements at the nuclear security summits do not mention the threat of sabotage or measures taken to address it.[vi]

States should take action to address these vulnerabilities. At a minimum, all nuclear power plants and other nuclear facilities whose sabotage could cause a major catastrophe should be protected against sabotage by a well-placed insider; a modest group of well-armed and well-trained outsiders, capable of operating as more than one team; and both an insider and outsiders working together. Plants in countries facing especially capable terrorist or criminal threats should be defended against even more capable adversaries. And all nuclear power plants should have fully operable and survivable equipment to provide emergency power and water in the event of a major accident or sabotage.

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iv Major international nuclear security instruments reflect this concern. The 2005 amendment to the physical protection convention, for example, broadens its coverage to include sabotage, and the 2011 revision to the IAEA's physical protection recommendations greatly expands their coverage of protection against sabotage. For a discussion of both safety and security lessons from Fukushima, see Matthew Bunn and Olli Heinonen, "Preventing the Next Fukushima."

v Bunn and Harrell, *Threat Perceptions and Drivers of Change,* p. 23.

vi "The Hague Nuclear Security Summit Communiqué," U.S. Department of State.

Increasing Understanding of the Nuclear Terrorism Threat

In addition to the security culture initiative, it is important to take steps particularly focused on increasing international understanding both of the nuclear terrorism threat and the potential vulnerabilities of existing nuclear security systems that require additional action. Important steps could include:

Agreement to Establish a Shared Database of Analyses of Incidents and Lessons Learned. Sharing of incidents, with root cause analyses and lessons learned, is routine, and extremely important, in strengthening nuclear safety. It is time to undertake a similar approach in nuclear security—within the inevitable constraints of necessary secrecy. The United States should work with other states to establish a shared database of security-related incidents. Each incident should be explored in depth, with analyses of the vulnerabilities that adversaries exploited to defeat security systems, and lessons learned (including security measures that could prevent such incidents from occurring at other sites). This would go well beyond the information available in the IAEA's databases, such as the Incident and Trafficking Database (ITDB); with a focus on how the incidents occurred and lessons learned from each one, it is more useful in understanding both the scope of the threat and the measures needed to address it.[210] Non-nuclear incidents that offer important lessons about the types of tactics against which nuclear materials and facilities must be protected should also be included.[211] Information about incidents and how to protect against them could be a major driver of nuclear security improvement, as it has been in safety; in a recent survey of nuclear security experts in 18 countries with weapons-usable nuclear material, incidents were cited far more often than any other factor as a dominant or very important driver of countries' recent changes in nuclear security policies.[212] The United States should kick things off with a detailed description of both the weaknesses that allowed the 2012 intrusion at the Y-12 nuclear complex to occur and the lessons learned and steps that have been taken to prevent similar occurrences in the

210 Even the ITDB information available to participating states offers little assessment of the causes of incidents or lessons learned. The information available to the public is little more than total numbers of incidents of particular kinds. See "IAEA Incident and Trafficking Database: Incidents of nuclear and other radioactive material out of regulatory control 2015 Fact Sheet," *International Atomic Energy Agency*, 2015, http://www-ns.iaea.org/downloads/security/itdb-fact-sheet.pdf (accessed February 19, 2016).

211 For three recent examples of such international incident assessments, seeking to draw lessons learned, see Jarret M. Lafleur, Liston K. Purvis, and Alex W. Roesler, *The Perfect Heist: Recipes From Around the World*, Vol. SAND-2014-1790 (Albuquerque, N.M.: Sandia National Laboratories, April 2014); Bunn and Sagan, *A Worst Practices Guide to Insider Threats: Lessons from Past Mistakes* and Pope and Hobbs, *Insider Threat Case Studies*. In the past, the U.S. government sponsored a nuclear security incidents database maintained by the RAND Corporation, but that effort is no longer being pursued. For examples of the kind of information that was included in the RAND database, see Kellen, "Appendix: Nuclear-Related Terrorist Activities by Political Terrorists."

212 Bunn and Harrell, *Threat Perceptions and Drivers of Change,* pp. 27–28.

future.[213] Participating states could begin with internal assessments of events within their territory, and then provide as much information as can reasonably be exchanged to an international collection of information.

Providing Briefings and Reports on the Threat. States that believe they have information on the nuclear terrorist threat should prepare reports and briefings and distribute them to other states. The United States, in particular, should prepare a detailed report on how easy or difficult it would be for a sophisticated terrorist group to make a crude nuclear bomb; past efforts by al Qaeda and other terrorist groups to get nuclear bombs and assessments of plausible future efforts by the IS and others; the potential for terrorists to be able to get plutonium or HEU from nuclear thieves and smugglers; and other elements of the nuclear terrorist threat. Different versions should be prepared for public distribution and for confidential exchange among states, including information that can be shared with non-nuclear-weapon states and more detailed information that could be shared with nuclear weapon states.[214]

Undertaking Discussions Among Intelligence Agencies. National governments get much of their information about the threats they face from their intelligence agencies. It would make sense, therefore, to work to ensure that relevant intelligence agencies are fully informed about nuclear terrorism threats. During the Bush administration, for example, Rolf Mowatt-Larssen, then head of the DOE Office of Intelligence and Counterintelligence, traveled to several capitals for in-depth discussions of the nuclear terrorism threat with intelligence counterparts. In some cases, these discussions appeared to provoke internal discussions between intelligence agencies and nuclear weapons design labs about the ease or difficulty of making a crude nuclear bomb, leading to intelligence agencies having a fuller appreciation of the topic.[215] In addition, in the years right after the 9/11 attacks, when U.S. intelligence encountered particularly alarming information about what were thought to be ongoing terrorist nuclear plots, it shared complete information with every government it thought likely to be able to help—even Iran.[216] The United States and other interested countries should launch a series of discussions among intelligence agencies to

213 While the United States has published several separate documents related to this incident, it has not make public any comprehensive account either of the root causes that led to the incident or the lessons the United States has learned about avoiding such incidents in the future.

214 For the briefing provided to the Sherpas for the 2014 Nuclear Security Summit, see William H. Tobey and Pavel S. Zolotarev, "The Nuclear Terrorism Threat," (paper presented at Meeting of the 2014 Nuclear Security Summit Sherpas, hosted by the Thai Ministry of Foreign Affairs Pattaya, Thailand 2014), http://belfercenter.ksg.harvard.edu/publication/23879 (accessed January 12, 2016).

215 Personal communication with Rolf Mowatt-Larssen, January 2016.

216 Mowatt-Larssen, *Al Qaeda WMD Threat*, p. 26.

explore assessments of the nuclear terrorist threat, remaining uncertainties, and priorities for reducing the uncertainties. Such discussions could also lead to expanded intelligence cooperation to deal with nuclear smuggling and nuclear terrorist activities.

Expanding the Use of Realistic Nuclear Security Tests, Including Force-on-Force Exercises. In the U.S. case, embarrassing failures in nuclear security inspections or tests—often followed by Congressional investigations—have driven action to strengthen nuclear security. Nothing is quite so convincing in countering the complacent view that a site's security measures are impregnable as a test in which mock adversaries manage to defeat them. The United States and other interested countries should work to convince as many of the countries with HEU or separated plutonium as possible to carry out regular, realistic tests of both their protection against insider thieves and their protection against outsiders trying to break in. Such exercises should be included in the commitment to stringent nuclear security principles suggested above, and should be a focus of nuclear security technical cooperation programs (which should include allowing experts from other countries to observe such exercises where appropriate). The fifth revision of the IAEA's nuclear security recommendations include a recommendation for force-on-force exercises; the IAEA should develop guidance and advisory services for states on how to conduct such tests, as well as realistic tests of protections against insider threats.

Nuclear Theft and Terrorism Exercises. Participating in a realistic simulation can give officials a "gut" feel for a problem in a way that no amount of reports, memos, and briefings can do. Building on past efforts, the United States and other interested countries should organize a series of exercises with senior policymakers from key states, exploring scenarios of nuclear theft and terrorist detonation of a nuclear bomb. Some exercises might focus on scenarios in which a nuclear theft has occurred and states need to cooperate to find and retrieve the nuclear material. Other scenarios might focus on intelligence that terrorists had nuclear material and were working to build a bomb at an unknown location; responding to a credible terrorist threat to detonate a nuclear bomb; dealing with a situation in which nuclear material or a nuclear bomb is on the road or on the sea and has to be found and intercepted; or coping with the aftermath of a terrorist nuclear detonation. Sabotage and "dirty bomb" scenarios should be the subject of such international exercises as well. These could be organized as part of the GICNT, through bilateral or "minilateral" cooperation among small groups of states, through the IAEA, or through non-government channels such as WINS.

The "Armageddon Test." There is much that is still unknown about the shadowy networks that attempt to smuggle nuclear and radiological materials. Many officials around the world believe terrorists would have little chance of getting nuclear material. An intelligence initiative could shed light on this question. The next U.S. President should direct U.S. intelligence—working in cooperation with agencies in other countries—to establish a small operational team dedicated to understanding and penetrating the world of nuclear theft and smuggling. They would seek to answer the outstanding questions from past cases—where previously confiscated material came from, who stole it and how, what smugglers were involved, whether there were real buyers, how buyers and smugglers connected with one another, and more. They would probe to see who is in the market today. In some cases they might pose as either potential buyers or sellers of nuclear material, although they should do nothing to simulate a demand for material that might make its theft more likely. In other cases, they might offer substantial sums for information leading to the capture of smugglers and the nuclear material in their possession. If they succeeded in making contact with smugglers who had access to weapons-usable material, this would dramatically highlight the continuing threat, and potentially identify particular weak points and smuggling organizations requiring urgent action. If they failed, that would suggest that terrorist operatives would likely fail as well, building confidence that measures to prevent nuclear terrorism are working.[217]

Recommendations for the Next U.S. President

The next U.S. president should:

- Work with other countries to launch an international initiative to strengthen nuclear security culture.
- Work with other countries to establish a shared database of security-related incidents and lessons learned, and to take other steps to build understanding of the threat and key vulnerabilities.

217 William Tobey and Rolf Mowatt-Larssen, "The Armageddon Test: To Prevent Nuclear Terrorism, Follow the Uranium," *Belfer Center for Science and International Affairs,* Harvard University, July 26, 2010, http://live.belfercenter.org/publication/20279/ (accessed January 21, 2016).

4. Broaden Nuclear Consolidation Efforts

The United States and other interested countries should make it a priority to reduce the number of locations where nuclear weapons and their essential ingredients exist around the world as much as possible. As detailed earlier in this report, existing consolidation programs have made considerable progress; half of all the countries that once had weapons-usable nuclear materials on their soil have eliminated it. These programs deserve strong support. But the consolidation effort should be broadened and expanded.[218] They should include not only civil HEU but civil plutonium and military stocks as well. Key steps are listed below.

A Comprehensive Approach

Each state with nuclear weapons, HEU, or separated plutonium should undertake a review of every site where these materials exist, eliminating any site whose continued benefits are outweighed by its costs and risks. This review should include the costs of ensuring effective security against a broad range of potential adversary threats if the material remains in place. The material at sites to be closed should then be consolidated at other locations.

Countries should ensure that operators have strong incentives to eliminate HEU or separated plutonium stocks where feasible, to help overcome facility operators' natural resistance to change.[219] Regulators should ensure that regulations appropriately require substantially more stringent security measures when HEU or separated plutonium is present (as IAEA recommendations suggest), so that operators can save money on security costs by eliminating this material.[220] States should eliminate any institutional incentives that may exist for operators to maintain HEU or separated plutonium (such as increased research funding for facilities using these materials, for example). The U.S. government and other interested governments should continue and expand their use of substantial

218 For more detailed analysis and recommendations, see Bunn and Harrell, *Consolidation: Thwarting Nuclear Theft.*

219 For more on eliminating the use of HEU, see Frank von Hippel, *Banning the Production of Highly Enriched Uranium* (Princeton, N.J.: International Panel of Fissile Materials, 2016), http://fissilematerials.org/library/rr15.pdf (accessed March 18, 2016).

220 In the United States, the high costs of meeting post-9/11 security requirements for plutonium and HEU have driven a major consolidation of nuclear materials in the DOE complex, with all Category I and Category II material eliminated from Livermore and Sandia National Laboratories, HEU removed from TA-55 at Los Alamos to the highly secure Device Assembly Facility in Nevada, and substantial reduction in the number of buildings with weapons-usable material elsewhere. But in a recent survey of nuclear security experts in 18 countries with plutonium or HEU, experts from nine countries reported that the nuclear security rules and procedures in their countries either created no significant incentive to consolidate these stocks or gave sites incentives to maintain the stocks they had. See Bunn and Harrell, *Threat Perceptions and Drivers of Change*, p. 31.

packages of incentives, shaped for the needs in each case, to convince countries to eliminate civilian sites with dangerous stocks of high-quality HEU or separated plutonium. Donors, for example, could offer financial support for work at other research reactors and help with decommissioning if an HEU-fueled research reactor shut down, or, if a high-flux research reactor agreed to convert to LEU fuel, donors could offer improved neutron guides that would allow the reactor to achieve a better flux of neutrons for their experiments than ever before.[221]

The U.S. government should have a blanket policy that wherever plutonium or HEU exists in the world, it will either take it back to be secured in the United States, help arrange its disposition elsewhere, or work to ensure that it has sustainable security that will protect it from the full range of plausible threats while it stays in place.

Bulk Processing Facilities

As large facilities that process weapons-usable nuclear material in bulk pose the greatest dangers of insider nuclear theft, the United States and other interested countries should work to ensure that:

- The number of such bulk-processing facilities does not increase;
- New states have incentives not to build such facilities;
- The overall scale of bulk processing worldwide decreases rather than increases;
- These facilities process material in forms as difficult to make into nuclear weapons as practicable; and
- Each of these facilities implements the highest standards of security, accounting, and control for the nuclear material it handles.

221 See Alexander Glaser and Uwe Filges, "Neutron-Use Optimization with Virtual Experiments to Facilitate Research Reactor Conversion to Low-Enriched Fuel," *Science & Global Security,* Vol. 20, No. 2–3 (2012), pp. 141–54.

Civil HEU

Countries using HEU for nonmilitary purposes should join together in agreeing on the goal of eliminating the civil use of HEU, and a target date for doing so.[222] While continuing to push to convert research reactors fueled with HEU to LEU, the United States and other interested governments should also offer incentives to shut down unneeded HEU-fueled reactors and to eliminate their dangerous nuclear material. (Most of the world's research reactors are underutilized, and many of the facilities with high-quality HEU would be quite difficult to convert to LEU.)[223] Shutting down reactors will frequently be cheaper than converting them, and unlike conversion, there are no technical barriers to shutdown. The United States, working with other countries (perhaps through the IAEA) should establish a program to offer incentives for unneeded HEU-fueled facilities to shut down, including assistance with decommissioning costs, funding for scientists to share time at other research reactors in their region, and more.[224]

The United States and other interested governments, working in collaboration with the IAEA, should help countries convert research reactors to particle accelerators wherever practical, accomplishing similar research and isotope production with reduced proliferation risk, as well as reduced fuel supply and waste management challenges.[225] The United States should offer to buy HEU from anyone willing to sell (and willing to promise not to make or get more).

Russia and the United States should each prepare a plan for achieving the science, training, and isotope production they need at minimum cost and risk, with minimum use of HEU or plutonium—plans for "Neutrons for America" and "Neutrons for Russia." This is important because Russia now has roughly two-thirds of the world's HEU-fueled critical assemblies, and two-thirds of the world's HEU-fueled pulse reactors (both of which often

222 For other recommendations on coping with civil HEU, see, for example, Andrew J. Bieniawski and Miles A. Pomper, *A Roadmap to Minimize and Eliminate Highly Enriched Uranium* (Washington, D.C.: Nuclear Threat Initiative, James Martin Center for Nonproliferation Studies, and Fissile Material Working Group, May 2015); Fissile Materials Working Group, The Results We Need in 2016; and Alan J. Kuperman, ed., *Nuclear Terrorism and Global Security: The Challenge of Phasing Out Highly Enriched Uranium* (New York: Routledge, 2013).

223 There are over 240 research reactors in the world (roughly half of them still fueled with HEU), and IAEA experts have estimated that the world only needs 30–40 such reactors for the long term. International Atomic Energy Agency, "New Life for Research Reactors? Bright Future but Far Fewer Projected" (Vienna: IAEA, March 8, 2004).

224 Bunn and Harrell, *Consolidation: Thwarting Nuclear Theft*, pp. 38–40.

225 Israel, for example, is replacing its Soreq research reactor with a particle accelerator, and expects to be able to accomplish even better scientific research than before. For a brief discussion of the potential role of accelerators as an alternative to many research reactors, see David Nusbaum, "Smashing Atoms for Peace: Using Linear Accelerators to Produce Medical Isotopes Without Highly Enriched Uranium" (Cambridge, MA: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, October, 2013), http://belfercenter.ksg.harvard.edu/publication/23513/ (accessed January 21, 2016).

have hundreds of kilograms or even tons of high-quality HEU), while the United States has several aging high-performance research reactors that cannot be converted to LEU with existing fuels. Neither country has a long-term plan for their research reactor fleets. If Russia and the United States are able to renew nuclear security cooperation, they should discuss the specifics of these plans, and ways they might work together (for example sharing certain facilities where scientific objectives overlap).

Finally, in cases where an HEU-fueled reactor is still needed, and it is projected to take many years before conversion can occur, states should: provide stringent security measures for the HEU; and consider converting 30-45 percent enriched HEU as an interim step to reduce risk until full conversion can be accomplished, as a recent National Academy of Sciences panel has recommended.[226]

Civil Plutonium

The United States and other countries should undertake new efforts to consolidate civilian separated plutonium and limit the buildup of ever-larger stockpiles. In particular, they should seek to get countries to commit to:

- Eliminate any unneeded sites with separated plutonium (as Switzerland and Sweden, among others, have done in recent years);
- Avoid expanding the number of plutonium reprocessing facilities, and the number of places where separated plutonium is stored and used;
- Reprocess no more plutonium than they use each year, so that stocks remain stable or decline, rather than increasing;
- Handle plutonium as much as possible in forms mixed with other materials, requiring chemical separation before they could be used in a bomb; and
- Maintain high standards of security and accounting throughout all storage, transport, processing, and use of separated plutonium.

226 National Academies of Sciences, Engineering, and Medicine, *Reducing the Use of Highly Enriched Uranium in Civilian Research Reactors*.

Military Stocks

At the same time, the United States, Russia, and other interested countries should expand cooperative efforts to consolidate military stocks of nuclear weapons, separated plutonium, and HEU. Russia and the United States, in particular, as the countries whose nuclear stockpiles are dispersed at the largest number of buildings and bunkers with nuclear weapons or weapons-usable material, should each develop a national-level plan for accomplishing their military and civilian nuclear objectives with the smallest practicable number of locations with nuclear weapons or weapons-usable material.[227]

Recommendations for the Next U.S. President

The next U.S. president should:

- Launch a comprehensive consolidation effort, covering bulk-processing facilities, civil HEU, civil plutonium, and military stocks, as described above.
- Make consolidation a major priority of the U.S. nuclear security program.
- Work with Congress to ensure that efforts to consolidate nuclear weapons and weapons-usable nuclear materials are not slowed by lack of funds.

5. Develop Approaches to Confirm That Effective Nuclear Security Is in Place

Insecure nuclear material anywhere is a threat to everyone, everywhere—and all countries have a national security interest in seeing that all countries with nuclear weapons or weapons-usable nuclear materials protect them effectively. Today, however, few mechanisms are in place to give countries confidence that such effective protection really is in place.

The United States and other interested states should establish an experts group to work out approaches to providing assurances that would build real confidence without unduly compromising sensitive information. For example, states could:

227 The United States has already gone much farther in consolidating its stocks than Russia, but may have more to do. In the 1990s, Russia's Ministry of Atomic Energy committed to developing a consolidation plan for civilian nuclear material, but this was never accomplished.

- Invite review of their nuclear security arrangements by international teams, whether led by the IAEA, by a state partner in technical cooperation, by a nuclear supplier, or by others. Actual visits to facilities, including discussions with the people there, can provide insights not available by another means. Review and advice from experts outside the group that designed and is implementing nuclear security systems can often be extremely helpful in finding areas for improvement. In particular, states should request IPPAS missions to review security for their civilian infrastructure.
- Publish at least general information about the kinds of threats operators are required to protect nuclear weapons, HEU, or separated plutonium against—for example, confirming that these threats include a group of well-armed and well-trained outsiders, an insider, and a broad range of possible tactics and approaches.
- Publish regulations (as many states do already), and expert analyses of what they mean.
- Publish detailed descriptions of how the state inspects and tests to ensure security is meeting requirements. This could be supplemented by allowing representatives from other countries to take part in or observe some of these inspections or tests.[228] Publish at least general information about how well its operators performed on these inspections and tests (for example, for years, DOE published the percentage of its sites that had been rated in the highest category in its security inspections, with fairly detailed descriptions of what items were included in these inspections).
- Publish detailed information about how weaknesses or problems were found and fixed, along with lessons learned and steps taken to ensure the weaknesses did not arise again.

If other countries knew that a country required operators to protect nuclear weapons, HEU, and separated plutonium against a robust range of potential adversary threats; understood the inspection and testing program used to confirm that operators were meeting these requirements; knew that a large fraction of the facilities had been shown in inspections to meet these standards; and understood that thorough and effective corrective actions were taken in response to any weaknesses identified, this could increase confidence in nuclear security substantially.

228 The United States, for example, has on several occasions allowed representatives from other countries to observe force-on-force exercises at U.S. facilities, and U.S. experts have observed nuclear security exercises in a number of other countries. In the 1990s, in some of the non-Russian states of the former Soviet Union, U.S. adversary teams carried out such tests at nuclear facilities. Technical cooperation programs sometimes include observers from another country taking part in nuclear security and accounting inspections.

There is also likely to be information that countries might be willing to exchange with one or a few other states, or with the IAEA, that they are not willing to make public. As discussed earlier, for example, states should work out ways to exchange information about the kinds of threats their nuclear security systems are designed to protect against, most of which should not be made public (to avoid giving information to adversaries about the kind of security measures they would have to defeat at nuclear sites).

There are a variety of particular forums where such information could be published or exchanged. If a group of countries joins in a nuclear security commitment such as that described earlier, for example, the participating countries (or subsets of them) could exchange such information amongst each other. Although the CPPNM and its 2005 amendment do not require national reporting of implementation steps, there would be nothing preventing a group of states from publishing detailed national reports (as states are obligated to do for the nuclear safety convention), and encouraging other states to do likewise. If a group of leading countries began providing such reports regularly, it could increase the pressure on others to do the same. Another approach would be for the IAEA to establish a Nuclear Security Register on its website for states to voluntarily register their achievements (along the lines of the Agency's Nuclear Safety Dashboard and the UN's Arms Trade Register).[229] Another possibility would be for states to include some of the information described above as part of their UNSCR 1540 reports. Whatever the particular forum, donor states and international organizations should be prepared to provide assistance in drafting these detailed reports to states with limited capacity. The IAEA or the WINS could provide guides that would suggest a common format and categories of information that might be included.

There may be a need for alternative measures for stocks that states judge to be particularly sensitive. In particular, it is unlikely that states will invite IAEA-led reviews of security for their nuclear weapons or military nuclear materials (and given the IAEA's civilian mandate, there is some doubt about whether it could realistically respond to such a request). States that have such stocks should work together to develop ways to provide assurance that they are protecting them effectively, including developing approaches to exchanging peer reviews of defense-oriented sites.

Operators need to build confidence with local communities and other stakeholders, just as they need to build confidence in safety. Nuclear operators should engage with a full spectrum of stakeholders to build confidence, address concerns, and gain ideas for strengthening their security programs. They should protect genuinely sensitive

229 Findlay, "Beyond Summitry."

information as needed, but share other information with key stakeholders to build confidence in the effectiveness of security implementation.

Recommendations for the Next U.S. President

The next U.S. president should:

- Establish a policy of the United States providing sufficient information about nuclear security to give other states a good understanding of the strengths of the U.S. nuclear security system, and the challenges still to be addressed.
- Request an IPPAS mission at a substantial U.S. nuclear facility (more substantial than the research reactor that the first U.S.-hosted IPPAS mission reviewed), such as the plutonium storage area at the Savannah River Site.
- Work with other countries to develop approaches to building confidence in states' nuclear security arrangements, as discussed above, and then work to get them broadly adopted.
- Work with countries holding U.S.-origin material to ensure that U.S. experts regularly visit all locations with U.S.-origin HEU or separated plutonium.[230] Continue an effective nuclear security dialogue after the summits end.

6. Continue an Effective Nuclear Security Dialogue After the Summits End

It is essential that nations come together and establish an effective ongoing dialogue on nuclear security after the summits come to an end. The end of the nuclear security summits will leave a serious gap, as there is no other forum at present to discuss next steps in nuclear security at the highest levels. Realistically, no forum can fully replace the three key things the nuclear security summits provided: attention from the highest levels of government; a decision-forcing schedule; and ongoing senior dialogue between meetings.

But a number of forums will continue to exist that may be able to fill parts of the gap, and the United States and other interested countries should work to ensure that they grow into

230 As the Government Accountability Office has noted, some 3.5 tons of U.S.-origin HEU, including 2.3 tons of material that has never been irradiated (the majority of the unirradiated U.S.-origin HEU) is located at sites U.S. teams have not visited in over 20 years. GAO, *DOE Made Progress,* p. 25.

truly effective forums for nuclear security decision-making. The 2016 summit is expected to lay out suggested "action plans" for five international organizations or coalitions: the IAEA; the UN and its UNSCR 1540 committee; GICNT; the GP; and Interpol. Each of these will clearly have their role to play, most prominently the IAEA. In each case, there is more to be done to strengthen the forum as a place where governments can come together for serious discussions and decisions. And there are other forums that may be able to contribute as well.

- *IAEA nuclear security meetings.* The IAEA's nuclear security meetings—planned every three years—are likely to be the most prominent regular international meeting focused on nuclear security. Countries should work together to turn these into working meetings intended to reach decisions on particular actions, as well as opportunities for technical exchange. A process similar to the Sherpas meeting between summits could be used to hash out initiatives to be agreed on—or announced by subgroups of states, as in the summit "gift basket" process—at the next IAEA meeting.[231] In addition, a subgroup of "friends of nuclear security" could meet to hash out recommendations more informally, which could then be acted on in the larger group. States interested in promoting new steps on nuclear security could use these meetings as occasions for announcing new steps they had taken—creating at least a part of the schedule-driving effect of the nuclear security summit process.

- *Physical protection convention reviews.* Once the amendment to the physical protection convention enters into force—which may finally occur in 2016—there will be a requirement to hold a review conference of the convention, and if a majority of parties wants them, such conferences could be held every five years. This would be another international forum focused specifically on nuclear security, with considerable political legitimacy. And such conferences, too, could be an occasion for announcing new nuclear security commitments.[232]

- *An expanded Global Initiative.* The participants in the GICNT could create an additional working group focused specifically on nuclear security. Remarkably, although security for nuclear materials is one of the Global Initiative principles, it has never been a major focus of the group. But that could change, especially if the summit participants, who are a majority of Global Initiative members, decided they needed

231 Findlay, "Beyond Summitry," p. 22. The United States has proposed that interested states work together to develop proposals to strengthen the IAEA's role and the international nuclear security framework. By allowing proposals to be discussed and developed in what would probably be a like-minded group of relatively modest size, this could increase the efficiency of concept development—and those ideas could then be addressed by the full IAEA membership.

232 Herbach and Pitts-Kiefer, "More Work to Do."

an ongoing forum to replace part of what the summits did. The Global Initiative is still co-chaired by the United States and Russia, and despite their tense relationship—and the breakdown of most U.S.-Russian nuclear security cooperation—both counties still take the Global Initiative seriously. Such a group would provide a working forum with flexible procedures that enable them to make decisions, which could focus on working out commitments to key nuclear security principles, exchanging best practices, working with states to help put particular security measures in place, and more. Plenary meetings of the Global Initiative often take place at the level known as Undersecretaries in the United States, roughly equivalent to deputy ministers in other countries—high enough to bring some political clout, but low enough to home in on specific action.

- *G7 and G20 summits.* Most of the world's weapons-usable nuclear material is in G7 countries, and the G7 has for many years included statements on nonproliferation, disarmament, and nuclear security at each summit—including the launch of the GP at the 2002 summit. The G7 summits could be an occasion for leaders to approve work done in an experts group, and to announce new initiatives and commitments.[233] The exclusion of Russia from the group, however, with its vast stocks of nuclear weapons and materials, would undermine the G7's promise as a forum for nuclear security progress. Nevertheless, the G7 summits could be another occasion for new commitments and announcements on nuclear security. Russia, China, India, and other important states are included in the G20, but to date the G20 has remained a forum focused almost exclusively on economic issues, rather than political and security issues.[234]

Recommendations for the Next U.S. President

The next U.S. president should:

- Work with other countries to ensure that an active, high-level dialogue on nuclear security, structured in a way that allows it to be effective in discussing and adopting

233 The G7 already makes an annual statement on nonproliferation, disarmament, and nuclear security, put together by the G7 Nonproliferation Directors. In 2015, this statement was issued well before the summit, in advance of the NPT Review Conference. See "G7 Statement on Nonproliferation and Disarmament." The G7 also has a Nuclear Safety and Security Group, but this group is not widely known or strongly influential, and in recent years it has focused primarily on safety. See, for example, "Report of the G7 Nuclear Safety and Security Group (NSSG) During the German Presidency in 2014/2015" (Schloss Elmau, Germany, June 7–8, 2015), http://www.g8.utoronto.ca/summit/2015elmau/2015-G7-nssg-report.pdf (accessed January 23, 2016).

234 See David Shorr, "A Bigger Table, A Broader Agenda," in John Kirton and Madeleine Koch, eds: *G8 & G20: The 2010 Canadian Summits* (Toronto: University of Toronto, 2010), http://www.g8.utoronto.ca/newsdesk/g8g20/g8g20-shorr.html (accessed March 6, 2016).

Preventing Nuclear Terrorism: Tools Beyond Nuclear Security

Preventing nuclear theft is the most important, but not the only, step that must be taken to reduce the risk of nuclear terrorism. Nuclear security will never be perfect, and there may well already be nuclear material that has been stolen and not recovered. A multifaceted international effort to reduce the risk of nuclear terrorism is essential.[i] Whatever other disagreements they may have, countries should be able to agree that terrorist groups must never be permitted to gain access to nuclear weapons or their essential ingredients.

Countries—and in particular the United States and Russia—should expand police and intelligence cooperation targeted on identifying and countering groups with nuclear aspirations and intercepting nuclear smuggling. The United States, in particular, should expand its intelligence collection and analysis focused on terrorist nuclear, chemical, and biological efforts to the kind of focused, well-resourced effort that existed in the years after the 9/11 attacks.

Countries should ensure that their legal systems impose significant penalties for participating in theft or smuggling of nuclear material or any assistance to nuclear terrorists—and that states have national police or intelligence units trained and equipped to deal with nuclear smuggling cases. States should establish a tip line and reward system to encourage people to blow the whistle on nuclear thieves or smugglers. (Such tips have led to some of the most important past seizures of plutonium and HEU.)

While it is extremely unlikely that states would intentionally transfer nuclear weapons or materials to terrorists, the United States and its international partners should attempt to reduce the likelihood of such an act even further by creating international packages of incentives and disincentives with enough impact and credibility to convince North Korea, in particular, that it should cap its nuclear program and that the consequences of ever transferring nuclear material or technology to non-state actors would be severe.

Much of this work is already happening, though there is more to be done. The killing of Osama Bin Laden and other members of the leadership of "core" al Qaeda has reduced the risk that al Qaeda would again attempt a nuclear bomb program. At the same time, as discussed earlier in this report, despite an international coalition attacking the IS, the group still has worrisome resources and capabilities should it ever turn seriously to seeking nuclear weapons. As noted elsewhere in this report, other terrorist groups have pursued nuclear weapons in the past and

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i For a list of the steps along a terrorist pathway to the bomb, and recommendations for the steps beyond improved nuclear security, see Mathew Bunn, *Securing the Bomb 2010*, pp. 8, 106–109. For a useful effort to think through a systems approach to reducing the risk, see Michael Levi, *On Nuclear Terrorism* (Cambridge, MA: Harvard University Press, 2009). For a joint U.S.-Russian description of next steps that should be taken, see Matthew Bunn *et al*, *Steps to Prevent Nuclear Terrorism: Recommendations Based on the U.S.-Russia Joint Threat Assessment.*

may do so in the future. Focused efforts to scan for signs of nuclear, chemical, or biological ambitions and activities—and to take action when such signs are found—are needed.

Many countries are also strengthening their ability to deter and interdict nuclear smuggling. Following up on UNSCR 1540, countries have put in place stronger criminal laws imposing severe penalties for crimes related to nuclear theft, smuggling, and terrorism. National nuclear forensics programs—designed to contribute to identifying the source of nuclear material—have also been strengthened, though there is a great deal still to be done. Many countries have installed radiation detectors at key ports, airports, and border crossings, often with U.S. help and financing.

Unfortunately, however, the vast length of national borders, the immense legitimate traffic across them, the pervasive smuggling of many other types of contraband that exists worldwide, the corruption of some border officials, and the difficulty of detecting nuclear bomb material make intercepting nuclear smuggling an enormous challenge. Uranium and plutonium, while radioactive, are not radioactive enough to be difficult to carry or easy to detect. Most of the detectors that have been installed around the world would have a good chance of detecting plutonium or gamma-emitting radiological sources, but would not be likely to detect well-shielded HEU.

Moreover, the news on interdicting nuclear smuggling has not all been positive. Genuine cooperation among intelligence agencies of different countries—particularly between Russia and the United States—on the nuclear smuggling threat remains scarce. Some very important borders—such as those of Afghanistan and Pakistan—are effectively impossible to control in current circumstances. Russia and the United States worked together to complete the installation of radiation detectors at all of Russia's official border crossings, but Russia's customs union with Kazakhstan and Belarus made many of those border crossings effectively irrelevant. That pushes the real border out to the edges of Kazakhstan and Belarus, and not all of their border crossings yet have radiation detectors. The freeze in US-Russian relations makes it more difficult to address these gaps.

Radiation detection is only one of many tools for reducing the risk of nuclear terrorism, and not the most effective one—but at sites where there is good reason to believe nuclear smuggling is a real risk and the geography suggests it would be difficult for smugglers to go around the official border crossing, it makes sense to install effective radiation detection. At areas with broad border areas through which smugglers might pass, or within countries, mobile detectors may be more effective. Such radiation detection programs should always be designed for sustainability—and must also address the corruption so often found in border control agencies. Ultimately, radiation detection should be only one part of a broader effort to counter nuclear smuggling that includes targeted police and intelligence efforts, nuclear forensics, and a strong component of international cooperation.

next steps to strengthen nuclear security, continues after the summit process comes to an end.

Making Nuclear Security a Priority

Together, these steps could help the international community get onto the upward nuclear security path envisioned earlier in this report, building a commitment to continuous improvement in the never-ending search for nuclear security excellence. To achieve that goal, the next U.S. president and the leaders of other interested states will have to continue to make nuclear security a priority, ensuring that their governments are continuing to find and fix weaknesses and overcoming obstacles to progress.

In particular, the next U.S. president should make clear that effective security for nuclear weapons and weapons-usable materials remains a top priority of the U.S. government, and take steps to back that rhetoric with action. Such steps should include:

- Designating a senior director on the National Security Council staff to lead efforts to strengthen nuclear security and prevent nuclear terrorism.
- Developing a clear strategic plan for nuclear security for the entire presidential term, integrating the actions of all relevant departments in a whole-of-government approach.
- Putting nuclear security high on the diplomatic agenda, as an item to be raised with every relevant country, at every level, whenever it would contribute to progress toward the nuclear security goal.
- Working with Congress to ensure that no effort that could significantly reduce the danger of nuclear terrorism is slowed by lack of funds.