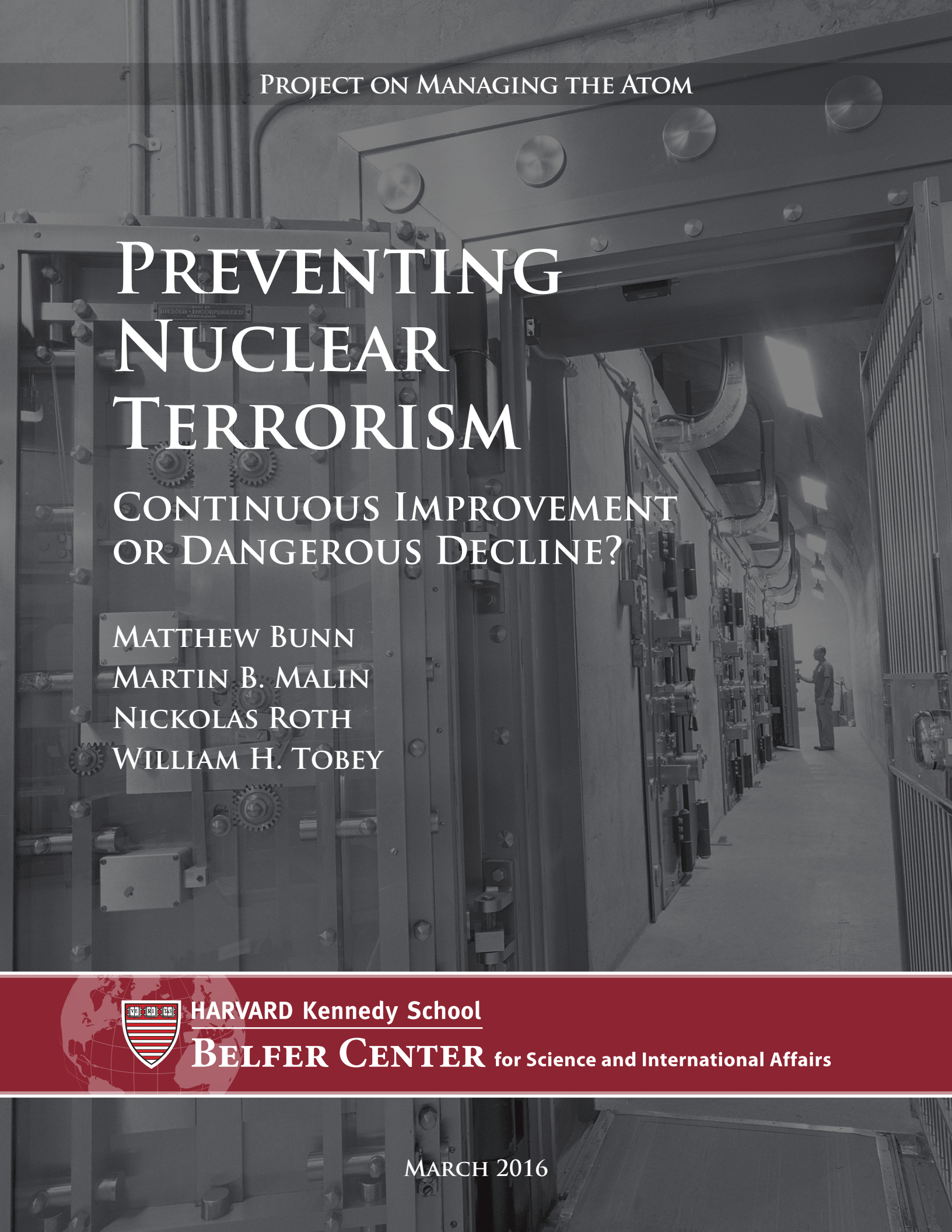

Project on Managing the Atom

Preventing Nuclear Terrorism

Continuous Improvement or Dangerous Decline?

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HARVARD Kennedy School
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Report

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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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nuclear weapons and materials with high terrorist threats and poor ratings on indices of corruption and regulatory effectiveness; and

- Briefer descriptions of recent improvements in nuclear security implementation in other countries around the world.

Russia

More nuclear weapons, plutonium, and HEU are spread across more buildings and bunkers in Russia than in any other country.[53] While Russia has greatly improved security and accounting for these stocks, important weaknesses remain, and the end of most U.S.-Russian cooperation has drawn a curtain of opacity over ongoing nuclear security implementation and the prospects for sustainability. Moreover, the deep corruption in Russia (including in the nuclear industry and the security services that guard it), combined with an ongoing organized crime problem and growing terrorist threats, mean that Russian nuclear security systems have to cope with potentially substantial adversary threats.

Security surrounding Russia's nuclear stockpile has improved dramatically since the political turmoil that followed the collapse of the Soviet Union. The fences around facilities have been mended, staff are paid regularly, guards stand their posts, and electric bills are paid on time. Russian nuclear facilities are generally equipped with modern fences, intrusion detectors, barriers, access control systems, vaults, and nuclear material accounting and control systems. It is significantly more difficult to steal weapons-usable nuclear material in Russia than it was 20 years ago.

Russia designs its nuclear security systems to protect against a significant range of outsider and insider capabilities, although it appears that facilities with nuclear weapons have more stringent requirements than those with weapons-usable nuclear material.[54] Russia now has requirements for weapons-usable nuclear material to be kept in secure vaults when not in use (with limited access to the vaults); detailed accounting of the material in and out of each area where material is stored and handled; and the use of uniquely identifiable

53 For a previous assessment from the same authors, see Bunn et al., *Advancing Nuclear Security*, pp. 24–28.

54 Bunn and Harrell, *Threat Perceptions and Drivers of Change*, p. 27. Two of the three Russian participants judged Russian DBTs to be more capable than the published description of the NRC DBT, while the other judged them to be generally as capable. A different set of two judged that Russian DBTs had changed substantially in the years since the turn of the century, while the other judged the changes to be more moderate. Interviews with U.S. and Russian experts, 2003–2014. Much the same is true in the United States, though the particular arrangements as to which facilities face what requirements differ.

tamper-indicating devices to reveal whether a canister or a door has been opened.[55] Indeed, the United States has helped Russian regulators draft scores of new rules and regulations focused on physical protection, material control, and material accounting, intended to help protect against both outsider and insider threats.[56] Russia has taken a number of steps in recent years to address insider threats, from additional monitoring of personnel to new anti-corruption initiatives (though the latter are primarily focused on corruption at the level of senior officials steering large procurement contracts in return for bribes, rather than line workers potentially helping with a nuclear theft).[57]

Russia has also significantly reduced the number of locations with nuclear weapons, plutonium, and HEU, for example closing its last plutonium production reactors and the two major plutonium reprocessing plants associated with them, reducing the number of nuclear weapon assembly and disassembly facilities from four to two, consolidating plutonium and HEU weapons component fabrication at a single site, and greatly reducing the number of buildings with weapons-usable nuclear material at some sites.[58] Although U.S. funding for such consolidation efforts is no longer available, Russia continues with some efforts on its own, such as the removal of weapon-grade uranium metal from the BFS critical assembly at the Institute for Physics and Power Engineering (IPPE) in Obninsk.[59] In the U.S.-Russian HEU Purchase Agreement that was completed in 2013, Russia destroyed 500 metric tons of weapons-grade HEU; it destroyed another 17 tons in U.S.-funded consolidation programs, and it has also used some HEU to re-enrich European enrichment

55 A revised version of the "Basic Rules on Nuclear Material Control and Accounting" (known by its Russian acronym, OPUK) finally went into force in 2012, after years of delay.

56 For a discussion of one part of this regulatory effort—strengthening Rosatom's agency-level rules on physical protection—see Alexander Izmaylov, *et al*., *Development of Physical Protection Regulations for Rosatom State Corporation Sites under the U.S.-Russian MPC&A Program*, PNNL-21418 (Richland, WA: Pacific Northwest National Laboratory, 2012). For a broader and more conceptual approach from an earlier stage of the work, see Greg E. Davis, Lorilee Brownell, Troy Wright, John Tuttle, Mitchel Cunningham, and Patricia O'Brien, "Creating a Comprehensive, Efficient and Sustainable Nuclear Regulatory Structure: A Process Report From the U.S. Department Of Energy's Material Protection, Control and Accounting Program," *Proceedings of the 47th Annual Meeting of the Institute for Nuclear Materials Management,* Nashville, TN, July 16–20, 2016 (Northbrook, IL: INMM, 2006). Recent major Russian nuclear security regulations are described briefly in Anton Khlopkov, "Russia's Nuclear Security Policy: Priorities and Potential Areas for Cooperation" (Muscatine, IA: Stanley Foundation, May 2015), http://www.stanleyfoundation.org/publications/pab/KhlopkovPAB515.pdf (accessed February 5, 2016). Recent Russian nuclear material accounting regulations are described in Dmitry Kovchegin, "Developing a Nuclear Material Control and Accounting System in Russia" (Maryland: Center for International and Security Studies at Maryland, University of Maryland, December 2013), http://cissmdev.devcloud.acquia-sites.com/sites/default/files/papers/developing_a_nuclear_material_control_and_accounting_system_in_russia.pdf (accessed February 18, 2016).

57 For a summary of anticorruption initiatives in Russia, see D. Donnelly, D. Kovchegin, S. Mladineo, L. Ratz, N. Roth, "Corrupting Nuclear Security: Potential Gaps and New Approaches to Insider Risk Mitigation," Institute of Nuclear Materials Management, 2015.

58 Pavel Podvig, "Consolidating Fissile Materials in Russia's Nuclear Complex," *International Panel on Fissile Materials Report*, May 2009, http://fissilematerials.org/library/rr07.pdf (accessed February 18, 2016).

59 Interview with Russian laboratory expert, July 2015.

tails in past commercial deals. Overall, Russia has eliminated more than three times as much HEU as the United States, although Russia began with a much larger stock.[60]

At the same time, with U.S. funding, Russia has established a range of training centers, from facilities to provide training in particular tasks related to physical protection or material accounting to masters degree programs that have provided a network of younger professionals working in the field.

Nevertheless, Russia's nuclear security and accounting systems still have important weaknesses that determined thieves could exploit; the end of nearly all U.S. financial support for nuclear security in Russia, combined with an economic downturn and government budget reductions, raises questions about whether all the nuclear facilities in Russia will be able to finance sustaining effective nuclear security and accounting programs; and Russia's nuclear security measures face substantial threats from both insiders and outsiders.

Suspension of Most U.S.-Russian Nuclear Security Cooperation. In December 2014, Russia cut off all but a small portion of U.S.-Russian nuclear security cooperation.[61] This step came in part as a response to the U.S. cutoff of nuclear energy cooperation as one component of the sanctions over Russia's action in Ukraine, and in part over broader concerns, including the Russia government's perception that cooperation in the mode of threat reduction assistance was no longer needed and was being implemented in a way that was unequal and unfair. Congress then acted to bar funding for any new contracts for nuclear security work with Russia unless the Secretary of Energy signed a waiver certifying that the activities served U.S. national security interests—and as of early 2016, no such waiver had been approved, bringing most remaining work nearly to a halt, even work with the Russian regulator to strengthen nuclear security regulations. Russia has also refused to participate in the 2016 Nuclear Security Summit, and has been criticizing summit preparations from outside the process.[62]

60 Throughout this report, when we refer to "tons" we mean metric tons, which is approximately 2,205 pounds. As of December 2014, the United States had downblended 146.1 tons of HEU, while Russia has eliminated 517 tons. See International Panel on Fissile Materials, "Countries: United States," last edited on January 14, 2016, http://fissilematerials.org/countries/united_states.html (accessed February 9, 2016). The IPFM estimates that the United States has 599 tons of HEU remaining, while Russia has 679 tons (with an uncertainty of over 100 tons).

61 For a description of what was cut off and what remained, see Matthew Bunn, "Rebuilding U.S.-Russian Nuclear Security Cooperation," *Nuclear Security Matters*, January 22, 2015, http://nuclearsecuritymatters.belfercenter.org/blog/rebuilding-us-russian-nuclear-security-cooperation (accessed February 9, 2016).

62 TASS, "Moscow slams organizers of fourth Nuclear Security Summit," *TASS Russian Politics and Diplomacy,* January 13, 2016, http://tass.ru/en/politics/849199 (accessed February 11, 2016).

Some limited cooperation between the two countries remains. In 2014 and 2015, Russia and the United States continued to cooperate to remove HEU from third countries, including Uzbekistan, Kazakhstan, and Georgia. There is still some ongoing cooperation with Russia's civilian nuclear regulator Rostekhnadzor to strengthen nuclear security and accounting regulations. There is also some cooperation on security improvements at sites that are neither under military or Rosatom control, like the Kurchatov Institute in Moscow.[63] Russia still remains an active participant in the GICNT, which it co-chairs with the United States. But continuing funding for even limited projects within Russia will require approval of a waiver.

By the time most U.S.-Russian cooperation was suspended in 2014, U.S. programs had assisted with comprehensive security and accounting upgrades for 218 of a planned 229 buildings in Russia with weapons-usable nuclear material, and at 97 nuclear weapon storage or handling sites. These represented all but a small fraction of the material buildings and warhead sites that exist.[64]

Material Accounting and Bulk Processing. Material accounting has improved significantly over the past 20 years, but still involves significant uncertainties, and there is no requirement for facilities to analyze the trends in material accounting to see if small amounts of material are being stolen over time. Indeed, as long as their accounting systems meet regulatory rules, facilities are not required to assess how effective they are in preventing insider thefts.[65] Some facilities have thousands of canisters of HEU or plutonium built up over decades, with paper records (slowly being computerized) of what is in each one—but no one has gone back to measure each canister to be sure the material is still there. Moreover, while Russian regulations now require the use of uniquely identifiable seals, rather than the easily-faked wax or lead seals used until recently, many of these seals—like many in use elsewhere—could be readily defeated.[66] Russia continues to conduct bulk processing of weapons-usable nuclear

63 Bunn, "Rebuilding U.S.-Russian Nuclear Security Cooperation."

64 Matthew Bunn, *Securing the Bomb 2010: Securing all Nuclear Materials in Four Years* (Cambridge, MA: Project on Managing the Atom, Harvard Kennedy School, and Nuclear Threat Initiative 2010), http://www.nti.org/media/pdfs/Securing_The_Bomb_2010.pdf? (accessed March 5, 2016), pp. 31–43. For an update of the number of buildings with completed security upgrades, see U.S. Department of Energy, *FY 2015 Congressional Budget Request: National Nuclear Security Administration*, Vol. 1, DOE/CF-0096 (Washington, D.C.: DOE, 2014), http://energy.gov/sites/prod/files/2014/04/f14/Volume 1 NNSA.pdf (accessed May 25, 2014), p. 521.

65 Interview with Russian regulatory official, June 2013, and interview with Russian nuclear accounting expert, July 2015.

66 Interview with U.S. laboratory expert, 2015. One remarkable 2003 study examined 213 types of both high-tech and low-tech seals and found that all could be defeated in ways that would not be detected with the seal inspection protocols in place, using equipment available from any hardware store, with an average defeat time of 2.7 minutes. See Roger Johnston, *Tamper-Indicating Seals: Practices, Problems, and Standards* (LAUR-03-0269 (2003), http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-03-0269 (accessed June 12, 2015). Seals and their use have improved somewhat since, but the problem of widespread unrecognized vulnerabilities remains.

material—the activity that creates the most risk of covert insider theft—on a large scale, reprocessing roughly a ton of plutonium per year, fabricating HEU and plutonium weapons components, and fabricating HEU fuels.

Nuclear Security Financing and Sustainability. Effective nuclear security is something that requires constant vigilance and sustained resources. The end of cooperation has left the United States with little knowledge of how nuclear security in Russia is evolving, and raises concern that some of the improvements of recent decades could erode. One issue for Russian facilities is the end of U.S. funding. When cooperation ended, U.S. funding had been phasing down for some time, but the Obama administration requested some $100 million for nuclear security cooperation with Russia for FY 2015, the last year such a request was made. Only a portion of these supported sustaining security and accounting measures at Russian facilities, as opposed to paying for U.S. experts to work on the cooperation. The end of U.S. funding comes at a time when low oil prices and sanctions are having a serious effect on the Russian government budget. At the same time, Russian facilities' own finances are becoming increasingly tight. The Russian government plans to fire 10 percent of state employees in 2016, and Rosatom plans substantial budget cuts—which will inevitably affect the funds sites have available to pay for security.[67] Russian nuclear facilities generally do not receive separate government funding for nuclear security, but must provide the funding needed to meet regulatory requirements from their general funds. This means they have every incentive to do the minimum required by Russia's still-modest regulations, and some smaller facilities with limited revenues—such as small research reactors with HEU—may not be able to afford the costs of effective security. In past periods of substantial budget reductions, Russian regulators found that they were not permitted to cut their employees' salaries, and with salaries taking up the vast majority of their budget, they had to virtually eliminate travel costs, making it almost impossible to travel to nuclear sites for inspections.[68]

Guard Forces. Insider threats are not the only concern. To protect against outsider attacks, many weapons-usable nuclear material sites still rely in large part on Ministry of Interior (MVD) troops for guard forces. Many of these forces are poorly paid conscripts who cycle through the force rapidly, so that soon after they are fully trained they are no longer available, and many have little idea of the importance of what they are guarding.

67 Arnaud Lefevre, "Russian government cuts Rosatom funding," *Dynatom News*, September 3, 2015, http://dynatom.org/russian-government-cuts-rosatom-funding/ (accessed February 5, 2016).

68 Interview with Russian regulator, March 2009.

Moreover, the possibility of corruption or recruitment raises the possibility that guards will become "the most dangerous internal adversaries," as the security chief of the Siberian Chemical Combine once put it.[69]

Regulatory Enforcement. Russian regulators exercise far less power, have far fewer resources, and sometimes have less expertise than the agencies they are seeking to regulate. Key nuclear security requirements are spread among several layers of national, agency-level, and site-level rules, and are sometimes vague or confusing, making it difficult in some cases for working-level personnel to know how to follow the rules.[70]

Nuclear Security Culture. Russian and U.S. experts worked together to develop many of the early ideas about how to strengthen nuclear security culture. Rosatom requires all of its major sites to have programs to strengthen security culture (including a "culture coordinator" charged with overseeing the effort), and Rostekhnadzor, the Russian regulatory agency, has issued guidelines on how facilities should approach the issue.[71] Unfortunately, however, many Russian nuclear experts still tend to dismiss the threat, believing either that terrorists could not make a nuclear bomb, or that Russian nuclear security measures are fully sufficient to prevent any possible nuclear theft—the belief propagated by the Russian government as well.[72] Belief in the threat is the foundation for a strong security culture.

Terrorism and Islamic Extremism. Whatever the strengths and weaknesses of Russia's nuclear security approaches, they must protect against a substantial range of potential threats, from corrupt insiders to terrorist outsiders. Terrorists in Russia continue to pose serious dangers, though there have been few complex, sophisticated terrorist attacks since Russia's brutal crushing of the Chechen rebellion years ago. The Kavkaz Emirat, once the leading coalition of terrorist organizations in Russia, is wracked by disputes between

69 Interviews with U.S. and Russian participants in nuclear security cooperation, 2010–2014. The quote is from Igor Goloskokov, "Refomirovanie Voisk MVD po Okhrane Yadernikh Obektov Rossii [Reforming MVD troops to guard Russian nuclear facilities]," *Yaderny Kontrol*, Vol. 9, No. 4 (Winter 2003), pp. 39–50.

70 Dmitri Kovchegin, "Developing National Regulations to Support Nuclear Security: Lessons Learned from the U.S. Support to Russia, Ukraine, and Belarus," *Security Index: A Russian Journal on International Security* (December 2014), p. 4.

71 Khlopkov, "Russia's Nuclear Security Policy," pp. 3–5.

72 See, for example, Office of the Russian President, "Statement of the Russian Federation on Nuclear Security," April 13, 2010, http://news.kremlin.ru/ref_notes/520 (accessed July 6, 2015). Sergei Ivanov, then the Russian Minister of Defense, summed up a widely expressed Russian view in 2004, asserting that it was "impossible for there to be any loss" of plutonium or uranium, and that there had never been "a single case of so much as a gram being lost." (This statement was clearly false, since there had been cases where individuals had been caught and confessed to their thefts.) Russian acceptance of cooperative threat reduction assistance, he said, "does not mean that nuclear materials are stored poorly." See Svetlana Babaeva, "Responsible, Rational, With No Fear on His Face," *Izvestia,* trans. by *What the Papers Say*, April 9, 2004.

supporters of al Qaeda and of IS, and weakened by the deaths of senior leaders of the group, but still poses a significant potential threat.[73] Perhaps more significantly, Russian President Vladimir Putin has estimated that 5–7,000 people from Russia and other former Soviet states are fighting for IS; many of these fighters still have extensive networks of contacts in Russia.[74] Recent reports suggest that Islamic extremism is spreading from the North Caucasus to the Urals, where several major Russian nuclear facilities are located.[75]

Corruption and Organized Crime. Corruption continues to be a serious problem throughout Russia, including in the nuclear industry and the security services that guard it. This has included such remarkable cases as the arrest of the director and two of the deputy directors of the Siberian Chemical Combine, one of Russia's largest HEU and plutonium processing facilities, for millions of dollars in kickbacks, and a general commanding a nuclear weapon storage facility relieved of his duties for corruption.[76] From 2009 to 2012, Rosatom fired 276 manager or executive level employees because of corruption charges.[77] In 2015, Transparency International ranked Russia 119th out of 168 countries, placing it in the most corrupt third of countries in the world.[78] An environment of pervasive corruption and embezzlement increases the chance that insiders could be bribed to participate in or facilitate a nuclear theft. At the same time, Russia continues to suffer a serious problem of organized crime, with far-reaching networks—including deep heroin-trafficking connections to Afghanistan—that might be used by nuclear thieves or smugglers. Organized crime has also penetrated into Russia's closed nuclear cities, in some of which narcotics pose a serious problem.[79]

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73 See, for example, Gordon M. Hahn, "The Caucasus Emirate Jihadists: The Security and Strategic Implications," in Stephen J. Blank, ed., *Russia's Homegrown Insurgency: Jihad in the North Caucasus* (Carlisle, PA: U.S. Army Strategic Studies Institute, 2012), pp. 1–97; Bill Roggio and Thomas Joscelyn, "Russian Trooops Kill Leader of Islamic Caucasus Emirate," *Long War Journal,* (April 19, 2015), http://www.longwarjournal.org/archives/2015/04/russian-troops-kill-leader-of-islamic-caucasus-emirate.php (accessed June 20, 2015).

74 "Putin: 'Thousands' from former Soviet bloc fighting with IS," *BBC News*, October 16, 2015, http://www.bbc.com/news/world-middle-east-34552318 (accessed February 9, 2016). Joanna Paraszczuk, "Russia Unveils New Post To Wage 'War On IS,'" *Radio Free Europe Radio Library*, March 13, 2015, http://www.rferl.org/content/russia-isis-islamic-state/26899257.html (accessed March 13, 2015).

75 Malashenko and Starostin, *The Rise of Nontraditional Islam in the Urals.*

76 Russian press accounts of the case are summarized in "Russia: CEO of Enrichment Center Arrested for Massive Fraud," *Uranium Intelligence Weekly*, June 29, 2012.

77 "Rosatom Risks: Exposing the Troubling History of Russia's State Nuclear Corporation" (The Netherlands: Greenpeace, October 2014), http://www.greenpeace.org/hungary/PageFiles/636986/rosatom_risks.pdf (accessed February 5, 2016), p. 20.

78 Transparency International, *Corruption Perceptions Index 2015* (Berlin: Transparency International, 2015), https://www.transparency.org/cpi2015 - results-table (accessed February 4, 2016).

79 Robert Orttung and Louise Shelley, *Linkages Between Terrorist and Organized Crime Groups in Nuclear Smuggling: A Case Study of Chelyabinsk Oblast*, PONARS Policy Memo No. 392 (Washington, D.C.: December, 2005); http://www.csis.org/media/csis/pubs/pm_0392.pdf (accessed February 22, 2016).

Risk Summary and Trend: Overall, the risks of nuclear theft in Russia appear to be moderate. Nuclear security measures are drastically improved, but still have some weaknesses, and the threats these security systems must counter are substantial. While Russia continues to make some nuclear security improvements, the overall risk trend appears to be toward increasing risk, with the end of all but a modest portion of U.S.-Russian nuclear security cooperation, an increase in the threat of Islamic terrorism, and increasing economic uncertainty that could make it difficult for facilities to allocate resources for nuclear security.

Pakistan

In Pakistan, a modest but rapidly growing nuclear stockpile, with substantial security measures, must protect against some of the world's most capable terrorist groups, in an environment of widespread corruption and extremist sympathies.[80]

Pakistan has substantially strengthened its nuclear security in the past two decades. In a recent survey of nuclear security experts, the Pakistani participant reported dramatic recent changes in the organizations governing nuclear security; in the numbers, training, and equipment of guard forces; in approaches to screening personnel; in requirements for nuclear material accounting and control; and in approaches to strengthening security culture, along with substantial changes in every other aspect of nuclear security covered in the survey.[81] By some estimates, the Strategic Plans Division, which manages Pakistan's nuclear weapons, has 25,000 troops available to guard Pakistani nuclear stocks and facilities. [82] Pakistani officials report that sites are equipped with extensive barriers and detection systems, that the components of nuclear weapons are stored separately (though that may be changing as Pakistan moves toward tactical nuclear weapons intended to

80 For a previous assessment, see Bunn *et al., Advancing Nuclear Security,* pp. 17–20.

81 Bunn and Harrell, *Threat Perceptions and Drivers of Change*, p. 9.

82 Finance Minister Ishaq Dar asserted that a "special security force of 25,000 personnel, who have been specially trained and provided sophisticated weapons, has been deployed to protect (the nuclear assets)." See "Pakistan Says "25,000 Guards Watching Nukes," *Global Security Newswire*, June 25, 2013, http://www.nti.org/gsn/article/pakistan-says-25000-nuke-oversight-duty/ (accessed June 5, 2015). By another account, the total strength of the "security division" of the National Command Authority was 20,000 in 2013, but headed upward to 28,000. Not all of these personnel may be assigned to guard duties at any particular time. See Naeem Salik and Kenneth N. Luongo, "Challenges for Pakistan's Nuclear Security," *Arms Control Today,* March, 2013, https://www.armscontrol.org/act/2013_03/Challenges-for-Pakistans-Nuclear-Security (accessed February 9, 2016). Security force for nuclear sites at 20,000, heading up to 28,000. Used to be mainly retired military. Now they are being replaced by new recruits trained at the new training center, allegedly comparable to the one the U.S. has established in New Mexico. Security force capabilities tested through "field exercises and war games." Sites have inner and outer perimeters with electronic sensors "and counterintelligence teams." All personnel brought into "any components of the strategic program" are screened "in concert with other intelligence agencies" (presumably ISI).