STRIKING A BALANCE
The Lessons of U.S.-Russian Materials Security Cooperation

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U.S.-Russian cooperation on nuclear materials, protection, control, and accounting (MPC&A) grew rapidly in the 1990s, but then stagnated. What explains this pattern, and what steps could be taken to revitalize joint efforts to secure nuclear material? This article contends that MPC&A cooperation is most effective when government officials set overall policy goals, lobby for political support and funding, and provide central coordination, while scientists build trust with their Russian counterparts, develop technical plans, and oversee implementation on the ground. MPC&A cooperation has faltered since the late 1990s primarily because this balance has shifted too far in favor of bureaucratic control in both the United States and Russia. The article recommends steps to re-establish a balance between government oversight and scientific leadership, and offers lessons from U.S.-Russian MPC&A cooperation for possible future dealings with Iran, North Korea, and other proliferant states.

KEYWORDS: Russia; Nuclear materials; MPC&A; Scientific cooperation; Russian navy; Proliferant states; Uranium; Plutonium

After 13 years of work and more than a billion dollars in funding, the results of U.S.-Russian cooperation on materials protection, control, and accounting (MPC&A) are disappointing.[1] The United States and Russia have adequately secured less than half the loose nuclear material left in the former Soviet Union. If work continues at the current pace, the task will not be finished for another 13 years.[2] Despite the importance of the U.S.-Russian MPC&A agenda for preventing nuclear terrorism and proliferation, the program's slow progress seems to have become accepted as a fact of life in both capitals, where policymakers and observers tend to focus on day-to-day bilateral wrangling over access, verification, taxation, liability, and the like. Absent from the discussion is any evaluation of some puzzling broader trends that characterize more than a decade of this work. After all, MPC&A cooperation experienced significant, rapid successes in the early to mid-1990s. Only in the mid-to-late 1990s did the program begin to experience more problems. What explains this variation in the effectiveness of the cooperation over time? And what, if anything, can be done to revitalize U.S.-Russian materials security cooperation now?

This question is important because the job of securing Russia's vast stocks of nuclear material is less than half finished. It is not too late to speed current efforts based on a better understanding of what has gone right and wrong. The question is also important because it is not hard to envision a day when the United States may face similar threat

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reduction challenges in places like North Korea, Pakistan, and even Iran. Again, unstable states may collapse and leave behind a sophisticated but vulnerable weapons-related scientific infrastructure, including weapons-usable nuclear, radiological, chemical, or biological materials. The United States is already scrambling to devise a strategy for combating the human and physical legacies of weapons of mass destruction (WMD) programs in Iraq and Libya. Recognizing that more than 40 countries possess stocks of weapons-usable highly enriched uranium (HEU), the United States also recently launched the Global Threat Reduction Initiative to secure or remove dangerous nuclear material from dozens of locations around the world.[3] Additionally, the United States supports a variety of efforts to improve physical protection of nuclear materials in other countries.[4] As Senator Richard Lugar has noted, the United States cannot hope to achieve even a "minimal victory" in the war on terrorism unless every nation in possession of weapons and materials of mass destruction engages in a proper effort to account for, secure, and control access to them.[5]

Given the indications that effective MPC&A programs are crucial to U.S. security, and that the need for such programs is likely only to grow in the future, the track record with Russia is troubling. We cannot expect every case to be exactly like the Russian one, but a closer examination of the conditions under which that cooperation has thrived — and faltered — is crucial. Why has U.S.-Russian cooperation experienced problems? And how can future programs avoid a similar fate?

Explaining Changes in Cooperation

The intuitive explanation for any decline in the effectiveness of international cooperation is that states pick "low-hanging fruit" first. They reap large gains from initial efforts by tackling easy problems with obvious and mutually agreeable solutions. But when that work is finished and governments have to move on to more challenging endeavors that require more money, more time, or more compromise, the cooperation stagnates or stops.

Elegant as it is, this explanation is not consistent with the empirical record of U.S.-Russian nuclear materials security cooperation. Contrary to what the "low-hanging fruit" argument would predict, American and Russian scientists actually addressed MPC&A at some of the most important, sensitive nuclear sites in Russia right at the outset of cooperation in the early 1990s, and they continued to make progress on other sensitive sites throughout the mid-1990s. It was only in the late 1990s that the effectiveness of materials security cooperation precipitously declined at both sensitive, "difficult" sites *and* relatively noncontroversial, "easy" sites. Most interestingly, during this same period, cooperation remained highly effective in other comparably advanced, complex, and sensitive areas of the U.S.-Russian threat reduction agenda, noticeably U.S.-Russian efforts to develop MPC&A systems for naval nuclear fuel.

This inconsistency suggests that some other factor besides the inherent complexity or sensitivity of particular cooperative tasks determined how effectively the two countries worked together. It also suggests that broader trends in U.S.-Russian political relations, or in the ease or difficulty of doing business in Russia generally, were not the cause, or at least not the sole cause, of changes in the effectiveness of U.S.-Russian work on the cooperative threat reduction agenda. If they had been, progress on all aspects of that agenda would have moved in lockstep, when in fact most of the MPC&A cooperation displayed a pattern of cooperation quite distinct from other areas.

The history described in this article will show that early MPC&A cooperation was highly effective in terms of the number, significance, and sensitivity of the nuclear sites where MPC&A work occurred. Although this initial work received scant funding, the program flourished largely because of low-level, lab-to-lab contacts among a transnational network of American and former Soviet scientists.[6] The program had high-level political support in both countries, but central government control and formal negotiations were relatively minimal, allowing true partnership and a joint decisionmaking process to emerge between technical experts from the two countries. Rapid results in securing nuclear materials soon followed.

As MPC&A achieved these results and garnered more funding, however, it also became the object of increasing top-down bureaucratic control, in both Russia and the United States. Efforts to take over and tightly control the activities of the scientists hampered the atmosphere of trust and expert judgment that had proved so crucial to the early gains of the program. In a sense, the program became the victim of its own success. By the late 1990s, it was flush with funding and bureaucratic oversight but not very effective in terms of the number, significance, and sensitivity of the nuclear sites where cooperation was under way.

This history suggests that the sensitivity and complexity of materials security cooperation between former adversaries requires a careful balance between government oversight and scientific leadership. Standard operating procedures—requiring formal government-to-government negotiations before cooperation can proceed, and high levels of central control over cooperation once it has begun—may be counterproductive. Encouraging and relying upon direct cooperation between technical experts may instead be a better way to ensure a deep and lasting partnership. However, such an approach may go against the instincts and interests of government bureaucracies, especially as small, successful programs become large, well-funded programs—which happens precisely because of the small programs' initial successes.

The key to successful, large-scale materials security cooperation is balance. Government officials should set overall policy goals, ensure political and financial support for cooperation, provide central coordination, and establish a legal framework within which cooperation can occur. High-level political support is crucial. Meanwhile, scientists should negotiate individual projects with their counterparts, develop technical plans, and oversee implementation on the ground. If the role of either group becomes too large or too small, the cooperation will suffer.

This article will closely examine three key phases of the U.S.-Russian MPC&A program: the period 1986–95, when cooperation began; the period 1995–97, when cooperation expanded; and the period 1997–present, during which cooperation experienced some serious problems. As will be discussed in more detail below, the U.S.-Russian MPC&A cooperation comprised three components: (1) government-to-government MPC&A, run largely by the Department of Energy (DOE) and focused primarily on Russian civilian nuclear facilities; (2) lab-to-lab MPC&A, focused primarily on Minatom

(Ministry of Atomic Energy) defense nuclear facilities; and (3) Russian naval MPC&A, conducted on a lab-to-lab basis, but largely separated from the work focused on Minatom facilities. The conclusion will suggest some ways to improve current MPC&A work and how best to design future MPC&A programs so that they are sustainable and effective in reducing the threat of loose nuclear material.

The article draws its information from open-source secondary literature and primary documents, and from original interviews with Russians and Americans involved in MPC&A cooperation. Although every effort was made to corroborate the data gained through interviews and to synthesize that information correctly, an oral history approach contains inherent limitations. Key individuals declined to sit for interviews; others would speak only anonymously or off the record; others decided to speak but not to discuss certain topics. Furthermore, interviews are only as good as the recollections and perceptions of the interview subjects. If not evaluated critically, interviews can introduce error and bias. Still, interviews offer one of the only ways to learn more about an unusual and complex phenomenon like U.S.-Russian MPC&A cooperation. Although far from perfect, this study is undoubtedly richer, more accurate, and more useful with interview material than it would be without it.

Cooperation Begins: 1986–1995

Early Lab-to-Lab Scientific Cooperation

In the mid-1980s, few people in the United States or the Soviet Union could have envisioned that scientists from the two countries would soon be engaged in extensive and highly sensitive nonproliferation cooperation. Nevertheless, the transnational ties that would lead to that outcome had already been growing through several decades of U.S.-Soviet scientific exchanges and professional contacts.[7] Starting in 1986, ties also grew among the American and Russian scientists involved in joint verification experiments for the Intermediate-Range Nuclear Forces Treaty. Despite their different nationalities, these two groups became fast friends. As one scientist involved in the early joint work explained, "Although personal contacts . . . did not occur until the 1980s, when they finally happened, it was like meeting old colleagues."[8]

While neither group of scientists could completely divorce research from politics, their similar educational backgrounds and professional experiences often meant that they had more commonalities than differences. The potential for cooperation within this epistemic community was so evident that as early as 1988, Soviet scientists broached the possibility of expanded joint experiments. As the Soviet Union collapsed over the next three years, these scientists continued to reach out to the Americans, inviting representatives of Los Alamos National Laboratory and Lawrence Livermore National Laboratory to visit two nuclear weapons design cities, Arzamas-16 and Chelyabinsk-70—locales so secret that they did not appear on Soviet maps. Although largely symbolic, these trips demonstrated the seriousness of the Soviet scientists' desire to cooperate and provided a forum for the discussion of further joint work.

Then, in December 1991, Siegfried Hecker, the director of Los Alamos and a participant in the U.S.-Russian cooperation up to that point, pitched U.S.-Russian lab-to-lab scientific collaboration to the DOE as one potential solution to the "brain drain" problem that was beginning to concern the U.S. government. Hecker argued that engaging former Soviet scientists in peaceful work with the United States would make them less likely to sell their expertise to states or groups trying to build nuclear weapons. Admiral James Watkins, the secretary of the DOE at the time, embraced Hecker's suggestion. With his blessing, the "Directors' Exchange" visits proceeded in early 1992, as the heads of Arzamas-16 and Chelyabinsk-70 visited Los Alamos and Lawrence Livermore, and vice versa.

The scientists' expert knowledge and shared sense of identity enabled them to develop trust and to agree quickly on several areas of potential collaboration, including basic scientific experiments, more joint work related to arms control, and efforts to maintain or improve nuclear security. Both groups of scientists agreed to try to gain their government's approval of these projects.[9] For the Russian scientists, gaining Minatom approval was fairly easy; the ministry's newly appointed head, Viktor Mikhailov, was himself an experienced nuclear scientist and had been involved in the joint experiments of the late 1980s.[10] A well-known hawk and close friend of President Boris Yeltsin, Mikhailov was the perfect person to advocate cooperation with the United States.[11] Moreover, because of the overall weakness of the Russian state during 1992–93, Mikhailov was free to make such decisions.

The DOE was supportive, too, but slightly more cautious. Although Secretary Watkins believed in the overall idea of U.S.-Russian cooperation, he sought to limit it to pure science because government-to-government efforts were already under way to tackle nuclear security in the former Soviet Union. In fact, although DOE permission was required to proceed, the DOE did not provide funding for the low-level scientific cooperation during this period.[12] It simply endorsed the collaboration and helped coordinate approval for the scientists' international travel with the U.S. Department of State.[13]

Because of Secretary Watkins's views on the appropriate scope of lab-to-lab cooperation, the scientists restricted their work to two series of experiments, which they negotiated through the spring and summer of 1992 and formalized in the first lab-to-lab contract, signed in October 1992. Through this agreement, Los Alamos and the All-Russian Scientific Research Institute of Experimental Physics (abbreviated from the Russian as VNIIEF, and often referred to as Arzamas-16 because of the city in which it is located) pledged to work together on experiments in pulsed-power generation and ultra-high magnetic fields. The experiments proceeded successfully in 1993.

Initial Government-to-Government MPC&A

Transnational cooperation was not the only game in town in the early 1990s, however. As the Soviet Union fell apart in late 1991, the first Bush administration recognized that the U.S. and Russian governments might need to work together to reduce the dangers of the Soviet nuclear legacy. By November, Congress had passed the Soviet Nuclear Threat

Reduction Act, more commonly know as the Nunn-Lugar Act. This legislation, which actually comprised several different programs to deal with various aspects of the Soviet nuclear complex, set aside $400 million of the existing Department of Defense (DOD) budget to help ensure that Soviet nuclear weapons and materials did not fall into the wrong hands as central authority eroded in Moscow.[14]

Only 2.5 percent of this money, or about $10 million, funded government-to-government efforts to improve MPC&A.[15] Nevertheless, with that meager $10 million in hand, the DOD began negotiating with Minatom in early 1992 to devise an MPC&A strategy for what had become by then the former Soviet Union.[16] Unfortunately, diplomatic formalities greatly slowed the pace of this effort. A senior U.S. official described the process as nearly pointless:

> In order to ensure that the government is speaking with one voice, most U.S. government communications to other governments are channeled through a few State Department or Embassy officials working from "talking points" prepared by interagency committees. This limits the rate of communication to one significant round every few months. In between, both bureaucracies ponder the response of the other side and prepare the next round of proposals and associated talking points. The process is so ponderous that most people involved lose track of the forest for the trees.[17]

Moreover, because the MPC&A program was an interagency spawn—statutorily funded by the DOD, largely managed by the DOE, and requiring travel and diplomatic clearance from the State Department—development of a formal U.S. negotiating position on MPC&A required extensive internal bargaining. Once the three institutions finally agreed on a particular stance, "it was difficult to introduce flexibility into the negotiating process," and "every step away from the original position was viewed as a concession to the other side," much as it would have been during the Cold War.[18] Even when the government-to-government program tried to include scientists from both sides—individuals with the requisite technical credentials and good working relationships—the inflexibility of the negotiating approach and the burden of bureaucratic formalities stymied progress.[19]

The Russian representatives assigned to MPC&A talks were also "highly suspicious" of the U.S. government's motives in initiating a top-down MPC&A program.[20] Questions of national pride figured powerfully into their official diplomatic discourse. As one American scientist noted, "At the government level under Nunn-Lugar. . .they weren't about to admit officially that they had difficulties" controlling nuclear materials.[21] Additionally, basic "organizational questions within the Russian government of who's responsible for what" remained unresolved, which only further complicated the effort to agree on an approach to MPC&A at the government level.[22] The weakness of the Russian state, combined with the inflexibility of the American bureaucracy and the inherent sluggishness of diplomatic negotiations, precluded progress toward effective MPC&A for nearly two years.

Finally, in September 1993, the DOD and Minatom signed an agreement to perform a model MPC&A upgrade on a low-enriched uranium (LEU) fuel fabrication line at a civilian site called Elektrostal. As all parties recognized, however, this part of the site posed virtually no proliferation risk. Meanwhile, the agreement did nothing to protect Elektrostal's thousands of kilograms (kg) of HEU.[23] American negotiators had hoped that an initial success with the LEU would lead to cooperation on the HEU, but despite continued talks in late 1993 and 1994, the part of the site containing HEU did not receive an MPC&A upgrade. Indeed, Russian negotiators repeatedly rejected U.S. attempts to expand the MPC&A cooperation to include weapons-usable material.[24] As Congress became increasingly aware of the "loose nukes" problem and more credible reports of nuclear materials thefts surfaced, the failure of these government-to-government efforts so frustrated U.S. officials that they began to wonder if they should change course.[25]

The Beginning of Lab-to-Lab MPC&A

The U.S. labs had pushed an alternative course—lab-to-lab MPC&A—since early 1992.[26] The years since only strengthened their case for a bottom-up approach. The purely scientific cooperation with the Russians proceeded successfully in 1993, and in a January 1994 meeting, the directors of Los Alamos and Arzamas-16 cemented their ties by signing an umbrella contract for additional lab-to-lab activities. This overarching framework enabled the scientists to execute their projects quickly, without renegotiating the same details again and again.

At this same 1994 meeting, the scientists also established a hypothetical plan for joint MPC&A, though they had little reason to expect that they would ever be able to implement it given that the DOE continued to confine lab-to-lab activities to pure science. Hecker had sent a letter to incoming Secretary of Energy Hazel O'Leary in early 1993 about the need for better nuclear materials control in Russia, but the DOE still had not responded by the time the umbrella contract was signed a year later.[27]

Soon, though, the failed experiment of government-to-government MPC&A convinced a newly appointed undersecretary of energy, Charles Curtis, to embrace the concept of a lab-to-lab approach. At his introductory meeting with Hecker in April 1994, Curtis empowered the labs to reach out to their Russian counterparts and approach MPC&A from the bottom up. According to Hecker, "Charlie said he would find the money one way or another and we should just go do it."[28] Given this freedom, scientists from Los Alamos quickly contacted their colleagues at Arzamas-16. Once informed of the opportunity, the Russians "had to get guidance from Moscow, from Mikhailov, . . .but it took only one weekend of telephoning back and forth and we had approval from the Russian side."[29]

Within six weeks, Hecker was at Arzamas-16 signing six contracts for lab-to-lab MPC&A, which Curtis had agreed could occur within the framework established by the January 1994 umbrella agreement. Hecker also signed a similar contract with the All-Russian Scientific Research Institute of Technical Physics (VNIITF) at Chelyabinsk-70—the sister laboratory to VNIIEF at Arzamas-16—and with the civilian Kurchatov Institute in Moscow. This latter contract paved the way for cooperation with the civilian nuclear complex and the Russian Navy, as will be discussed below. Actual construction of an MPC&A system at the Institute at Arzamas-16, which was to serve as a model to other facilities in need of security, began within two months.

By the end of 1994 the scientists had also largely completed a model MPC&A system for a key facility known as Building 116. Part of the sensitive Kurchatov Institute, Building

116 was a far cry from the LEU fuel fabrication line at Elektrostal. It contained plenty of HEU—although for several years after the end of the Cold War, only a decrepit chain-link fence and unarmed night watchman had stood between that HEU and the surrounding population of Moscow.[30] As with the MPC&A upgrade at Arzamas-16, the scientists made rapid progress once the DOE gave its approval. The Kurchatov Institute was able to work with U.S. labs even more easily than could Arzamas-16 because it was not under the authority of Minatom. Once again, although the labs had the DOE's blessing, "there were no formal diplomatic negotiations."[31]

The accelerated pace of the bottom-up approach was striking: In a matter of months the scientists had achieved what years of government-to-government negotiations had hardly been able even to discuss—and they did it with less than $2 million.[32] As all participants acknowledged, the transnational networks of trust that had formed during the late 1980s and early 1990s were crucial to this initial success. Scientists involved in the cooperation repeatedly stressed the importance of personal relationships to jumpstarting MPC&A at significant, sensitive sites like VNIIEF and Building 116. As one American explained:

> The issue of personal trust is extremely important in Russia. I still remember when [the directors] signed the first nuclear materials control contracts in June 1994. There was a pause as [the Russian director of Arzamas-16] picked up his pen. . . .You could see him thinking, "I'm taking a hell of a risk here. And you had better be telling me the truth."[33]

Of course, warm, fuzzy feelings were not the only reason this initial venture succeeded. The scientists' shared technical expertise also enabled them to coordinate the details of the project easily. Moreover, they collaborated closely to ensure that the project served both U.S. and Russian objectives.[34] As a senior laboratory scientist involved in this early project explained, "Half the equipment at the demonstration was Russian, and half was American. Everything about the demonstration was planned together, and the plan was written in Russian and English."[35] This spirit of partnership, grounded in shared knowledge and goals, enabled the scientists to overcome the hurdles that had stymied the government-to-government approach.

Cooperation Expands: 1995–1997

Growing Support for MPC&A

Early 1995 saw growing support for MPC&A cooperation in both Russia and the United States. The work at Building 116 helped build grassroots support for cooperation among Russian scientists. Although Minatom did not control the Kurchatov Institute, nuclear experts from Minatom-controlled facilities all over Russia attended the MPC&A demonstration held there in February 1995. Mikhailov eventually moved the demonstration materials to his office, where he personally continued to show it to hundreds of Russian officials in Minatom and other agencies. After hearing Mikhailov's carefully tailored pitch, they came away with a clear sense that cooperation with the United States was both necessary and feasible. "As a result," according to one observer, "a more extensive network of laboratory-to-laboratory contacts began to grow as pressure was placed on Minatom to allow the cooperation to expand."[36]

Rose Gottemoeller, then the director of Russia, Ukraine, and Eurasian Affairs in the National Security Council and later a senior official in the DOE's Office of Nonproliferation and National Security, explained that "we had stopped knocking on Minatom's door.... But then suddenly Minatom was knocking on our door after they saw the success of the Kurchatov demonstration."[37] Similarly, the work at Arzamas-16 created more support for cooperation within Minatom. In March 1995, the scientists there held a special MPC&A demonstration for Mikhailov, which reinforced his belief in the need to allow further scientific cooperation with minimal bureaucratic constraints.[38]

These early successes also built high-level support within the United States for expanded lab-led cooperation. Top White House and DOE officials had the opportunity to tour the upgraded Building 116 at a December 1994 meeting of the Gore-Chernomyrdin Commission, and the visible improvements there convinced officials that expanded cooperation required better use of laboratory ties.[39] Although the State Department remained reticent to empower the labs as informal representatives of the U.S. government, high-level officials from most other parts of the U.S. government became dedicated in 1995 to increasing funding for the lab-to-lab effort and to making better use of laboratory knowledge and connections in the government-to-government effort.[40]

With these goals in mind, the DOE implemented three key changes at headquarters. First, it brought laboratory experts to Washington to help lead both the DOE lab-to-lab and DOE government-to-government programs. Positioned in a variety of different offices, these lab experts "served to organize the growing number of labs that were participating in the program, vetted technical plans, ... and helped to integrate the policy and technical aspects of the program."[41]

The DOE also began to call regularly upon a steering committee of senior U.S. laboratory experts to hear ideas and feedback on both the government-to-government and lab-to-lab programs. According to one observer, "this approach allowed new input from the U.S. laboratories on MPC&A issues to be plugged into the decisionmaking process at DOE on a timely and continuous basis."[42]

Finally, the DOE supported the formation of a Technical Working Group comprising U.S. and Russian scientists who met regularly to discuss progress and problems in both the government-to-government and lab-to-lab MPC&A programs.[43] This forum preserved and enhanced the scientist-to-scientist communication that had proved so productive in the early 1990s, yet ensured that the fruits of that communication would travel back up the chain of command to the DOE and actually affect policy.

Meanwhile, the increased role of lab officials at the DOE "freed federal managers to deal with policy issues and generate the needed political support for the program inside and outside the government."[44] This change provided DOE officials the time and energy to lobby for whopping increases in MPC&A funding, which rose to more than $40 million in fiscal year 1995, to nearly $100 million in fiscal year 1996, and to almost $115 million in fiscal year 1997.[45] This new division of labor—whereby the lab officials contributed their expertise and worked their transnational connections, while government officials established overall policy and lobbied for programmatic resources—reflected the recognition among top DOE officials of the need to replicate the key elements of the early lab-to-lab successes by endowing the labs with more autonomy. It also reflected the growing political salience of MPC&A cooperation.

The Expanded Effectiveness of the Lab-to-Lab Approach

Despite the many positive changes at the DOE in 1995–96, however, the lab-to-lab approach still had three clear advantages over the government-to-government track.

First, the lab-to-lab approach relied on expert judgment and thereby avoided the standard operating procedures typical of bureaucracies. Although the scientists engaged in the lab-to-lab program did have to adhere to the broad guidelines of DOE policy and Minatom regulations, they still enjoyed great latitude to determine which projects should be implemented, where, and how. As one participant explained, "You can draw a contrast between having a highly skilled person using judgment and experience to solve the problem—like a craftsman or artist would—and using a standard tool, which is what bureaucracy does. . . . Lab-to-lab was more the former," thereby allowing more creative innovation in response to challenges.[46]

Second, because the lab-to-lab program worked from the bottom up through personal relationships, it was not hostage to the sluggish and unpredictable processes of diplomacy. Only after the American and Russian experts had agreed among themselves about what to do did the governments become more involved. As Hecker, the director of Los Alamos, reflected:

> We would convince our leadership here. . .at the DOE and Congress. And then they would work with their political leadership in the appropriate ministries, and so we did not have much of an interface between the U.S. DOE and the Ministry of Atomic Energy. . . . This is how we were able to overcome the normal hesitancy the Russians had about letting us anywhere near these facilities. We made enormous inroads with the philosophy of "you work your government, we'll work our government."[47]

Indeed, a lab-to-lab agreement was usually a fait accompli, because the governments had a hard time turning down detailed plans to which people on the ground had already committed. At that point U.S. officials were reluctant to impose the additional restrictions that they might have introduced into more formal negotiations, as were their Russian counterparts.[48] As one DOE official simply explained, "the personal relationships among the scientists. . .brought the bureaucrats along."[49]

Third, the lab-to-lab approach focused on the objective of having the Russians themselves enhance the security of their nuclear materials, rather than on imposing a standardized set of imported safeguards. This objective required genuine joint planning between the two groups of experts, which, unsurprisingly, led to better-designed security systems that were more likely to be sustainably implemented. Furthermore, as Russian scientists became invested in the projects, they recognized the need to bring the Russian Security Service, known as the FSB, on board if the projects were to have long-term success. They included FSB representatives in early-stage, informal negotiations over how to secure materials, making the services part of the solution, instead of the problem. This move made the services much less likely to veto cooperation at a later juncture.[50]

The effectiveness of the lab-to-lab program was indisputable during this period. By the end of 1996, it was conducting MPC&A work at seven more sites in Russia, bringing the total to nine. More important than the total number of sites, however, were their significance and sensitivity. All were of moderate to high significance in terms of the types and estimated amounts of nuclear material at the site. Furthermore, some of the sites were quite sensitive as well, particularly VNIITF at Chelyabinsk-70 and the Siberian Chemical Combine at Tomsk-7, which was the largest multifunction nuclear site in Russia. As Table 1 illustrates, the pattern of work suggests that trust in the lab-to-lab interactions was high and that cooperation was very effective.

In addition to gaining initial access to these sites, U.S. scientists in the lab-to-lab program also began negotiating an agreement to do work at the most sensitive buildings within those sites, to which Russian law prohibited direct U.S. entry.[51] With permission from the DOE, American scientists had worked with their Russian counterparts to develop the idea of verification measures known as ''assurances'' to show that U.S. assistance was being used as intended, even if Americans were not physically present. These assurances, which were to include ''written certifications of work done by Russian officials, technical reports on that work by relevant institutes, and photographs and videotape of the equipment in use after the installation,'' as well as any other specific measures negotiated for a particular site, would conform to the letter of Russian law and quell Russian concerns about U.S. intrusion.[52]

After a relatively short period of negotiation, the Russian and U.S. labs reached a general agreement on the acceptability of these types of assurances in fall 1995. They then began to try to apply the concept to the two most sensitive sites where MPC&A work was already occurring: the nuclear weapons research and design facilities at the two cities discussed earlier, Arzamas-16 and Chelyabinsk-70. This process ''required enormous efforts to build personal trust and confidence between the U.S. and Russian project team leaders.''[53] But ultimately the two sides did devise acceptable verification measures, and the MPC&A upgrades began at the most sensitive and highly vulnerable buildings within these two sites.[54] This expansion of MPC&A greatly increased the program's effectiveness and again testified to the success of the lab-to-lab approach.

During this period the U.S. and Russian labs also worked to initiate MPC&A cooperation at the four most sensitive remaining sites in Russia, the nuclear weapons assembly and disassembly sites.[55] Throughout the 1990s, the Russians had been reticent to allow the United States access to these locations—the Avangard Electrochemical Plant at Arzamas-16 (renamed Sarov), the Elektrokhimpribor Combine at Sverdlosk-45 (renamed Lesnoy), the Instrument Making Plant at Zlatoust-36 (renamed Trekhgornyy), and the START Production Association at Penza-19 (renamed Zarechnyy)—and yet these sites, known in Russia as serial production facilities, each contained thousands or tens of thousands of kilograms of both plutonium and HEU, all potentially vulnerable to diversion.[56]

Both U.S. and Russian scientists recognized MPC&A at these sites as crucial to reducing the risk of loose nuclear material in Russia. The problem was finding an approach

TABLE 1
Lab-to-Lab Effectiveness in the Mid-to-Late 1990s

Name and Location of Site	Work Begun	Significance (Types and Amounts of Nuclear Material at Site)	Sensitivity (Activities at the Site)
1. All-Russian Scientific Research Institute of Experimental Physics (VNIIEF), Sarov/Arzamas-16	1994	High: >1,000 kg HEU >1,000 kg Pu	High: nuclear weapons research, design, development
2. Kurchatov Institute, Russian Research Center, Moscow	1994	Moderate: >1,000 kg HEU unknown Pu	Moderate: scientific research, reactors, fissile material storage
3. All-Russian Scientific Research Institute of Technical Physics (VNIITF), Snezhinsk/ Chelyabinsk-70	1995	High: >1,000 kg HEU >1,000 kg Pu	High: nuclear weapons research, design, development
4. Bochvar All-Russian Scientific Research Institute of Inorganic Materials, Moscow	1995	Moderate: <1,000 kg HEU <1,000 kg Pu	Low: fuel-cycle technologies and fissile material processing
5. Siberian Chemical Combine, Seversk/ Tomsk-7	1995	High: >1,000 kg HEU >1,000 kg Pu	Moderate: materials production, storage, enrichment, reprocessing
6. Institute of Physics and Power Engineering, Obninsk	1995	High: >1,000 kg HEU >1,000 kg Pu	Moderate: nuclear power research and development
7. Mining and Chemical Combine, Zheleznogorsk/ Krasnoyarsk-26	1996	High: >1,000 kg HEU >1,000 kg Pu	High: spent fuel reprocessing
8. Electrochemical Plant, Zelenogorsk/Krasnoyarsk-45	1996	Moderate: >1,000 kg HEU	Moderate: uranium enrichment, downblending
9. Urals Electrochemical Integrated Plant, Novouralsk/ Sverdlovsk-44	1996	Moderate: >1,000 kg HEU	Moderate: uranium enrichment, downblending
10. Avangard Electrochemical Plant, Sarov/Arzamas-16	1997–1998 agreement	High: >1,000 kg HEU >1,000 kg Pu	High: nuclear warhead assembly/disassembly (serial production plant)
11. Elektrokhimpribor Combine, Lesnoy/ Sverdlovsk-45	1997–1998 agreement	High: >1,000 kg HEU >1,000 kg Pu	High: nuclear warhead assembly/disassembly (serial production plant)

TABLE 1 (*Continued*)

Name and Location of Site	Work Begun	Significance (Types and Amounts of Nuclear Material at Site)	Sensitivity (Activities at the Site)
12. Instrument Making Plant, Trekhgornyy/Zlatoust-36	1997–1998 agreement	High: >1,000 kg HEU >1,000 kg Pu	High: nuclear warhead assembly/disassembly (serial production plant)
13. START Production Association, Zarechnyy/ Penza-19	1997–1998 agreement	Moderate: >1000 kg HEU, >1000 kg Pu	High: nuclear warhead assembly/disassembly (serial production plant)

kg = kilogram; HEU = highly enriched uranium; Pu = plutonium
Source: John Wolfsthal, Cristina-Astrid Chuen, and Emily Daughtry, eds., *Nuclear Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union* (Monterey, CA and Washington, DC: the Monterey Institute of International Studies and the Carnegie Endowment for International Peace, 2001), pp. 75–126; senior national laboratory official, e-mail correspondence with the author, Feb. 25, 2003; and Matthew Bunn, e-mail correspondence with the author, July 12, 2004. Note that in the case of cities that have been renamed since the collapse of the USSR, both the old and new names are listed.

to MPC&A there that would satisfy both governments. After some false starts, the scientists ultimately devised a system very similar to the one initiated at VNIIEF and VNIITF, focused on assurances that would obviate the need for providing the Americans physical access to the sites. In winter 1997–98, the DOE and Minatom committed to this system of assurances in writing, and it seemed poised to take effect at key sites in Russia.[57] In its fiscal year 1998 budget justification, the DOE even requested increased funding specifically for MPC&A at the serial production plants.[58]

The Modest Effectiveness of the Government-to-Government Approach

Due to important changes in the structure and management of the government-to-government program—changes that tried to make it function more like a lab-led effort—the mid-1990s saw some modest successes for top-down MPC&A, especially compared to the performance of the early years. As mentioned earlier, the government-to-government program greatly benefited from the transplantation of laboratory expertise and transnational ties into DOE headquarters.

During this period the United States also streamlined management of the government-to-government program, giving the DOE full financial and managerial control over MPC&A beginning in fiscal year 1996.[59] Although the State Department still had to approve MPC&A travel, the clear transfer of overall authority from DOD to DOE immediately helped reduce the bureaucratic cross-currents that had proved so damaging in the early 1990s. DOE and Minatom developed an expanded working relationship. Top

DOE officials also repeatedly raised the subject of MPC&A at the semiannual meetings of the Gore-Chernomyrdin Commission, and Secretary O'Leary and Minister Mikhailov even signed a joint statement on the importance of MPC&A in July 1996.[60]

Nevertheless, high-level negotiations continued to create as many problems as they solved. For example, in 1995 high-level officials from both countries decided that the Gore-Chernomyrdin Commission should produce a report for Presidents Clinton and Yeltsin on the status of fissile material security in Russia and future plans for cooperative work in that area. Although a good idea in principle, this proposal "almost derailed US-Russian MPC&A progress."[61] Because it aimed for a comprehensive examination of cooperation, it opened the door to intense bureaucratic fighting both within and between the governments over how to measure progress and whom to hold accountable for failures. The two countries also disagreed about the scope of the report.[62]

Most important, the pressure to produce the report politicized the fragile ongoing lab-to-lab negotiations over Russia's most sensitive buildings and sites. The DOD and State Department insisted that the tentative agreements the labs had reached be included in the report, even though Russian scientists had not yet had time to sell these plans to their own government. "By forcing the plan to be revealed before it was ripe, progress on the overall cooperation was slowed as the Russian bureaucracy pored over the details of the plan."[63] The Russians immediately axed the most crucial part of that plan, which involved initiating MPC&A work at the four nuclear warhead assembly and disassembly sites discussed earlier. As discussed above, the lab-to-lab negotiators did not manage to regain this ground until 1997–98. In the meantime, though, the two governments could never get past the drafting stage, and a final version of the report for the presidents never emerged.[64] Tremendous time and energy had been wasted in the highest offices of both governments.

Progress on the ground was not much better. The government-to-government program did manage to initiate MPC&A upgrades at 17 additional sites during the mid-1990s. Unfortunately, as Table 2 illustrates, these sites were mostly of low significance, in terms of the types and amounts of nuclear material they housed, and low sensitivity, in terms of the activities that occurred there. Although the sites upgraded in the government-to-government program did contain weapons-usable material, unlike the LEU line at Elektrostal in 1994, the work did not represent a level of effectiveness comparable to that achieved in the lab-to-lab program. Indeed, at Mayak—the one sensitive, significant site where government-to-government MPC&A cooperation did begin in 1996—Russians still limited U.S. access. Specifically, they refused to allow Americans to go anywhere inside the Russian complex comparable to where Russians had not been able to go inside the equivalent American complex, Hanford.[65]

No system of "assurances" emerged to solve this problem. The rigidity of the arrangement was just another example of how the government-to-government approach seemed to harden the two sides' positions, rather than encouraging them to develop the trust and creativity needed to tackle a difficult problem. At the end of the day, the government-to-government program was more effective in the mid-to-late 1990s than it had been during the early 1990s, but it still lagged behind the effectiveness of the lab-to-lab approach.

TABLE 2
Government-to-Government Effectiveness in the Mid-to-Late 1990s

Name and Location of Site		Work Begun	Significance (Types and Amounts of Nuclear Material at Site)	Sensitivity (Activities at Site)
1.	Elektrostal Machine Building Plant, Elektrostal	1994	Moderate: >1,000 kg HEU	Moderate: fuel fabrication and materials storage
2.	Beloyarsk Nuclear Power Plant, Zarechnyy	1996	Moderate: >1,000 kg HEU	Low: nuclear power plant
3.	Institute of Theoretical and Experimental Physics, Moscow	1996	Moderate: >1,000 kg HEU	Low: heavy water applications research
4.	Joint Institute of Nuclear Research, Dubna	1996	Low: <100 kg HEU <10 kg Pu	Low: peaceful scientific research
5.	Karpov Research Institute, Obninsk	1996	Low: <100 kg HEU	Low: research reactors
6.	Khlopin Radium Institute, St. Petersburg Branch	1996	Low: <5 kg HEU <5 kg Pu	Low: scientific research, production of radioactive isotopes
7.	Khlopin Radium Institute, Gatchina Branch	1996	Low: gram quantities of HEU and Pu	Low: scientific research, production of radioactive isotopes
8.	Luch Scientific Production Association, Podolsk	1996	Moderate: >1,000 kg HEU	Low: research, reprocessing
9.	Mayak Production Association, Ozersk/ Chelyabinsk-65	1996	High: >1,000 kg HEU >1,000 kg Pu	High: warhead production, fissile material production and storage
10.	Moscow Engineering and Physics Institute, Moscow	1996	Low: <100 kg HEU very little Pu	Low: educational institute
11.	Novosibirsk Chemical Concentrates Plant, Novosibirsk	1996	Moderate: >1,000 kg HEU	Low: fuel fabrication
12.	Petersburg Institute of Nuclear Physics, Gatchina	1996	Low: >100 kg HEU	Low: physics research
13.	Scientific Research Institute of Atomic Reactors, Dimitrovgrad	1996	Moderate: >1,000 kg HEU at least 100 kg Pu	Low: scientific research, production of radioactive isotopes
14.	Scientific Research and Design Institute of Power Technology, Moscow	1996	Low: <10 kg HEU	Low: design of nuclear reactors, other scientific research

TABLE 2 (*Continued*)

Name and Location of Site		Work Begun	Significance (Types and Amounts of Nuclear Material at Site)	Sensitivity (Activities at Site)
15.	Scientific Research and Design Institute of Power Technology, Zarechnyy	1996	Low: >100 kg HEU	Low: nuclear reactor design and development
14.	Scientific Research and Design Institute of Power Technology, Moscow	1996	Low: <10 kg HEU	Low: design of nuclear reactors, other scientific research
15.	Scientific Research and Design Institute of Power Technology, Zarechnyy	1996	Low: >100 kg HEU	Low: nuclear reactor design and development
16.	Tomsk Polytechnical University, Tomsk	1996	Low: <100 kg HEU	Low: education, nuclear research
17.	Scientific Research Institute for Instruments, Lytkarino	1997	Moderate: >1,000 kg HEU	Low: design of instruments for radioactive environments

kg = kilogram; HEU = highly enriched uranium; Pu = plutonium
Source: John Wolfsthal, Cristina-Astrid Chuen, and Emily Daughtry, eds., *Nuclear Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union* (Monterey, CA and Washington, DC: the Monterey Institute of International Studies and the Carnegie Endowment for International Peace, 2001), pp. 75–126; senior national laboratory official, e-mail correspondence with the author, Feb. 25, 2003; and Matthew Bunn, e-mail correspondence with the author, July 12, 2004. Note that in the case of cities that have been renamed since the collapse of the USSR, both the old and new names are listed.

Cooperation Falters: 1997–Present

Increased Top-Down Control on the American Side

In the United States, the transition to the second Clinton administration left MPC&A politically vulnerable after the departure of many of its high-level supporters in the DOE and the White House. As the new administration coalesced and the DOE waited for appointees to fill various vacancies, a small group of mid-level officials chose to assert more control over the MPC&A program and the scientists who ran it.[66] Although these DOE officials acknowledged that "in the early days, the labs made [cooperation] happen,"[67] many felt that the scientists had since overstepped their bounds in trying to manage a wide-ranging government program with a hefty price tag. "At a certain point," one official explained, "we said, 'Enough! We have to do this top-down.'"[68]

After all, what seemed like flexibility, innovation, and creativity to the scientists often appeared as inconsistency, waste, and misallocation to the bureaucrats. DOE officials, genuinely committed to the success of the program, argued that bottom-up, lab-to-lab MPC&A desperately needed more centralized control and coordination. In their view, early lab-to-lab work had proceeded on a virtually random basis, without any comprehensive, coherent prioritization of which sites should be tackled first and, within sites, which projects should be handled in what order. In the eyes of some DOE officials, this haphazard, building-by-building approach led to inconsistent results, with different approaches taken at different times, depending on the expertise of the U.S. and Russian scientists involved and the particular types of cooperation they preferred.

It also left room for projects of questionable utility. In some instances American scientists seemed too willing to cooperate with their Russian counterparts on projects only indirectly related to MPC&A; for better or worse, they would sometimes order their tasks according to which would build the most initial trust between the parties, rather than according to which would lead most immediately to a functioning MPC&A system. At other times American scientists seemed too eager to push the interests and products of their particular labs.[69]

Such episodes, combined with the heavy reliance on expert judgment and personal relationships, clashed with the DOE's modus operandi, which stressed the need for systemwide, standard operating procedures that could suffice regardless of the individuals involved. Indeed, this tension had long plagued the DOE-lab relationship across a range of areas.[70] As Leonard Spector, former assistant deputy administrator for arms control and nonproliferation in the Clinton administration, later explained, "You needed professional managers. You can't just rely on individuals once a program becomes this large."[71] Although he and most DOE officials recognized the technical expertise of the scientists, the "plant a thousand seeds" approach worried experienced program managers. As one DOE official observed, "People in labs are scientists, not policymakers."[72]

Indeed, many DOE officials viewed increased top-down control as essential to sustaining long-term congressional support for the program. "By law, we were supposed to be in charge of those funds," a former senior MPC&A official explained.[73] A senior national laboratory official noted ruefully, "When you're a $3 million program you don't have nearly the oversight you do when you're a $300 million program. . . . With a highly visible program, if one lab or project makes a mistake, everyone feels the repercussions. If one lab gets cancer, we all get chemotherapy."[74] DOE officials worried that one damning Government Accounting Office (GAO) report could undermine the entire MPC&A program and that only better top-down control could stave off such an outcome.[75]

The beginning of 1997 gave these officials a chance to implement their desired changes, as several key defenders of the lab-to-lab approach left the federal government. Almost immediately, a group of mid-level officials in the DOE pushed successfully for a merger of the government-to-government and lab-to-lab programs, effectively abolishing the latter. Lab officials had long recognized that the two approaches would someday unite as one, especially after the DOD relinquished authority over MPC&A.[76] But the manner in which the DOE officials executed this change disturbed many of the scientists involved. The agenda seemed to be one not simply of program consolidation and coordination— for the two efforts had already become more closely intertwined, as described above—

but of specifically driving lab officials from the DOE and from positions of authority over MPC&A. Positions from which lab officials might have exercised power were largely eliminated, and many scientists left Washington voluntarily over the next two years.[77]

Unfortunately, the labs had little leverage with which to counter the new DOE agenda, especially as headquarters pursued what one senior lab official referred to as a "divide and conquer" strategy: If one lab did not want to adhere to new DOE regulations, the DOE simply gave the MPC&A work to a different lab, regardless of whether it had a strong track record in that area.[78] Furthermore, the DOE ceased to call meetings of the lab-led steering group that had served as an important source of technical feedback on MPC&A during the mid-1990s.

The DOE also markedly changed the role of the Technical Working Group of U.S. and Russian scientists that had met during the 1990s. What had once been a forum for developing joint work became an arena in which U.S. participants were rewarded for confrontational behavior and vocal criticism of Russian counterparts. The move further eroded the spirit of partnership and mutual respect that had been so crucial to the program's early successes.

In place of these two institutions, which had relied on expert judgment, the DOE in 1998 generated a standardized set of guidelines for all MPC&A work at every site in Russia. Later that year it also formed a Technical Survey Team (TST) tasked with reviewing all current MPC&A work in Russia to ensure it met these newly established standards. Although these moves toward consistency were laudable in principle and certainly placated congressional and GAO critics of the program, they created more problems than they solved. The new guidelines were established without input from anyone in Russia, least of all the scientists who had actual knowledge of MPC&A on the ground. They were also applied retroactively, leading to the freezing or cancellation of projects already under way and undermining the credibility of the scientists on both sides who had negotiated and developed these projects.[79] The mood at DOE shifted away from the earlier emphasis on mutual interests to a more hard-edged, single-minded focus on U.S. interests alone. As Jack Caravelli, the assistant deputy administrator for international material protection who led MPC&A from 1999 to 2002, explained, "My program is good because it serves a direct U.S. national interest. And that's why we do it—not because we like the Russians."[80]

On a broader scale, the DOE also redirected the locus of MPC&A negotiations away from the scientists and back to the government-to-government level.[81] Instead of allowing scientists to arrange cooperation at individual sites, mid-level DOE officials now focused on negotiating formal agreements with their Minatom counterparts, much as they had done in the government-to-government program during the early 1990s. Only then were U.S. or Russian scientists brought back into the picture to execute particular projects. Even at that point, officials from headquarters accompanied scientists on all trips to work on such projects and carefully monitored their decisions.[82]

Lab officials in many cases were not allowed even to communicate about the MPC&A program to outside sources such as nongovernmental organizations or scholars; many feared they would lose their jobs if they so much as spoke about the program without prior approval from headquarters.[83] The focus on secrecy created an insular, selfcontained program that had few channels for receiving outside criticism or well-intentioned feedback. This atmosphere made it hard for the program to learn and adapt in the face of changing conditions.

Scientists also faced onerous restrictions on their travel from a State Department increasingly skeptical of international activities conducted outside the purview of its authority.[84] State Department interference only strengthened the case of those within the DOE who wanted to limit the labs' autonomy in conducting work in Russia.[85] Understandably, the attrition rate among the American scientists working on MPC&A in Russia became very high, with each turnover setting back the processes of negotiation and trust-building by months, or even years.[86] As Hecker, who had done so much to jumpstart the cooperation of the early 1990s, noted, "It took about two years for the labs to go from being the brains of the program to being the hands of the program."[87] By 2002, Caravelli was equally frank in stating the result of his tenure at the DOE: "Labs are on the way out."[88]

Increased Top-Down Control on the Russian Side

In the early to mid-1990s, the nascent Russian state had had more pressing concerns than policing the activities of a few scientists at a couple of nuclear sites. The government itself was in disarray as the bureaucratic remnants of the Soviet system fought for resources and tried to re-establish roles. Indeed, it was partly this fragmentation at the top that had allowed low-level, transnational cooperation to proceed. By the mid- to late 1990s, however, both the scale of U.S.-Russian cooperation and the strength of the Russian state increased significantly. As such, several different parts of the Russian government sought to increase top-down control over MPC&A cooperation and to limit Minatom's freedom of action.

Most prominent among them was the reconstituted FSB. Even in late 1995 and 1996, the FSB had begun to impose more formal controls over the range of activities that individual nuclear sites could negotiate on their own.[89] However, as a "self-declared hawk," Minatom head Mikhailov had often been able to convince the security services that cooperation was in Russian interests.[90] He had provided political cover for the program in Russia, much as some top-level DOE and White House officials had done in the United States. In 1998, however, the FSB's efforts to control the cooperation intensified dramatically, because of two key events. First, Mikhailov resigned as head of Minatom amid accusations of corruption, leaving the ministry more politically vulnerable.[91] And second, Vladimir Putin became the head of the FSB, injecting the organization with new life.[92]

After these two key changes, more ex-FSB officials began to appear in top positions in Minatom, including offices that oversaw MPC&A cooperation.[93] According to a Russian participant in the MPC&A program at a Minatom closed city, the FSB continued an old practice of sending representatives to nuclear institutes as "deputy directors for security." These individuals were highly skeptical of cooperation and intent on vigorously enforcing Russian law protecting state secrets.[94] The new crop of FSB officials tended to deny that materials security problems existed in Russia or that outside help was needed to solve them. Their resistance to cooperation only worsened as DOE managers shifted all MPC&A negotiations to the government-to-government level. The FSB strongly distrusted U.S. government officials, more so than they did the U.S. scientists. Furthermore, unlike in lab-to-lab negotiations, the FSB representatives were now excluded from the early stages of project development planning, which made them even less likely to understand or accept foreign approaches to MPC&A.[95] In the midst of all this, stories emerged in the Russian media detailing supposed instances of U.S. espionage at the sites of nuclear cooperation, which cast a shadow of further skepticism and illegitimacy over U.S.-Russian cooperative activities.[96]

As Putin's star continued to rise with his appointment as prime minister in August 1999 and his election to the presidency in March 2000, the FSB rose with him. Its presence intruded more heavily into some areas of Russian life, and MPC&A was no exception.[97] The security forces vigorously fanned Russian fears of foreign infiltration, in particular the notion that "under the cover of scientific cooperation, foreign special services [were] trying to conduct their intelligence activities."[98] This supposed spy campaign by the United States then created a viable pretext through which the FSB could justify extensive restrictions on Americans' travel to Russian nuclear sites. Even scientists and DOE officials who had traveled to Russia many times before suddenly faced intrusive vetting and a six-week waiting period before they could receive visas for any trip related to MPC&A.[99] Putin also made good use of his Security Council to keep close tabs on Minatom activities during this period.[100]

Putin and the security services were not alone in their efforts to increase Russian government control over MPC&A cooperation. The Russian Ministry of Foreign Affairs (MFA), a debilitated institution during the early to mid-1990s, also emerged as a stronger voice in Russian foreign policy after the appointment of Yevgeny Primakov as foreign minister in early 1996. An experienced diplomat, Primakov was also an excellent manager and re-asserted the MFA's presence in Russian decisionmaking. While scholars continue to debate Primakov's true attitudes toward the West, he clearly viewed U.S.-Russian cooperation more skeptically than did his predecessor, the reformer Andrei Kozyrev.[101] Like Putin, Primakov had for many years worked in the intelligence services and was inclined to impose additional restrictions on Americans traveling to sensitive sites within Russia. Even after he left the MFA for a brief stint as prime minister in 1998–99, the ministry continued to meddle in Minatom activities, including MPC&A.[102] All in all, the late 1990s saw a major increase in top-down Russian control over MPC&A cooperation as the scope of the cooperation and the capacity of the state to control it expanded.

The Eroding Effectiveness of MPC&A Cooperation

The increased American and Russian top-down control over MPC&A significantly decreased the program's effectiveness in terms of the number and types of sites where cooperation occurred. As discussed earlier, during the mid-1990s American and Russian scientists had developed a series of verification measures known as "assurances" that had enabled the initiation of MPC&A work at some of the most sensitive facilities within two key Russian nuclear sites. They had also negotiated an agreement, to which the DOE and

Minatom had committed in writing and for which the DOE had requested additional funding, to expand MPC&A to the four extremely sensitive and vulnerable Russian serial production plants through an assurances-based approach. Unfortunately, as mid-level DOE officials and ex-KGB agents gained more control over MPC&A in 1998–99, this crucial progress disintegrated.

First, on the U.S. side, the mid-level bureaucrats' distrust of the Russians led the DOE to demand a level of access to Russian facilities that was clearly impossible to provide given Russian laws about nuclear secrecy. Despite this reality, the newly formed TST categorically dismissed the idea of assurances and insisted on the importance of full physical access to sites. Federal managers "argued that they were unable to carry out their peer review mission effectively at facilities where they could not gain access, and tended to be critical of those projects where little access for U.S. personnel had been achieved."[103]

Worsening the situation was a 1999 internal DOE report that those within the department read as criticizing the expenditure of MPC&A money at sites where U.S. representatives did not enjoy full physical access.[104] In actuality, the report listed a variety of methods besides physical access—such as "facility descriptions, documents, schematics, and discussion with site personnel," "inferences...based on...knowledge of the processes conducted at the site, and of operations at similar U.S. nuclear facilities," "photographs and videotapes of installed equipment, written certification of site officials, and...operating data from installed equipment"—through which to make judgments about MPC&A upgrades.[105] But some officials at the DOE instead homed in on the report's conclusion that lack of physical access for the Americans "reduced assurances that certain MPC&A upgrades were justified, properly installed, used, and maintained."[106]

This message, combined with growing criticism of assurances in the TST process, set the stage for the DOE's ultimatum a few months later: If the Russians would not allow greater access, the DOE would refuse to sign additional contracts at Arzamas-16, Chleyabinsk-70, and the serial production plants—the six most sensitive and significant sites in the Russian nuclear weapons complex.[107]

Russia could not have been less receptive to the U.S. ultimatum than it was in 1999. The DOE had not done itself any favors in eliminating Russian input into MPC&A planning and unilaterally changing or canceling a large number of ongoing projects because the projects did not meet retroactive TST standards.[108] In fact, by the late 1990s the "Russian participants repeatedly complain[ed] that while the effort was once run by real U.S. technical experts who had earned their respect, they [were] now in effect being given orders by DOE managers who [had] little MPC&A expertise."[109] MPC&A now had few Russian lobbyists on the ground, and the U.S. decision to abrogate the winter 1997 agreement that Russian scientists had helped negotiate did not improve the credibility or morale of the remaining advocates of cooperation.[110]

Indeed, with the labs cut out of the picture, "all [the bureaucrats] could do was work with their counterparts in the ministries. Those people in turn [did not know as much about] the technical aspects of nuclear security. There was an upping the ante about who could be more intrusive, who could hold more back from the other."[111] Meanwhile, Russia's own domestic political conditions, marked by the rise of Putin and the pervasiveness of the security services, hardly left room for compromise.

As a result, the DOE made good on its threats to sign no new contracts at the institutes at Arzamas-16 and Chelyabinsk-70 and to begin no MPC&A work at the serial production plants, despite the 1997 agreement the DOE and Minatom had signed. Interestingly, in October 1999 Russia and the United States nevertheless signed an additional agreement that had been negotiated over the summer, explicitly stipulating the acceptability of assurances as a means of verification of MPC&A at sites where Russian law prohibited American access. But the DOE chose not to abide by the terms of this agreement and continued to embargo additional MPC&A work at crucial sites. Rather than prompting some change in the Russian position, this decision seemed only to confirm the suspicions of those in the security services that scientific cooperation had been a pretext for intelligence gathering all along.[112] Thus, even though funding for MPC&A continued to increase steadily, reaching over $170 million in fiscal year 2001, the DOE did not channel that money to some of the sites that most needed security upgrades.[113]

Even at sites where MPC&A work continued, top-down control impeded progress. As the experience of the government-to-government program in the early 1990s would have predicted, formal negotiations proceeded slowly. All communications and visas had to go through the State Department, which often entangled MPC&A in broader political issues that would not have concerned the scientists.[114] Meanwhile, the reduction in lab leadership severed many of the personal ties among scientists that had engendered trust between the two countries. It also required government officials to reinvent the scientific wheel each time they negotiated a project. As one senior lab official explained: "If you had the right technical people at headquarters on board, it could work. But [right now] you spend a lot of time negotiating things that should be fairly straightforward."[115]

Although it is difficult to quantify the effect of these problems, it seems clear that they prevented the program from achieving its full potential, especially in light of the rapid progress made during the mid-1990s. They provide more evidence that top-down control actually decreased the effectiveness of cooperation.

The Naval MPC&A Program

The contrasting experience of the naval portion of the MPC&A program, managed separately from the rest of the MPC&A work described earlier, confirms this conclusion. Unlike the more general MPC&A cooperation, naval MPC&A cooperation began as a low-cost, low-profile, highly effective partnership among scientists and Russian Navy personnel—and for the most part it stayed that way throughout the late 1990s and up to the present. The program enjoyed steady high-level political support in both the United States and Russia, which limited the control that mid-level officials could exert over the cooperation. The original spirit of partnership and joint work among low-level participants managed to flourish instead of diminish, with excellent results.

Many of the details surrounding the naval cooperation remain murky, but it is possible to sketch a basic history of the program. As mentioned, Los Alamos signed a contract in mid-1994 to work with the Kurchatov Institute. Then, in 1995, the Russian Navy approached the institute to act as an intermediary between it and the United States in the implementation of security upgrades at a variety of sensitive, significant Russian naval sites housing nuclear weapons, materials, and waste. Kurchatov had a "long-standing relationship with the navy because of its responsibility for designing naval propulsion reactors and providing scientific training and support to naval nuclear operations."[116] Hence the Navy and Kurchatov figured that they could work together to leverage American expertise and resources toward naval MPC&A.

Following a drawn-out series of formal negotiations both within the Russian and U.S. governments and between them, the DOE, the Kurchatov Institute, and the Russian Navy issued a joint statement in July 1996 in support of naval MPC&A. Even before the formal statement emerged, however, U.S. and Russian scientists had begun to tackle the problem, "virtually without top-level permission," much as the general MPC&A program had started.[117] In February 1996, the scientists signed "a protocol on the scope and approach for the MPC&A work" at naval sites that specified the need for "one small, coherent and experienced U.S. team to handle all the projects."

Because of this protocol, "a four-person team to work directly with the Russian navy was. . .put together on the U.S. side, with highly qualified personnel from four different laboratories."[118] After a few visits to key sites in the United States and Russia—similar to the "Directors' Exchange" visits that occurred in the early 1990s between Arzamas-16 and Los Alamos—the scientists developed a more specific agenda. As soon as the high-level agreement had been signed, work commenced at a variety of naval sites, where scientists applied the same basic protection, control, and accounting techniques to naval nuclear fuel that they had applied to the fissile material addressed in the more general MPC&A program. The scientists again worked on a "step-by-step approach,. . .one facility at a time," using expert judgment and shared knowledge to make decisions about the direction of the program.[119] The use of a Russian intermediary, the Kurchatov Institute, reflected flexibility on the part of the United States and also produced advocates and ombudsmen for the program on the ground in Russia.[120]

High-level political support for the program continued. In December 1997, the head of the Russian Navy and the U.S. secretary of energy signed a protocol expressing commitment to the program. Officials from the two navies, the Russian Ministry of Defense (MOD), the DOD, the DOE, and the National Security Council continued to meet periodically on the subject. And in 2000, the DOE and MOD signed an agreement "that solidified the cooperation and outlined expanded future joint work" on naval nuclear materials security.[121] Even then, however, there was little mid-level bureaucratic control over the program, which received scant funding compared to the rest of the MPC&A effort.[122] The original U.S. and Russian scientists continued to run the program from the bottom up, with joint decisionmaking on all plans, designs, and equipment purchases.

Indeed, the naval MPC&A program had immediately begun work at sites, such as Severomorsk Naval Base, just as sensitive as those addressed in the general MPC&A program.[123] Also known as Site 49, the base contains the largest fresh naval fuel storage facility in Russia, housing more than a metric ton of fresh and spent nuclear fuel as well as a large but unknown quantity of fresh fuel on board nearby battlecruisers.[124] The base was a highly significant, sensitive site, yet cooperation proceeded promptly and smoothly there in May 1996.[125] This rapid progress typified the naval program as a whole, which did not experience the ongoing access and verification problems that arose in the general MPC&A program.

As one observer who conducted extensive interviews with the participants of the navy program noted:

> Instead of demanding a strict on-site inspection regime, a more cooperative and less adversarial approach was chosen. U.S. and Russian MPC&A experts would rather sit down together and jointly assess the situation before and after the security upgrades. What the U.S. team might lose in terms of insight through formal inspections with such an approach, they were likely to gain through a voluntary flow of informal information from their Russian counterpart.[126]

The results were stunning. In stark contrast to the general MPC&A effort, the navy program managed to begin upgrades at *all* relevant sites containing fissile material by January 2001. Table 3 illustrates just how effective the small-budget, bottom-up naval program was compared to the highly funded, top-down, general MPC&A program occurring at the same time. The program's fast progress on naval nuclear fuel enabled it to move on to security upgrades for actual naval nuclear weapons. As of 2001, work had begun at 41 of 42 naval weapon sites. Although the naval cooperation did not completely escape DOE efforts to impose more top-down control during this period, it demonstrated an impressive ability to avoid the access disputes that plagued the general MPC&A effort once it was taken over by DOE headquarters, Minatom, and the security services.[127]

Why was the naval MPC&A experience so different from that of the general MPC&A work? Some experts have pointed to the Russian Navy's frightening experiences with unauthorized diversion of HEU during the early 1990s as a motive for its enthusiastic MPC&A cooperation.[128] This explanation is unsatisfying, however, because several thefts of arguably even greater seriousness occurred at military and civilian nuclear sites during the early 1990s, without similarly positive effects on the sustainability of cooperation there.[129] Also, while past thefts might explain the attitudes within the navy toward MPC&A, they do not explain why government officials outside the program allowed it to retain more autonomy than the general MPC&A effort. The lack of publicly available information about

TABLE 3
Effectiveness of Naval MPC&A

Type of Site	Percentage of Buildings Where U.S. Teams Did Not Have Physical Access as of January 2001
Russian nuclear weapon laboratories	73%
Russian civilian sites	12%
Russian naval nuclear fuel sites	0%

Source: Gary Jones and Harold Johnson, "Nuclear Nonproliferation: Security of Russia's Nuclear Material Improving; Further Enhancements Needed," Report to Congressional requesters, General Accounting Office report GAO-01-312, Feb. 2002, p. 15. <www.gao.org>.

the naval program makes attempts to understand it somewhat speculative, but several observable factors do seem different between the case of the general MPC&A program and that of the naval program.

First, the naval program managed to keep a considerably lower political profile, perhaps because the Russian nuclear navy, not unlike its U.S. counterpart, has a great deal of political autonomy.[130] Even more important, as one observer argued, is that although "the naval MPC&A program had top-level support in DOE, it may have lacked high-level *interest*. In the beginning, the small program was not perceived as very important and was more or less 'left alone.' This may have actually, if paradoxically, helped in the initial stages of the program, as it gave the U.S. side discretion to build the strong foundation its Russian counterpart was looking for."[131]

Furthermore, the program's low level of funding seems likely to have played a role in reducing its attractiveness to government officials, sending a signal to bureaucracies both in the United States and Russia that control over the program was not worth too hard a fight. During 1996–99, the program received less than 10 percent of the nearly half-billion dollars spent on nuclear material security by the U.S. government.[132] During fiscal years 2000–01, funding remained modest as well, at around $13 million and $9 million, respectively.[133] The program received little attention in either the fiscal request from the DOE to Congress or in the GAO reports that so thoroughly investigated other parts of US-Russian nonproliferation cooperation in the late 1990s.[134] Naval MPC&A retained an anonymity—and a level of autonomy—that were impossible for its highly funded, high-profile general counterpart.

Additionally, the naval program benefited from some dogged behind-the-scenes defenders, both in the United States and Russia, who helped the program ward off attempts at increased top-down control. In the United States, the laboratory leading the naval MPC&A work happened to be in a state represented by a powerful U.S. senator who believed strongly in the program. Whenever officials at DOE headquarters tried to reduce this lab's power—and specifically, when headquarters tried to use the "divide and conquer" strategy of threatening to shift work to other labs—this senator's staff aggressively defended the lab's role in the naval MPC&A program.[135] This reaction created political costs for anyone trying to turn the labs into merely "the hands of the program." It also helped ensure that the same American scientists continued to work with their Russian counterparts, preventing the attrition that had damaged trust and severed personal relationships in the general MPC&A program.

Meanwhile, the program also had a cadre of defenders in Russia. Strong leadership from within the Russian Navy, and particularly from Admiral Nikolai Yurasov, head of the Defense Ministry's Inspectorate for Nuclear and Radiation Safety and Security, "eased interactions with headquarters-level bureaucrats and military opponents of this collaboration," and reduced tensions with the FSB.[136] Representatives of the Kurchatov Institute also lobbied extensively for the program on the ground in Russia. Furthermore, unlike in the general MPC&A program, the Russians involved in the naval program conditioned all work on the maintenance of a consistent team of American counterparts and the retention of the same DOE manager, and repeatedly resisted efforts by the DOE to renege on this agreement. This tactic left "the U.S. side with very little choice but to keep the original team." As a result, the same Russians and the same Americans were able to work on naval MPC&A projects from start to finish, which built trust, eased communication, and reduced inefficiency.[137]

Conclusion

The experience of naval MPC&A casts doubt on the idea mentioned at the start of this article that states have a tendency to stop cooperating once they pick the "low-hanging fruit" and complete easy initial projects. In fact, in the area of naval MPC&A, as in the general MPC&A effort, U.S. and Russian scientists wasted no time in initiating work at sensitive, significant installations like Arzamas-16 or Site 49. Only the long-run trajectories of the efforts diverged, largely because of differences in the way they balanced the need for government oversight with the need for scientific leadership.

This reality suggests that cooperative threat reduction programs do not succeed or fail based solely on how "difficult" or "sensitive" the agenda is, or how much funding the programs do or do not receive. Rather, the fate of these programs depends on the political environment in which they operate. In particular, cooperation is effective when government officials are in charge of setting policy goals, ensuring political support and funding for the program, and handling legal and management issues—and when technical experts are given the autonomy to negotiate with their counterparts on the ground about the complex, sensitive task of implementation. It is this balance that largely determines the effectiveness of materials security cooperation. And individuals both here and abroad have a key role to play in ensuring that this balance is maintained. This finding in itself suggests several recommendations for future instances of cooperative threat reduction.

First, if and when those cases arise, the United States should avoid relying solely on the formal government-to-government negotiations that repeatedly deadlocked in the U.S.-Russian case. Instead, the United States should do whatever possible to jumpstart cooperation through consistent, direct contact between technical experts from the relevant countries. Because these relationships are personal and tend to be grounded in mutual professional respect, they can encourage the flexibility, creative problem solving, joint decisionmaking, and genuine partnership that accounted for so many of the gains in the U.S.-Russian materials security effort during the 1990s. This approach does not exclude the possibility of government-to-government efforts, but in all cases technical experts from both countries should play key roles in designing, coordinating, assessing, and implementing materials security work. The naval MPC&A effort powerfully demonstrates the benefits of such an approach.

Furthermore, where possible, the United States should also fund purely scientific cooperation between U.S. scientists and scientists in countries that might *potentially* be threat reduction partners, *before* a crisis arises or a regime collapses. After all, the lab-to-lab work of the 1990s grew directly from the joint arms control experiments of the 1980s and from a long history of scientific exchange prior to that. Those face-to-face, low-level interactions gave the scientists from both countries a chance to form the relationships and build the trust that later led to much more sensitive and complex cooperation; they created advocates for MPC&A within two political systems that still harbored tremendous mutual suspicion. Without this foundation, it is hard to say whether the lab-to-lab program would have been able to make rapid gains when they were most needed. Fortunately, some nascent ties are already emerging with North Korea and especially Iran.[138] These should be encouraged, emulated, and expanded if and when the opportunity arises.

Just as important as initiating direct technical cooperation is ensuring that an appropriate division of labor is maintained between technical experts and government officials. This is a difficult task, and becomes perhaps ever more difficult as low-level cooperation becomes more and more successful—such success means that increasingly more money, more resources, and a more significant series of activities are outside the control of bureaucracies. And whether the bureaucracies are in Moscow, Washington, or some other city, they tend not to look favorably upon another group, in this case a network of scientists, infringing on what they perceive to be their core mission of national security policy. To a certain extent, these concerns are justified; as programs grow larger, central coordination must increase.

Nevertheless, the complexity and sensitivity of materials security cooperation mean that significant scientific leadership will also always be necessary. A significant proportion of the progress on materials security since the end of the Cold War has occurred precisely because individuals within the governments of Russia and the United States—individuals ranging from high-level political appointees to congressional staffers, from presidential aides to military leaders—have provided political cover for scientific cooperation and defended it from time to time against efforts by some mid-level government officials to minimize scientific leadership and assert bureaucratic control.

By contrast, most of the problems in materials security cooperation have arisen and persisted because such individual defenders have left office, changed their focus, or otherwise been outmaneuvered. Too much power has shifted to institutions that are simply ill-equipped to handle a problem of this complexity and sensitivity alone.

It would be a gross misreading of the history of MPC&A cooperation to suggest that there is no role for government officials, mid-level or otherwise, in effective materials security cooperation—quite the contrary, especially in a large program like the general MPC&A effort. The division of labor established by the national laboratories and the DOE in the mid-1990s—in which the laboratories worked with their Russian counterparts to develop and implement projects, and the DOE focused on overall coordination and management of funds—produced excellent results. During this period Russia and the United States made major strides on the MPC&A agenda; political support and funding for the program grew dramatically; and both scientists and officials were using their skills to maximum advantage. This balance allowed enough central control over MPC&A to ensure that work was efficient and well-coordinated, but it preserved the bottom-up joint decisionmaking and low-level relationships that were so crucial to the program's success.

It is this equilibrium that the United States should try to re-establish in its current MPC&A program with Russia. It could start by giving laboratory officials the latitude to return to true joint decisionmaking with their Russian counterparts—although it remains to be seen whether the agenda can be rejuvenated after several problematic years. Future instances of materials security cooperation would benefit greatly from a conscious effort to create this equilibrium, in anticipation of the fact that conflicts will arise between the scientists' desire for autonomy and the officials' desire for control. Balance is key.

In a world of uncertainty, all policies carry risk. The question for the United States, in both its current and future materials security cooperation programs, is what risks it is willing to accept. Would it rather ensure that rapid gains are made in reducing the threat of loose nuclear materials, while accepting that coordination may be imperfect, every dollar may not be spent efficiently, and some government officials may have to share power with scientists in the national labs? Or would it rather insist that all materials security cooperation projects be executed in exactly the same way and in exactly the order proscribed by Washington, while accepting that nuclear material may be secured only very slowly, or not at all?

For the last several years, the United States has effectively taken the latter position in the Russian case, even though other government rhetoric and policy initiatives indicate a recognition of the serious dangers of inadequately secured weapons and materials, there and elsewhere. As the risks of terrorism and proliferation grow, the United States would do well to reconsider its assessment of the Russian case, not only to improve the effectiveness of cooperation there, but in preparation for the myriad threat reduction challenges it has already identified in the rest of the world.

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NOTES

1. For a technical explanation of the components of MPC&A see Kenneth Sheely, ''MPC&A Program Overview—Incentives for Acceleration and Expansion'' (Powerpoint presentation prepared for the Institute of Nuclear Materials Managements: June 2002), available from the author. Following the convention of the non-proliferation literature, and of the U.S. government, this article will treat MPC&A as one interrelated set of tasks addressed by U.S.-Russian cooperation. In fact, reports indicate some variation in the levels of progress the United States and Russia have achieved with regard to different aspects of MPC&A. For instance, ''considerable progress has been achieved in installing physical protection systems,'' while ''little progress has been made in upgrading the primitive material accountancy systems used at almost all sites.'' Maintenance of MPC&A systems is also a serious problem. Office of International Affairs, National Research Council *Protecting Nuclear Weapons Material in Russia* (Washington, DC: National Academy Press, 1999), pp. 18–19. The nature of the Soviet accounting measures—or lack thereof—may

explain why developing accurate baseline inventories and monitoring changes in them continues to be so difficult in Russia, even when protection and control measures have been successfully implemented. Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Materials* (Cambridge, MA and Washington, DC: The Project on Managing the Atom and the Carnegie Endowment for International Peace, April 2000), pp. 10–16; and Jessica Stern, ''Cooperative Activities to Improve Fissile Material Protection, Control, and Accounting,'' in John Shields and William Potter, eds., *Dismantling the Cold War: U.S. and NIS Perspectives on the Nunn-Lugar Cooperative Threat Reduction Program* (Cambridge, MA: MIT Press, 1997), pp. 309–44.

2. For the most detailed and recent figures on MPC&A work to date and projected rates of progress, see Matthew Bunn and Anthony Weir, *Securing the Bomb*. Belfer Center for Science and International Affairs, and the Nuclear Threat Initiative, May 2004, pp. 45–7.
3. A summary of the program is available at <www.usun-vienna.usia.co.at/Statements/Global_Threat_Reduction_Initiative_Highlights.html>. For more on HEU in other countries, see Philip Bleek, ''Project Vinca: Lessons for Securing Civil Nuclear Material Stockpiles,'' *Non-Proliferation Review* 10.3 (fall/winter 2003), pp. 2–3.
4. A summary of these efforts is available at <http://www.nnsa.doe.gov/na-20/glob_nuc.shtml>.
5. See the Lugar Doctrine, stated Dec. 6, 2001, available at <http://lugar.senate.gov/lugar_doctrine.html>.
6. A transnational network need not be formally coordinated, nor need its members give up their national identities. Most important is the subjective belief among participants of their membership in a shared community, often based on common bodies of knowledge, and the importance of particular policy goals. Matthew Evangelista, *Unarmed Forces: the Transnational Movement to End the Cold War* (Ithaca, NY: Cornell University Press, 1999), p. 83. See also Thomas Risse-Kappen, ed., *Bringing Transnational Relations Back In: Non-State Actors, Domestic Structures, and International Institutions* (New York, NY: Cambridge University Press, 1995).
7. For background on U.S.-Russian scientific cooperation, see Richard G. Hewlitt and Jack M. Holl, *Atoms for Peace and War, 1953–1961: Eisenhower and the Atomic Energy Commission* (Berkeley, CA: University of California Press, 1989); David Holloway, *Stalin and the Bomb: the Soviet Union and Atomic Energy, 1939–1956* (New Haven, CT: Yale University Press, 1994); and Glenn E. Schweitzer, *Scientists, Engineers, and Two-Track Diplomacy: a Half-Century of U.S.-Russian Interacademy Cooperation* (Washington, DC: National Academies Press, 2004).
8. John Shaner, quoted in ''Russian-America Collaborations to Reduce the Nuclear Danger,'' *Los Alamos Science* 24 (1996), available from the author, p. 3.
9. ''Russian-American Collaborations,'' p. 22.
10. Ibid. pp. 3–41.
11. Siegfried Hecker, ''Increasing Our Nonproliferation Efforts in the Former Soviet Union,'' prepared testimony before the Senate Committee on Foreign Relations, April 23, 2002. <www.eisenhowerinstitute.org/programs/globalpartnerships/safeguarding/senate-nonproliferation.htm.>

12. Laboratory directors have a fixed discretionary percentage of the lab's total budget, known as Lab-Directed Research and Development. It was from this source that early cooperation was funded. Matthew Bunn, e-mail correspondence with author, Oct. 15, 2004. For more information on the financial relationship between DOE and the labs, see Victor Rezendes, "Department of Energy: Observations on the Future of the Department," testimony before the Committee on Energy and Natural Resources, US Senate, General Accounting Office report GAO/T-RCED-96-224, Sept. 4, 1996, pp. 1–2. <www.gao.org>.

13. "Russian-American Collaborations," pp. 8–9, 26–7.

14. For more on the history of Nunn-Lugar, see Ashton B. Carter and William Perry, *Preventive Defense: a New Security Strategy for America* (Washington, DC: Brookings Institution Press, 1999), pp. 70–2.

15. Oleg Bukharin, "U.S.-Russian Cooperation in the Area of Nuclear Safeguards," *Nonproliferation Review* (fall 1994), p. 32.

16. Government-to-government MPC&A originally fell within the bureaucratic jurisdiction of the DOD. As will be discussed below, the program was transferred to the DOE in fiscal year 1996 so that one department could oversee both the government-to-government and lab-to-lab efforts.

17. Quoted in Oleg Bukharin, "Minatom and Nuclear Threat Reduction Activities," in Potter and Shields, eds., *Dismantling the Cold War*, pp. 222–3.

18. Kenneth Luongo, "A Case Study in Post-Cold War Security Policy Formulation and Implementation: The United States-Former Soviet Union Fissile Material Security Program," remarks before The Research Institute of the German Society for Foreign Affairs Conference on Fissile Material Security in Russia and the CIS, April 7, 1997. <www.ransac.org/new-web-site/pub/reports /bonnspeech.html>.

19. Ron Aug.on, quoted in "Russian-American Collaborations," pp. 33–4.

20. Bukharin et al., *Renewing the Partnership*, p. 46.

21. Paul White, quoted in "Russian-American Collaborations," p. 33.

22. Ibid. p. 35.

23. For a full review of which types and amounts of fissile material are required to produce which types of nuclear weapons, see Owen R. Coté, "A Primer on Fissile Materials and Nuclear Weapon Design" in Graham Allison et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge, MA: MIT Press, 1996), pp. 203–28. On the attractiveness of different types of nuclear materials to proliferants, see David Albright, "A Proliferation Primer," *Bulletin of the Atomic Scientists* 49.5 (June 1993), pp. 14–23; and Joel Ullom, "Enriched Uranium Versus Plutonium: Proliferant Preferences in the Choice of Fissile Material," *Nonproliferation Review* (fall 1994), pp. 1–15.

24. Allison et al., *Avoiding Nuclear Anarchy*, pp. 80–3.

25. On the thefts, see Bunn, *The Next Wave*, pp. 16–19.

26. "Russian-American Collaborations," p. 9.

27. Ibid. pp. 8–9, 31–3.

28. Quoted in "Russian-American Collaborations," p. 34.

29. Steve Younger, quoted in "Russian-American Collaborations," p. 35.

30. Bukharin et al., *Renewing the Partnership*, p. 46; Charles Curtis, ''Securing Fissile Material in the Former Soviet Union,'' transcript of the Henry L. Stimson Center Nuclear Roundtable, Feb. 28, 1996. <www.bits.de/NRANEU/NonProliferation/docs/Curtis_remarks1996.htm>.
31. Luongo, ''A Case Study.''
32. During this period the lab-to-lab MPC&A program was still funded by the DOD, even though it was run by the DOE.
33. Younger, quoted in ''Russian-American Collaborations,'' p. 36.
34. Katherine Johnson, ''Sustaining Nuclear Threat Reduction Programs: the Bottom-up Approach,'' in Potter and Shields, eds., *Dismantling the Cold War*, p. 246.
35. Younger, quoted in ''Russian-American Collaborations,'' p. 35.
36. Luongo, ''A Case Study.''
37. Personal interview by author, Washington, DC, Aug. 14, 2002.
38. Luongo, ''A Case Study.''
39. Ibid.
40. Jason Ellis, *Defense by Other Means: the Politics of US-NIS Threat Reduction and Nuclear Security Cooperation* (Westport, CT: Praeger, 2001), p. 127.
41. Bukharin et al., *Renewing the Partnership*, pp. 53–4.
42. Ibid. p. 54.
43. *Program Plan: Government to Government Cooperation with Russia on National Protection, Control, and Accounting of Nuclear Materials*, US Department of Energy Office of Arms Control and Nonproliferation, March 1, 1996. Available from the author.
44. Bukharin et al., *Renewing the Partnership*, p. 54.
45. Through fiscal year 1996, both the DOD and DOE contributed funds to MPC&A. The specific breakdown of funding was as follows: in 1995, DOD contributed $30.577 million, while DOE contributed $10.18 million; in 1996, DOD contributed $14.277 million, while DOE contributed $85 million. As might be inferred from these numbers, the DOD's commitment to MPC&A declined throughout the early 1990s as the DOE assumed more and more responsibility for the actual funding, management, and execution of both tracks of MPC&A. After one last lump sum payment from the DOD in 1996, the DOE became totally responsible for funding all MPC&A in fiscal year 1997. The substantive effects of this transfer of authority on cooperation will be discussed below. For now, it is important simply to note the overall trend of increasing funding for MPC&A in the mid-1990s; regardless of source, the overall amount of money supporting this cooperation rose significantly. All figures from Matthew Bunn and Anthony Wier, ''Controlling Nuclear Warheads and Materials,'' report issued by Managing the Atom and the Nuclear Threat Initiative, March 2003. <www.nti.org/cnwm>.
46. Senior national laboratory official (name withheld by request), telephone interview by author, Aug. 15, 2002.
47. Telephone interview by author, Aug. 22, 2002.
48. Johnson, ''Sustaining Nuclear Threat...,'' p. 245.
49. Michael McClary, personal interview by author, Washington, DC, Aug. 27, 2002.
50. Siegfried Hecker, e-mail correspondence with author, Oct. 29, 2004.
51. ''Under Russian law, information on the design, operation, construction, or security provisions of facilities in the nuclear weapons complex, as well as information on

materials used in nuclear weapons, is considered a state secret." Law of the Russian Federation on State Secrets, passed July 23, 1993. Discussed in Gary Jones and Harold Johnson, "Nuclear Nonproliferation: Limited Progress in Improving Nuclear Material Security in Russia and the Newly Independent States," General Accounting Office report GAO/RCED/NSIAD-00-82: 18, March 2000, p. 11. <www.gao.org>.

52. Bukharin et al., *Renewing the Partnership*, p. 72.

53. Ibid. pp. 72–3.

54. Ibid.

55. Luongo, "A Case Study."

56. John Wolfsthal, Cristina-Astrid Chuen, and Emily Daughtry, eds., *Nuclear Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union* (Monterey, CA and Washington, DC: the Monterey Institute of International Studies and the Carnegie Endowment for International Peace, 2001), pp. 75–174.

57. Bukharin et al., *Renewing the Partnership*, p. 73.

58. Department of Energy, *FY1998/FY1999 Congressional Budget Request* <www.cfo.doe.gov/budget/98budget/index.htm> See specifically the section titled "Arms Control and Nonproliferation: International MPC&A."

59. Jason Ellis, *Defense*, pp. 122–4; and Rose Gottemoeller, "Presidential Priorities in Nuclear Policy," in Potter and Shields, eds., *Dismantling the Cold War*, pp. 69-72.

60. *Joint Statement of Control, Accounting, and Physical Protection of Nuclear Materials*, July 16, 1996. <www.ransac.org/new-web-site/primary/secure/ mpca.html>

61. Luongo, "A Case Study."

62. Senior national laboratory official (name withheld by request), personal interview by author, Washington, DC, Aug. 26, 2002.

63. Luongo, "A Case Study."

64. Ibid.

65. Bunn, e-mail correspondence; and Wolfsthal et al., *Nuclear Status Report*, p. 106.

66. Bukharin et al., *Renewing the Partnership*, pp. 45, 47, 52.

67. Former senior MPC&A official, personal interview by author, Aug. 2002.

68. Jack Caravelli, personal interview by author, Washington, DC, Aug. 26, 2002.

69. Current and former laboratory and DOE officials (names withheld by request), personal and telephone interviews by author, Aug. 2002; and David Kostorowski, "Cost Effectively Addressing the Challenges of MPC&A Program Implementation," paper from the annual meeting of the Institute of Nuclear Materials Management, available from the author, 2001, p. 2.

70. Victor Rezendes, "DOE's National Laboratories: Adopting New Missions and Managing Effectively Pose Significant Challenges," testimony before the Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives, General Accounting Office report GAO/T-RCED-94-113, Feb. 3, 1994, pp. 1, 3, 5. <www.gao.org>. For more general information on problems in the management of the DOE-lab relationship, see also Gary Jones, "Department of Energy: Views on DOE's Plan to Establish the National Nuclear Security Administration," testimony before the Special Oversight Panel on Department of Energy Reorganization, Armed Services Committee, House of Representatives, General Accounting Office report GAO/T-RCED-00-113, March

2, 2000 <www.gao.org>; and Rezendes, ''Department of Energy: Observations on the Future''.

71. Personal interview by author, Washington, DC, Aug. 23, 2002.

72. Mary Alice Hayward, telephone interview by author, Aug. 20, 2002.

73. Personal interview by author, Aug. 2002.

74. Senior national laboratory official (name withheld by request), telephone interview by author, Aug. 21, 2002.

75. Former senior Department of Energy officials (names withheld by request), personal interviews by author, Aug. 6, 2002 and Aug. 14, 2002.

76. ''Russian-American Collaborations,'' p. 37

77. Former senior MPC&A official, personal interview by author, Aug. 2002.

78. Siegfried Hecker, telephone interview by author, Aug. 22, 2002.

79. Bukharin et al., *Renewing the Partnership*, p. 49.

80. Personal interview.

81. Ibid.

82. Ibid.

83. This pervasive culture of secrecy accounts for the anonymity of many interviews in this article. Officials in the national labs and even in the lower ranks of the DOE repeatedly redirected all efforts at communication to the MPC&A leadership at headquarters, citing fear of internal repercussions if they were perceived to have revealed the program's secrets or to have criticized the program, even constructively.

84. Former senior MPC&A official, personal interview, Aug. 2002.

85. Bukharin et al., *Renewing the Partnership*, p. 51.

86. Bunn, e-mail correspondence.

87. Telephone interview.

88. Personal interview.

89. Bukharin et al., *Renewing the Partnership*, p. 46. For a general discussion of the FSB's increased presence in Russia during this period, see Bartosz Weglarczyk, ''Just Like the Bad Old Days?'' *Bulletin of the Atomic Scientists* 52.6 (Sept./Oct. 1996). <www.thebulletin.org>.

90. Hecker, ''Increasing Our Nonproliferation Efforts.''

91. Igor Khripunov, ''Russia's Nukes: Minatom at the Edge,'' *Bulletin of the Atomic Scientists* 55.3 (May/June 1999), p. 2. <www.thebulletin.org>

92. Keith Bush, ''Yeltsin Fires His Prime Minister—Again,'' *Russian and Eurasian Expert Briefs*, Center for Strategic and International Studies, Aug. 9, 1999. <www.csis.org/ruseura/ex995.html>.

93. Viktor Mizin, telephone interview by author, Aug. 15, 2002.

94. (Name withheld by request), telephone interview by author, Aug. 13, 2002.

95. Bunn, e-mail correspondence; Hecker, e-mail correspondence.

96. Mizin, telephone interview; Oleinikov, telephone interview.

97. Nikolai Petrov, ''Broken Pendulum: Recentralization Under Putin,'' PONARS Policy Memo 159 (Nov. 2000) <www.csis.org/ruseura/ponars/ policymemos/pm_index.htmetrov>; and Georgi Derluguian, ''Reflections on Putin's Rise to Power,'' PONARS Policy Memo 104, (Jan. 2000) <www.csis.org/ruseura/ponars/policymemos/pm_index.htm>; McClary, personal interview.

98. "Professional Holiday of Chekists," *City Courier* at Sarov, Dec. 20, 2001, available from the author; and "Spies at South Urals," *Chelyabinskiy Rabochiy*, May 8, 2002, available from the author.

99. Bukharin et al., *Renewing the Partnership*, p. 51.

100. Igor Khripunov, "Minatom: Time for Crucial Decisions," *Problems of Post-Communism* 48.4 (July/Aug. 2001), p. 51.

101. For a fairly positive account of Primakov, see Jeffrey Checkel, "Primakov in Context: Myths and Realities of Russia's New Prime Minister," PONARS Policy Memo 41 (Nov. 1998). <www.csis.org/ruseura/ponars/policymemos/pm_index.htm> For a more pejorative account of Primakov's "suspicion and distrust of US foreign policy intentions," see Marian Leighton, "From KGB to MFA: Primakov Becomes Russian Foreign Minister," *CSIS Post-Soviet Prospects* 4.2 (Feb. 1996), pp. 1–6.

102. Pavel Oleinikov, telephone interview by author, Aug. 9, 2002.

103. Bukharin et al., *Renewing the Partnership*, p. 73.

104. Ibid. p. 74.

105. *Nuclear Material Protection, Control, and Accounting Program*, US Department of Energy, Office of Inspector General, Office of Audit Services. available as Audit Report DOE/IG-0452, Sept. 1999, p. 6. <www.ig.doe.gov/igreports.htm# cal1999>.

106. Gregory H. Friedman, "Memorandum for the Secretary," addendum to *Nuclear Material Protection, Control, and Accounting Program*, p. 1. <www.ig.doe.gov/igreports.htm#cal 1999.Friedman>

107. Bukharin et al., *Renewing the Partnership*, pp. 73–5.

108. Ibid. p. 49.

109. Ibid. p. 56.

110. Ibid. p. 75.

111. Hecker, telephone interview.

112. Bukharin et al., *Renewing the Partnership*, p. 75.

113. Funding information from database in Bunn and Wier, "Controlling Nuclear Warheads".

114. McClary, personal interview; and Bukharin et al., *Renewing the Partnership*, p. 56.

115. Senior national laboratory official (name withheld by request), telephone interview by the author, Aug. 21, 2002.

116. Bukharin et al., *Renewing the Partnership*, p. 61.

117. McClary, personal interview.

118. Morten Bremer Maerli, "U.S.-Russian Naval Security Upgrades: Lessons Learned and Future Steps," *Yaderny Kontrol (Nuclear Control) Digest* 7.4 (fall 2002), p. 40.

119. Ibid. p. 42.

120. Bunn, e-mail correspondence.

121. Ibid. p. 41.

122. Ibid. p. 42.

123. Bukharin et al., *Renewing the Partnership*, p. 60; Maerli, "US-Russian Naval," p. 38. For a list of the sites involved in the program, see Wolfsthal et al., *Nuclear Status Report*, pp. 127–57.

124. Wolfsthal et al., *Nuclear Status Report*, p. 137.
125. Maerli, ''US-Russian Naval,'' p. 40.
126. Ibid. pp. 42–3.
127. Ibid, p. 39.
128. Gottemoeller, ''Presidential Priorities,'' pp. 61–81.
129. Bunn, *The Next Wave,* pp. 16–19.
130. Bunn, e-mail correspondence.
131. Morten Bremer Maerli, ''U.S.-Russian Naval Security Upgrades: Lessons Learned and the Way Ahead,'' *Naval War College Review* vol. LVI, no. 4 (autumn 2003), p. 30.
132. Jones and Johnson, ''Nuclear Nonproliferation'', p. 18.
133. Department of Energy, *FY 2002 Budget Request* <www.cfo.doe.gov/budget/02budget/index.htm>
134. The DOE's budget justifications from 1998 to the present are available at www.cfo.doe.gov/budget/. All GAO reports from the last decade are available at www.gao.gov.
135. Bunn, e-mail correspondence.
136. Maerli, ''U.S.-Russian Naval Security Upgrades: Lessons Learned and the Way Ahead,'' p. 30; and Maerli, ''U.S.-Russian Naval Security Upgrades: Lessons Learned and Future Steps,'' p. 46.
137. Maerli, ''U.S.-Russian Naval Security Upgrades: Lesson Learned and Future Steps,'' pp. 41, 46.
138. On Iran, ''the U.S. National Academies, along with other U.S. organizations, have been engaged in scientific cooperation on a very limited scale with Iranian counterparts for a number of years.'' A report on these activities is forthcoming from the National Academies. Glenn Schweitzer, electronic mail correspondence, Nov. 15, 2004. On North Korea, see Siegfried Hecker, ''The Nuclear Crisis in North Korea: a U.S. Delegation Was Shown North Korea's Nuclear Facilities,'' *The Bridge* 34.2 (summer 2004), pp. 17–23. For a history of science as a tool of soft power, see Norman P. Neureiter, ''Science and Technology in the Department of State,'' *Technology in Society* 26 (2004), pp. 303–20.