U.S. ASSISTANCE PROGRAMS FOR IMPROVING MPC&A IN THE FORMER SOVIET UNION

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Ironically, some of the changes that have allowed us to reduce the world's stockpile of nuclear weapons have made our non-proliferation efforts harder. The breakup of the Soviet Union left nuclear material dispersed throughout the newly independent states. The potential for theft of nuclear materials has increased. We face the prospect of organized criminals entering the nuclear smuggling business. Add to this volatile mix the fact that a lump of plutonium the size of a soda can is enough to build a bomb, and the urgency of the effort to stop the spread of nuclear materials should be clear.[2] (President Bill Clinton, March 2, 1995)

From the beginning of the atomic age, the nuclear weapons states assumed that the difficulty of producing or acquiring fissile materials would constrain nuclear proliferation. This assumption is a key premise of the international safeguards system and has shaped the debate on nonproliferation policy. Widespread knowledge of weapons design has increased the relative importance of protecting fissile materials from theft, but experts fear that worldwide safeguards may not be adequate to the task. This problem of inadequate security for fissile materials is particularly acute in the Newly Independent States (NIS) of the former Soviet Union, where social and economic changes have outpaced safeguards reform. Russian officials claim that the potential for insider theft has increased at many nuclear facilities. Kilogram-quantities of stolen weapons-usable highly-enriched uranium (HEU) have been recovered in Russia and in Europe, demonstrating the urgency of improving nuclear safeguards worldwide.

Assisting the NIS to reduce the dangers of nuclear proliferation resulting from the breakup of the Soviet Union has become one of the highest priority tasks on the U.S.-NIS nuclear agenda.[3] This article considers the extent to which U.S.-NIS cooperative programs for fissile material protection, control, and accounting, including joint projects between the U.S. and NIS governments and between U.S. and Russian national laboratories, have achieved this goal.

What would an ideal nuclear security system look like? It would contain three basic elements: 1) physical protection (barriers, sensors, and alarms to prevent intruders from gaining access); 2) material control (including locked vaults for storage of nuclear materials, portal monitors equipped to detect nuclear materials and prevent workers from walking off the site with nuclear material in their pockets, continuous monitoring of nuclear-material storage sites with tamper-proof cameras, tamper-proof seals, prohibition of access to sensitive materials unless scientists enter sites in pairs, known as the "two-man rule"); and 3) material accounting (including a regularly updated measured inventory, based on regular measurements of weapons-usable material arriving, leaving, lost to waste, and within the facility, plus a measurement control program to ensure the accuracy of the measurement equipment). These three elements together are referred to as

material protection, control, and accounting or "MPC&A." Other desirable elements of a nuclear security system include a system of personnel reliability (background checks, training, and reliable salaries for nuclear custodians) and regulation and inspection by an outside agency with real enforcement powers.

In order to make an assessment of MPC&A in the NIS, it is necessary to appreciate the disarray in the NIS nuclear security system. This article begins by analyzing inadequacies in Russia's nuclear security, focusing especially on the inventory system. Similar problems exist at the dozen or so nuclear facilities located elsewhere in the NIS, but this assessment focuses on Russia because many more nuclear facilities, and a far greater quantity of weapons-usable nuclear material, are located there. This study then describes and evaluates the successes and key problems of ongoing joint efforts to increase NIS nuclear security, including U.S.-NIS government-to-government MPC&A programs and the U.S.-Russian Lab-to-Lab program. Of particular concern in this assessment are potential threats to the continued viability of the programs, including bureaucratic issues on both sides.

This study concludes that the MPC&A program is on the right track, but its success will depend on how quickly the projects are completed. As one proponent of the program inside the U.S. government has asked, "We are making good progress, overcoming many bureaucratic obstacles as they arise, but will we succeed soon enough to prevent something terrible from happening?" That is the question, this official commented, "that keeps me awake at night."[4] Ultimately, success will depend on four additional variables: 1) bureaucratic politics (including the ability of both sides to resist taking what is now a highly successful, flexible, but somewhat messy multi-pronged approach and transforming it into a single, comprehensive, and centrally-managed government-to-government MPC&A program); 2) the ability of NIS partners to overcome their suspicions about U.S. motives, which continue to hamper cooperation; 3) the proper long-term implementation, operation, and maintenance of upgraded MPC&A systems by NIS partners, which in turn depends on the development of a safeguards culture in these countries; and 4) the U.S. administration's greater involvement in educating the public and the Congress about the importance of these programs, in order to ensure their continued funding.

INADEQUATE MPC&A FOR NUCLEAR MATERIALS

The Soviet system for protecting nuclear materials, which worked effectively for five decades of Soviet rule, "was not designed for a democratic state," according to an official with the Russian Ministry of Atomic Energy (Minatom).[5] It was designed with two objectives: preventing terrorist attacks and keeping American spies from acquiring nuclear secrets. "Nobody even considered the possibility of workers stealing nuclear materials," this official acknowledged. Another Minatom official, in a recent published account, has described a system based on "regulations and ordinances which either no longer are in place or are not effective, and upon military discipline and a sense of responsibility which no longer exist."[6]

Civilian research facilities, even those that process or store weapons-grade materials, were not considered strategically important targets for potential foreign espionage and thus have only minimal security. Since the principal purpose of the Soviet system was to keep out American spies, and since many of the people who ran that system are still on the job, it is not surprising that American experts are viewed with suspicion. Convincing Minatom officials that Americans touring and inspecting Russian nuclear sites are part of the answer, rather than the problem, "has been a difficult sell that has required a prolonged period of socialization," in the words of a U.S. government official familiar with this process.

The Russian system of accounting for nuclear material was developed to maximize quality and quantity of the material produced. Inventories were conducted once a year using two forms—one for the Ministry of Finance and one for Minatom. For direct use (weapons-usable) materials, inventories might be taken more frequently, depending on the site, according to officials at Minatom and at the State Committee for Nuclear and Radiation Safety Supervision (known in Russian as Gosatomnadzor, or "GAN"). Russian officials explain that the philosophy of the Soviet inventory system, which stressed production targets rather than security, led to practices that they now believe must be changed in order to bring the system up to international standards. First, as a rule, input materials or feed stocks are not measured—only output is measured. "In this respect we treat HEU no differently from

carbon," a GAN official said in a recent interview.[7] But output is measured very carefully.

A second important distinguishing feature of the inventory method is the system of "allowed losses." Officials at GAN and at Minatom explain that they do not measure "material unaccounted for" or MUF, as long as material unaccounted for is within a certain range. Someone who knows the quantity of allowed losses could steal a significant quantity of HEU or plutonium, provided he did so slowly, staying within that limit over months or years.

To illustrate the "allowed losses" system, one Minatom official describes a similar regime for truck drivers responsible for transporting vodka from the production plant to the store. The Ministry of Finance (MOF) instated a system that allowed truck drivers to arrive at the store with N minus X bottles of vodka (where N is the number of bottles the truck can hold and X is an allowed number of losses, which the MOF set based on average losses per truckload). No one was concerned whether those bottles were broken or stolen, as long as the amount of vodka delivered to the store was at least N minus X. "You can be sure," this official said, " that every truck driver was exceedingly careful and that those [X number of] bottles went straight into the truck drivers' pockets." The analogy illustrates the systemic problems in Russia's nuclear inventory procedures that, unless corrected, could continue to encourage thefts of material. In the words of this same Minatom official:

> The system we need to put in place for a proper nuclear materials inventory is one in which the precise amount of missing or extra material is recorded. We cannot use the Ministry of Finance system of allowed losses. We need to bring our system up to the level of international standards. But nobody in this country has any idea of how to conduct a thorough inventory of all nuclear material because we have never done it. There are only a handful of people in Russia who understand the concept of safeguards….They are scientists who have worked for the IAEA.[8]

Several officials have recounted in interviews the case of nuclear material theft in Podol'sk, in which a worker stole one and a half kilograms of HEU over a long period of time. The missing HEU was never detected during inventories because the worker knew to stay within the allowed losses limit.[9] One official from the Russian National Security Council also confirmed in a recent interview what other Russian officials have said in the past: to ensure their ability to meet production quotas under the Soviet system, nuclear facilities often produced extra plutonium to have on hand in case of an inventory shortfall in future years. As much as 10 percent of production might have been diverted without being entered into the accounting system, this official explained.[10]

This practice of producing excess plutonium was not considered dangerous from the standpoint of theft, since there was no market in Russia for HEU or plutonium. Now, however, there is a growing perception of a lucrative market for nuclear materials. These secret caches of material, likely to be found at many production sites, present a real danger in the current economic environment in Russia.

INADEQUATE MATERIAL CONTROL AND ACCOUNTING (MC&A) AND WARHEAD SAFETY

Many (but not all) Russian and U.S. officials are more sanguine about warhead security than about nuclear materials security.[11] There is a basic "guards, gates, and guns," approach to warhead security. Unlike materials, in the words of one U.S. government official, "you can't use uncertainties in the accounting system to steal warheads, and you can't put them under your overcoat. It's clearly much harder to steal a warhead than to steal the materials to make one."[12]

Nonetheless, Russia's transition from an authoritarian, command economy to a struggling, chaotic democracy is subjecting the warhead security system to stresses it was not designed to withstand. Undisciplined, understaffed, and underpaid, the military is facing a crisis. Troops desperate for hard currency routinely sell conventional weapons to private consumers, often with the "mafiya" as middleman. A new openness in Russia has reduced the distance between personnel with access to nuclear weapons and "those who may hope to profit from the theft of a nuclear weapon," a U.S. intelligence official has testified. Russian security procedures were not designed to counter well-planned insider threats to weapons.[13]

Stanislav Lunev, a former Colonel in Russia's Military Intelligence Agency, the GRU, wrote recently that he believes some tactical weapons were lost in the immediate aftermath of the breakup of the Soviet Union:

> Practically all army divisions located in the former Soviet republics and abroad

> had missile battalions and other military units capable of using tactical nuclear weapons. But nobody knows where these weapons went after the disintegration of the USSR. The Russian government doesn't know either, but still insists that there is nothing to worry about.[14]

Lunev also claims that the Russian government is depending on custodians who are paid inadequately and whose role models are "corrupt senior officers" to protect the warheads from theft. Russian officials have repeatedly denied that any warheads are missing. U.S. officials also doubt the veracity of Lunev's claims, but, as one knowledgeable analyst has admitted, "we really don't know what to believe."[15]

In a November 1995 interview, General Evgeniy Maslin, Head of Strategic Forces of the Main Directorate of the Russian MOD, repeated his assurances that an inventory of all Russian warheads, in which seals are removed and the warheads are physically inspected, takes place two times every year. However, a Minatom official who requested anonymity has claimed that the seals are removed only to assess the electronic equipment inside the warhead, not to verify the presence of nuclear material. One could easily replace a warhead with an "imitator," and the substitution would not be noticed for many months because the seals are of poor quality and can be falsified. In the view of this official, the MOD does not understand the requirements for a high-confidence inventory and instead uses a paper-based system prone to human error, in which warheads are counted *na pal'tsakh* (by fingers).[16] Moreover, the system is not designed to deter insider threats. Like the system for materials, it was designed with two principal objectives: to keep out Western spies and to prevent intruders from obtaining access to the weapons.

With rare exceptions, the Russian government has officially denied that nuclear warheads are vulnerable to terrorist attack or to theft. Nonetheless, the government has taken steps to remove nuclear weapons from the volatile Caucasus region and to consolidate nuclear warheads in storage— from over 600 sites in 1989, to 200 sites in 1991, to fewer than 100 in 1995.[17] Moreover, General Maslin and other officials have admitted concerns about the security of the warheads in transit. For example, in a 1995 account, General Maslin is reported to have observed:

> What is theoretically possible and [for] what we must always be prepared is train robbery, attempts to seize nuclear weapons in transit. We ran some modeling exercises at our facilities [to test our warhead security system]…. And I must tell you frankly that as a result of those exercises, I became greatly concerned about a question that we had never even thought of before: What if such acts were to be undertaken by people who have worked with nuclear weapons in the past? For example, by people dismissed from our structures, social malcontents, embittered individuals?[18]

The troubled economy, the government's inability to pay custodians of both nuclear materials and warheads adequately, the rise of organized crime and corruption, the KGB's loss of absolute power, and the absence of a "safeguards culture" have led to a dangerous situation vis-a-vis protection of nuclear materials and, perhaps to a lesser extent, of warheads.

THE PROBLEM OF NUCLEAR THEFT: DISTINGUISHING RUMOR FROM FACT

As early as 1991, Kurt Campbell, Ashton Carter, Steven Miller, and Charles Zraket warned:

> Economic disorder within the Soviet nuclear weapons complex…creates a potential source of nuclear proliferation outside the Soviet Union unlike any ever faced by the non-proliferation regime. Nuclear materials, sensitive non-nuclear components of nuclear weapons, the talents of skilled bomb-builders, and even entire nuclear weapons might find their way onto world markets.[19]

Since the dissolution of the Soviet Union, increasing U.S. and international attention has focused on the question of clandestine transfers of fissile or other nuclear materials from poorly guarded nuclear facilities in former Soviet republics to foreign states or terrorist groups. A key analytical dilemma, however, has been to determine the real dimensions of the nuclear smuggling problem. As two recent analysts of confirmed and alleged smuggling incidents have observed, there are several difficulties in determining the scale and severity of the problem:

> First, nuclear trafficking is sufficiently serious that intelligence agencies are rarely willing to confirm more than the broadest outlines…. Second, Russian sensitivities and the belief in some quarters in Moscow that the danger is being artificially exaggerated in order to put Russia's nuclear weapons under international control have added another element of uncertainty…. Compounding these difficulties is the prevalence of numerous 'con men' and "scam artists" in the market. A high profile black mar-

> ket provides many opportunities for fraud.[20]

Most reports of alleged smuggling of nuclear weapons or weapons-usable components have been unreliable.[21] Nonetheless, a number of reported smuggling cases warrant concern. The most serious cases are those few that have involved fissile materials that could be used to make nuclear devices.[22] While no single known case has involved enough material to manufacture a bomb, kilogram quantities of stolen weapons-usable HEU have been seized both inside and outside the Russian Federation. Examples include:

- One and a half kilograms of 90 percent enriched HEU, stolen from the Luch production facility at Podol'sk in October 1992;
- Nearly two kilograms of 36 percent enriched HEU, stolen from a naval base in Andreeva Guba in July 1993;
- Four and a half kilograms of 20 percent enriched HEU naval fuel, stolen from the Murmansk shipyard in late 1993;
- Three separate caches of weapons-usable HEU and plutonium, ranging in size from less than a gram to 350 grams, seized in Germany in the summer of 1994;
- Nearly three kilograms of 87.7 percent enriched HEU, seized in Prague in December, 1994.[23]

Western officials believe that some of the materials seized abroad may also have come from Russia, although Russian officials deny this. The technical distinction between "weapons-grade" and "weapons-usable" nuclear materials has been an important issue in U.S.-Russian discussions about the smuggling problem. Russian officials have repeatedly denied that any smuggling case has involved "weapons-grade" uranium, which according to the strict definition, is uranium enriched to greater than 90 percent or plutonium with less than seven percent Pu-240. However, all the cases cited above involved nuclear materials which, in fact, could have been used in a nuclear weapon, albeit with a less efficient yield than weapons-grade material.

Are There Consumers for Stolen Nuclear Materials?

U.S. and Russian government officials claim that there is little evidence to suggest that countries or terrorist groups are actively seeking black market nuclear materials.[24]

This lack of evidence notwithstanding, the prospect that terrorists or irresponsible leaders could acquire nuclear material from poorly protected facilities in the NIS is cause for serious alarm. One Russian official has privately expressed grave concerns on this issue:

> I (like many nuclear custodians) would know exactly how to go about stealing nuclear materials. I am very afraid about the future—that a terrorist group—either inside or outside Russia—will learn details about our poor level of MPC&A, the terrible economic situation…[and] that a group will find a way to pay off the relevant officials. Business in Russia is actually legalized stealing. Nearly everyone is corrupt; nearly anyone can be bought.[25]

There have been cases that appear to link buyers with sellers. Reports began to surface shortly after the dissolution of the Soviet Union that Iran had purchased nuclear weapons components, and even intact warheads, from Kazakhstan. The U.S. government looked into the reports and concluded that they had no basis in fact.[26] Subsequently, reports emerged that Iran had approached Kazakhstan in connection with enriched uranium located at the Ulbinsky (Ulba) Metallurgy Plant, a nuclear reactor fuel fabrication facility near Ust-Kamenogorsk in northeast Kazakhstan.[27] However, the veracity of these claims, made by a number of U.S. government officials, including Secretary of State Warren Christopher, has been the subject of some dispute. U.S. government experts, in confidential interviews, have recounted claims by Kazakhstani officials that Iran had approached the Ulba plant about a possible purchase of low-enriched uranium (LEU) but *not* HEU. In another reported case, Turkish police apprehended a professor in the act of selling two and a half kilograms of uranium of uncertain enrichment to three Iranians, reportedly agents for the Iranian secret service. According to Turkish police, the uranium was brought to Turkey by visiting Russians.[28] The accuracy of this case also has been questioned, however. Konrad Porzner, Head of Germany's BND Intelligence Service, told a German parliamentary committee that he has definitive proof that Iran and Iraq have been seeking materials on the black market. Of 32 cases of interested buyers registered by German intelligence in 1995, 16 involved states, he claimed. The Iranian government denied the charge.[29]

Although it remains unclear whether any transfers of fissile or other nuclear materials from former Soviet facilities have actually taken place, the risk of such transfers clearly exists. The consequences of this problem are sufficiently grave to warrant immediate action. With this in mind, it is worth examining

recent and ongoing cooperative efforts to address this threat.[30]

U.S.-NIS JOINT EFFORTS TO ADDRESS INADEQUATE NUCLEAR SECURITY

The Nunn-Lugar Cooperative Threat Reduction (CTR) program has been the Clinton administration's principal tool for working with the NIS to improve nuclear security. The original Nunn-Lugar legislation authorized the DOD to help former Soviet States to: 1) destroy weapons of mass destruction; 2) store and transport weapons slated for destruction; and 3) reduce the dangers of proliferation. The MPC&A projects, originally funded under the Nunn-Lugar program, are the most important instrument for reducing the dangers of proliferation associated with weapons dismantlement and inadequate nuclear safeguards.[31]

Since 1992, the original Nunn-Lugar MPC&A program has evolved and expanded into several independent initiatives: the Government-to-Government MPC&A program (originally funded from DOD's Nunn-Lugar budget); the Lab-to-Lab program (principally funded from DOE's budget but also receiving some funds from DOD); the DOE-GAN program (a new program funded under DOE's budget); and the warhead security program (funded from DOD's Nunn-Lugar budget). As a background to these various activities, let us first consider the White House's involvement in the MPC&A initiative and then examine in greater detail each of the four components of the program.

In January 1994, Presidents Clinton and Yeltsin agreed that reducing the risk of nuclear theft should be a "high priority," and agreed to expand cooperation to include fissile materials at both civilian and military facilities. In September 1994, they endorsed expanded cooperation, and in May 1995, they directed U.S. Vice President Gore and Russian Prime Minister Chernomyrdin to provide a status report on progress in U.S.-Russian MPC&A cooperation.

After START entered into force in December 1994, President Clinton began to focus surprisingly intensively on fissile material security issues. He raised the issue repeatedly in conversations with President Yeltsin and other foreign leaders, as well as in formal summit meetings. President Yeltsin responded by proposing a G-7 plus one (P-8) conference on nuclear safety and security, now scheduled for April 1996. The White House also established a Nuclear Smuggling Response Group, overseen by the Department of State, to coordinate U.S. government responses to significant smuggling incidents. On September 28, 1995, the president signed a decision directive that called for an acceleration of joint U.S.-NIS programs to enhance security and accounting of nuclear materials and weapons, and an expansion in diplomatic, law enforcement, and intelligence efforts aimed at stopping nuclear smuggling.

The Government-to-Government MPC&A Program

On September 2, 1993, the United States and Russia signed a Nunn-Lugar implementing agreement that included up to $10 million for MPC&A activities. This agreement became known as the "Government-to-Government" MPC&A agreement to distinguish it from the less formal "Lab-to-Lab" agreements that were negotiated in separate fora, described below. Other Government-to-Government MPC&A cooperation agreements were subsequently signed with Belarus, Kazakhstan, Lithuania, Latvia, Ukraine, and Uzbekistan.

The purpose of the Government-to-Government program is to strengthen, in a timely manner, NIS national systems of MPC&A. MPC&A systems provide the capability to deter, detect, delay, and respond to possible adversarial acts or other unauthorized use of nuclear material and, if necessary, aid in recovering nuclear materials.[32]

Initially Russian government officials were highly suspicious of U.S. motives and reluctant to allow the U.S. side access to sensitive sites. The two sides had fairly different expectations. According to one DOE official familiar with the process, the U.S. side had hoped "to begin work right away and finish as soon as possible." The United States was forced to moderate its hopes, especially about the pace of the program, in the months and years that followed.

Russia at first agreed to allow MPC&A cooperation only at civilian sites; military sites were to be off limits. Moreover, Russia initially objected to cooperation with the United States at any sites, civilian or military, involving weapons-usable materials (plutonium or HEU that can be used to make nuclear weapons). Russia first suggested two demonstration MPC&A systems at the LEU lines at Elektrostal and at Novosibirsk. LEU does not pose a significant proliferation threat, however, and the U.S. side was determined to achieve more, insisting that security be improved at sites where

weapons-usable materials were most susceptible to theft or diversion. However, the Russians were understandably reluctant to allow U.S. experts to inspect security vulnerabilities at these sites; many of the sites had broken down fences and wholly inadequate controls. The suspicion that the United States had ulterior motives—to collect intelligence about Russian nuclear weapons programs—was extremely strong then and persists even now. After further discussions, the two sides agreed to an interim arrangement that included a single demonstration system at Elektrostal**,** as well as reciprocal visits to plutonium storage facilities at Hanford and Mayak as first steps toward greater cooperation. In January 1995, after extensive negotiations, the MPC&A Agreement was amended to include an additional $20 million in Nunn-Lugar funds, and an agreement by Russia to allow access to sites housing weapons-usable nuclear materials. Eventually the two sides agreed to cooperate at Obninsk, Dmitrovgrad, Podol'sk, Mayak, and the HEU line at Elektrostal. However, delays and broken promises continued even through the first six months of 1995. The most frustrating problem was that, despite the January agreement, U.S. experts were repeatedly denied permission to carry out site surveys at agreed facilities, a necessary first step for putting MPC&A upgrades in place. Out of $30 million allocated to MPC&A between 1992 and 1994, the administration had spent only about $1.5 million as late as June 1995. The Government-to-Government MPC&A program appeared to be in serious trouble.

A long awaited breakthrough was reached at a meeting of the Gore-Chernomyrdin Commission in June 1995. By the end of that session, DOE Secretary Hazel O'Leary and Minatom Minister Viktor Mikhailov signed an agreement calling for site surveys at all five of the agreed Government-to-Government program sites, thereby shifting the program into much higher gear. Background discussions between U.S. and Russian officials revealed that the delay in the first half of 1995 had been due, in part, to a bureaucratic battle within Minatom over responsibility for MPC&A, which had been largely resolved. Within two months, surveys were completed at all five Russian sites.[33] Since that time, a number of MPC&A activities have been ongoing at these facilities:

- At the Dmitrovgrad Scientific Research Institute of Atomic Reactors, U.S. and Russian MPC&A experts are upgrading physical protection systems at several key sites. These upgrades are expected to be complete by the end of 1996. U.S. and Russian negotiators have also discussed improvements to additional facilities at Dmitrovgrad that process HEU and plutonium.
- At the Production Association Machine Building Plant at Elektrostal, DOE has provided upgraded MPC&A equipment and MPC&A training at the LEU facility. Agreement has been reached to begin upgrading MPC&A at the HEU fuel fabrication line as well. A joint working group agreed to strive to complete the upgrades by the end of 1996.
- At the Institute of Physics and Power Engineering at Obninsk, the two sides agreed to establish a Russian Safeguards Training and Methodology Center to train Russian MPC&A specialists. This is arguably the most important element of the entire MPC&A program in that it will help establish a safeguards culture in Russia. U.S. and Russian experts have also developed a plan to expand MPC&A cooperation at Obninsk, focusing on physical protection and access control.
- At the Luch Scientific Production Association in Podol'sk, the two sides are upgrading MPC&A at two facility sites that house HEU. These upgrades are expected to be completed by the end of 1996.
- At the Mayak Chemical Metallurgical Combine at Chelyabinsk-65, experts have begun planning MPC&A upgrades for plutonium reprocessing sites. The two sides agreed to install MC&A equipment and physical protection system upgrades by the end of 1996.

By 2002, DOE hopes to have cooperative programs in place for nuclear materials in each of four sectors in Russia: the Minatom civil complex; the Minatom weapons complex; facilities processing fresh naval fuel; and non-Minatom civil nuclear facilities, such as research reactors. DOE officials explain that the MPC&A program is designed to help Russia through a difficult transition until its nascent safeguards culture is more fully developed. These officials are hopeful that, by 2002, the two sides together will have put in place MPC&A upgrades at all of the most vulnerable nuclear sites, and that the program will then move on to a second phase, characterized by joint experiments, some of which are likely to be related to nonproliferation.

Non-Russian NIS

In general, Government-to-Government MPC&A projects have run more smoothly in the NIS outside Russia. Compared to Russia, there are fewer nuclear facilities in these states, housing less nuclear material, and with fewer bureaucratic obstacles to overcome. DOE has encountered some problems, however. In Ukraine and Kazakhstan, some difficulty was encountered with state licensing of MPC&A technologies to be installed at nuclear facilities. Other problems experienced throughout the NIS include customs duties, taxes, and protection of proprietary information.

As discussed below, MPC&A programs are underway at four sites in Ukraine, four sites in Kazakhstan, and one site in Belarus. DOE is also cooperating with other International Atomic Energy Agency (IAEA) members to upgrade MPC&A at sites in Latvia (Salaspils Institute of Physics), Lithuania (Ignalina Nuclear Power Plant), and Uzbekistan (Tashkent Institute of Nuclear Physics). There has been substantial progress at the site in Belarus, and the project in Latvia is expected to be completed soon. DOE conducted an initial site survey at a facility in Tbilisi, Georgia, in early January 1996 and hopes to begin cooperative work on physical protection soon. The programs for Ukraine, Kazakhstan, and Belarus, unlike the programs for Latvia, Lithuania, Uzbekistan, and Georgia, have been funded principally under DOD's Nunn-Lugar program, but future work will be carried out mostly with DOE funding.[34] When the agreement with Georgia is implemented, DOE will have joint MPC&A programs in place at all sites known to house weapons-usable material in the non-Russian NIS.

Ukraine

An MPC&A implementing agreement was signed with Ukraine in December 1993. Work is proceeding or planned at four sites:

- Kharkiv Institute for Physics and Technology: DOE completed a physical protection assessment report in September 1995 and has already supplied hand-held metal and special nuclear material detectors, computer systems, and accounting software. The project is expected to be complete by the end of 1997.
- Kyiv Institute for Nuclear Research: The project includes provision of a variety of MPC&A equipment, including hand-held metal and special nuclear material detection equipment, portal monitors, communications equipment, computer systems, a material accounting software system prototype, and seals. DOE provided MPC&A training in September 1995. A central alarm station, access control equipment, and intrusion detection equipment will be installed soon. Physical protection upgrades are expected to be complete by October 1, 1996, and MPC&A upgrades by November 1, 1997.
- South Ukraine Nuclear Power Plant: DOE has delivered a variety of MPC&A equipment (the same list as for Kyiv above, as well as a personnel badge system). DOE continues to purchase and install MC&A equipment upgrades. Physical protection upgrades are currently in the design stage and are expected to be complete by late 1997.
- Sevastopol Naval Institute: A site survey was postponed due to negotiations over the future of the Black Sea fleet and, until recently, complications involving access to a closed city.

Kazakhstan

An MPC&A implementing agreement was signed with Kazakhstan in December 1993. Work is proceeding, or planned, at four sites. DOD has provided a one-time allocation from fiscal year (FY) 96 funds for the first project. DOE has used program funds to begin work at the other three sites.

- Aktau BN-50 Breeder Reactor: DOE conducted a site survey in November 1995 and plans to provide additional MPC&A training for reactor personnel in 1996. The Japanese government is cooperating with DOE in installing a spent fuel gate monitor.
- Ulba State Holding Company, Fuel Fabrication Plant: DOE has provided MC&A equipment, MPC&A training, and a computer system for MPC&A activities.
- Almaty Research Reactor: DOE conducted a site survey in September 1995 and will provide MPC&A training in early 1996. Additional cooperation under discussion depends on the availability of funds.
- Semipalatinsk-21: DOE is providing physical protection training. Experts have discussed nuclear materials security upgrades.

Belarus

An MPC&A implementing agreement was signed with Belarus in June 1995. Work, which began in

advance of the agreement, is proceeding at one site.

• Minsk Institute of Nuclear Power Engineering (Sosny): The U.S. government has agreed to cooperate with the Swedish and Japanese governments to carry out immediate physical protection upgrades at this site. U.S. experts cooperated with Swedish experts to conduct a site survey in April 1994, and provided recommendations for physical protection upgrades to the IAEA. A team of U.S. experts visited the site in August 1995 and again in November 1995. The United States will fund upgrades at the central alarm station, MC&A upgrades, training in physical protection, nondestructive assay, tamper indicating devices, and other MPC&A equipment. All work at Sosny is expected to be complete by the end of 1996.

The Lab-to-Lab Program in Russia

While the Government-to-Government MPC&A program in Russia was temporarily foundering, the Lab-to-Lab program was proceeding on a parallel but much faster track. This program employs a "bottom up" approach to MPC&A improvements, in which U.S. and Russian scientists developed their own upgrade programs at individual facilities throughout Russia, without, until recently, significant involvement by government officials. From its inception the program has been astonishingly successful, especially in comparison with the slow progress of the Government-to-Government MPC&A program until summer 1995.

A Joint U.S.-Russian Steering Committee, made up of representatives of the participating U.S. and Russian laboratories, began meeting in mid-1994 to set priorities for the joint program. By summer 1994, the two sides had drawn up work plans with contracts specifying concrete deliverables. The program includes installation of upgraded MPC&A systems at the most vulnerable sites; as well as joint projects to develop, demonstrate, and produce MPC&A equipment. By December 1994, the first tangible results were in evidence. The first project completed was at building 116 of the Kurchatov Institute, one of the most poorly protected nuclear facilities in Russia. Seventy kilograms of HEU, used as fuel for zero-power criticality tests of a model space reactor, are stored at the Moscow site. Prior to the joint MPC&A upgrade project, the fence surrounding the building was in need of repair, and there was no equipment to prevent laboratory workers or others in the building from stealing nuclear materials or equipment.[35] Only two months after the two sides began working together, fences had been put up or repaired, video cameras continuously monitored sensitive areas, and portal monitors were installed to deter insider thefts. Much of the equipment deployed was Russian. By early 1995, a MC&A demonstration system was also up and running at Arzamas-16. All this was achieved in the space of half a year, whereas the Government-to-Government MPC&A program, by that time, had been languishing for nearly two years. Programs are now underway at a wide range of sites throughout Russia's nuclear complex, including nuclear weapons facilities.[36]

The excitement and *esprit de corps* among U.S. scientists involved in the Lab-to-Lab program is palpable and has been extremely productive. Many factors explain this excitement: the opportunity to work jointly with Russia on a pressing security problem to which nuclear weapons scientists are particularly sensitive; the lure of a new program at a time of dwindling opportunities for weapons scientists; and the chance to work with their former enemies at places that hold a special fascination, such as at Arzamas-16, the famous, ultra-secret nuclear weapons design laboratory.[37]

For their part, scientists at the Russian laboratories appear thrilled by the success of the Lab-to-Lab program. For example, at the Institute of Physics and Power Engineering at Obninsk, technicians proudly demonstrate to visitors a nascent inventory system, which will eventually record the location, mass, and isotopic content of thousands of tiny plutonium and HEU disks used to fuel the fast critical assemblies at the site.[38]

Obninsk was once considered to be a prime candidate for insider thefts of nuclear materials, in part because of the easy portability of these disks. As a result of the joint work, workers have boarded up doors to minimize the number of exit points. Specialized doors fitted with sensors check workers' passes electronically, as well as their weights. Video cameras continuously monitor all activities. The "two-man rule" applies in the plutonium storage facility: scientists can enter the facility only in pairs. All employees must pass through a portal monitor upon leaving the facility. "The Obninsk system is a showcase for the very best in U.S. and Russian protection, control, and accounting capabili-

ties," explains Mark Mullen, Special Assistant to the Lab-to-Lab program. "We're not only installing new equipment, but also helping spread the principles of nuclear materials safeguards in the most concrete way possible."[39]

Scientists at Obninsk are uniquely qualified to judge the relative strengths of the Lab-to-Lab and Government-to-Government programs, as it is the only facility so far to be targeted by both programs. There is unanimous agreement among scientists interviewed at the facility that the Lab-to-Lab program is more flexible and more efficient. Engineers explain that the Lab-to-Lab program allows them quickly to change course mid-stream if doing so will improve results. For example, these engineers claim that under the Lab-to-Lab program they were allowed to switch vendors in the middle of a project when they discovered the existence of an alternative device that was demonstrably superior to the original—something they could not do under the more bureaucratic procedures of the Government-to-Government program. They especially welcome the Lab-to-Lab system of contracts, in which each side commits to a list of concrete deliverables. This system has now been incorporated in the Government-to-Government program as well. They, like their American counterparts, enjoy working directly with scientists who understand their problems, rather than with *chinovniki* or bureaucrats. Moreover, the Lab-to-Lab program affords them greater flexibility in choosing either Russian or U.S.-manufactured MPC&A equipment or a combination of both.

In the words of one DOE official involved in the program,

> We recognize that the key to consensus between the United States and Russia on MPC&A was the creation of an indigenous MPC&A capability. As Russian personnel have been empowered to create, maintain, and purchase MPC&A equipment and services, we have gained a resolute buy-in from Russian scientists and officials….This has greatly increased the speed and scope of MPC&A cooperation.[40]

Moreover, Russian officials are in a position to lobby for greater MPC&A funding, which will enable the program to expand still further.

Perhaps the most important outcome of the Lab-to-Lab program is that it has created a cadre of safeguards enthusiasts in the field. The U.S. government is eager to cooperate with Russia in upgrading MPC&A for all sites with weapons-usable material, while protecting legitimate secrets that both sides still have. DOE has drawn up a comprehensive plan for projects through 2002. The program will only be as good as the scientists, technicians, and guards charged with running it, however. The enthusiasm and pride exhibited by personnel at Kurchatov and Obninsk is an important first step in the development of an indigenous safeguards culture, which in turn will influence the ultimate success of the entire joint effort. The long-term question is whether the success of the program depends on its small scale or whether it can be expanded effectively to larger-scale problems.

The GAN Program

In principle, GAN is responsible for inspecting and licensing all facilities that handle nuclear and other radioactive materials. In practice, it has been unable to enforce compliance at Minatom or at Ministry of Defense (MOD) facilities, at least so far. The MOD has done its best to prevent GAN, a civilian agency, from overseeing its nuclear stockpiles, much as DOD would fight the U.S. Nuclear Regulatory Commission (NRC) if the NRC had been given similar responsibilities. President Yeltsin repealed GAN's oversight over MOD facilities in July 1995.[41] GAN is still responsible for inspecting all Minatom facilities associated with production of nuclear materials, however, including plutonium production reactors and reprocessing facilities.

U.S. officials have tried to support GAN in its efforts to become an independent nuclear regulatory agency. In June 1995, DOE and GAN signed an agreement to cooperate on developing a national MPC&A system for Russia. The two sides met to begin planning their joint program in October 1995. GAN came to the meeting with six proposals: to exchange experience in developing regulations; to work together to design elements of a federal MPC&A information system; to request equipment for GAN inspectors and to develop Russian prototypes of the equipment; to work together on an MC&A information center; to request MPC&A training for GAN inspectors and operators; and to assess and upgrade MPC&A systems at six research reactors.[42]

Site visits by DOE are scheduled at four facilities for February 1996 and at two remaining facilities (Tomsk and Norilsk) in April 1996. Work is ongoing to develop a comprehensive plan of action. U.S. officials are clearly excited about GAN's readiness to begin cooperation immediately, especially at the

six sites, all of which were identified by GAN as high-priority sites needing MPC&A upgrades.

The Warhead Security Program

The warhead security program consists of two parts: transportation security and storage security. Both parts deal only with nuclear weapons taken out of the Russian stockpile. Nearly $60 million has been committed under this program through FY 95, and $42.5 million was approved for FY 96.[43]

Under the transportation security program, DOD is supplying supercontainers, used to protect warheads in transport from terrorist attack; emergency support equipment, including communication and diagnostic equipment (the latter used to determine whether there has been a nuclear yield in the event an explosion occurs); and security upgrades for rail cars, both for nuclear cargo and for personnel.

Under the storage security program, DOD is helping the Russian MOD to: 1) develop an automated inventory management system, the ultimate goal of which is to put tags on every warhead in storage; 2) implement storage site and guard force upgrades by supplying computers and guard force training; 3) improve the MOD's personnel reliability program, to include drug testing and personality testing; and 4) enhance storage site security, by providing generic material protection and control equipment.

General Maslin has claimed that the program has "really improved nuclear warhead protection during transportation."[44] While DOD is understandably proud of this program, officials hope in the future to move to a systems approach, identifying a full range of vulnerabilities for all weapons slated for dismantlement, from "cradle to grave." The biggest challenge in moving forward with this program, as was the case for the Government-to-Government MPC&A program, is Russian sensitivity about revealing security vulnerabilities at these sites.

PROSPECTS FOR THE VIABILITY OF THE MPC&A PROGRAM

A number of issues have emerged that may threaten the continued viability of the overall MPC&A effort. These include bureaucratic politics—both between partners and within the U.S. and NIS governments; potential cuts in funding; and continuing suspicions of U.S. government motives, especially on the part of Minatom.

Bureaucratic Politics: Hurdles in the United States

Beginning in FY 96, as a part of its effort to streamline the program, the Clinton administration transferred the MPC&A program from DOD to DOE. DOD had already transferred $30 million of FY 92-94 funds to DOE and, in order to ease the transition, has agreed to an additional top-line transfer of FY 95 DOD funds.[45] DOE made its own budget request for $70 million for MPC&A activities (including for Russia and the other NIS). Non-Russian NIS programs have been covered under Nunn-Lugar funds allocated in prior years, including $22 million for Ukraine, $3 million for Belarus, and approximately $17 million for Kazakhstan. DOE has funded MPC&A projects for Lithuania, Latvia, and Uzbekistan out of overhead.[46]

At the time, critics claimed that transferring authority for MPC&A to DOE, a symptom of what former National Security Council (NSC) staff member Rose Gottemoeller has called the "balkanization" of Nunn-Lugar, would reduce White House involvement in MPC&A projects and might ultimately damage their budgetary prospects.[47] Precisely the opposite occurred, however, at least in the immediate aftermath of the decision.

Shortly after the decision was taken to transfer the program to DOE, several steps were taken that worked to ensure interagency coordination and focus on the MPC&A problem. The NSC established an MPC&A interagency working group charged with submitting the program to interagency review, ensuring that the sites most deficient in security were preferentially targeted for assistance, providing instructions to diplomatic delegations, and keeping the issue at the top of the NIS foreign policy agenda. National Security Advisor Anthony Lake recruited Ken Fairfax, a renowned expert on fissile materials and nuclear security, to focus exclusively on NIS fissile material security issues for the NSC. Moreover, the White House drafted a decision directive that instructed agencies to devote substantial personnel, financial, and intellectual resources to NIS fissile materials security problems and to combating nuclear smuggling.

Nor did balkanization adversely affect the program's budget, at least for FY 96. DOE's budget request of $70 million for MPC&A projects, which was granted, was significantly higher than similar requests for any single previous year under the Nunn-Lugar program. The remain-

der of the Nunn-Lugar program did not fare so well: out of its $371 million FY 96 budget request, DOD received $300 million for all projects remaining under Nunn-Lugar. DOE plans to request $95 million for FY 97.[48]

Proponents of shifting the MPC&A program out of DOD and Nunn-Lugar, such as former Deputy Secretary of Defense Gloria Duffy, who until August 1995 was Special Coordinator for the Nunn-Lugar program, have observed that because Senator Nunn plans to retire, and Senator Lugar is busy with his presidential campaign, the program may lack a strong proponent in Congress and will require a broader base of support. Dr. Duffy has argued that giving budgetary authority to the agencies responsible for carrying out individual parts of what formerly came under the Nunn-Lugar umbrella inevitably will attract a broader group of Congressional supporters.

The long-term effects of "balkanization" of the program are difficult to predict, however. Ultimately, the success of the program will probably depend at least as much on the administration's willingness to build and sustain Congressional and public support as on NIS partners' continuing willingness to cooperate. Although in principle it might be easier to promote a single, unified Nunn-Lugar program than several related projects housed in separate agencies, the agencies that have been responsible for running the projects (DOE with respect to MPC&A; the Department of State with respect to the International Science and Technology Center) may be better suited to testify on behalf of the projects than is DOD.

Bureaucratic Hurdles in Russia

The response of the Russian government to the problem of nuclear security is complicated. On the one hand, most official statements deny that Russia is the source of any of the weapons-usable material seized in smuggling incidents. Russian government officials tend to blame the nuclear smuggling problem either on German "provocateurs" or on journalists. For example, SVR General Evstafiyev wrote in a recent article,

> With respect to the so-called leakage of nuclear materials from Russia, the Germans were the initiators. Following the Germans, the Americans also got involved. It is obvious that before October of last year the leakage was a problem of only one country—Germany. Ninety percent of the illegal nuclear-material consignments were seized on German territory.[49]

Russian officials claim publicly that the government has taken a thorough inventory of its fissile material stockpile and that nothing is missing. Minatom's spokesman has told a group of journalists that the material missing at Minatom facilities "is not in the realm of tons of kilograms, but grams. You might not agree with this, but it is a fact."[50] Before the spate of significant smuggling incidents beginning in 1994, however, senior Minatom officials claimed that many significant quantities of plutonium were missing from a single facility, the RT-1 plutonium separation plant in Chelyabinsk.[51]

Despite frequent official denials that Russia faces a nuclear security problem, the Russian government has actively sought assistance in establishing a modern fissile material inventory system and in upgrading physical security at nuclear sites. The Yeltsin administration also issued two important orders related to nuclear security. On September 15, 1994, President Yeltsin issued a decree "on urgent measures to perfect the system of accounting and storing of nuclear materials," that charged a newly established interagency commission to develop a plan to improve nuclear security and accounting.[52] Subsequently, on January 13, 1995, Prime Minister Chernomyrdin drafted a resolution that ordered GAN, in consultation with other agencies, to develop and implement a state nuclear materials control and accounting system. It also ordered the Ministry of Finance to allocate the necessary funds "on a priority basis."[53]

More impressive is the fact that, in private conversations, lower level Minatom officials acknowledge the seriousness of the nuclear material inventory problem. These admissions contrast sharply with interviews of more senior officials, and with the public statements of many Russian officials in the press. One mid-level Minatom official interviewed for this study, who had worked for the IAEA, was adamant in his belief that the problem was far worse than generally recognized.[54]

The most disturbing bureaucratic development that emerges in conversations with Minatom officials is that ministry's alleged plans to take over control of the Lab-to-Lab program. At least one senior Minatom official has expressed grave reservations about what he calls the "chaotic nature" of the Lab-to-Lab program. Some of these officials also remain deeply suspicious of U.S. motives and are convinced of the need to keep the system of physical protection a state secret. In the view

of these officials, resistance to allowing Minatom more control over the program is only evidence that the United States has ulterior motives for working with the nuclear weapons laboratories.

However this potential crisis is resolved, these issues are bound to reemerge. Government agencies have a natural tendency to expand their territory, a characteristic that organizational theorists call "bureaucratic imperialism." Agencies are most likely to exhibit "colonizing" behavior when "boundaries are ambiguous and changing," or when programs are new, with ill-defined owners.[55] If this theory is correct, it is possible that turf battles in both countries will continue into the indefinite future. This tendency must be resisted if the program is to be successful.

There is growing sentiment in some agencies in Moscow that Minatom is functioning as a "state within a state" and should be reigned in. Yeltsin's National Security Council staff is currently drafting a presidential decree that would limit Minatom's powers and require it to submit export proposals to interagency review.[56] The root of the problem, in the view of one Ministry of Foreign Affairs official, is the system of closed cities that has overseen design and production of nuclear weapons. Over the past decades, Minatom has had all the responsibilities of a state in these cities, and it has grown accustomed to power and secrecy. Minatom currently controls agricultural production on a land mass the size of an oblast, and more than one million people work for the ministry, which translates to a large number of votes. The most egregious example of Minatom's apparent independence from the rest of the government was its attempt in 1995 to include enrichment equipment in the sale of a nuclear reactor to Iran.[57]

The Response of Non-Russian NIS Governments

As mentioned above, non-Russian NIS partners have generally been far more cooperative on MPC&A issues than Russia. As one DOE official has explained, "These are smaller countries with smaller governments. There are fewer bureaucrats able to set up barriers." Another important distinction is that Russia is the single nuclear weapons state in the NIS, with the largest amount of weapons-usable nuclear material and the most complicated fuel cycle. Moreover, as non-nuclear weapon states party to the NPT and subject to IAEA safeguards, the non-Russian NIS governments inevitably have fewer reservations about protection of classified, weapons-related information.

Obstacles in carrying out MPC&A projects have been fairly prosaic, including problems with shipping, customs, taxes, duties, and reporting. There have also been problems, as in Russia, with access to closed cities. An additional area of disagreement in the non-Russian NIS has been the definition of the scope of work. As another DOE official explained recently, "While some countries have been slow to accept the extent of work necessary to upgrade indigenous MPC&A systems, others have requested and been turned down for assistance in areas outside our mandate, i.e., non-MPC&A upgrades (dry storage, fire protection, emergency response, etc.)." Despite these problems, MPC&A work with non-Russian NIS partners is expected to be completed by the end of 1997, five years earlier than the work in Russia.

Concerns About the Pace of the Program

Critics have accused the Clinton administration of exceedingly slow progress in cooperative threat reduction in the area of MPC&A. As one prominent critic has claimed,

> The foot-dragging that has characterized much U.S. and Russian implementation of such measures…is deplorable….The responsible bureaucrats in both countries, most of whom appear to be in no hurry to get on with the job, need to be reminded in particular that protecting plutonium and highly enriched uranium …represents not only one of the most urgent of arms control and nonproliferation tasks but also one of the most cost effective.[58]

Bureaucratic battles inevitably hamper the program. Government officials, especially in the United States and Russia, have allowed interagency and even interpersonal rivalries to stymie progress. Perhaps even worse is the danger that U.S. and Russian bureaucrats, in their zest for control, will damage the program's greatest strength, which is its flexibility. The worst possible outcome would be if Minatom succeeds in taking control of the Lab-to-Lab program, especially if U.S. funds are required to go through Minatom, rather than directly to the facilities where MPC&A activities are taking place. This shift in control would significantly damage the program's flexibility, and could impair excellent working relationships that have developed over several years.

The principal obstacle to progress, however, is not bureau-

cratic infighting. It is the lack of trust. Lingering suspicions about U.S. motives persist, especially in Russia, despite the substantial progress already achieved through cooperative efforts. Alleged Minatom attempts to take control of the Lab-to-Lab program, for example, are partly a symptom of this deeper problem. Activities related to nuclear weapons have always been the most closely held of government secrets, and development of trust inevitably takes time. Many Russian officials believe that the U.S. government is still insufficiently aware of Russian sensitivities. In the words of one Minatom official, "It is very important that you stress repeatedly that you have no intention of stealing secrets. You don't do this enough." U.S. officials might profitably heed this advice.

CONCLUSIONS

The MPC&A program, though only a few years old, is already fulfilling one of the principal objectives of the Nunn-Lugar program—reducing the risks of proliferation resulting from the breakup of the Soviet Union. Ultimately, success will depend on four variables explored in this article: trust between the United States and NIS partner governments; bureaucratic politics in both donor and recipient countries; continued Congressional funding, which in turn depends on public awareness of the nuclear security problem; and the extent to which the flexibility of the program can be maintained and enhanced.

Until now, the program has been unusually flexible, in that it incorporates parallel, mutually reinforcing components. The advantage of this multi-pronged approach—including projects managed from the bottom-up as well as from the top-down—is that when problems arise, as they inevitably will, cooperation may nonetheless proceed along an alternative route. This principle was illustrated most dramatically during the first two years of the Government-to-Government MPC&A program, when, try as it might, the U.S. government could not convince the Russian government to accept equipment it obviously needed. However at the same time, Lab-to-Lab cooperation was proceeding at a rapid pace. The multi-pronged approach is the greatest strength of the MPC&A effort, and might usefully be incorporated into other parts of the Nunn-Lugar program. Other useful innovations include contracting directly with NIS facilities and personnel for goods and services, thereby fostering indigenous capabilities.

While significant progress has been made at many NIS nuclear facilities, many sites are still vulnerable to theft. A convincing inventory of nuclear materials has yet to be taken in Russia, and the MPC&A system for warheads is still inadequate. These are among the most serious threats to international security, and deserve far greater U.S. funding than they have received so far.[59] The problem is sufficiently grave that government agencies in all the relevant countries cannot afford to conduct business as usual. To the greatest extent possible, interagency rivalries and lingering suspicions should be set aside. This effort, according to one of the program's most prominent proponents, U.S. Secretary of Defense William Perry, is neither an aid program nor a means to achieve unilateral Russian disarmament. It is "defense by other means," a particularly cost-effective way for taxpayers—in both the United States and the NIS—to protect future generations.[60]

[1] The author wishes to thank the Council on Foreign Relations, the Hoover Institution, and the MacArthur Foundation for funding this research; Nicholas Burns and Chip Blacker, for providing encouragement to pursue these subjects; Jerry Dzakowiz, for constant support; Matthew Bunn and Frank von Hippel, for providing tutorials and the constant motivation to do more; the members of the MPC&A and Nuclear Smuggling Interagency Working Groups, for insights on how government works; the many Russian and U.S. government officials who consented to be interviewed and provided comments on this chapter, especially William Alberque and Kate Baur Bricker of the Department of Energy; Tatiana Krasnopevtseva, for helping to formulate and translate questions for interviews in Moscow; and John Shields, William Potter, Richard Combs, and Laura Holgate for their useful comments on earlier drafts of this study.

[2] President Clinton's Address to the Nixon Center for Peace and Freedom Conference, Mayflower Hotel, Washington, D.C., March 2, 1995.

[3] As is explained below, beginning with the FY 96 budget request, U.S.-NIS MPC&A projects for nuclear materials will no longer by funded by the Department of Defense's (DOD's) Nunn-Lugar Cooperative Threat Reduction (CTR) budget. They will instead be funded out of Department of Energy (DOE) funds. Conceptually, however, MPC&A remains part of Nunn-Lugar and must be addressed in any comprehensive treatment of the Nunn-Lugar initiative. MPC&A for warheads remains a DOD Nunn-Lugar program.

[4] Author's interview with a U.S. government official, December 1995 (name withheld).

[5] Author's interview with unidentified Minatom official. Much of the material in this chapter is based on interviews in Moscow between November 3 and 15, 1995 with Minatom, GAN, and Russian Nuclear Security officials who asked not to be identified by name.

[6] Mark Hibbs, "Physical Protection Reportedly Eroding at Minatom's 10 'Closed Cities' in Russia," *Nucleonics Week*, January 2, 1995, p. 13.

[7] Author's conversation with *Gozatomnadzor* official, who requested not to be identified, November 8, 1995.

[8] Author's interview with Minatom official, who requested not to be identified, November 7, 1995.

[9] Even the best possible inventory system (with no system of allowed losses) would not solve the problem of the determined, well-informed thief who knows to spread his thievery out over a long period of time, always staying within the technical limits of the accounting system. According to

the Head of the Department of Arms Control and Nonproliferation of Russia's Federal Intelligence Service (SVR), General Gaennady Evstafiyev, who was interviewed by the author for this study, "No accounting system can detect losses of less than one percent of the total inventory. This is why it is important to install a comprehensive MPC&A system," that is, one that includes not only accounting, but also systems to detect attempts to remove even small amounts of nuclear material.

[10] Author's interview with a senior member of Russian President Boris Yeltsin's National Security Council staff, November 1995.

[11] See, for example, David Osias, Testimony before the Senate Foreign Relations Committee, Subcommittee on European Affairs, August 22, 1995.

[12] Author's interview with a U.S. government official, December 1995 (name withheld).

[13] David Osias, Testimony before the Senate Foreign Relations Committee, Subcommittee on European Affairs, August 22, 1995.

[14] Stanislav Lunev, "Russia's Nuclear Safety Problems," *Prism*, Part 1, Volume 1, Number 22, October 20, 1995.

[15] Author's interview with a U.S. government official, December 1995 (name withheld).

[16] Author's interview with an unidentified Minatom official on November 14, 1995.

[17] The figure of 600 storage sites for 1989 is from the testimony of Gordon Oehler, the Director of the Nonproliferation Center, Central Intelligence Agency, before the Senate Armed Services Committee, January 31, l995, S. Hrg. 104-35, p. 4. In an August 1995 discussion with U.S. officials, General Maslin noted that there had been 200 sites in 1991.

[18] Vladimir Orlov, "A Threat of Nuclear Terrorism Exists in Russia," *Moskovskiye Novosti*, No. 44, June 25, 1995, p. 14.

[19] Kurt Campbell, Ashton B. Carter, Steven E. Miller, and Charles A. Zraket, *Soviet Nuclear Fission* (Cambridge: Center for Science and International Affairs, Harvard University, November 1991), p. 125. Conversations between Ashton Carter and Senators Nunn and Lugar in the formulation of this book were a major factor behind the genesis of the Nunn-Lugar program.

[20] Phil Williams and Paul N. Woessner, "Nuclear Materials Trafficking: an Interim Assessment," *Transnational Organized Crime*, 1 (Summer, 1995), pp. 206-238.

[21] Several technical aspects of the nuclear smuggling problem have been muddled in press reports. One of these is the distinction between nonfissile radioactive isotopes and fissile material used to make nuclear weapons. The former include medical isotopes which, although extremely toxic, cannot be used to create a nuclear detonation in a bomb. A second important distinction, relating to the isotopic purity of fissile material, is between "weapons-grade" material and so-called "weapons-usable" material, which could be used, albeit less efficiently, in a nuclear weapon. Strictly speaking, HEU is uranium that has been enriched to greater than 20 percent U-235. "Weapons-grade" HEU refers to HEU that has been enriched to 90 percent U-235 or higher. U.S. and Russian bomb designers typically use weapons-grade fissile material in order to ensure a high degree of weapon reliability and efficiency, which also allows design of smaller weapons more easily transported by plane or in a missile warhead. However, HEU enriched to between 20 and 90 percent U-235, according to unclassified IAEA data, can also be used in a weapon, although a lower level of enrichment will require a larger amount of material to make a detonable weapon, resulting in a proportionately heavier and larger weapon. Similarly, "weapons-grade" plutonium typically contains no more than seven percent Pu-240. However, relatively less pure plutonium, including reactor-grade plutonium, can be used to make a bomb, albeit with an assured yield of only one to a few kilotons for a simple, Nagasaki-type design, and a higher, but still reduced yield for more sophisticated designs. An understanding of these distinctions helps place the smuggling problem in some perspective: it is not as bad as many journalists would have the public believe, but it is far worse than many Russian government officials are willing to admit.

[22] Often overlooked are the many cases of stolen medical isotopes and other radiation sources. These incidents are discounted because radioisotopes cannot be used to make detonable nuclear devices; MPC&A programs cannot possibly address the threat they pose. But they can be used by terrorists to draw attention to their cause, to wreak havoc, and to terrorize civilians. Shamil Basayev, the leader of the Chechen group who took more than 1,000 hospital patients hostage in June 1995, has claimed credit for placing a packet of radioactive cesium in Izmailovski Park in Moscow, a popular recreation spot for families, frequented by tourists as well as by Muscovites. Cesium-137, a radioactive isotope used in the treatment of cancer, is a waste product of nuclear reactors with a relatively long half life, and areas contaminated with it require extensive clean-up. It can be absorbed into the food chain and is carcinogenic. Cesium is used in industry in photoelectric cells, for measuring the thickness or density of materials, and in gamma-radiography. A related concern is the possibility of terrorism directed against nuclear power plants or other civilian facilities. Dzhokar Dudaev, leader of the rebellious republic of Chechnya, has frequently threatened to attack Russian nuclear power plants or to commit other acts of nuclear terrorism. The Russian government formed an interagency group to address concerns about nuclear terrorism, including Dudaev's threats. The group ordered that additional safeguards be put in place at power plants, for example, but the effort was not serious, according to a Minatom official who requested anonymity. An intelligent terrorist could easily circumvent the beefed-up controls, he said.

[23] For an excellent analysis of these incidents, see William Potter, "Before the Deluge? Assessing the Threat of Nuclear Leakage From the Post-Soviet States," *Arms Control Today* 25 (October 1995), pp. 9-16. Experts speculate that the 0.8 gram cache of 87 percent enriched HEU seized in Germany may have come from the same source as the consignments seized in Prague, which were of similar isotopic content.

[24] Thieves of nuclear materials tend to be amateurs who have no specific buyer in mind. As General Gaennady Evstafiyev, the head of the Department of Arms Control and Nonproliferation of Russia's Federal Intelligence Service (SVR), has observed, "As a rule, the thieves hide the material with extreme care, often for a long time, and only then do they begin to search for a buyer." General Gaennady Evstafiyev, "Yadernaya Mafiya v Rossii. Pravda I Mify," ("Nuclear Mafia in Russia: Truth and Myths") *Vek,* September 22-28, 1995, pp. 1, 10.

[25] Author's interview with a Minatom official, November 14, 1995.

[26] James Wyllie, "Iran—Quest for Security and Influence," *Jane's Intelligence Review*, July 1, 1993, p. 311.

[27] In 1994, nearly 600 kilograms of HEU were subsequently airlifted from this poorly secured site to safe storage in the United States in a joint U.S.-Kazakstani operation dubbed Project Sapphire. For a complete description of this operation, the events that surrounded it, and the possible "Iranian connection," see William Potter, "Project Sapphire: A Study of U.S.-Kazakstani Cooperation for Nonproliferation," paper prepared for the conference on "The Nunn-Lugar Cooperative Threat Reduction Program: Donor and Recipient Country perspectives," at the Center for Nonproliferation Studies, Monterey, California, August 20-22, 1995. Mark Hibbs, "Kazakhs Say Iran Sought LEU for VVER Fuel, Not 'Sapphire' HEU," *Nuclear Fuel*, July 17, 1995, p. 11-12.

[28] *Ankara Anatolia*, in English, 10:15 GMT, October 6, 1993, as reported in an unclassified cable, serial TA06 10103193; *Istanbul Turkiye*, in Turkish, October 7, 1993, as reported in an unclassified cable, serial NC0910082 693. Details of this incident are also based on a conversation by the author with Ozgen Acar, an editorial and special investigative reporter for *Cumhuriyet*, a major Turkish daily paper.

[29] Reuters World Service, "Iraq, Iran secretly buying on nuclear market," January 18, 1996; Reuters World Service, "Iran Objects Over German Nuclear Charges," January 25, 1996.

[30] The U.S. government has a comprehensive program to combat nuclear smuggling in addition to programs to enhance fissile materials protection, but space limitations preclude discussion of anti-smuggling initiatives in this paper.

[31] Beginning with the FY 96 budget request, MPC&A projects for nuclear materials will no longer be funded out of DOD's Nunn-Lugar CTR budget. Instead, they will be funded by DOE. As of January 1996, MPC&A projects paid for by DOD funds include: 1) the Lab-to-Lab program for FY 95, which was funded by $15 million transferred from DOD to DOE in a one-time, top-line transfer; 2) Government-to-Government MPC&A projects through FY 95, which

were funded by $30 million allocated to DOD between FY 92 through FY 94 for the (then) Nunn-Lugar MPC&A program; and 3) some of the non-Russian NIS MPC&A projects. DOE is now the Executive Agent for the entire MPC&A effort for nuclear materials. Warhead transport and security remain a Nunn-Lugar program, however. Author's interviews with DOD and DOE officials, November 1995.

[32] Information provided by a DOE official, December 1995.

[33] *Ibid*.

[34] *Ibid*.

[35] Mark Hibbs, "Russia Improving Protection for Sensitive Nuclear Sites," *Nucleonics Week*, March 30, 1995, p. 12.

[36] These include the Institute of Physics and Power Engineering Institute, Obninsk; the All-Russian Scientific Research Institute of Automatics; ELERON; the Kurchatov Institute; Arzamas-16; Chelybinsk-70; Avangard, Penza-19, Sverdlovsk-45, and Zlatoust-36 dismantlement facilities; and Tomsk-7. Recent bureaucratic decisions have slowed work at the dismantlement sites, however. Information provided by Department of Energy, November 1995.

[37] Arzamas-16 is located in a closed city straddling Nizhny Novgorod oblast and Udmurtia Republic. The first joint Lab-to-Lab project was initiated at this laboratory, which Russian scientists jokingly refer to as Los Arzamas, because it was partially modeled on Los Alamos. Public Affairs Office, Los Alamos National Laboratory, "Los Alamos Works with Russian on New Systems to Track Nuclear Materials," January 16, 1994.

[38] Author's tour of the Institute of Physics and Power Engineering at Obninsk, November 13, 1995. These disks, which weigh approximately five grams, could easily be slipped into a thief's pocket. There are tens of thousands of them at the site, totaling about eight metric tons of HEU and about 800 kilograms of plutonium.

[39] Los Alamos National Laboratory Public Information Group News Release, "U.S., Russian Scientists Demonstrate Nuclear Materials Security System at Russian Power Institute," September 21, 1995.

[40] Author's interview with a DOE official.

[41] Penny Morvant, "Gosatomnadzor Ceases Military Inspections," *OMRI Daily Digest* 1, No. 179, September 14, 1995, and "Statute on Nuclear Radiation Safety Updated," *Rossiyskaya Gazeta*, August 2, 1995, p. 4.

[42] Karpov Research and Development Institute of Physics and Chemistry, Obninsk; Institute of Nuclear Physics, Gatchina; Moscow Institute of Physics and Engineering, United Institute of Nuclear Research, Dubna; Tomsk Polytechnical University; and Nikel Combine, Norilsk.

[43] Author's conversation with DOD officials, November 1995.

[44] Interview with General Maslin in *Yaderny Kontrol*, reprinted in *The Monitor* (University of Georgia, Spring, 1995), p. 13.

[45] In addition, beginning in FY 1996, the Department of State assumed responsibility for the International Science and Technology Center (ISTC), as well as for several projects related to export control assistance to Ukraine, Belarus, Kazakhstan, and Russia.

[46] Author's conversation with DOE officials, November 1995.

[47] This critique and the events surrounding the "balkanization" of Nunn-Lugar are explained in detail in Rose Gottemoeller, "The Nunn-Lugar Program and Presidential Priorities in Nuclear Policy," prepared for conference on "The Nunn-Lugar Cooperative Threat Reduction Program: Donor and Recipient Country Perspectives," at the Center for Nonproliferation Studies, Monterey, California, August 20-22, 1995.

[48] Information provided by DOD and DOE officials, November and December 1995 and February 1996.

[49] General Gaennady Evstafiyev, "Yadernaya Mafiya v Rossii. Pravda I Mify."

[50] Mark Hibbs, "Europeans Term 'Worthless' Minatom Claim that No HEU or Pu is Missing," *Nuclear Fuel*, March 27, 1995, p. 12.

[51] *Ibid*. The IAEA defines a significant quantity as eight kilograms of elemental plutonium and 25 kilograms of HEU enriched to at least 20 percent U-235.

[52] "Ukaz President Rossiskoi Federatsii, O pervoocherednyx merakh po sovershenstvovaniyu systemu i sokhrannosti yadernykh materuyalov," ("Decree of the President of the Russian Federation on Emergency Measures to Perfect a System of Secure Storage of Nuclear Materials") September 15, 1994.

[53] Resolution of the Government of the Russian Federation, "On Priority Projects for 1995 to Develop and Implement the State Nuclear Materials Control and Accounting System," January 13, 1995, no. 34.

[54] Author's interview with Minatom official, November 14, 1995. This official refrained from blaming the smuggling problem on German provocateurs or on journalists exaggerating the problem to sell newspapers. Nor did he employ another tactic in vogue among officials interviewed by this author, as well as in official statements in the press—deflecting attention to the problem by focusing on Western failings in the nonproliferation arena, such the West's alleged responsibility for the Pakistani, Israeli, South African, and Iraqi nuclear programs. This mid-level Minatom official was so determined that the urgency of the MPC&A problem be communicated that he asked to read over the author's written translation of interviews to ensure that no important points had been missed.

[55] Graham T. Allison, *Essence of Decision* (Boston: Little Brown, 1972), p. 96.

[56] Author's interview with a senior member of President Boris Yeltsin's National Security Council staff, November 1995.

[57] Alexei Yablokov, "Atomic Energy Ministry Mixed Up Its Own Interests With National Ones," *Izvestia*, June 2, 1995, p. 3.

[58] John Holdren, "Nobel Lecture Delivered on Behalf of the Pugwash Conferences on Science and World Affairs," Oslo, Norway, December 10, 1995.

[59] For an excellent proposal on how future funds should be allocated for MPC&A activities, see John Holdren, "Reducing the Threat of Nuclear Theft in the Former Soviet Union: Outline of a Comprehensive Plan," unpublished proposal submitted to Senator Richard Lugar, November 1995.

[60] Secretary William Perry, Speech before the National Press Club, January 5, 1995. Secretary Perry was referring to the entire Nunn-Lugar effort. He said, "It's neither Russian aid, nor is it unilateral Russian disarmament. Indeed, for the United States, Nunn-Lugar is defense by other means, a particularly effective way to protect ourselves against nuclear weapons that were once aimed at our cities."