Renewing the Partnership

Recommendations for Accelerated Action To Secure Nuclear Material In the Former Soviet Union

August 2000

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Executive Summary

The cooperative U.S.-Russian effort to ensure that Russian bomb material does not fall into hostile hands—known as the Material Protection, Control, and Accounting (MPC&A) program, managed by the Department of Energy (DOE)—is absolutely crucial to U.S. national security, playing a fundamental role in the global effort to stem the spread of nuclear weapons. Precisely because of the urgency and importance of the task, however, it is essential to ensure that it is being carried out in a manner that will reduce the security threat posed by insecure nuclear material as quickly and effectively as practicable.

This report provides an assessment of the current MPC&A program and makes recommendations designed to accelerate and strengthen the effort, including steps toward the difficult goal of achieving sustainable security for nuclear material in the former Soviet Union over the long term.

The report's major findings are as follows:

- The MPC&A program is achieving major successes in addressing the threat of nuclear theft, having substantially increased security for large amounts of vulnerable nuclear weapons-usable material in Russia and the other states of the former Soviet Union. The program deserves strong support, including increased funding and personnel.
- Most of the work, however, remains to be done, and a substantial acceleration of the effort is urgently needed.
- The scope of the work to be done is now understood to be substantially larger than originally believed, but the program's planned budgets have not increased commensurately.
- The projected completion of the initial security upgrades and material consolidations has been delayed by many years, and planned schedules are now unacceptably stretched out, given the grave danger to international security now posed by inadequately protected fissile material.
- Balanced MPC&A systems involving physical protection, material control, and material accounting are needed to effectively protect against outsider and insider threats. Much less progress has been made in material accounting to date than in physical protection.
- The program has usefully begun to focus on material consolidation and conversion, but this aspect of the program has not moved forward as aggressively as necessary.

- Realistic testing of the performance of MPC&A systems in defeating insider and outsider threats is absolutely essential to achieving high levels of security and sustaining the systems for the long haul. Little realistic performance testing has so far been accomplished in U.S.-Russian MPC&A cooperation.
- The development of effective regulation of MPC&A in Russia is an essential element of the long term sustainability of security upgrades. The development of effective MPC&A regulation has been slow, however, and the emphasis on regulation in the cooperative MPC&A program has been reduced in recent years.
- Sustainability of the MPC&A effort is essential and complex. A broad range of steps are needed to help ensure that Russia and the other former Soviet states have the resources, incentives, and organizations in place to ensure that improved MPC&A systems and approaches will be sustained over the long haul. Insufficient attention to sustainability in both the United States and Russia, as well as congressional skepticism about the scope and cost of the proposed sustainability measures, have retarded progress in this essential area.
- While there have been management improvements in recent years, ranging from establishing consistent objectives for MPC&A upgrades to improving financial tracking, there have also been a number of negative steps, that could, if not corrected, substantially undermine the program's prospects for future success, including:
  - The downgrading of the policy role of the U.S. laboratories—who have more MPC&A technical expertise, on-the-ground experience and personal relationships in Russia, and creative energy than DOE headquarters—and their removal from the management structure of the program;
  - A substantial decrease in emphasis on maintaining a genuine partnership with Russian participants, and particularly the Russian nuclear laboratories, excluding them from many key decision-making processes. This has created controversy and resentment in Russia and has slowed the program's progress;
  - A U.S. decision to cut off new work on MPC&A upgrades at the weapon design and assembly/disassembly facilities in the Russian nuclear weapons complex (which contain huge quantities of fissile material) until Russia agrees to provide access to these facilities, after the United States had already negotiated and signed agreements providing for methods to carry out upgrades effectively without direct U.S. access.
- Sustained high-level support and attention—which has frequently been lacking in recent years—is needed to overcome obstacles to accelerated progress as they arise. To succeed, the program requires energetic, visionary leadership with access to the highest levels of the U.S. government.

Immediate steps are needed to address these issues. This report recommends the following actions.

Schedule and Resources

- The President of the United States should make achieving an agreement with Russia to work out an accelerated plan to reduce this security threat a top priority. The plan should focus on completing the security improvements in the shortest possible time.
- DOE should develop, in partnership with Russian experts, an accelerated strategic plan designed to reduce the proliferation threats posed by insecure nuclear material in the former Soviet Union as rapidly as possible.
- The President and DOE should work close-

ly with Congress to ensure that adequate funding and personnel resources are provided to implement the accelerated plan.

Elements of an Accelerated Program

Consolidation and Conversion

The United States should:

- Working jointly with Russian experts, conduct a comprehensive material consolidation analysis that would address the scope of consolidation, possibilities for substantial acceleration of the process, consolidation bottlenecks and ways of eliminating them, and consolidation schedule and budget requirements scenarios. The aim should be to reduce the number of buildings and facilities holding plutonium or highly-enriched uranium (HEU) as much as possible, as rapidly as possible.
- Work to convince the top leadership of the Ministry of Atomic Energy (Minatom) to issue a high-profile directive ordering their facilities to consolidate their material into the fewest possible locations (following the example of the top Navy leadership in emphasizing consolidation), and to prepare strategic plans to accomplish that objective for Minatom review by a specified date.
- Increase the priority of working with the large defense and fuel cycle facilities to carry out such consolidations, including seeking to work with the leadership of each facility to flesh out strategic plans detailing how much consolidation is to be accomplished by when, and with what resources.
- Provide adequate financing for preparing and transporting nuclear material, and rapidly providing secure storage facilities to which it could be shipped.
- Work to strengthen MPC&A regulation (at Gosatomnadzor, within Minatom, and within the MOD), and work to ensure that all facilities are informed of the likely costs of maintaining their HEU or plutonium stockpiles while complying with the regulations.
- Undertake an intensive program to provide comprehensive incentives to small, vulnerable research sites to give up their HEU stockpiles, including cash for purchasing the HEU, funding for alternative research not requiring HEU, and assistance in converting to low-enriched uranium (LEU) fuels where appropriate. (This would include strengthening the Reduced Enrichment for Research and Test Reactors (RERTR) cooperation program, and improving coordination between this effort and the MPC&A program.)
- Ensure that the MPC&A material consolidation and conversion (MCC) effort and other initiatives involving blending of HEU are properly coordinated and have clear and compatible objectives. In particular, since the blending envisioned under the MCC project is a tiny fraction of the amount of HEU being blended in the HEU purchase agreement, the MPC&A program should place primary emphasis in MCC not on the amount of HEU blended but on the number of buildings or facilities from which all weapons-usable material has been removed (which is what most reduces the threats of theft and the future costs of MPC&A); the amount of material blended down is relevant primarily with respect to the degree of incentive the payment for this blended material provides to Russian organizations to clean HEU out of buildings and facilities.
- Provide extensive briefings for senior Minatom officials and site managers on the dramatic savings in safeguards and security costs that are being achieved through consolidation in the United States.

MPC&A Upgrades

The United States should:

- Continue to prioritize those upgrades likely to provide the largest and fastest sustainable reduction in theft risk per dollar spent, with an integrated approach to MPC&A.
- Improve U.S.-Russian coordination and joint planning, and resolve current access issues stalling upgrades at key sites (see sections on partnership and access below for more detailed recommendations).
- Conduct lessons-learned sessions with representatives of various Russian sites, and establish other regular mechanisms for lateral communication between experts working on different sites and different parts of the MPC&A program.
- Work with Russian experts to improve the understanding of material control and accounting practices at Russian facilities.
- Undertake a high-level effort to gain Russian agreement to carry out rapid item inventories, identifying, tagging, and sealing each item or container with plutonium or HEU. As part of that effort, the U.S. government should work out an arrangement to overcome disincentives, such as an "amnesty" period in which inventories could be carried out without repercussions if they did not match past paper records.
- Increase the scale of support for actual measured inventories of material.
- Redouble efforts to put in place an effective national inventory system as rapidly as practicable.

Sustainable Security

Sustainability Resources

The United States should:

- Expand and plan for funding of "emergency measures" where needed—funding to keep guards on the job, keep security systems running temporarily, provide backup electricity supplies, and the like—as DOE did on a small scale in the winter and spring of 1998–99.
- Finance the first 2–3 years of operations and maintenance of systems installed with U.S. assistance, as an initial settling-in period, and work during that period to reach firm commitments that Russia will pay to keep the systems operational after that.
- Begin working with the Russian government now to gain Russian commitment to specific steps to provide adequate funding for sustaining effective MPC&A after U.S. assistance phases down in the future.
- Put increased reliance on indigenous personnel and firms to design, build, upgrade, and operate MPC&A systems, building up the indigenous capacities to carry out these missions in the former Soviet states.
- Simultaneously (a) work to reestablish good relations with Eleron, and to improve its capability to produce high-quality equipment to be used for MPC&A and warhead security, and (b) continue to work to broaden the base of indigenous suppliers of such equipment in the former Soviet Union.
- Initiate the establishment of, and provide funding for, a program of realistic tests of the performance of MPC&A systems at Russian facilities against both outsider and insider threats, relying primarily on Russian testing teams—with wide dissemination of test results and lessons learned, and funding for fixing problems identified (see more detailed recommendations on performance testing below).
- Help finance transition costs (recruitment, training, equipment, and the like) for a shift to more professional guard forces for nuclear material—either highly trained officer-dominated forces comparable to those that guard nuclear weapons, or (at least at civilian facilities) commer-

cial firms such as those that guard Russian banks, or nuclear facilities in the United States.

- Finance expanded training programs designed to build the cadre of qualified MPC&A personnel, including regular training at individual sites as well as the existing national training effort, with a focus not only on technical MPC&A but also on the critical importance to Russia and the world of preventing the spread of nuclear weapons, and the key role of effective MPC&A in that effort.
- Explore possible new revenue streams that could finance robust security and accounting programs for nuclear material in the former Soviet Union after international assistance declines, ranging from spent fuel storage to additional HEU purchases to "debt for security" swaps.

Sustainability Incentives

The United States should:

- Put nuclear security and accounting at the top of the U.S.-FSU nonproliferation agenda, as a fundamental requirement for preventing the spread of nuclear weapons, which all states handling weapons-usable nuclear material must meet. This issue should be accorded an importance at least comparable to that of ratification of arms control treaties and enforcement of effective export controls. The United States should make clear that this is a fundamental requirement for improved nuclear relations, something to be emphasized at every level on every occasion until the problem is adequately addressed (as is now done with issues such as cooperation with Iran, to take one example)—and work with other leading nuclear powers to convince them to take a similar approach.
- Increase the priority devoted to strengthening regulation of MPC&A. A realistic prospect of being fined or shut down if MPC&A did not meet stringent standards would create a major incentive for facility managers to invest scarce resources in ensuring adequate security and accounting.
- In particular, provide adequate funding for Nuclear Regulatory Commission (NRC) support of MPC&A regulation in the former Soviet states; expand efforts to improve Minatom's internal regulatory capabilities; and develop regulatory support and training programs with the Ministry of Defense body responsible for regulating military-related facilities in Russia comparable in scope and level of effort to those pursued with Gosatomnadzor and Minatom.
- Write requirements for MPC&A operations and maintenance, and realistic testing, into MPC&A contracts with facilities, with incentives written into the contracts to fulfill these commitments.
- Give preference to facilities with good MPC&A in all U.S. government contracts, and use the leverage provided by such contracts to pursue MPC&A objectives. Over time, facility managers in the former Soviet Union should come to understand that excellent MPC&A is a basic "price of admission" for doing business with the United States, just as refraining from transfers of sensitive technology to potential proliferators is—and the United States should work with other leading nations to convince them to take the same approach. At the same time, the United States should seek to use the considerable leverage that funds flowing to Russian facilities from U.S. programs provide to seek additional MPC&A progress—for example, using the fact that some large Russian facilities receive most of their cash income from the HEU deal to convince them to cooperate in ensuring stringent standards of security and accounting.
- Make achievement of high standards of MPC&A a prerequisite for U.S. support for new efforts involving bulk processing

or transport of fissile material, which would otherwise increase, rather than decrease, the risks of theft and proliferation. At the same time, the United States should place high priority on working with Russia to upgrade MPC&A for those bulk processing and transport programs that are already under way with U.S. support, such as the HEU deal.

- Consciously attempt to identify and support individuals at facilities and within organizations who are working to change their institution's approach to MPC&A for the better—known in the managerial literature as "change agents."

Sustainability Organization

The United States should work with Russia and the other former Soviet states on a systemic program of reform of the organizations involved in MPC&A, designed to ensure that:

- Each facility with weapons-usable nuclear material has a designated office for MPC&A, with appropriate personnel and authority;
- Each national institution with facilities with weapons-usable nuclear material under its control has appropriate institutional procedures and regulations for managing this material, and a designated office for MPC&A, with appropriate personnel and authority;
- The facility offices communicate appropriately with each other, and with the national authorities;
- There are clear and authoritative laws and regulations in place requiring MPC&A measures which, if complied with in their entirety, would ensure an effective system;
- The regulatory authorities have the authority, independence, personnel, equipment, and procedures required to carry out effective MPC&A regulation, including the authority to impose fines or close facilities for failure to comply with MPC&A regulations;
- There are recruitment, compensation, promotion, and training procedures in place to ensure that highly qualified people are available for all aspects of MPC&A, and have incentives for good performance;
- There are effective mechanisms in place for interagency coordination, joint action, and dispute resolution on MPC&A issues;
- There exists a substantial body of nongovernmental organizations, journalists, and legislators interested in monitoring MPC&A progress and lobbying for change when that is necessary.

Types of Material to be Protected

The United States should:

- Revise the MPC&A program guidelines to ensure that theft of enough material for a bomb in the form of low-weight-percentage material is not significantly easier than theft of enough pure material for a bomb—bringing the guidelines closer to conformance with international standards.
- At the same time, instruct the MPC&A teams to place first priority on security and accounting for pure material that could be used in weapons without chemical processing.

Non-Russian Facilities of the Former Soviet Union

The United States should:

- Provide funding for a sustainability program for the non-Russian facilities comparable to the program needed for Russian facilities.
- Undertake a high-priority effort to convince as many of these facilities as possible to give up their fissile material stockpiles completely within a few years, offering targeted packages of incentives tailored to the needs of each facility.

- Undertake a similar effort for other states that received HEU from the Soviet Union, outside the former Soviet Union itself.

Management and Partnership

- The President, the Vice President, the Secretary of Energy, and other senior members of the national security team should make reducing the threat posed by insecure nuclear material a top priority, and should devote the sustained time and effort needed to ensure that the MPC&A program is carried out as rapidly and effectively as possible, and that obstacles to progress are quickly overcome.
- The U.S. national laboratories should be given a stronger voice in key policy decisions on the future of the MPC&A program. Specifically, senior laboratory experts should be brought back into the DOE management structure, and the laboratory advisory committee should be given a greater role, with its input solicited on all key policy and technical decisions.
- In addition to this strengthened laboratory committee, DOE should establish an independent committee of outside experts to advise on the best approaches for carrying out the MPC&A program.
- The MPC&A program should adopt as a fundamental principle that every objective will be achieved in partnership with the Russians, with programs designed to serve both U.S. and Russian interests, and Russian experts integrated into all phases of program design and implementation; the mission statement should make unambiguously clear that the goal of the program is to serve both U.S. and Russian interests.
- The MPC&A program should work with Russia to build a central policy role for the Joint Coordinating Committee called for in the 1999 government-to-government agreement, and to ensure that senior technical experts (as well as regulators) are represented on both sides of that committee.
- The MPC&A program should work with Russian experts to develop a new joint strategic plan for the MPC&A effort—a greatly accelerated one. In particular, the U.S. side should work with the leaders of key Russian sites with large quantities of material and ask for their perspectives on how best to rapidly consolidate and upgrade security for the material at their sites. The U.S. side should seek a political-level mandate—perhaps from the U.S. and Russian Presidents—to work out such an accelerated joint plan.
- The MPC&A program should develop a new joint version of the program guidelines and objectives, giving Russian experts an important voice in the final product.
- The MPC&A program should establish mechanisms for integrating Russian perspectives into the work of the Technical Survey Team. Potential options include encouraging the establishment of a parallel Russian team, or even integrating Russian participants into what has until now been a U.S.-only team.
- The MPC&A program should seek to establish Russian teams that can play key roles in designing and carrying out upgrades, on the model of the work the Kurchatov Institute experts have done on the Navy projects. This could ultimately include encouraging the establishment of additional private Russian firms that would receive MPC&A contracts on a for-profit basis, giving them an incentive to find ways to overcome obstacles and expand cooperation.
- The MPC&A program should seek to increase the management and problem-solving roles of both the U.S. and Russian laboratories and facilities, de-emphasizing reliance on talks between DOE and Minatom headquarters officials to the extent possible.

- U.S. project leaders should be instructed not to present new ideas as U.S. demands, but rather to seek to work with their Russian counterparts to jointly develop MPC&A approaches and modify them as necessary, with the goal of achieving maximum Russian "buy-in" and support for upgrades and changes in procedures and culture.
- Where possible, experts selected to be U.S. project leaders should have previous successful international experience (ideally experience working with Russian nuclear experts), and project and team members should be given at least introductory training in Russian culture and negotiating in a Russian context.
- The MPC&A program should avoid sudden drastic changes in technical approaches taken at individual sites, and should seek to keep the same U.S. project leaders for individual MPC&A sites for several years, to improve program consistency and allow personal relationships and trust to build up over time.
- As recommended in more detail below, the United States should resolve the access issue quickly, returning to its past commitments in this area.

Access

- DOE should immediately lift the cutoff of further contracts at the two weapons design laboratories and the four weapons assembly and disassembly facilities. DOE should send the message to Russia that new management is taking a new approach, and return to implementing the agreements previously reached.
- At the same time, DOE should continue to work with the Russian side, in a problem-solving spirit, to work out improved approaches to providing sufficient information to prioritize MPC&A upgrades and confirm the appropriate use of U.S. assistance. The use of trusted Russian citizens, as in the Department of Defense Cooperative Threat Reduction program, should be explored.
- DOE should offer Russian experts reciprocal access at U.S. facilities engaged in comparable activities. Offering to let the Russians see the same things the U.S. wants to see will help build trust, undermine the argument that the United States is spying through such visits, familiarize additional Russian experts with how similar security and accounting issues are addressed in the U.S. system, and make clear to U.S. officials just how difficult and sensitive it is to arrange the kinds of access they are seeking in Russia.
- DOE should work closely with Congress to demonstrate that it is possible to have confidence that U.S. assistance is being used appropriately even in the absence of direct U.S. access to these sensitive facilities, and to emphasize that the cooperation at these sensitive sites is crucial to reducing the threat of nuclear material theft.

Performance Testing

The United States should:

- Place high priority on working to establish effective performance-testing programs both at individual facilities, and within agencies with regulatory responsibilities including Minatom, Gosatomnadzor, and the Ministry of Interior (MVD).
- Work with Russia to develop performance-oriented safeguards regulations. In particular, the MPC&A program could work with Minatom, Gosatomnadzor and other organizations to encourage the development and use of a practical design basis threat as a part of the regulatory process.
- Sponsor performance testing methodology workshops. Performance testing work-

shops could be conducted at the Russian Methodological and Training Center (RMTC), other training centers, and regional Gosatomnadzor offices.

- Conduct inspector-accompaniment missions for performance testing inspections in the United States as well as (possibly simulated) inspections in Russia. Because of access difficulties at DOE facilities, it might be easier to organize Russian visits to nuclear power plants. Russian experts have already observed some of NRC's performance testing inspections at U.S. civilian power reactors.
- Write requirements for facility-level performance testing programs into MPC&A contracts at individual sites and facilities.
- Provide limited training in performance testing techniques to selected personnel from nuclear facilities, Gosatomnadzor, Minatom, and MVD.
- Provide equipment that enhances the effectiveness of performance testing (for example, Multiple Independent Laser Engagement System (MILES) equipment for force-on-force drills).
- Support and sponsor the development of a performance testing core group at Gosatomnadzor and/or Minatom headquarters.
- Work to establish in Russia a group that is professionally in the business of conducting such performance tests, with appropriate knowledge of MPC&A systems and adversary tactics and characteristics, comparable to the contractors in the United States who support performance testing at DOE facilities and work with NRC-licensed facilities to help them prepare for performance tests.

Travel Constraints

- The Secretary of Energy should send a clear message that MPC&A is a top nuclear security priority and that travel for the purpose of implementing MPC&A should not be interfered with. He should task a senior staffer with the job of overcoming the obstacles to MPC&A travel and greatly streamlining the process.
- Increased emphasis should be placed on establishing teams on the ground in Russia that can do much of the MPC&A design and implementation work, on the model of the Kurchatov Institute team that works with the Russian Navy programs, lessening the travel burden on U.S. experts and the portion of the program cost that must be spent at the U.S. laboratories.

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RECOMMENDATIONS FOR ACCELERATED ACTION TO SECURE NUCLEAR MATERIAL IN THE FORMER SOVIET UNION

August 2000

I. Introduction

The cooperative U.S.-Russian effort to ensure that Russian bomb material does not fall into hostile hands—known as the Material Protection, Control, and Accounting (MPC&A) program, managed by the Department of Energy (DOE)—is absolutely crucial to U.S. national security, and plays a fundamental role in the global effort to stem the spread of nuclear weapons. This essential effort to stop nuclear proliferation at its source is one of the most cost-effective security investments found anywhere in the U.S. federal budget, and it deserves strong support.

After six years of effort, however, most of the needed work remains to be done: by the end of 2000, initial security and accounting upgrades will be fully completed for only one-fifteenth of the nuclear material outside weapons in the former Soviet Union, though some significant progress will have been made on tens of tons of additional material (see "Measuring MPC&A Progress," pp. 10-11). Precisely because of the urgency and importance of the task, it is critical to scrutinize this effort closely and ask: are there ways to get this job done faster and more effectively? We believe the answer to this question is yes. The purpose of this report is to assess the current MPC&A program and make recommendations for accelerating the effort and improving its effectiveness.

DOE appointed a new director of the MPC&A program in December, 1999, as this report was being written. Most of the program approaches critiqued in this report were initiated before the new management took the helm, and it is too early to assess what new approaches the new management will take. However, as this report was being completed, the new MPC&A program management had begun to take several important steps in some of the directions recommended in the report. The authors believe that these are steps in the right direction but that the recommendations in this report remain key steps toward a more effective MPC&A program. It is our hope that this report will prove useful to the new management in strengthening and accelerating the MPC&A effort for the future.

Time for Reexamination

Several factors make a critical reexamination of the MPC&A program timely:

- Schedule and Resources. While it was once hoped that the MPC&A program could be completed by 2002, it is now clear that this will not be possible. Some plans prepared in the spring of 2000 stretched the program out to 2020 before even initial security upgrades and consolidations were complete. This pace simply does not match the scope and urgency of the threat. The program can and should be substantially accelerated with a renewed sense of urgency and additional financial and personnel resources.
- Partnership. In many areas the spirit of partnership with the Russian participants—absolutely critical to success in improving security for Russian material—has eroded, and the level of in-depth coordination of the effort with the Russian government and its experts has declined.[1] The conflict over access to sensitive facilities—which has resulted in a U.S. decision to cut off all new contracts at some of the most important facilities in Russia until the issue is resolved—is one particularly critical example. This report recommends a series of steps designed to renew and reinvigorate the partnership with Russian experts in this common endeavor.
- Technical and Policy Approaches. There are increasingly important debates within the program over the best technical and policy approaches to take—what types of security and accounting upgrades to emphasize, what types of material to focus on, what threats MPC&A systems should be designed to defend against, how to achieve security that will be sustained over time, which efforts within the program should receive priority funding, and the like. It is extremely important that these questions and the possible answers to them be fully debated and explored beyond the narrow group that has made decisions on these matters within the MPC&A program in recent years.
- Management, Review, and Self-Correction. There are significant questions about the management approach and policy directions that have been taken in the program in recent years, including whether they are as effective as they need to be, and whether sufficient mechanisms are in place for review, critique, and self-correction.

In addition to these issues internal to the MPC&A effort, the program faces an increasingly difficult external operating environment, including:

- continuing uncertainty about the Russian economy and the country's future political stability and direction;
- the poor state of U.S.-Russian strategic relations;
- loss of high-level attention to the fissile material control agenda from political leaders on both sides;
- increased public, legislative, and security apparatus scrutiny of program budgets and approaches to sensitive issues, again on both sides; and

[1] This report focuses primarily on Russia, where more than 99 percent of the former Soviet Union's fissile material resides. But facilities in Ukraine, Kazakhstan, Belarus, Uzbekistan, and Latvia also contain enough weapons-usable material. Initial MPC&A upgrades at these non-Russian FSU sites have been completed, and further work passed from the MPC&A program to DOE's International Safeguards office, so that the MPC&A program now focuses only on Russia. See "MPC&A at Non-Russian Facilities in the Former Soviet Union," pp. 14-15.

- implementation of increasingly restrictive counterintelligence and security policies in the United States and in Russia.

When coupled with the internal issues, these changes in the operating environment present a daunting set of hurdles that could seriously undermine the future success of this program, unless the program is continually shepherded forward in a focused and energetic manner at the highest levels of the U.S. and Russian governments.

Finally, a reexamination of this issue is timely because Russia has a new President, and the United States will soon elect a new President as well: a new Administration will have the opportunity to pursue new approaches to this vital agenda.

Structure and Method

This report proceeds as follows: Section II contains an analysis of the program's current overall strategy, including planned budgets and schedules, and recommendations for a radical acceleration of the effort. Section III discusses key issues and opportunities for accelerated action in each of the three principal areas of cooperation:

- consolidating nuclear material in fewer buildings and sites;
- installing improved MPC&A technology to protect highly-enriched uranium (HEU) and plutonium, and providing associated training; and
- achieving sustainable security for the long term, including the necessary national-level infrastructure.

In Section IV the report evaluates some of the program's past and current management approaches and policies, and recommends a series of steps designed to reinvigorate the partnership with the former Soviet states, and increase the program's effectiveness through expanded mechanisms for peer review and critique of key decisions and policies. Finally, the report analyzes one particularly important part of the partnership issue—the problem of access at sensitive facilities. An appendix to the report addresses the specific issue of instituting realistic performance testing of MPC&A systems in Russia.

This report is based on the authors' years of experience working with the MPC&A pro-

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[2] For official summaries of the MPC&A program, see *MPC&A Program Strategic Plan* (Washington, DC: U.S. Department of Energy, January 1998) available at http://www.nn.doe.gov/mpca/frame03.htm; Kenneth B. Sheely and Mary Alice Hayward, "New Strategic Directions in the MPC&A Program," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999 (available at http://www.nn.doe.gov/mpca/pubs/frame_tec.htm); and U.S. Congress, General Accounting Office, *Nuclear Nonproliferation: Limited Progress in Improving Nuclear Material Security in Russia and the Newly Independent States*, GAO/RCED/NSIAD-00-82 (Washington DC: General Accounting Office, March 2000). For recent unofficial summaries, see Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Material* (Washington DC: Harvard University Project on Managing the Atom and Carnegie Endowment for International Peace, April 2000); Emily Ewell Daughtry and Fred Wehling, "Cooperative Efforts to Secure Fissile Material in the NIS," *Nonproliferation Review*, Spring 2000; National Research Council, Committee on Upgrading Russian Capabilities to Secure Plutonium and Highly Enriched Uranium, *Protecting Nuclear Material In Russia* (Washington DC: National Academy Press, 1999); William C. Potter and Fred L. Wehling, "Sustainability: A Vital Component of Nuclear Material Security in Russia," *Nonproliferation Review*, Spring 2000; Todd Perry, "Securing Russian Nuclear Materials: The Need for an Expanded U.S. Response," *Nonproliferation Review*, Winter 1999, Vol. 6, No. 2; and Todd Perry, "From Triage to Long-Term Care: A U.S. NGO Perspective on the Future of the MPC&A Program," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

gram and with related U.S.-Russian nuclear security cooperation efforts; detailed review of the growing literature on U.S.-FSU MPC&A cooperation;[2] extensive briefings, interviews, and discussions with U.S. participants from DOE headquarters, the U.S. nuclear laboratories, and the Nuclear Regulatory Commission (NRC); and briefings and discussions with Russian participants from individual sites, the Ministry of Atomic Energy (Minatom), the Russian Navy, and the Russian nuclear regulatory agency, Gosatomnadzor.[3] We are grateful to all of those who took the time to provide their views on these critical subjects. Any remaining errors of fact or analysis, however, are solely the responsibility of the authors.

[3] Unless referenced to a specific source, information in this report is from interviews with U.S. or Russian participants in the MPC&A program who preferred not to be cited by name.

II. Budgets and Plans: Accelerating the Reduction in Proliferation Risk

The Urgency of the Threat

The risk that plutonium or highly enriched uranium—the essential ingredients of nuclear weapons—could be stolen and fall into the hands of hostile states or terrorist groups remains one of the most urgent security threats facing the international community. These materials remain dangerously insecure in a variety of countries around the world, but this danger is particularly acute in the former Soviet Union, home to the largest global stockpile of these materials. The Soviet nuclear security system was designed for a single state with a closed society, closed borders, carefully screened and well-paid nuclear workers, and political oversight and close surveillance of everyone by the KGB. In the wake of Communism's collapse, the Soviet nuclear stockpile has been splintered among multiple states with open societies, open borders, desperate, underpaid nuclear workers, and rampant theft and corruption—a situation the security system was simply never designed to address.[4]

Multiple documented thefts of real weapons-usable material have already occurred. While most of these were in the early to mid-1990s, as recently as 1998, a group of conspirators on the staff of one of Russia's largest nuclear weapons facilities attempted to steal 18.5 kilograms of weapons-usable material, but were thwarted by the Federal Security Service (FSB, successor to the KGB) before the material ever left the site.[5]

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[4] For discussions of the state of security and accounting for nuclear material in the former Soviet Union, see, for example, Bunn, *The Next Wave*, op. cit.; Oleg Bukharin, "Security of Fissile Materials In Russia," *Annual Review of Energy and the Environment*, 1996, Vol. 21, pp. 467–96; Frank von Hippel, "Fissile Material Security in the Post-Cold War World," *Physics Today*, June 1995; Graham T. Allison, Owen R. Coté, Jr., Richard A. Falkenrath, and Steven E. Miller, *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge, Mass.: MIT Press, CSIA Studies in International Security, 1996); Oleg Bukharin and William Potter, "Potatoes Were Guarded Better," *Bulletin of the Atomic Scientists*, May/June 1995, pp. 46–50; Jessica Eve Stern, "U.S. Assistance Programs for Improving MPC&A in the Former Soviet Union," *Nonproliferation Review*, 1996, Vol. 4, No. 2, pp. 17–32; and "We Cannot Preclude the Possibility of Nuclear Materials Theft," (edited transcript of Duma hearing), *Yaderny Kontrol Digest*, No. 5, Fall 1997.

[5] For the original announcement of this case, see "FSB Agents Prevent Theft of Nuclear Material in Chelyabinsk," *Itar-Tass*, December 18, 1999. The chief of the FSB for the Chelyabinsk region, Major General Valeriy Tretyakov, expressed "concern" about security for nuclear material at nuclear facilities in the region, and said that while U.S. MPC&A assistance was helpful, it was "far from being [the] permanent measure we need." (See also Monterey Institute for International Studies, Center for Nonproliferation Studies, Nuclear Smuggling Database [http://cns.miis.edu/db/nistraff/index.htm], Document 19980790, quoting Alevtina Nikitina, "Komu vygodno razrusheniye FSB?" *Chelyabinskiy rabochiy*, December 19, 1998.) In late 1999, this incident was confirmed by the head of Minatom's material accounting department, Victor Yerastov, in a published interview. In one translation, Yerastov described the material as "a sort of semi-finished product made of fissile material," which "can be used in the manufacture of various military and civilian products in the nuclear industry," and said that if the theft had succeeded, it "it could have inflicted a significant damage to the [Russian] state." (See "Interview: Victor Yerastov: Minatom Has All Conditions for Providing Safety and Security of Nuclear Material," *Yaderny Kontrol Digest*, Vol. 5, No. 1, Winter 2000.) In the original Russian, however, Yerastov used a phrase meaning "nuclear material" rather than "fissile material." Yerastov reports that "the attempt to steal this material was prevented at the very beginning, on the enterprise territory, and we do not find it correct to say that the theft occurred." In the interview, Yerastov also says that there was a case of fissile material theft (explicitly distinguished from thefts of other types of nuclear material) at a Minatom enterprise in

With a sufficient supply of fissile material, most states, and potentially even some terrorist groups, could make at least a crude nuclear bomb. Because the acquisition of nuclear materials and the bomb-making effort could be difficult, if not impossible, to detect, the international community might be confronted with nuclear threat with little or no warning. This would send shock waves through the international security system.

While there is as yet no evidence that enough nuclear material for a bomb from the FSU has fallen into the hands of states such as Iraq, Iran, North Korea, or Libya, it is impossible to know what has not been detected. Such a proliferation disaster could occur at any time. It is known that both Iran and Iraq have extensive procurement networks in place in the former Soviet Union seeking the technologies of weapons of mass destruction and the means to deliver them (including fissile material). The Japanese doomsday cult Aum Shinrikyo and Osama bin Laden's group are also believed to have attempted to acquire fissile material for weapons in the former Soviet Union.[6] Thus, the MPC&A program's mission of helping Russia improve security and accounting for their fissile nuclear material is extraordinarily urgent and must be treated as a central element in the global effort to control the proliferation of nuclear weapons.

The Scope of the MPC&A Effort

The MPC&A program's task is very large. The existing Russian inventories of fissile materials are estimated at over 1,000 metric tons of HEU (90-percent U-235 equivalent) and over 160 metric tons of plutonium.[7] (Roughly four kilograms of plutonium or three times that amount of 90-percent enriched HEU is enough for a nuclear bomb.[8]) Roughly half of this material has been fabricated into warhead components and is associated with deployed, reserve or retired intact nuclear weapons. Except for those awaiting dismantlement at Minatom facilities, these intact weapons are under the control of the Ministry of Defense. The rest, approximately 650 t (metric tons) of HEU and plutonium, is stored, processed, and used in more than 300 buildings at over 50 sites operated by Minatom (warhead production, fuel cycle, and research facilities), the Navy (naval fuel storage facilities), and other institutions (research reactors, laboratories, and civilian nuclear icebreakers).[9]

1995, while the last previously confirmed seizure had taken place in 1994. Yerastov attributed the decline in thefts since 1995 to a combination of a decline in press exaggeration of the prices available to thieves, unilateral Russian government efforts to improve security, and international MPC&A cooperation, particularly with the United States.

[6] For a discussion, see Bunn, *The Next Wave*, op. cit., pp. 14–15.

[7] See, for example, David Albright, Frans Berkhout, and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies* (Oxford, UK: Oxford University Press for the Stockholm International Peace Research Institute, 1997).

[8] See, for example, U.S. National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington DC: National Academy Press, 1994). The International Atomic Energy Agency (IAEA) defines a significant quantity of fissile material as 8 kg plutonium or 25 kg HEU. This definition of significant quantities corresponds to nuclear material requirements for a single Nagasaki-type, first-generation nuclear explosive device with a significant fraction of fissile material going to waste and process scrap during component fabrication. Explosive devices of more advanced designs require significantly smaller amounts of fissile materials.

[9] There are estimated to be a total of 332 identified buildings that require security upgrades. Of the 332 buildings, 206 contain fissile materials and the remaining 126 buildings do not contain fissile materials but are used to support fissile material operations. See GAO, *Nuclear Nonproliferation*, op. cit., pp. 7–8.

These inventories are not static. Tens of tons of fissile materials are recovered annually from dismantled nuclear weapons. Russia also continues to separate one to three tons of weapon and reactor grade plutonium. Tens of tons of HEU is disposed of annually under the 1993 U.S.-Russian HEU agreement (81 tons as of spring 2000) and some HEU is used in reactor applications.

In the early stages the MPC&A effort, based on the limited information then available about which facilities in the former Soviet Union housed fissile material, the program envisioned a need to spend an average of $5 million upgrading security and accounting for each of the roughly 80–100 separately fenced areas containing fissile material that had been identified. It was expected that the program's major objectives could be completed by the year 2002 at a total cost of roughly half a billion dollars.[10]

Since that time, however, it has become clear that the MPC&A job will cost more and take longer to complete, for four principal reasons:

- Additional buildings. As cooperative work progressed, the program has become aware of additional buildings housing nuclear material at many of the sites; new sites (particularly associated with the Ministry of Defense and the Navy, not included in the initial count) have also been added to the list of facilities requiring MPC&A upgrades.[11] Work has also begun on improving security of lightly irradiated HEU fuel of naval reactors that might be no longer self-protected. As noted above, the total number of buildings believed to require upgrades has now risen to more than 300.
- Additional assistance in sustaining security. Originally, the focus of the program was on the need for a quick infusion of modern security and safeguards equipment to provide a barrier of protection around vulnerable fissile material that Russia temporarily could not afford. An underlying premise of the program was that the Russian economy would recover as the program progressed, and that Russian safeguards experts would develop the technical expertise and infrastructure needed to sustain and improve the systems over time. The working assumption was that after the period of initial upgrades, the program could hand off future work to the Russians and phase down U.S. funding to a minimal support level. Unfortunately, the Russian economy has not yet recovered. So, Russian facilities still do not have the funds to sustain effective security and accounting systems. It also has become clear that fundamental changes in the "safeguards culture" in Russia as well as the procedures, incentives, and organizations necessary to affect this change will require additional U.S. involvement, and a much longer and more expensive period of U.S.-Russian cooperation.

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[10] According to GAO's March 2000 report, "When the [MPC&A] program was established, the Department [of Energy] estimated that it would require $400 million and 7 years to improve nuclear material security at 80 to 100 buildings in Russia and the newly independent states where weapons-usable material was known to be located." (GAO, *Nuclear Nonproliferation*, op. cit., p. 4.) Unfortunately, this figure with respect to buildings is not directly comparable to the earlier figure of 80 to 100 separately fenced areas, as many of these areas contain several buildings. Although current program officials frequently treat these figures as comparable in public statements—implying that the number of buildings involved has more than tripled—in fact the program has not yet succeeded in performing a direct apples-to-apples comparison of today's assumptions about the magnitude of the job to those of 1994.

[11] Most of these new sites are relatively small research and reactor facilities.

- Additional costs for upgrades. In general, many of the needed upgrades have turned out to cost more and take longer to implement than originally was envisaged. In part this is because the magnitude of the gap between past MPC&A approaches in Russia and those that are needed to address the new threats in Russia is even larger than had been recognized. Other reasons include the decision to re-do certain upgrades and to finance construction of secure storage facilities for weapon-usable nuclear material at Russian Navy sites.
- Adding consolidation and conversion. Finally, the program has added consolidation of material at fewer buildings and sites, and conversion of some of this material to non-weapons-usable forms, as a key priority. Reducing the number of buildings to be protected will cut theft risks and costs of sustaining security over the long haul, but these are largely new activities that involve substantial up-front costs that were not included in previous plans.

Strategy, Schedule, and Budget

In response to these developments, the MPC&A program, after long deliberation, adopted a modified implementation approach. This approach, combining new and old elements, focused on (a) consolidating material in as few facilities and buildings as practicable (rather than installing security upgrades to every new building or room where fissile material is found); (b) upgrading security and accounting systems at the remaining buildings (with an intensified focus on "inherently sustainable" upgrades, such as bricking over windows, installing massive blocks in front of doors, and the like), and providing associated training; and (c) improving the sustainability of these security and accounting improvements (including strengthened MPC&A regulation and various other national-level programs).[12]

Given the factors outlined above, it is logical to expect that the program would take longer to complete and cost more than originally planned. But some recent program strategies would stretch the schedule out far more dramatically than the circumstances warrant. While it was originally expected that most of the work would be done by 2002, the reality is that only 7 percent of the fissile material in Russia is in buildings where security and accounting systems has been fully upgraded (though some progress has been made on a substantial additional amount of material, see "Measuring MPC&A Progress," pp. 10-11).[13] As of the fall of 1999, DOE expected the program to continue for 10–15 years at the current level of funding of approximately $150 million per year, and by the spring of 2000, some plans called for the program to continue until 2020 before initial upgrades and consolidations were complete. This funding level of $150 million per year was originally estimated to be the top level required based on the original understanding of what would be needed, before any of the new factors described above were taken into account. DOE has been reluctant to request the significant increase in funding that is required to meet its new programmatic scope

[12] This three-part characterization differs somewhat from the actual program structure, which includes different groups for the different types of facilities (civilian, Minatom defense, Navy, etc.), which are responsible for both consolidation at fewer buildings within sites and upgrades at those sites; a group focused on consolidations involving cleaning out entire facilities; another group focused on sustainability; and a group focused on national-level programs, including regulation, transportation, a national accounting system, and the like.

[13] GAO, *Nuclear Nonproliferation*, op. cit.

on an accelerated time frame, though it has requested some modest increases. In its FY2001 budget request, DOE asked for $20 million in addition to the MPC&A program's core budget of $150 million.[14] But despite this modest increase in expected budgets, the projected schedule is still unacceptably stretched out. These schedule expectations are based on internal estimates of how long it will take, at today's rate of improvements, to complete upgrades at all known sites and building locations (taking into account expected consolidations).

This schedule simply does not match the scope and urgency of the threat—and a yearly budget of $150-170 million is unlikely to be sustainable in Congress over another 15–20 years. The national security demands, and Congress wants, a strategy designed to reduce the security threat posed by insecure nuclear material as rapidly as possible. As Senator Richard Lugar (R-IN) has said, "We cannot wait until a convenient budgetary situation arrives to do this work. We need to be moving as quickly as possible to remove this threat." Lugar called the current pace of the MPC&A program "unacceptable."[15]

Remarkably, the DOE leadership has never challenged the managers of the MPC&A program to answer the simple question: "What's the fastest this job could get done, and what would it take to make that happen?" The time has come to ask that question, and to lay out (in full partnership with Russian experts, as described in more detail in a later section) an accelerated strategic plan designed to provide effective and sustainable security for Russia's nuclear material as rapidly as technology and U.S.-Russian cooperation will allow. The Clinton Administration has announced that its policy for national missile defense is to ensure that the program is "limited only by what is technologically practical, not by money": the same approach should be taken for the far less costly task of controlling proliferation at its source.[16] Such an accelerated strategic plan would identify the key bottlenecks that have slowed progress to date (including, but not limited to, funding, hiring additional qualified personnel, and limits on U.S.-Russian cooperation), and means to overcome those bottlenecks and accelerate progress to the extent practicable.

Unfortunately, the government has not yet assessed how much the schedule could be accelerated with the application of additional funds, personnel, and high-level leadership. Publicly available information is insufficient

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[14] DOE proposed a $100 million new "Long-Term Nonproliferation Program for Russia," which included $15 million "to consolidate nuclear materials to fewer sites and fewer buildings and to expand DOE MPC&A activities into a new category of Russian facilities: highly sensitive Russian Navy nuclear sites," as well as $5 million for further MPC&A upgrades at the Mayak reprocessing facility. See *Fact Sheet: Long-Term Nonproliferation Program for Russia, U.S. Department of Energy,* February 7, 2000.

[15] "Nunn-Lugar: The Past as a Guide to the Future," remarks at the Center for Nonproliferation Studies, Monterey Institute of International Affairs, December 13, 1999. Similarly, the Senate in its version of the FY2001 Defense Authorization bill, specifically expressed concern about the slow pace of the MPC&A program, and demanded an annual report on how much material had been secured. This represents the first time that the Congress has required a formal annual accounting for the MPC&A program and reflects a change in the privileged status of this effort on Capitol Hill. Members of the House Armed Services committee have expressed similar concerns; see, for example, hearings before the House Armed Services Committee, Subcommittee on Military Procurement, March 21, 2000.

[16] "National Missile Defense Policy," remarks of Undersecretary of Defense Walter Slocombe, Washington DC: Center for Strategic and International Studies, November 5, 1999.

MEASURING MPC&A PROGRESS

In recent months, there has been a debate over how much progress the MPC&A program has made—and how to measure that progress. While this debate has so far shed more heat than light, it has raised a fundamentally important issue, as strategic management of any large government program requires having reasonably accurate metrics by which to measure one's progress toward the program's goal.

The public part of this discussion began with the publication of a General Accounting Office report that concluded, using DOE's own numbers, that only 7 percent of the fissile material outside of weapons was in buildings whose MPC&A upgrades had been completed.[1] Acting Deputy Administrator for Defense Nuclear Nonproliferation Rose Gottemoeller then challenged this figure as "not accurate," asserting that DOE had "completed rapid security upgrades" for 450 tons of material, 70 percent of the estimated 650 tons of fissile material in Russia which resides outside of nuclear weapons.[2] Elsewhere Gottemoeller asserted that the 7 percent figure represented only those facilities where "every jot and tittle" of MPC&A work had been completed, and that security and accounting for 70 percent of the material had been "substantially improved."[3]

Neither the impression many drew from the GAO report that only 7 percent of the MPC&A work is done nor the impression that Gottemoeller left that a substantial portion of the work for 70 percent of the material was already done is accurate. The 7 percent figure, as GAO correctly pointed out, represents the material in buildings whose initial MPC&A upgrades have been declared to be fully completed. Work is underway on the other 63 percent in Gottemoeller's 70 percent, and in some cases this work has already made substantial security improvements, but for the majority of this material, the work done to date only scratches the surface.

More broadly, any serious analysis of MPC&A progress has to get beyond numerical counts of buildings upgraded or monitors installed. The goal is not to install a certain number of widgets, but to reduce the risk of theft of nuclear material in Russia. It is because progress toward that overall goal is difficult to measure that other metrics such as the number of buildings upgraded are used as proxies. But these proxies can both overstate and understate how much has been accomplished—and do not adequately account for "softer" contributions which are difficult to measure but critical to the program's long-term success, such as improvements in MPC&A regulation and training.

Metrics such as the amount of fissile material in buildings that are upgraded can overstate progress because (a) the MPC&A upgrades may not be effective, either because they were poorly designed or installed, or because they are not being appropriately used and sustained; and (b) the threat comes from intelligent adversaries who will consciously target whatever weak points have not yet been addressed. Even the facilities where site-wide MPC&A upgrades have been declared "complete" do not, in general, have good enough MPC&A that they would be allowed to operate if they were in the United States. At most of these facilities, actual accounting for the nuclear material on hand has barely begun and the effectiveness of the security systems and procedures has not been proven. And though a sustainability program has been launched, whether these facilities can maintain these upgrades, and change the "safeguards culture" in ways that will make the upgrades as effective as they need to be, is very much an open question. Thus it is clearly not the case that "every jot and tittle" of the needed work at these facilities has been done.

And having 7 percent of the material in upgraded facilities may not reduce the risk by anything resembling 7 percent, as intelligent potential thieves will target the material that is not yet secured. If, for example, 90 percent of the fissile material at a site has been protected, but the same facility personnel have access to the other 10 percent that is not yet protected, the reduction in the risk of theft at that site may be close to zero until the other 10 percent is dealt with.

At the same time, such simple metrics understate the degree of progress by failing to measure the widespread impact on ways of thinking and doing business that such programs can and do have. The MPC&A cooperative program has indisputably helped foster changes in the approach to MPC&A that have reverberated through much of the Russian nuclear complex, resulting in at least small improvements even at sites where little direct cooperation has yet been accomplished. The fact that regulations specifying the required levels of protection for fissile material have been issued, for example, and that in at least a few cases facilities have been fined or closed briefly for failing to meet them, has encouraged site managers throughout Russia not to cut safeguards and security budgets as much as they might otherwise have done. The spreading realization that insider thieves are potentially a serious problem and that new technologies are needed to address that problem is having subtle but far-reaching effects throughout much of the Russian nuclear complex, and clearly originated in part in discussions with U.S. MPC&A experts. Because these kinds of effects are intangi-

ble, they are difficult to measure—but since they can affect the incentives of the players in the system, and their ways of thinking and doing business, they may be among the most important accomplishments of the program in contributing to sustainable security in the long term.

It is also important to understand that the effectiveness of upgraded MPC&A systems will vary depending on the level of threat. Rapid security upgrades—for example, the installation of fissile material monitors at facility's perimeter access points—are important improvements because they could deter an opportunistic insider (which may have been the most typical security threat in the mid-1990s) from simply walking off with HEU in his pocket. Completed site-wide upgrades, if effective, would protect nuclear materials against a specified design-basis threat, typically a single knowledgeable insider who may act in collusion with several armed outsiders. Threats such as the possibility that the senior management of a facility would consciously decide to sell nuclear material, or the possibility that a rogue military unit would decide to attack a facility and remove material (or weapons) are simply beyond the capacity of the types of security systems being installed to effectively address. Even a conspiracy of several insiders not including the facility management—as has apparently occurred at some Minatom facilities in the past—would likely be able to figure out ways to overcome the types of systems being installed.[4] It is very difficult to design technology-based MPC&A systems that would be effective against such higher-level threats; primary reliance in dealing with such threats has to be placed on rigorous, government-level personnel reliability programs and clandestine oversight by security and counterintelligence services.

Faced with these difficulties in measuring progress, the first step the MPC&A program took was to institute peer reviews to ensure that other senior MPC&A experts agreed with the project teams that the MPC&A upgrades being funded would provide high-priority, measurable reductions in the risk of theft at those facilities. (This is the Technical Survey Team described elsewhere in this report.) Experts at Lawrence Livermore National Laboratory developed a proposed methodology that sought to go further, and collect data from the project teams which would make it possible (using an elaborate weighting scheme to pull together a variety of non-comparable factors) to give each site a 0-100 rating summarizing the remaining degree of risk at that site (with high numbers more secure, and a typical U.S. facility in the range of 70), but this approach was not adopted by the program.[5]

In general, it is very difficult to design metrics that can adequately reflect the contribution made by efforts such as the regulatory program, the sustainability program, training efforts, and the like—just as it is hard to measure the value of maintaining a spirit of partnership in the MPC&A effort. But these are nonetheless crucial to achieving the goal of sustainable security for Russia's nuclear material. The performance testing approach described elsewhere in this report can at least provide confirmation that high levels of security are being achieved and sustained, if not a metric for which particular initiatives contributed most to this accomplishment. Performance tests that showed that a particular site was maintaining and improving its MPC&A systems' effectiveness over time could be a critical part of demonstrating the value of sustainability and training programs.

Ultimately, since the actual threat of nuclear material theft and the amount by which it has been reduced cannot be measured, the best that can be hoped for is to measure what fraction of the work has been done to date, and what fraction still remains. This requires virtually a building-by-building assessment of what upgrades are required and what remains to be done, combined with a comprehensive assessment of the work done to date and remaining in other areas, such as regulation, sustainability, and training. This would make it possible to say "this job will ultimately cost this much money (or take this number of person-years), and this is the percentage of that work that has been finished so far." The MPC&A program is beginning to work on such a comprehensive assessment, and should pursue it further—ideally in partnership with Russian experts, who have much more information available about Russia's nuclear materials than U.S. experts do. It is clear, however, that any objective assessment would show that after six years of effort, the vast majority of the needed work remains to be done.

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[1] U.S. Congress, General Accounting Office, *Nuclear Proliferation: Limited Progress in Improving Nuclear Material Security in Russia and the Newly Independent States*, GAO/RCED/NSIAD-00-82, March 2000.

[2] See, for example, testimony to the House Armed Services Committee, Military Procurement Subcommittee, March 21, 2000.

[3] Remarks to the 2000 Carnegie International Nonproliferation Conference, March 16, 2000.

[4] The same is true of nuclear security systems in the United States or anywhere else; the only difference resides in one's assessment of the probability of such threats arising.

[5] Deborah Yarsike Ball, personal communication. While such "quick and dirty" quantifications of complex qualitative judgments can be a useful tool for judging the pace of progress, their results are often highly sensitive to different weightings of the factors involved, and the weightings are often a matter of contention among different experts. If such approaches are to be used, a key factor is making them transparent enough to allow sensitivity analysis showing how the results would change if particular factors were weighted or rated differently.

to make a detailed independent analysis.[17] It is the authors' judgment, however, that with sufficient funding and focus, accomplishing the initial consolidations and upgrades within roughly seven years (to 2008) is an ambitious but potentially achievable target.

There are variables and uncertainties associated with an aggressive schedule. In particular, such an accelerated effort would have to be approved and facilitated at high levels in both governments. The major issues that would need to be addressed include access to sensitive facilities and the rate of material consolidation and conversion.

There also may be limitations on the program's ability to absorb increased funding. In the United States, any substantial workload increase would require additional program staff—and the personnel resources in this highly specialized area are finite but not yet fully tapped. Russia's ability to provide high-quality experts to work on implementing modernized MPC&A could be even more constrained. Russian nuclear facilities have established small professional MPC&A groups on a facility-by-facility basis but there has been a reluctance to expand these groups for a short-term effort in the absence of long-term employment opportunities for these specialists. Safeguards personnel shortages also exist in Minatom headquarters and in other relevant government organizations. (Minatom officials, for example, have indicated that because of these factors they would prefer a continuous multi-year cooperative program to a rapid near-term expansion—an attitude that reflects their focus on providing sustained employment for their staff, rather than on the security issues that seem so urgent from a U.S. perspective.) There are also difficulties related to the language barrier, cultural differences, communication infrastructure, and the ability of Russian managers to negotiate contracts and fulfill contract commitments.[18] However, these obstacles have been overcome in the past and could be surmounted once again with sufficient focus and political will.

Budget and Plans: Recommendations

- The President of the United States should make achieving an agreement with Russia to work out an accelerated plan to reduce this security threat a top priority . The plan should focus on completing the security improvements in the shortest possible time.
- The Department of Energy should develop, in partnership with Russian experts, an accelerated strategic plan designed to reduce the proliferation threats posed by insecure nuclear material in the former Soviet Union as rapidly as possible.
- The President and DOE should work closely with Congress to ensure that augmented funding and personnel resources are provided to implement the accelerated plan.

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[17] DOE has indicated to GAO that it does have much of the necessary information available: "DOE has not developed a new [compared to 1996] cost estimate for completing the program… However, the Deputy Assistant Secretary told us that DOE has the information necessary to develop a revised estimate and is planning to do so in the near future." (GAO, *Nuclear Nonproliferation*, op. cit., p. 21.)

[18] For a discussion of some of these issues, see Gennady Pshakin, "MPC&A Upgrades in Russia: Results, Problems, and Perspectives," *The Monitor*, Winter-Spring 1999, Vol. 5, No. 1–2, pp. 18–20.

III. Elements of an Accelerated MPC&A Program

As noted in the previous section, the three key elements of an effective MPC&A program are: (a) consolidating weapons-usable material in as few buildings and facilities as possible; (b) upgrading MPC&A systems and procedures; and (c) ensuring sustainable security over time (including national-level efforts such as improved regulation). This section will address each of these elements in turn.

Nuclear Material Consolidation and Conversion

Consolidation of nuclear materials is an urgent priority: protecting fewer buildings and fewer sites means that higher levels of security can be provided at lower cost over the long run. Though there will be significant costs in moving material in the short run the long-run savings can be very substantial. According to U.S. nuclear safeguards experts, for example, security expenditures at a typical (but modestly sized) HEU processing facility in the United States would be on the order of $4–5 million every year, comparable to the cost of initial security equipment procurement and installation. While operations costs for Russian facilities may be lower, they are still likely to be substantial, and can be eliminated if the weapons-usable material is removed from the facility. Moreover, when material is removed from facilities completely, the risk of theft at those facilities is also eliminated entirely. Hence, DOE's current guidelines for the MPC&A program emphasize that "consolidation of material should be the first priority," before considering specific MPC&A upgrades at a site.[19] Wherever nuclear material is not regularly used for essential work, removing it for storage at another location should be considered.

Currently, the MPC&A program has two separate consolidation efforts underway: the project teams working at each individual site are responsible for working with Russian facility personnel on "intra-site" consolidation—moving the material to fewer buildings within individual sites, while a separate "Material Consolidation and Conversion" (MCC) effort is responsible for moving material out of sites, and ideally cleaning out 100 percent of the fissile material from certain sites, so that they will no longer require extensive MPC&A systems. This split has a certain logic, as the project teams, with their long-standing relationships with individual sites, are in the best position to work with the individual sites on consolidation within those sites. But this approach has precluded a focus on a single, integrated approach to the consolidation issue. It is not clear whether this strategic focus on consolidation has ever been raised with the top leadership of Russia's nuclear establishment on a sustained basis.

Material consolidation could be a particularly effective approach for the large number of sites—in Russia and in other former Soviet states—associated with research reactor or material research activities, which have relatively small inventories (several tens of kilograms) of HEU. Many of these sites are no longer actively working with fissile materials. And, compared to larger sites, small research and training facilities are in even worse shape economically, and have fewer resources to assure effectiveness and sustainability of their safeguards and security systems.

Unfortunately, however, the obstacles to consolidation at the smaller sites have been

[19] *Guidelines for Material Protection, Control, and Accounting Upgrades at Russian Facilities* (Washington DC: U.S. Department of Energy, December 1998).

MPC&A IN THE NON-RUSSIAN STATES OF THE FORMER SOVIET UNION

Today, all of the nuclear weapons and more than 99 percent of the weapons-usable nuclear material in the former Soviet Union are in Russia. But significant quantities of HEU or plutonium still exist at facilities in Ukraine, Belarus, Kazakhstan, Latvia, and Uzbekistan as well.[1] Several of these facilities pose substantial proliferation hazards: the 350 kilograms of HEU at Sosny, in Belarus, and the 75 kilograms of bulk HEU powder at Kharkiv, in Ukraine, are only two of the more prominent examples.

MPC&A upgrades for all of the former Soviet facilities outside Russia have been declared completed—though as in the case of Russian facilities, a variety of issues (particularly systems and procedures effectiveness, maintenance, and further upgrades) often remain to be addressed after the initial upgrades are declared complete.[2] In addition to the United States, Japan and Western European countries have also provided MPC&A assistance to these countries (coordinated in many cases by the IAEA). All of the non-Russian states of the former Soviet Union have placed their nuclear facilities under IAEA safeguards, and hence their weapons-usable material is regularly inspected by IAEA monitors.

In the United States, further efforts to support MPC&A at these non-Russian sites have been transferred from the MPC&A program to DOE's International Safeguards division, so that the MPC&A program itself is now exclusively focused on Russia. DOE's International Safeguards division, however, only received $250,000 of additional funds when this transfer was made, and lacks adequate resources to maintain an effective level of MPC&A cooperation in these countries.[3] Yet as with the sites in Russia, it seems unlikely that the substantial U.S. investment that has been put in to MPC&A at these facilities will in fact result in effective security and accounting being maintained over the long term in the absence of a focused effort to achieve that objective, with requisite funding. The economic conditions in many of these states and at many of these facilities are no better than those in Russia, and in some cases worse. In short, funds need to be allocated to finance a sustainability effort for these sites comparable to that recommended for Russian facilities in the main text, designed to ensure that for each of these facilities, the resources, incentives, and organizations are in place to ensure effective security for the nuclear material for the long haul. While discussions of additional funding for MPC&A for these facilities are underway within DOE, there is no indication as yet that they will receive funding commensurate with the sustainability needs.

Even with an expanded sustainability effort, improved MPC&A provides no guarantees against theft, but only reduces the risk. It is therefore also important to pursue a parallel track of simply removing the material from many of these facilities (as was done with HEU from one site in Kazakhstan in Project Sapphire in 1994, and one site in Georgia in Operation Auburn Endeavor in 1998). Indeed, a committee of the National Academy of Sciences recommended in 1997 that DOE seek to remove all of the fissile material from every one of the non-Russian nuclear facilities within a few years, thereby limiting the remaining theft risk only to Russia.[4]

After years in which this approach was not seriously pursued, DOE has begun exploring the possibility of seeking to remove material from some of these non-Russian sites. DOE's fiscal year 2001 budget request includes $3 million (only enough to make a small beginning) to cooperate with Russia to arrange HEU "take-backs," under which both fresh and irradiated HEU provided by the former Soviet Union would be taken back to Russia for safekeeping and blending to non-weapons-usable forms, and some of the former Soviet facilities could be early candidates for such an approach. The U.S. RERTR program has also been having discussions with research reactor operators in Tashkent (Uzbekistan), Alatau (Kazakhstan), and Kiev (Ukraine) to prepare their reactors for conversion to low-enriched uranium fuel.

The time has come to launch a scaled-up, high-priority effort to get most or all of the fissile material out of the non-Russian states. Most of these facilities were eager in the past (after Project Sapphire) to sell their HEU for a modest sum. Today, it still should be possible to persuade these facilities to part with their HEU, if they were offered integrated packages of incentives tailored to the needs of each facility, including cash payment to purchase their HEU, funding for other research not requiring HEU, and, where relevant, help in converting to the use of LEU fuels instead of HEU, allowing high-tech nuclear research to continue. (The research reactor in Tashkent, Uzbekistan is already converting from 90-percent HEU fuel to 36 percent material without U.S. assistance, ameliorating one source of proliferation threat.)[5] Though at some facilities, research with HEU has taken on an almost mystical status, it nevertheless should be possible to use such an integrated package of incentives—coupled with disincentives, such as strengthened regulators making clear that maintaining HEU will require maintaining expensive security for it—to eliminate many, if not all, of the dangerous HEU stockpiles that now exist in the non-Russian states of the former Soviet Union.

This effort to remove HEU from the non-Russian FSU states can and should be seen as one part of the broader effort to work with Russia on a research reactor conversion and fuel take-back program that would also include bringing back the HEU from states such as Yugoslavia (where more than a bomb's worth of fresh HEU is stored at the facility where most of the veterans of Yugoslavia's past nuclear weapons program still work), North Korea, Libya, and Vietnam. Eliminating HEU stockpiles in such sensitive states would be a major, long-term victory for nonproliferation, and working together toward that objective could reinforce currently strained U.S.-Russian nonproliferation cooperation.

If these steps are not taken, there is a substantial risk that the next country or group to acquire a nuclear weapons capability will acquire it from one of these sources.

RECOMMENDATIONS

- Provide funding for a sustainability program for the non-Russian facilities comparable to the program needed for Russian facilities.
- Undertake a high-priority effort to convince as many of these facilities as possible to give up their fissile material stockpiles completely within a few years, offering targeted packages of incentives tailored to the needs of each facility.
- Undertake a similar effort for other states that received HEU from the Soviet Union.

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[1] For a listing of the specific facilities and order-of-magnitude estimates of the amount of fissile material at each, see *MPC&A Strategic Plan*, Washington DC, DOE, 1998, p. 17. This list would once also have included Georgia, which had HEU at the research facilities at Tbilisi and at Sukhumi. The Tbilisi material was moved to Britain with U.S. help, to reduce the proliferation risk it posed, in Operation Auburn Endeavor (following the earlier Project Sapphire, which removed nearly 600 kilograms of vulnerable HEU from Kazakhstan in 1994)—and the Sukhumi material is missing, presumed stolen. See discussion in Bunn, *The Next Wave*, op. cit., pp. 18–19 and 38–39.

[2] For a useful discussion of the state of MPC&A at individual facilities in the non-Russian states of the former Soviet Union, see Emily Ewell Daughtry and Fred Wehling, "Cooperative Efforts to Secure Fissile Material in the NIS," *Nonproliferation Review*, Spring 2000.

[3] GAO report, p. 14.

[4] National Research Council, Committee on Dual use Technologies Export Control and Materials Protection Control and Accountability, *Proliferation Concerns: Assessing U.S. Efforts to Help Contain Nuclear and Other Dangerous Materials and Technologies in the Former Soviet Union*, Washington DC: National Academy Press, 1997.

[5] See, for example, discussion in Daughtry and Wehling, op. cit.

substantial. Many facilities are quite reluctant to give up their HEU or plutonium, seeing it as a status symbol for the nuclear research institutes, and facility managers ask the question "without the HEU, what would we do here?" These are legitimate issues but these questions must be answered as part of the ultimate restructuring of the old Soviet nuclear complex. Also, because there is not yet strong nuclear regulation forcing facilities to pay high costs to provide effective security and accounting for such materials, there is little disincentive to maintain stocks of HEU or plutonium that have conferred status or brought research dollars in the past. Until recently, there has been little pressure from Minatom headquarters for consolidation. On the U.S. side, while consolidation was always seen as a desirable goal, the MPC&A program did not put high priority on it during its early stages and now that substantial sums have been spent building upgraded MPC&A systems to protect the material at particular facilities, there is a reluctance to recommend spending substantial additional sums to remove that material—even though that may be the most effective approach to securing it over the long haul.

In the aftermath of the August 1998 ruble crisis, which brought the costs of sustaining security painfully to the fore, the U.S. program increased its emphasis on consolidation, and Minatom's top leadership became more supportive of the concept. Notable consolidation successes (some initiated before this increase in emphasis) include the Luch Production Association in Podolsk (where the number of storage locations with fresh HEU has been reduced from 30 to 2), the Novosibirsk fuel fabrication facility (where the number of buildings holding HEU is being reduced from four to one), and the Russian Navy (where the number of locations with fresh HEU is in the process of being reduced from 20 to 2).[20] Similar consolidation is planned for the future at the Institute of Physics and Power Engineering (IPPE) at Obninsk, but has not yet been accomplished (see "The IPPE 'Nuclear Islands' Project," pp. 64-65). Nevertheless at the majority of sites, including the massive weapons design and production centers, little consolidation has occurred. The number of buildings holding fissile material remains far beyond plausible present needs, and little intensive dialogue over the consolidation issue has yet gotten underway.

For inter-site consolidation, DOE and Minatom agreed on a new approach in 1999. This effort began with a model project at the Luch Production Association. Under the new approach consolidation is linked with HEU disposition and financial incentives are employed as a means of facilitating both processes. In this case HEU is not only removed from a building or facility but is also down-blended to below 20 percent U-235. The DOE pays the HEU disposition (down-blending) facility, which, in turn, reimburses the HEU donor facility. The down-blended uranium stays in Russia but it is no longer weapons usable and therefore no longer in

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[20] See Rose Gottemoeller, Assistant Secretary for Nonproliferation and National Security, Department of Energy, "The Importance of Sustainability in Securing Nuclear Material in the Former Soviet Union," paper presented at "Global '99: Nuclear Technology- Bridging the Millenia," Jackson Hole, Wyoming, August 30–September 2, 1999 (available at http://www.nn.doe.gov/mpca/pubs/frame_tec.htm), and Thomas Wander and Neil R. Zack, "The MPC&A Material Consolidation and Conversion Project: Exploring the Material Conversion Option," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999. There is a third site where a partially completed submarine is loaded with fresh HEU fuel. See James Clay Moltz, "Russian Nuclear Submarine Dismantlement and the Naval Fuel Cycle," *Nonproliferation Review*, Spring 2000.

need of intensive protection. The MPC&A program and Luch have agreed that ten percent of the revenues would be reinvested for MPC&A improvement purposes.[21]

As of December 1999, 250 kg of HEU had been downblended at Luch,[22] much of which came from the research facility at Lytkarino. The hope is to clean out all the HEU at Lytkarino and thereby avoid the substantial costs of providing upgraded MPC&A for that facility. With the success of the initial downblending, DOE and Minatom reached agreement on expanded downblending and emptying of facilities in a "pilot project";[23] contracts have been signed to expand Luch's blending to 500 kg of HEU per year, and to begin blending at NIIAR in Dmitrovgrad at an initial rate of 250 kg per year.

At the same time, the program is working with Minatom to flesh out a plan outlining which buildings and facilities would have their HEU completely removed. The Russian government also has granted Minatom the authority to work with the Ministry of Defense, Ministry of Education, and other Russian agencies to develop a master plan that would identify excess HEU stocks and make them available for downblending. A follow-up project is planned, which would dispose of 4-5 t HEU from Minatom sites and 4-5 t HEU from non-Minatom sites over a period of two to three years, with at least two sites emptied of HEU each year—but program officials now believe, given the resistance of many sites to giving up their HEU, and the modest funding available for the effort, that these goals are not likely to be achieved.

In short, while significant initial consolidation has been accomplished at a few sites, and the MCC effort has demonstrated some early successes, much remains to be done, and a number of significant issues remain:

- The number of buildings that have been emptied of fissile material, or would be emptied in the next few years if the program's most ambitious current consolidation goals are achieved, is a small fraction of the total that need to be emptied.
- There has been no systematic approach to working with top Minatom officials and site-level leadership on all aspects of the consolidation issue, in part because of the split between intra-site consolidation in the hands of the project teams and inter-site consolidation in the hands of the MCC project.
- The U.S. government has not given serious consideration to the need to tailor broad packages of incentives that are likely to be needed to convince sites to give up their HEU, including cash to purchase HEU, and directing funding from programs such as Initiatives for Proliferation Prevention (IPP), and International Science and Technology Center (ISTC) to pursue other types of research and projects that could satisfy the facilities' needs for status and jobs.
- There has been little coordination between the consolidation effort and the Reduced Enrichment for Research and Test Reactors (RERTR) effort, which is conducting reactor conversion feasibility studies and developing fuels that would

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[21] DOE MPC&A Program RANSAC Briefing, October 7, 1999, DOE, Washington, DC.

[22] GAO, *Nuclear Nonproliferation*, op. cit., p. 9.

[23] For a brief description of the pilot project, see "Significant Milestones Reached for the MPC&A Program's Material Consolidation and Conversion Project," September/October 1999 MPC&A News, available at http://www.nn.doe.gov/mpca/frame04.htm.

allow sites to perform their nuclear research with low-enriched uranium (LEU) rather than HEU fuel, potentially overcoming perhaps the largest obstacle to consolidation.[24]

- There is also a lack of coordination between the MPC&A consolidation and conversion project and other initiatives focused on blending down HEU in Russia, including the 1993 HEU Purchase Agreement (which now has a goal of blending 30 tons of HEU per year, many times the amounts envisioned in the MCC project) and nascent efforts to buy or blend-down additional amounts of HEU (sometimes referred to as "HEU II").[25]
- The MCC project has insufficient funding to achieve its objectives as rapidly as practicable.
- There has been no comprehensive analysis (by either the U.S. or Russian sides) of which facilities and buildings should continue to have fissile material and which should not, and whether there are steps that would make it possible to radically accelerate and expand the consolidation effort.
- With the exception of the Russian Navy, little progress has been made in consolidating nuclear materials into fewer buildings at large fuel cycle and defense sites. Chelyabinsk-70 has implemented a contract to conduct a material consolidation feasibility study and to design a new central storage facility. No support, however, has been provided for the actual construction of the proposed storage facility.
- No effort has yet been made to consolidate Soviet-supplied HEU from non-Russian facilities, including research institutes in Ukraine, Kazakhstan, Belarus, Latvia, Uzbekistan, and possibly other countries the Soviet Union supplied with HEU, though $3 million of initial funding for such an effort is included in DOE's FY2001 budget request. (See "MPC&A in the Non-Russian States of the Former Soviet Union," pp. 14-15.)

Nuclear Material Consolidation and Conversion: Recommendations

- Working jointly with Russian experts, conduct a comprehensive material consolidation analysis that would address the scope of consolidation, possibilities for substantial acceleration of the process, consolidation bottlenecks and ways of eliminating them, and consolidation

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[24] The RERTR cooperative program with Russia was initiated in December 1993 to establish the feasibility of converting Russia-supplied research and test reactors to LEU fuel. The RERTR program could potentially eliminate the use of HEU at several of research reactor sites in Russia and other countries with Russia-supplied research reactors. Its progress, however, has been slow because of bureaucratic problems in Russia, technical problems, and insufficient attention to the program within DOE. For a review, see Oleg Bukharin, "U.S.-Russian RERTR Cooperation," (forthcoming as Princeton University's CEES Research Report).

[25] The phrase "HEU II" covers a variety of concepts focused on buying or paying for the blending of large additional stockpiles of HEU beyond the 30 tons per year whose blending and purchase is called for under the original HEU purchase agreement. The key distinction is that the MCC project is focused on clearing out small stockpiles of HEU at various, potentially vulnerable research facilities, eliminating the need to build and sustain effective MPC&A systems at these facilities, while the HEU II concepts are generally focused on reducing the overall magnitude of the HEU stockpile in Russia, and hence involve quantities of tens or hundreds of tons, rather than hundreds of kilograms. For a discussion of some of these concepts, see Bunn, *The Next Wave*, op. cit., pp. 99–102.

schedule and budget requirements scenarios.[26] The aim should be to reduce the number of buildings and facilities holding plutonium or HEU as much as possible, as rapidly as possible.

- Work to convince the top leadership of Minatom to issue a high-profile directive ordering their facilities to consolidate their material into the fewest possible locations (following the example of the top Navy leadership in emphasizing consolidation), and to prepare strategic plans to accomplish that objective for Minatom review by a specified date.
- Increase the priority of working with the large defense and fuel cycle facilities to carry out such consolidations, including seeking to work with the leadership of each facility to flesh out strategic plans detailing how much consolidation is to be accomplished by when, and with what resources.
- Provide adequate financing for preparing and transporting nuclear material, and rapidly providing secure storage facilities to which it could be shipped.
- Work to strengthen MPC&A regulation (at Gosatomnadzor, within Minatom, and within the Ministry of Defense [MOD]), and work to ensure that all facilities are informed of the likely costs of maintaining their HEU or plutonium stockpiles while complying with the regulations. (In the United States, the cost of meeting strengthened MPC&A and nuclear safety regulations was a significant contributor to the enormous reduction in the number of sites with HEU over the past couple of decades.)
- Undertake an intensive program to provide comprehensive incentives to small, vulnerable research sites to give up their HEU stockpiles, including cash for purchasing the HEU, funding for alternative research not requiring HEU, and assistance in converting to LEU fuels where appropriate. (This would include strengthening the RERTR cooperation program, and improving coordination between this effort and the MPC&A program.)
- Ensure that MCC and other initiatives involving blending of HEU are properly coordinated and have clear and compatible objectives. In particular, since the blending envisioned under the MCC project is a tiny fraction of the amount of HEU being blended in the HEU purchase agreement, the MPC&A program should place primary emphasis in MCC not on the amount of HEU blended but on the number of buildings or facilities from which all weapons-usable material has been removed (which is what most reduces the threats of theft and the future costs of MPC&A); the amount of material blended down is relevant primarily with respect to the degree of incentive the payment for this blended material provides to Russian organizations to clean HEU out of buildings and facilities.
- Provide extensive briefings for senior Minatom officials and site managers on the dramatic savings in safeguards and security costs that are being achieved through consolidation in the United States.

[26] For example, if those parts of the process involving actual blending down of HEU are limited by the available blend-down capacity at Luch and Dimitrovgrad, the MPC&A program should consider using the HEU processing facilities in Chelyabinsk-65 and Tomsk-7.

Security and Accounting Upgrades

MPC&A Upgrades at Individual Facilities

The installation of technical systems and procedures that allow for the protection, control and accounting of HEU and plutonium at individual facilities has always been the core task of the MPC&A program. At every site, the general pattern of cooperative work includes a preliminary exchange of information, site survey, assessment of MPC&A needs, technology transfer, installation and testing of equipment, and personnel training. These activities are carried out by a project team, which consists of U.S. and Russian safeguards experts. The United States covers the cost of equipment and labor in accordance with contracts signed by representatives of the U.S. project team and the recipient facility.

As of early 2000, site-wide security and accounting systems were installed at approximately 25 out of over 55 sites, all of them relatively small research facilities that initially possessed serious security vulnerabilities. These facilities represent completed MPC&A improvements in DOE's view. More sites are being completed one by one. Currently, 113 buildings containing approximately 50 t (out of 650 t) of fissile materials have had initial security and accounting equipment upgrades completed.[27] Initial MPC&A work, varying in scope from laying out plans for upgrades to actual installation of massive concrete blocks blocking access to fissile materials, has begun at facilities containing another 350 t or so of fissile materials (see "Measuring MPC&A Progress," pp. 10-11). All of the facilities in the former Soviet Union with HEU or plutonium that are outside Russia are among the 25 completed sites, and have been handed over to the DOE international safeguards division for long term management. Unfortunately, this office has not been provided with the resources to finance an effective sustainability effort (see "MPC&A in the Non-Russian States of the Former Soviet Union," pp. 14-15).

Work is underway on the larger fuel cycle production and research centers, but at many of these it is either focused on a small number of buildings, or on upgrades far from the fissile material itself (such as the installation of portal monitors at the perimeter, rather than at the buildings where the fissile material is located). The progress has been slow at the Sverdlovsk-44, Krasnoyarsk-45, and parts of Tomsk-7 and Chelyabinsk-65, complexes that have substantial revenue streams from the HEU downblending under the U.S.-Russian HEU agreement and other export operations. Compared to some other facilities that view MPC&A cooperation as an essential source of revenues, these facilities are less interested in MPC&A contracts and therefore their management pays much less attention to the issue. In addition, because of access difficulties, little work has been done at Russia's four serial warhead assembly/disassembly facilities, and further contracts for MPC&A improvements at both these facilities and the warhead research and design institutes in Arzamas-16 and Chelyabinsk-70 have been cut off (see discussion of access issues below). In contrast, significant progress has been achieved in working with the Navy to improve security of HEU fuel for naval propulsion reactors (see "The Navy MPC&A Program: Lessons of Success," pp. 60-61).

National-Level Programs

In addition to this work at individual sites, the MPC&A program includes a variety of national-level efforts, including: (a) support for MPC&A regulation (discussed under "Sustainable Security" below); (b) establishment and operation of national-level MPC&A training programs (also discussed under "Sustainable Security" below); (c) work to cre-

[27] GAO, *Nuclear Nonproliferation*, op. cit. report, p. 5.

ate a computerized national nuclear material accounting system; and (d) upgrading security for fissile material transports within sites and from one site to another.

National Material Accounting System

The effort to create a national material accounting system (referred to as the "Federal Information System," or FIS) was a topic of discussion from the earliest days of the MPC&A program. The effort was formally initiated as a DOE-Gosatomnadzor (also known as GAN) cooperative project in June 1996. Gosatomnadzor is the Russian government equivalent of the U.S. Nuclear Regulatory Commission. Subsequently, however, the Russian government shifted responsibility for the national system from Gosatomnadzor to Minatom, so the focus of the cooperative work also shifted to Minatom and its associated information institute, CNIIAtominform. A substantial portion of the work of designing the system, and working out key issues related to protection of classified information within the system, has been completed, and initial components of the system are being implemented on a trial basis at three pilot facilities. The system still has to demonstrate to the satisfaction of Russian security bodies that classified information will be protected in order for it to receive the "attestation" (certification for an overall system) required before it can be broadly implemented, and since the system was developed before Russian regulations governing it were completed, it is at least possible that some backfitting and modification will be needed.[28]

Transportation Security

While the initial focus of the MPC&A program was on upgrading the security of buildings and sites with nuclear materials, it was clear that transportation of HEU and plutonium was widespread and represented a particularly high security risk. Shipments of nuclear materials are inherently more difficult to protect, because they lack many security elements routinely employed at fixed facilities, such as outer perimeter fences and detection and assessment systems. Nuclear material shipments travel on railroads and highways that (unless inside closed cities or a facility's protected area) are accessible to the public. And should an accident or deliberate attack occur during the transportation process, off-site response forces are often hours if not days away, for remote areas in Siberia or other parts of Russia. Because of the sensitivity of nuclear material operations in Russia, however, U.S. and Russian teams did not manage to reach agreement on beginning a transportation security upgrades effort until 1996.

As most nuclear material shipments in Russia are conducted by rail, the initial cooperative effort was on upgrading security of rail transports. The proposed improvements included installation of rapid upgrades on railcars (including railcar hardening and installation of secure locks, intrusion detection systems, and voice communication equipment) and security overpacks (hardened metal vaults that are installed inside railcars and are designed to increase access delay). In addition, the project addressed on-train security and command and control center upgrades that in the future would allow Minatom's operations center to monitor and control train movement via satellite communication systems.[29]

In 1996, Eleron, which was designated by Minatom as the lead organization for the project on the Russian side, developed an inte-

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[28] For a discussion of this project, see, for example, Sandy Taylor, U.S. FIS Project Leader, "Federal Nuclear Material Control and Accounting Information System Project Goals and Plans," briefing, February 1999.

[29] For a discussion of this project, see N. Shemigon, M. Garcia, and J. Gronager, "Security Improvements for Rail Movement of SNM," in *Partnership for Nuclear Security*, U.S. DOE, September 1998, pp. 147–152.

grated transportation security concept. A prototype railcar security system was successfully demonstrated on a round trip from Moscow to Yekaterinburg in November 1997. The production (by Eleron) and installation of rapid upgrades on operational railcars began in 1998. Also in 1998, a contract to produce security overpacks was placed with the Design Bureau of Automotive Equipment (KB ATO, an organization responsible for the development of nuclear warhead transportation and handling equipment).

In the summer and fall of 1998, however, DOE de-emphasized the rail security project and instead focused on truck transportation security. This shift was prompted by several factors, including new Russian data that indicated that Minatom's fleet of railcars was rapidly aging; growing problems with rail operations in Russia (such as interruptions in shipments due to railroad labor strikes); and, to a certain extent, increasing tensions in relations with Eleron. It was judged that trucks, which in Russia are primarily used for intra-site shipments, could become a viable alternative to rail transports for shipments between sites as well.

The truck transportation project began in 1998 and included transportation needs assessments for nuclear sites in Russia, as well as the production and upgrades of protective overpacks, armored transports, and armored escort vehicles.[30] KB ATO was designated the lead Russian organization for the project, and the first transportation sets (armored trucks, overpacks, and escort vehicles) were produced and provided to Tomsk-7 in 1998. Additional vehicle systems have since been manufactured and delivered to Minatom facilities and the Navy.[31]

What Types of Upgrades?

The determination of the type of upgrade to be performed at a building or facility is the backbone of the MPC&A program. It drives the planning for the job, equipment purchases, and the sustainability tail that will have to be managed in the future. However, from the earliest days of the MPC&A program, there have been fundamental disputes between different experts on both the U.S. and Russian sides over what types of upgrades to emphasize—physical protection vs. material control and accounting; high-tech and highly-effective vs. cheaper, quicker, lower-tech, but less effective; focus on insider threats vs. focus on outsider threats; close to the material (the U.S. preference) vs. at the facility perimeter (a frequent Russian preference); designed to deal primarily with nuclear material theft (the U.S. preference) vs. designed to address risk of sabotage to facilities as well (the Russian preference), and so on.

Unfortunately, in recent years the U.S. side has tended to take a "he who pays the piper calls the tune" approach, essentially imposing its preferences on these issues. This new assertion of U.S. preferences has been combined with a substantial lack of continuity in the program. For example, there is frequent turnover in the U.S. management and implementation of the program, coming both from shifting directives from DOE headquarters and changing approaches by project teams at individual sites. When this situation is combined with the shift in leadership emphasis from senior laboratory experts to DOE headquarters staff, substantial frustration is generated among Russian participants, who see the U.S. side as constantly changing its mind and no longer

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[30] For a discussion of this project, see E. Kornilovich and B. Gardner, "Upgrades for Truck Transportation of SNM in the Russian Federation," in *Partnership for Nuclear Security*, U.S. DOE, September 1998, pp. 153–156.

[31] It was decided that all newer rail cars (several dozen) would receive security upgrades. A significant number of upgraded trucks have also been manufactured.

being led by serious MPC&A experts (see section on U.S.-Russian partnership, below).

For the U.S. side at least, the issues concerning what types of upgrades to focus on have now been hashed out in an official set of guidelines specifying the goals each project team should attempt to achieve (issued in late 1998). The guidelines instruct the project teams to focus first on those upgrades that "will produce the greatest reduction in risk" of theft of the material, with an integrated approach including both physical protection and material control and accounting.[32] The guidelines mandate a focus on relatively low-cost, "inherently sustainable" upgrades as a first step—obvious examples being bricking over windows, piling up large concrete slabs to block access to material, and the like—recognizing that this may necessitate doing additional, more elaborate upgrades in the longer term after initial upgrades have been completed. They also call for upgrades to be designed to defend against a single knowledgeable insider, a small group of armed outsiders, or insiders and outsiders working together. They instruct the teams to focus upgrades as close to the material as possible and to be highly skeptical of proposals for upgrading security perimeters. And they call for a focus only on preventing theft of plutonium or HEU, not on preventing sabotage of key nuclear facilities.

Physical Protection vs. Material Control and Accounting

Despite the issuance of the guidelines, the balance between physical protection, material control, and material accounting remains a key issue and a subject of some controversy. Physical protection advocates maintain that the measures they focus on are the ones that have the biggest immediate impact in reducing immediate theft risks, and point out that material accounting can at best detect thefts after they have occurred—it does nothing to actively prevent them. Physical security upgrades are often less complicated technically, require less understanding of a facility's operations and are therefore less sensitive, and, in some cases, more sustainable. Physical protection upgrades are also valuable politically, because items such as new fences and vaults are highly visible and demonstrable.

Material accounting advocates point out that accurate and regularly updated accounting of all the material on hand is the only way to confirm that the physical protection and material control measures have effectively prevented any theft, and that material accounting is a crucial element in detecting, deterring, and preventing thefts by insiders with knowledge of the weaknesses of the security systems.

These specialists note that while a violent assault by external terrorist to seize nuclear materials or sabotage a facility cannot be ruled out (and the possibility of such an attack may have increased) the primary proliferation threat at Russian nuclear facilities comes from knowledgeable and corrupted insiders attempting to steal materials either for profit or political reasons, or because of coercion by external criminals. Physical security does offer some deterrent against such insider threats. For example, fissile material monitors and secure material vaults are directly designed to address the insider threat. The installation of portal monitors to detect fissile materials also is an important measure to deter and prevent an opportunistic insider from removing nuclear materials from the facility. Physical security alone, however, is not sufficient and must be complemented by a material control and accounting system that provides for positive control of nuclear materials and ensures timely detection of a diversion. Ultimately, mate-

[32] *Guidelines for Material Protection, Control, and Accounting Upgrades at Russian Facilities*, op. cit.; the guidelines and the work of the Technical Survey Team are described in more detail in the section on management, below.

WHAT TYPES OF NUCLEAR MATERIAL SHOULD BE PROTECTED?

The MPC&A program is focused on securing and accounting for those materials whose theft could pose the greatest proliferation risks. But categorizing the materials according to the risks they pose has proven controversial—and the approach currently being used offers little protection for some lower-quality materials that still pose substantial proliferation risks.

Domestic U.S. MPC&A regulations,[1] IAEA recommendations for physical protection,[2] and Russia's own physical protection regulations[3] each contain approaches to categorizing material into higher and lower levels of proliferation risk. This allows a "graded safeguards" system to provide the highest levels of protection for materials that would be most attractive to a potential proliferator for use in nuclear weapons. Pure plutonium or HEU, in amounts that are a substantial fraction of the amount needed for a bomb, would be "Category I" material, requiring the highest levels of security. Plutonium or HEU in intensely radioactive spent fuel, by contrast, would be in a low category requiring only modest physical protection, as the intense radioactivity is considered to render the material "self-protecting."

In the IAEA recommendations, the U.S. Nuclear Regulatory Commission regulations, and the Russian regulations, material containing substantial quantities of plutonium or HEU which is not irradiated is considered a potentially serious proliferation threat, even if it is mixed with substantial quantities of other material. No distinction is made between, for example, pure plutonium or HEU oxides and mixtures, such as plutonium-uranium mixed-oxide (MOX) fuel, which typically contains 4-7percent by weight plutonium, with the remainder being natural or depleted uranium.[4] The United States has fought hard, and successfully, to ensure that these international standards continue to require security for materials such as MOX comparable to those required for pure plutonium.

But DOE's instruction guides for implementing its domestic MPC&A regulations, and its guidelines for the MPC&A program in Russia, take a radically different approach on this issue. Under this approach, any material with less than 10 weight percent plutonium or U-235 is considered "low-grade material," which can never be Category I. Under the guidelines, the teams are directed not to design MPC&A systems to provide any substantial degree of protection for such material. The guidelines specifically instruct the teams to ignore the higher categorization of this material that would result from applying Russian regulations.[5] In conversations with U.S. participants in the program, material such as fabricated MOX fuel is frequently dismissed as "junk" material.

There are two issues in considering the proliferation threat posed by possible theft of materials containing low weight percentages of fissile material: the difficulty of stealing enough material for a bomb, and the difficulty of making the material into a bomb once it is stolen. A thief stealing material that contained only 5 percent plutonium would have to steal 20 times as much material to get enough for a bomb. Stealing 100 kilograms of material would presumably be far harder to do, in most cases, than stealing 5 kilograms of material, and the need to steal such a large quantity could rule out some scenarios which might otherwise be credible. But once the material was successfully stolen, making a bomb from it would not be difficult. As long as these materials have not been irradiated, chemically separating the plutonium or HEU from the rest would not, in most cases, be particularly difficult to do, as it involves only widely available chemical materials and completely unclassified processes; any state or group that would be able to accomplish the relatively difficult task of making a bomb from pure plutonium would also be able to accomplish the simpler task of making pure plutonium from a mixture such as MOX. Thus, going from pure plutonium or HEU oxide to an unirradiated mixture makes the act of stealing enough material for a bomb more difficult, but does not substantially reduce the proliferation threat if sufficient material were to be successfully stolen.

Because the hardest part of making a nuclear weapon is acquiring the plutonium or HEU, and because producing pure plutonium or HEU from mixtures that had not been irradiated is not very difficult, in 1994 a committee of the National Academy of Sciences recommended that to the extent practicable, all plutonium or HEU that was not in forms so radioactive as to be comparable to spent fuel should be guarded and accounted for essentially as well as nuclear weapons themselves are—the so-called "stored weapons standard."[6] Following this recommendation, DOE has decided that in the plutonium disposition program, all transports of plutonium and MOX fuel will be carried out using the same Safe, Secure Transports (SSTs) used to transport nuclear weapons—in stark contrast to the actual requirements of DOE's domestic orders or the MPC&A program guidelines.

The approach taken in the MPC&A guidelines needs to be changed. While pure materials should continue to have first priority, dealing effectively with the proliferation threat requires having a significant level of protection for these low-weight-percentage materials. The guidelines should be revised to require levels of protection for different types of materials designed to ensure that a potential thief would not have a significantly easier job to get enough material for a bomb by stealing low-weight-percentage materials than by stealing pure materials—which would bring the guidelines closer to international standards and Russia's own domestic regulations.

This issue is important because there are substantial quantities of such low-weight-percentage material in use in Russia for a variety of purposes. Both MOX-based disposition of Russia's excess weapons plutonium, and HEU-fueled conversion of the plutonium production reactors, if these programs go forward, would involve U.S. sponsorship of very large-scale processing, transport, and use of such low-weight-percentage fissile material, and it will be absolutely critical, both for security reasons and for the political future of nuclear security cooperation, to ensure that no material is stolen from programs proceeding under U.S. sponsorship.

Recommendations

- Revise the guidelines to ensure that theft of enough material for a bomb in the form of low-weight-percentage material is not significantly easier than theft of enough pure material for a bomb—bringing them closer to conformance with international standards.
- At the same time, instruct the MPC&A teams to place first priority on security and accounting for pure material that could be used in weapons without chemical processing.

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[1] For DOE facilities, see *DOE Manual 474.1: Control and Accountability of Nuclear Materials*, August 11, 1999 (available at http://www.explorer.doe.gov:1776/htmls/currentdir.html), previously Order 5633.3B, and associated guides; for facilities regulated by the Nuclear Regulatory Commission, see *Code of Federal Regulations Title 10: Energy: Part 73: Physical Protection of Plants and Materials* (Washington DC: Government Printing Office, 1999), available at http://www.access.gpo.gov/nara/cfr/.

[2] International Atomic Energy Agency, "The Physical Protection of Nuclear Material and Nuclear Facilities," INFIRC 225, Rev. 4 (corrected) (Vienna, Austria: IAEA, 1999), available at http://www.iaea.or.at/worldatom/program/protection/inf225rev4/rev4_content.html.

[3] *Basic Rules on the Physical Protection of Nuclear Materials, Nuclear Installations, and Nuclear Material Storage Facilities*, Approved March 7, 1997, Decree No. 264.

[4] Interviews with NRC officials suggest, however, that the NRC may require somewhat less than the highest, Category I levels of security for fresh MOX fuel that will be briefly stored prior to loading in U.S. civilian reactors in the plutonium disposition program.

[5] *Guidelines for Material Protection, Control, and Accounting Upgrades at Russian Facilities*, op. cit.

[6] U.S. National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington DC: National Academy Press, 1994).

rial accounting is an essential element of integrated safeguards and security systems.[33]

In the MPC&A program to date, equipment for complete physical protection, material control, and material accounting systems has been provided—but (with exceptions at a few sites) the first emphasis and the most notable successes have been in physical protection. Except at a few sites, there has been little progress in actually using the equipment to carry out material accounting.[34] In fact, the U.S. understanding of the specific material control and accounting practices used in many Russian facilities still contains substantial uncertainties. And the Soviet system of providing accounting contains many serious flaws that are a function of the old Soviet production culture where excess production was stockpiled in good months for use during periods of under production. While there is now an increased emphasis on material accounting, progress has been slow to date, and faces numerous obstacles.

In particular, there are substantial disincentives to carrying out an accurate and complete physical inventory of the weapons-usable nuclear material in Russia. First, under current rules, if an accounting is taken which shows that there is less material on hand than paper records indicated there should be, the managers of the facility and the areas where the material has been handled are personally responsible—creating an understandable reluctance to carry out accurate accounts. Second, under the Soviet quota system, if a particular facility produced more than its quota in a given year, a smart manager would put the extra material aside in case the facility was unable to meet its quota the following year. Therefore many facilities reportedly had secret "honey pots" of material not listed on the official accounts, and an accurate accounting would require acknowledging these stockpiles, with the associated possibilities of embarrassment or repercussions for failing to account for them openly sooner. Third, for at least some of the larger facilities, an accurate accounting might well turn up material in areas not known to have material, that has effectively been forgotten. At the same time, because accounting involves detailed knowledge of the operations of the facility, many Russian experts have seen the renewed U.S. emphasis on material accounting not only as an example of U.S. unilateralism and inconsistency, but also as reflecting a U.S. desire to gather sensitive information about inventories and locations of nuclear materials at Russian facilities.

Nevertheless, a major breakthrough in improving material accounting in Russia is urgently needed. The first priority for accounting is to identify, tag, and seal every item or container with weapons-usable fissile material; the laborious and costly task of actually measuring the contents of those thousands of items and containers can be pursued in parallel, and will take far longer to complete.[35] Given the disincentives and concerns just described, making major progress in this area is likely to require a very high-level push, and creative approaches to meeting the Russian concerns. In particular, a temporary "amnesty" from punishment is likely to be needed to gain facility managers' support for carrying out complete and accurate accountings at their facilities. And the U.S. participants must make clear to their Russian counterparts that

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[33] For a useful discussion, see David R. Wilkey and Charles R. Hatcher, "Implementation of Materials Accounting in Russia," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

[34] See, for example, William C. Potter, remarks to the 7th Carnegie International Nonproliferation Conference, Washington DC, January 11–12 1999 (available at http://www.ceip.org/programs/npp/potter.htm).

[35] See Wilkey and Hatcher, op. cit.

what is important is for Russia to know exactly how much material is where, not for the United States to receive all of that sensitive information. A necessary counterpart to the facility level accounting is the rapid implementation of a national accounting system.

LEARNING LESSONS

The current structure of the MPC&A program—with separate U.S. and Russian project teams for each site—is effective in building partnerships between U.S. and Russian experts at the site level, but creates an environment in which similar problems are addressed again and again at different sites. Improved mechanisms for lateral communication among both Russian and U.S. experts working on different sites are needed to share information and lessons learned. Recent "lessons learned" workshops sponsored by the MPC&A program are a useful first step, but other steps, such as regularized meetings and newsletters of MPC&A experts from many sites on each side (and occasionally with both sides together) should be added.[36]

Security and Accounting Upgrades: Recommendations

- Continue to prioritize those upgrades likely to provide the largest and fastest sustainable reduction in theft risk per dollar spent, with an integrated approach to MPC&A.
- Improve U.S.-Russian coordination and joint planning, and resolve current access issues stalling upgrades at key sites (see sections IV and V for more detailed discussion and recommendations).
- Conduct lessons-learned sessions with representatives of various Russian sites, and establish other regular mechanisms for lateral communication between experts working on different sites.
- Work with Russian experts to improve the understanding of MC&A practices at Russian facilities.
- Undertake a high-level effort to gain Russian agreement to carry out rapid item inventories, identifying, tagging, and sealing each item or container with plutonium or HEU. As part of that effort, work out an arrangement to overcome disincentives, such as an "amnesty" period in which inventories could be carried out without repercussions if they did not match past paper records.
- Increase the scale of support for actual measured inventories of material.
- Redouble efforts to put in place an effective national inventory system as rapidly as practicable.

Sustainable Security

The goal of the MPC&A program must not be simply to install modern equipment, but rather to achieve effective and sustainable security and accounting for the long haul, for all weapons-usable nuclear material in the former Soviet Union. International assistance will not continue forever, and the problem of how to ensure that the improvements in security and accounting achieved in the MPC&A program will be sustained is by far the most difficult intellectual and policy challenge facing the program.

Achieving sustainable long-term security will require changes in ingrained habits, ways of thinking, and priorities among thousands of people in the former Soviet Union, from the President down to workers on individual processing lines handling nuclear material. Those changes will have to come from those individuals concluding that such changes are in their interests and the interests of their facilities, organizations, and countries; exactly

[36] For discussion, see Daughtry and Wehling, "Cooperative Efforts," op. cit.

how the United States and other international partners can best encourage such changes remains open to debate.[37] Further complicating the policy challenge is the inevitable problem of balancing near-term upgrade measures that are urgently needed to address immediate risks of theft with long-term measures needed to build a sustainable base for the future.

During the MPC&A program's early years, it was expected that by the end of the few years required to carry out initial upgrades, the economies of the former Soviet states would have improved, and the Russian safeguards culture would have absorbed and internalized the key aspects of modern MPC&A. Hence, maintenance and further improvement of the installed systems could be handed off to the former Soviet states with only modest needs for further U.S. assistance. Unfortunately, improvements in both economic conditions and safeguards priorities in the Russian system have been far slower than anticipated. Thus sustainability, always recognized as important, has come to be seen as a critical issue for the future of the program.

This increased emphasis on sustainability began in 1997–98, as MPC&A technology upgrades were completed at some facilities, and problems with spare parts and equipment warranties emerged. The August 1998 economic crisis brought the issue into sharp relief; reports of sites simply not using their newly-installed equipment because they did not have the money to operate and maintain it, of guards leaving their posts to forage for food, and of security systems shutting down because the facility's power had been shut off for non-payment of bills, made clear that systemic problems with achieving sustainable security remained. It has become clear that, faced with economic difficulties, nuclear facilities and the Russian government are unlikely to assign nuclear safeguards their due priority in allocations of funding and personnel, that many safeguards concepts and technologies introduced by the DOE MPC&A program have not yet become integrated into the safeguards culture at Russian sites, and that the national-level safeguards infrastructure remains underdeveloped.

In response to the August 1998 crisis, the MPC&A program launched the Site Operations and Sustainability (SOS) program.[38] After working to provide emergency assistance to sustain safeguards during the winter of 1998–99, this effort moved on to

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[37] For recent unofficial discussions of the sustainability issue, see Bunn, The Next Wave, op. cit.; Oleg Bukharin, *Achieving Safeguards Sustainability in Russia* (Princeton, NJ: Center for Energy and Environmental Studies, Princeton University, Report No. 305, March 1998); Potter and Wehling, "Sustainability," op. cit.; James E. Doyle and Stephen V. Mladineo, "Assessing the Development of a Modern Safeguards Culture in the NIS," *Nonproliferation Review*, Winter 1998; Todd Perry, "From Triage to Long-Term Care: A U.S. NGO Perspective on the Future of the MPC&A Program," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999; and Todd Perry, "Securing Russian Nuclear Materials: The Need for an Expanded U.S. Response," Nonproliferation Review, Winter 1999, Vol. 6, No. 2.

[38] For official summaries of the sustainability effort, see Rose Gottemoeller, Deputy Administrator for Defense Nuclear Nonproliferation, Department of Energy, "The Importance of Sustainability in Securing Nuclear Material in the Former Soviet Union," paper presented at "Global '99: Nuclear Technology- Bridging the Millenia," Jackson Hole, Wyoming, August 30–September 2, 1999 (available at http://www.nn.doe.gov/mpca/pubs/frame_tec.htm); Carrie Smarto et al., "MPC&A Site Operations and Sustainability: A Policy Overview," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999 (available at http://www.nn.doe.gov/mpca/pubs/frame_tec.htm); and Michael Haase et. al., "Material Protection, Control, and Accountancy (MPC&A) Sustainability," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

address longer-term sustainability issues. To date, the effort has focused primarily on ensuring that (a) spare parts and maintenance services are available to maintain equipment; (b) procedures are put in place to use that equipment effectively; (c) people are trained to use this equipment and these procedures; (d) guards are also appropriately trained and equipped; (e) there is increased operational evaluation of how well overall MPC&A systems are actually working, and how well particular pieces of equipment are performing; and (f) at least limited initial steps are taken to foster the growth of Russia's "safeguards culture," including through "nonproliferation awareness" training.[39] The issue of carrying out material inventories, discussed above, has also been lumped under the rubric of sustainability. The sustainability effort has made some notable progress, including an evaluation of the MPC&A equipment market in Russia, and site-level training needs assessments for several facilities. A sustainability program strategic plan is to be completed during FY2000.[40] These efforts are absolutely necessary, but they are not likely to be sufficient.

What is needed is to increase the former Soviet states' sustainable capacity to manage nuclear materials securely, and convince them to use that capacity for this purpose. Unfortunately, experience with U.S. and international "capacity-building" programs—designed to improve recipient states' abilities to carry out tasks ranging from tax collection to providing public health services—is littered with programs that had little or no long-term benefit because they focused only on providing the technical equipment and training needed to carry out the specific task at hand (as the MPC&A program has generally done to date). For lasting benefit, experience suggests that broader problems such as the authority, resources, and organization of the institutions carrying out the task, their effectiveness in hiring and retaining qualified personnel and providing incentives for good performance, the communications among the relevant players working on the task, the presence or absence of mechanisms for regular assessment and critique of performance, and the like must also be addressed. Yet these broader issues are frequently seen as being "beyond the scope" of the assistance program, as they generally have been in the case of MPC&A.[41] In addition, the U.S. Congress has not been notably enthusiastic about funding sustainability efforts. The Congress does not want to see the U.S. investment in security upgrades squandered once that job is done, but the Congress has not been convinced that the administration has a sensible package of initiatives that really will achieve sustainability for the long haul at a reasonable price. It is not clear whether Congress will ultimately be willing to provide the funding required to carry out the multitude of sustainability efforts that would be required to reasonable ensure long-term MPC&A effectiveness in Russia.

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[39] See Smarto et. al., op. cit.

[40] DOE MPC&A Program RANSAC Briefing, October 7, 1999, DOE, Washington, DC.

[41] In general, there is much to be learned for the MPC&A program from other experiences in providing assistance to build a state's capacity to carry out particular government functions. The necessary broad program of reform requires a systemic understanding of how the system whose capacity is to be built actually functions, which the MPC&A program and related efforts are just beginning to have. See Merilee S. Grindle, ed.: *Getting Good Government: Capacity Building in the Public Sectors of Developing Countries* (Cambridge, Mass.: Harvard Studies in International Development, Harvard University Press, 1997). For a provocative application of these lessons to the problems of nuclear material management in the former Soviet Union, see Stacy VanDeveer, "Cooperative Security and Capacity Building in the Former Soviet Union," (Cambridge, Mass.: Managing the Atom Project Discussion Paper, Harvard University, forthcoming).

Today, facilities in the former Soviet states lack both the resources (money, appropriate equipment, appropriately trained personnel, appropriately functioning organizational structures, etc.) needed for effective security and accounting for nuclear material over the long haul, and the incentives to use what resources they have for this purpose. Spending on safeguards and security creates no additional products or revenues ("safeguards don't produce kilowatt-hours," as the saying goes), so in the absence of effective regulation imposing stringent security and accounting requirements, facility managers in the former Soviet Union facing desperate budget crises have every incentive to skimp on providing the needed funding for effective MPC&A. Beyond the individual facilities is an overall context in Russia of a dysfunctional government, depressed economy, rampant crime and corruption, and only modest high-level attention devoted to MPC&A, all of which makes sustainable security far more difficult to achieve.

An expanded MPC&A sustainability effort should focus on three key areas: providing the former Soviet states and their facilities handling plutonium and HEU with the resources to sustain effective MPC&A, the incentives to use those resources for that purpose, and assistance in structuring the organizations needed to carry out the task effectively. Before making our recommendations in each of these three key areas, we discuss four specific issues within them—regulation, training, building up the indigenous technical base, and performance testing of MPC&A systems—in more detail.[42]

MPC&A Regulation

Regulatory oversight is a key element of an integrated and sustainable system of nuclear safeguards.[43] As noted above, effective regulation—including the realistic prospect of being fined or shut down for failure to meet regulatory requirements—is critical to providing facility managers the incentive to assign money and people to achieving effective MPC&A.

The principal MPC&A regulatory responsibilities include development and maintenance of rules and regulations, licensing, inspection, and compliance assurance (a term including enforcement and various other means to convince regulated entities to comply with regulations). Maintenance of capabilities for emergency response and post-incident investigation, along with development and maintenance of a design basis threat, are additional important regulatory functions.

Several agencies have key nuclear safeguards regulatory functions in Russia. The Inspectorate for Nuclear Material Safety of the Ministry of Defense (MOD) regulates safety and security of intact nuclear weapons and nuclear materials at defense installations of Minatom and the Ministry of Defense. Civilian nuclear facilities and civilian parts of Minatom's defense sites are regulated by Gosatomnadzor. Other agencies, such as Minatom and the Ministry of Internal Affairs, participate in the development of federal MPC&A regulations and other national-level regulatory activities. Minatom and other individual agencies are also responsible for establishing ministerial-level standards, instructions, and guidance documents as well as for conducting internal oversight and supervision of MPC&A activities. Within Minatom a ministerial-level regulatory effort is administered by the Department for the Protection of Sites, Information, and Materials, which is designed to ensure that

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[42] Many of these recommendations are drawn from Bunn, *The Next Wave*, op. cit., pp.81–88; see also Potter and Wehling, "Sustainability," op. cit.

[43] Bureaucratically, however, regulatory support is managed separately from the sustainability effort within the MPC&A program, and therefore was not listed above among the sustainability effort's key emphases.

Minatom facilities meet the ministry's requirements; inspections are carried out by a newly established group at the Federal Nuclear Center—Institute of Experimental Physics (Russian acronym VNIIEF, in the town formerly known as Arzamas-16). In early 1999, Minatom was given responsibility for licensing its defense facilities, though the MOD still has authority for regulating them.[44]

Russia has made some significant progress in developing a national nuclear regulatory system for MPC&A, but much more remains to be done. The Law on Nuclear Energy was signed into effect in 1995, and since then has served as the legal basis for the MPC&A regulatory framework. An interagency group, composed of representatives from Minatom, Gosatomnadzor and other agencies, has been working for years to develop federal level regulatory documents for physical protection and MC&A. A rather broad set of physical protection rules has been issued and entered into force, with more specific documents still under development. After the interagency group had failed for some years to reach consensus on the parallel MC&A rules, Minatom issued the draft rules as ministerial requirements for facilities under its control, but work on completing the federal-level version continues. Several documents incorporating more specific federal-level requirements relating to both physical protection and material control and accounting are under development. Similarly, a variety of more specific agency-level regulations and guidance documents have been adopted or are under development in Gosatomnadzor, Minatom, and other agencies.[45]

While still weak, Russia's nuclear regulatory authorities are becoming more effective in implementing their inspection and enforcement functions. Gosatomnadzor plays a particularly important role, at least for civilian nuclear activities. In addition to the headquarters in Moscow, it has offices in seven regions across the country, five of which have dedicated MPC&A inspection groups. Many large facilities have resident inspectors. Gosatomnadzor officials report that over two hundred of the agency's inspectors and experts are involved, to various extents, in MPC&A regulation.[46] Gosatomnadzor personnel have largely completed familiarization with nuclear facilities and have developed an elaborate system of inspections.[47] Gosatomnadzor has also demonstrated its willingness and ability to enforce regulatory requirements, at least in some cases. In 1999, for example, because of MPC&A inadequacies, it suspended operations at the Institute of Atomic Reactors in Dimitrovgrad. A federal law passed in early 2000 specified the fines Gosatomnadzor has the authority to impose.

Considerable difficulties in developing a consistent, integrated, and effective system of regulatory oversight remain, however:

- The principal nuclear regulatory agency, Gostatomnadzor, simply does not yet

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[44] Russian Federation Government Decree No. 1007 (signed by then-Prime Minister Putin), September 4, 1999: "On Licensing Activity Involving the use of Radioactive Material in Carrying Out Work To Utilize Nuclear Power for Defense Purposes," published in *Rossiyskaya Gazeta*, September 28, 1999.

[45] For a discussion of most of this information, see Frederic Morris et al., "Creating the Regulatory Base for MPC&A in the Russian Federation: Challenges and Strategy," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

[46] These include MC&A and physical protection officials in the headquarters in Moscow, MPC&A groups in the regional offices, and resident inspectors at some facilities which observe MPC&A practices in addition to performing their duties in the area of nuclear safety and radiation protection.

[47] Alexander Dmitriev, remarks at the International Conference on Physical Protection, Vienna, November 9–14, 1997.

have the political clout, finances, and personnel to conduct fully effective regulatory oversight of MPC&A—particularly when its power and resources are compared to those of Minatom, the ministry in charge of many of the facilities Gosatomnadzor is supposed to regulate. Gostatomnadzor has frequently been excluded from access to key facilities or information, and has faced overwhelming political pressure not to carry out its regulatory duties too vigorously. Gosatomnadzor has developed relatively little experience over the years in effective MPC&A regulation. Low salaries make it difficult to hire and retain experienced safeguards experts and this results in high turnover rates. The lack of funds limits the scope of Gosatomnadzor inspection activities. Enforcement frequently is difficult because many facilities are unable to pay monetary fines and their operations cannot be suspended for safety and economic reasons.

- The regulatory program is fragmented. In part due to vague and imprecise language of the 1995 Law on Nuclear Energy, the division of regulatory responsibilities between various agencies is ambiguous and has been shifting continuously.[48] By the Presidential decree of July 21, 1995, for example, the regulatory oversight responsibility for nuclear defense activities was transferred from Gosatomnadzor to the Ministry of Defense, but precisely where one agency's authority stopped and the other's began was left vague. As a result, according to Gosatomnadzor officials, "[T]here are attempts by certain [Minatom] weapons-production and dual-use fuel-cycle facilities to circumvent the existing regulatory system and to assume oversight responsibilities without a permission from either Gosatomnadzor or the Ministry of Defense."[49] Gosatomnadzor also has virtually no ability to regulate the Ministry of Interior (MVD) guard forces, which are inspected and controlled internally.

  In 1999, Gosatomnadzor and the Ministry of Defense came to a common understanding on the division of their respective regulatory authorities. The coordination process, however, was set back in the fall of 1999 when the Russian government charged Minatom with licensing of Minatom's defense facilities. Additional interagency consultations are now required to demarcate Gosatomnadzor and Minatom licensing activities, and to coordinate Minatom's licensing with Ministry of Defense's inspection and enforcement activities.

- The regulatory development process is slow because of power struggles and substantive debates among the agencies drafting the regulations, and limited Russian resources and experience in drafting MPC&A regulations. As a result, Russia has yet to develop a consistent regulatory base that is sufficiently detailed to be effective, and many needed regulations are not yet available. For example, the document Basic Rules on Physical Protection is considered too general to provide the basis for effective regulation, and the document Basic MC&A Rules has not yet been adopted (except for Minatom facilities, as noted above). More detailed regulations are still in development after years of work. Because some regulatory documents are

[48] Morris et. al., "Creating the Regulatory Base," op. cit.

[49] *1995 Gosatomnadzor Repor*t, 1996, Gosatomnadzor, Moscow, p. 51.

missing, there is also a possibility that U.S.-sponsored upgrades would not meet Russia's future regulatory and certification requirements. The lack of regulations thus is slowing down MPC&A upgrades and might require backfitting in the future.

Strengthening Russia's regulatory programs and helping its regulatory agencies to overcome their current limitations is important for improving sustainability of nuclear safeguards in Russia. This was one of the original objectives of the MPC&A program, and continues to be an important goal. But in recent years, in part because of frustration over the slow pace of progress in strengthening regulation in the former Soviet Union, DOE has reduced efforts in this area to a very modest level, and has virtually eliminated the role of the U.S. Nuclear Regulatory Commission (which has far more regulatory experience than DOE).

The DOE MPC&A program has initiated regulatory projects with both Minatom and Gosatomnadzor. With the exception of a modest level of regulatory development assistance under the MPC&A Navy Fuels program, however, no substantial regulatory activities have been initiated with the Ministry of Defense regulators responsible for regulating all military nuclear activities. This should be corrected. Given the broad regulatory authority this body has over both Ministry of Defense and Minatom facilities, a regulatory support program should be established with this group comparable in size and scope to the programs needed with Gostatomnadzor and Minatom.

The DOE-Minatom regulatory project was launched in 1997 and focused on the development of Minatom's MPC&A regulations. In particular, the project facilitated the drafting of the MC&A rules (drafted by an interagency committee led by Minatom), which were issued in early 1999 and since have become the agreed standard for Minatom facilities. Beyond regulation development, however, the program has not attempted to strengthen Minatom's internal regulatory capabilities. Ultimately, if Russia's overall regulatory system is to be fully effective, Minatom needs a substantial ability to regulate itself, including a complete body of regulatory documents, strengthened inspection capabilities, and clear authority for the internal regulatory group at Minatom to fine, shut down, or suspend Minatom budget payments to facilities that do not meet Minatom MPC&A requirements.

DOE assistance to Gosatomnadzor has largely been provided under the June 1995 DOE-Gosatomnadzor agreement.[50] Initial projects included the review and writing of regulatory documents, training, development of an inspector information support system, development of a state system of material accounting, regional inspection equipment centers, and MPC&A upgrades at Gosatomnadzor-proposed (non-Minatom) facilities.

Since that agreement, the national accounting system project with Gosatomnadzor ceased to exist after the Russian government transferred the responsibility for the system to Minatom, away from Gosatomnadzor.[51] The project to establish regional equipment centers has been scaled down to a single center in Novosibirsk, because of concern over Gosatomnadzor's ability to operate and main-

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[50] Y. Volodin and T. Kroupchatnikov, "Past, Present, and Future of MPC&A Cooperation: GAN Perspective," in *Partnership for Nuclear Security*, U.S. DOE, September 1998, pp. 31–38; see also Morris et. al., "Creating the Regulatory Base," op. cit.

[51] In the United States, NRC inspectors do not have a dedicated information support system; the NRC also is not directly involved in the development or operation of the state material accounting system.

tain complex and expensive equipment.[52] The DOE MPC&A program has continued to sponsor upgrades at Gosatomnadzor-proposed facilities, and these have resulted in important security and accounting improvements at those facilities, but this makes little contribution to Gosatomnadzor's regulatory capabilities.

The remaining support to Gosatomnadzor primarily focuses on regulatory document development and training. Even in these areas DOE support has declined, mainly because of their perceived low near-term return. Recently, however, there have been joint inspection-accompaniment visits involving reviews of MPC&A at U.S. and Russian facilities by both Gosatomnadzor personnel and U.S. personnel, which have had a significant beneficial impact, and may offer the first step toward a strengthened regulatory support program.

The low priority of regulatory support within DOE's MPC&A program is particularly evident in DOE's treatment of the Nuclear Regulatory Commission's MPC&A support program for the former Soviet Union. The NRC is the only U.S. nuclear regulatory agency with experience in fully independent oversight and regulation. Funded by the Cooperative Threat Reduction (CTR) program, it was providing training to Gosatomnadzor personnel (and comparable agencies in other former Soviet states) in the areas of regulatory process development, design basis threat development and maintenance, safeguards licensing, and inspection activities (including performance testing). In Russia, many of these activities were directed at Gosatomnadzor's regional offices. In FY99, however, the CTR funding for NRC safeguards work in the former Soviet Union expired and DOE failed to step in. NRC repeatedly requested DOE funding for regulatory support activities for MPC&A in the former Soviet Union that it believed were critically necessary. Ultimately, DOE would only agree to provide a much smaller amount of funding, focused on NRC support for DOE-directed activities, not independent regulatory support. This forced the NRC to cancel activities it had scheduled for FY99 and FY00.[53] As of June 2000, an inter-agency DOE-NRC agreement was finally reached. No significant NRC work is, however, expected to begin in Russia or other NIS countries before the fall of 2000.

The weaknesses of Russia's MPC&A regulatory structure require a renewed effort in regulatory support, including working with the highest levels of the Russian government to ensure that adequate resources and authority are devoted to regulation; assistance in drafting and implementing appropriate regulations and rules; provision of training and equipment to regulatory bodies; and helping them with organizational reform. MPC&A regulatory support programs need to be beefed up with additional funding and personnel, a new sense of strategic mission, and new ideas, focusing not only on Gostatomnadzor but also on the Ministry of Defense regulatory body that regulates military-related facilities, and on internal self-regulation within Minatom. In particular, DOE should provide the U.S. Nuclear Regulatory Commission with the funding it needs to continue and expand its regulatory support work in the former Soviet Union.

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[52] In the United States, NRC inspectors do not conduct independent measurements or operate sophisticated measuring equipment. Instead they observe measurements, including calibration and validation measurements and procedures, that are performed by the operating organization.

[53] See, for example, William H. Travers, "Update on U.S. Department Of Energy Funding For U.S. Nuclear Regulatory Commission Material Protection, Control, and Accounting Assistance To the Republics Of The Former Soviet Union," memorandum to the NRC commissioners, SECY-99-068, March 4, 1999 (available at http://www.nrc.gov/NRC/COMMISSION/SECYS/secy1999-068/1999-068scy.html)

Technical Infrastructure Development

Another critical element of long-term sustainability is building up the indigenous technical infrastructure to design, produce, install, operate, and maintain MPC&A systems. While there are a growing number of entities in Russia with at least some capability to manufacture MPC&A equipment, overall, the indigenous infrastructure for modern MPC&A systems in Russia remains weak, if compared to what will be needed to maintain effective MPC&A for the long haul. This situation represents a significant failure to achieve one of the principal goals of the MPC&A program.

This raises the obvious issue—faced by both the MPC&A program and DOD's warhead security and accounting program—of whether to rely primarily on Western or indigenously produced equipment (and within these categories, which particular firms' equipment). A strong argument can be made that it is better to use indigenously produced equipment where possible. Such equipment is likely to be cheaper, easier for the sites to maintain, easier to integrate into existing systems, and its use would build up indigenous Russian capabilities to design, produce, and maintain effective MPC&A systems. Moreover, it is likely to be easier to gain the acceptance of Russian security services for indigenously produced equipment—which is likely to raise fewer concerns that it might be bugged or otherwise contribute to spying—and such acceptance is crucial to actually being able to get equipment installed at sensitive facilities (see discussion below).

For these reasons, in some parts of the MPC&A program—for example, the initial work at the Kurchatov Institute, and the continuing work in the Navy program—the equipment installed was almost entirely Russian (the exception generally being security cameras and computers, that tend to be foreign-made). The issue is not clear-cut, however, as there are a variety of areas where Western equipment is superior (at least in the judgment of Western experts). Hence, in a variety of other parts of the MPC&A program, there has been a tendency to focus on equipment from Western manufacturers, some of which is judged by the U.S. participants, and sometimes by experts from Russian sites, to be more effective, more reliable, and have better warranty maintenance and support. In one extreme case, the leader of a U.S. project team insisted that all of the physical protection to be installed be American-made, and even had a reinforced steel door produced in the United States and shipped to Russia. Originally, the program management used to closely track what percentage of the equipment installed was indigenous; now, the figures that are usually presented are the percentage that is produced by firms that have in-country offices and support capabilities, lumping indigenous firms and Western firms with Russian offices together. The MPC&A program has undertaken a "market survey" of firms in Russia that provide physical protection equipment, and has been working to increase both the number of indigenous firms and the number of Western firms whose equipment is certified for use at Russian nuclear facilities.[54] It is important, however, to increase the focus on working with existing and potential indigenous suppliers to increase their ability to mass produce high-quality, cost-effective, easily maintained MPC&A equipment that would be competitive with equipment from Western suppliers. This is a key issue in the development of a sustainable safeguards environment.

The next key issue on sources of equipment is from which firms purchases should be made. In Soviet times, virtually all physical protec-

[54] DOE MPC&A Program RANSAC Briefing, October 7, 1999, DOE, Washington, DC.

tion equipment for both Minatom, MoD nuclear weapons storage areas, and other high-security facilities was developed and (often) produced by Eleron, Minatom's physical security equipment design and manufacturing center. Moreover, equipment cannot be installed at sensitive nuclear facilities unless it is "certified" as safe, effective, and not rigged in some way to provide intelligence information—and until recently, Eleron was in charge of performing the certifications, allowing it to maintain its near-monopoly. Recently, a new certification system was put in place that no longer places total reliance on Eleron, and an increasing number of other suppliers have managed to receive certifications for equipment, though the process remains an extremely difficult one and continues to place unfortunate constraints on the equipment that can be used.[55]

Both the MPC&A program and the CTR warhead security program have concerns about Eleron as an equipment supplier, including uneven quality, poor post-installation support, and high cost. Eleron nonetheless maintains an essential position of trust inside the Russian nuclear bureaucracy. And its support for security improvements has had positive political effects inside the Russian government.

The MPC&A program has been struggling with some success to break Eleron's monopoly and get other suppliers certified. In 1998, however, the program went even further, and attempted to end purchases of Eleron equipment entirely, an approach that has proven to be counterproductive. Eleron has more experience in physical protection for nuclear facilities than any other Russian vendor. It is also a designated organization for physical security upgrades under Minatom's internal programs. Eleron has very close political ties with the senior officials in charge of security at Minatom and the MoD. Finally, Eleron is immune from restrictions imposed by FSB guidelines that call for minimizing visits to nuclear facilities by outsiders, such as representatives of Russian or foreign commercial companies. These restrictions, particularly in the current environment of increased emphasis on security and access limitations, could make it difficult to arrange for equipment service and maintenance by commercial companies. Given these factors, it would be highly unwise to attempt to exclude Eleron from the MPC&A upgrade process—effectively launching a war with the firm that has the ear of the most senior MPC&A officials in Russia. Rather, a more sensible approach would be to work with Eleron to help them improve their products, while simultaneously working with Minatom headquarters officials to emphasize the importance of a broad base of suppliers for MPC&A equipment and the need to expedite the process of certification for equipment from others suppliers.

Production of MPC&A equipment also represents an important defense conversion opportunity. A number of Minatom's defense facilities, including many nuclear warhead assembly and disassembly facilities, are involved in the production of security hardware. Some of these efforts, such as the production of portal monitors at the Avangard warhead assembly plant in Arzamas-16, are being considered for support by the U.S.-Russian Nuclear Cities Initiative (NCI) program (a program focused on the conversion of Russian scientists and the redirection of activities in the weapons complex). The DOE MPC&A program has already supported the production of portal monitors at Tomsk-7 and Arzamas-16, for example. There is still much more that could be done, however, to fully

[55] For a discussion of the Russian certification system (sometimes referred to as "CAL" for certification, attestation, and licensing), see Ronald B. Melton et. al., "MPC&A Program Certification Primer—Certification in Russia," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

engage Minatom defense facilities as suppliers of safeguards and security equipment—meeting the objectives of MPC&A and defense conversion simultaneously.

Beyond the issue of equipment manufacture, there is also the area of design of MPC&A systems for individual sites. This function is currently carried out by joint U.S.-Russian teams for each site, with a substantial amount of work done by U.S. team members, frequently traveling to the site in question to work with their Russian counterparts. This creates a substantial travel burden on U.S. participants; high costs for paying the U.S. participants; frequent communication difficulties as, with no one on the ground full-time, U.S. and Russian participants often can meet only once every several months, allowing misunderstandings to fester and grow; and difficulties with access to sensitive facilities. In the Navy program, however, an increasing fraction of these duties has been carried out by the Kurchatov Institute team (see "The Navy MPC&A Program: Lessons of Success," pp. 60-61). This has reduced costs and travel burdens, allowed problems that arise to be addressed continuously by on-the-ground personnel, and reduced access difficulties, while allowing continued oversight and approval of the overall effort by U.S. experts. Similarly, the MPC&A team from Chelyabinsk-70 has agreed to serve as the "general contractor" for MPC&A upgrades at Sverdlovsk-44.[56] Increasing the emphasis on building up Russian entities that can perform such roles should be a high priority for the MPC&A program, as it would both contribute to building up Russia's indigenous MPC&A technical infrastructure and help address a number of problems now facing the MPC&A program; if a small number of entities were each helping to design systems at several sites, this would also help improve site-to-site consistency in the overall program. Such approaches, however, will inevitably require some compromises on how closely the program is controlled from DOE headquarters.

Training and Personnel Issues

To achieve sustainable security for nuclear materials in Russia it is critical to provide effective training in modern safeguards and security technologies and approaches and also to convey the fundamental importance of controlling HEU and plutonium to the security of Russia and the world.

The MPC&A program has supported a wide range of training efforts, but problems remain.[57] DOE's MPC&A program, the European Union, and Minatom's internal funds all supported the establishment of the Russian Methodological and Training Center (RMTC) at the Institute of Physics and Power Engineering in Obninsk, which is now Russia's principal national MPC&A training center. Initially intended to train Minatom personnel, it now provides training to experts from Gosatomnadzor and other agencies as well. Given the vast number of people who are involved in handling nuclear material and using MPC&A equipment in Russia, much of the RMTC's work has focused on a "train the trainers" approach, in which the RMTC would provide training to representatives from particular sites, who would then return to their sites and train others there. Recently, however, the program has focused increasingly on site-specific training, as a complement to the general training provided at the RMTC.

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[56] See Gennady Tsygankov et al. "Progress and Future Plans for MPC&A at Chelyabinsk-70," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

[57] For a useful discussion of MPC&A training programs, see Todd Perry, "Coordinating U.S.-Sponsored MPC&A Training: A Prerequisite for Sustainable Russian MPC&A Upgrades," in *Proceedings of Global '99: Nuclear Technology- Bridging the Millenia*, Jackson Hole, Wyoming, August 30–September 2, 1999, La Grange Park, IL: American Nuclear Society, 1999.

The MPC&A program has also sponsored the establishment of a graduate degree program in MPC&A at the Moscow Engineering Physics Institute (MEPHI)—a training program more advanced and intensive than is available at any university in the United States. The first graduates of this program have taken relevant positions in several agencies dealing with MPC&A. The number of trainees willing to spend years learning about MPC&A will always be small, however, and the expense of supporting tuition for such an extended program is substantial. One U.S. review recommended that the program also provide training relevant to commercial security, such as protection of banks, in order to draw more students and move closer to becoming financially self-sustaining.[58]

In addition to these major training programs, there have been a wide range of small-scale training efforts supported by the U.S. MPC&A program or related programs, such as various types of inspector training for nuclear regulators, special courses on particular topics, the early beginnings of training on general nonproliferation issues, and the like.

Several Russian participants have recommended the establishment of additional training centers comparable to the RMTC, to handle the training load. The U.S. and Russian teams at Chelyabinsk-70 initially agreed to establish an MPC&A training center there, to train personnel from the several large facilities in the Urals region and Siberia (the center was formally established by a Minatom decree in 1999). The U.S. side then put this project on hold due to lack of sufficient funding.

It is not yet clear, however, that all of the people who most require MPC&A training are in fact receiving appropriate training, that the leadership of Russian facilities is committed to making MPC&A training an integral part of staff training (as issues such as safety and health already are), or that training is in fact leading to personnel effectively implementing procedures that will result in achieving high standards of security and accounting for nuclear material. The procedures issue is particularly crucial: no amount of modern equipment will result in a secure system if security and accounting procedures do not exist or are routinely bypassed when they are inconvenient. (To address this issue, the sustainability program is sponsoring workshops to help Russian facilities draft appropriate procedures for their MPC&A systems.)

Currently, different parts of training support are included in several bureaucratically separate parts of the MPC&A program. While it is valuable to integrate training into particular projects, training is sufficiently important to the overall effort—and sufficiently at risk of being underfunded in favor of more "demonstrable" equipment installations—that it may make sense to establish a centralized mechanism within the program to coordinate and advocate for all the different training efforts underway.[59]

But training will not be effective unless the trained personnel are effectively retained and used—which means that ensuring that the personnel systems for MPC&A experts in the various relevant agencies are functioning effectively is also a key part of the puzzle. If most people who are being trained are quickly leaving for other jobs, or being reassigned to other tasks within their organizations—as has frequently been the case in other U.S. aid efforts designed to "build capacity" of foreign governments to carry out governmental tasks—the benefits of the training will be short-lived. It appears that the MVD troops who guard

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[58] National Research Council, Committee on Upgrading Russian Capabilities to Secure Plutonium and Highly Enriched Uranium, *Protecting Nuclear Material in Russia* (Washington DC: National Academy Press, 1999).

[59] See Perry, "Coordinating U.S.-Sponsored MPC&A Training," op. cit.

nuclear facilities (and who operate some of the physical protection equipment being provided) are a particular problem in this regard, as many of them cycle through after relatively brief assignments, creating a continuous training need. It may be worth considering a new initiative to establish a central training facility for all such guards, comparable to the U.S. Safeguards and Security Central Training Academy established in 1984.[60]

Finally, it is crucial that training include not only the technical details of MPC&A, but also the reasons why high standards of MPC&A are so critical to Russian and international security. If the people within the MPC&A system understand that the entire global effort to stem the spread of nuclear weapons depends on ensuring that all plutonium and HEU is secure and accounted for—that it depends, in a very real sense, on them doing their jobs well—they are more likely to be motivated to achieve high standards, avoid cutting corners, and take the initiative to correct weaknesses in the system and suggest ways that it could be improved. Hence, at least a modicum of training in nonproliferation is crucially important to achieving sustainable MPC&A. DOE has begun to support some nonproliferation training, but there is much more that could be done to fully integrate nonproliferation into the training of all MPC&A experts in the former Soviet Union.[61]

Performance Testing

Realistic testing of how well MPC&A systems actually do in defeating insider and outsider threats is critically important, as the performance of a system in the real world is almost always different from its performance on paper. In the U.S. experience, achieving a fully effective MPC&A system typically requires a repeated process of testing the system, fixing vulnerabilities revealed in the test, testing it again, and fixing it again. Without a realistic performance testing program—sometimes more broadly referred to as "operational evaluation" to ensure that such items as testing the quality of material accounting measurements and procedures are also included—there can be little confidence that installed MPC&A systems will perform effectively when they have to. And if they don't, they may even reduce security of nuclear materials by lulling facility operators, policymakers, and the public into a false sense of security. Moreover, in the U.S. system, spectacular failure in realistic tests has proven to be an excellent mechanism for convincing high-level officials that more funding for security really was required.

Typical causes of safeguards vulnerabilities are improper application of safeguards technologies or ineffective response strategy and tactics. These problems cannot be identified and corrected without site-specific performance testing—actual drills conducted in the controlled environment under realistic threat assumptions and a range of safeguards contingencies. Depending on the goals of a particular test, performance testing can be limited in scope to address individual elements of the security system, or it can be comprehensive. To be effective, performance evaluations must be conducted by specially trained and experienced personnel who have a military and security background and are knowledgeable of adversary techniques, tactics and capabilities. (Such skills and expertise are not readily available and require specialized training.) In that, performance testing differs from more conven-

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[60] This center is now one part of the broader Nonproliferation and National Security Institute; for more information, see the institute's website, at http://www.nnsi.doe.gov/.

[61] William C. Potter has played a key role in focusing attention on this issue, and in helping DOE structure initial efforts in nonproliferation training. See, for example, Potter and Wehling, "Sustainability," op. cit.

tional compliance testing, which is based on checklist inspections to assure that all safeguards elements are installed and operable.

Russian facilities perform a variety of types of tests of their security systems; it appears that specific approaches vary considerably from one site to the next. But there are apparently no institutionalized programs to carry out full-scale tests of the MPC&A systems' performance in defeating realistic outsider or insider threats (who may use tactics the defense does not expect, designed to exploit vulnerabilities of the system). Because of sensitivities over revealing detailed means to overcome security systems to U.S. participants, to date it has not proved possible to reach agreement on widespread performance of tests at Russian facilities in which U.S. teams would participate. At the small number of facilities in Russia and other former Soviet states that have been made available for such testing, knowledgeable U.S. testers demonstrated their ability to easily defeat newly installed or upgraded intrusion detection and assessment systems.

The MPC&A program has identified performance testing as a key issue. The guidelines document mentioned above, for example, emphasizes that teams should incorporate performance testing programs into their work with individual sites, and suggests that "it is advisable that this [performance testing] concept be discussed early during the upgrade selection process to establish the need for the program."[62] There are also proposals to make performance testing a part of contract requirements. Overall, however, it appears that there has still been little success in instituting a practical full-scale performance testing program for former Soviet nuclear facilities.

The NRC made some limited progress in this area through its technical and methodology exchanges with Gosatomnadzor. By limiting discussions to less sensitive facilities (such as nuclear power plants and research reactors) the NRC personnel were able to engage in performance testing discussions with representatives not only from Gosatomnadzor but also from MVD and Minatom. As a part of training workshops, the NRC regulatory support program also organized performance tests using highly trained U.S. nuclear security experts. The funding difficulties for the NRC program discussed above, however, brought these useful efforts to a halt.

Performance testing and related operational evaluations should become a key element of the U.S.-Russian MPC&A cooperative activities. Given the sensitivities over revealing specific vulnerabilities to the U.S. participants, what is likely to be required is to assist with establishing appropriately trained Russian teams to carry out such tests. Appendix 1 of this report provides a further discussion of difficulties and opportunities for such cooperation.

Sustainable Security: Recommendations

Because achieving sustainability over time remains the most intellectually challenging aspect of the MPC&A program, and an area where the program is still feeling its way and fleshing out new approaches, we provide below more detailed recommendations in this area than in other technical areas of the program. These recommendations focus on ensuring that Russian institutions handling weapons-usable material have the resources, the incentives, and the organizations to sustain stringent standards of security and accounting for nuclear material over the long haul.

Sustainability Resources

The United States should:

- Expand and plan for funding of "emergency measures" where needed—funding to keep guards on the job, keep security

[62] *Guidelines*, op. cit.

systems running temporarily, provide backup electricity supplies, and the like—as DOE did on a small scale in the winter and spring of 1998–99.

- Finance the first 2–3 years of operations and maintenance of systems installed with U.S. assistance, as an initial settling-in period, and work during that period to reach firm commitments that Russia will pay to keep the systems operational after that.[63]
- Begin working with the Russian government now to gain Russian commitment to specific steps to provide adequate funding for sustaining effective MPC&A after U.S. assistance phases down in the future.
- Put increased reliance on indigenous personnel and firms to design, build, upgrade, and operate MPC&A systems, and build up the indigenous capacities to carry out these missions in the former Soviet states.
- Simultaneously (a) work to reestablish good relations with Eleron, and to improve its capability to produce high-quality equipment to be used for MPC&A and warhead security, and (b) continue to work to broaden the base of indigenous suppliers of such equipment in the former Soviet Union.
- Initiate the establishment of, and provide funding for, a program of realistic tests of the performance of MPC&A systems at Russian facilities against both outsider and insider threats, relying primarily on Russian testing teams—with wide dissemination of test results and lessons learned, and funding for fixing problems identified (see further discussion in appendix).
- Help finance transition costs (recruitment, training, equipment, and the like) for a shift to more professional guard forces for nuclear material—either highly trained officer-dominated forces comparable to those that guard nuclear weapons, or (at least at civilian facilities) commercial firms such as those that guard Russian banks, or nuclear facilities in the United States.[64]
- Finance expanded training programs designed to build the cadre of qualified MPC&A personnel, including regular training at individual sites as well as the existing national training effort, with a focus not only on technical MPC&A but also on the critical importance to Russia and the world of preventing the spread of nuclear weapons, and the key role of effective MPC&A in that effort.

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[63] DOE is currently working to ensure that installed systems have "extended warranties," and that adequate servicing capabilities and supplies of spare parts are available, but the proposal to simply pay for the full cost of operations and maintenance during the initial settling in period would expand this approach substantially.

[64] Currently there is an ongoing transition in Russia in the opposite direction: to reduce costs. At some sites guard forces from the Ministry of Interior are being replaced with private guards that are regarded as being much less capable. See, for example, First Deputy Minister of Atomic Energy Valentin Ivanov, "Status and Future Role of Nuclear Material Safety Within Minatom's System," remarks presented at Global '99: Nuclear Technology- Bridging the Millenia, Jackson Hole, Wyoming, August 30–September 2, 1999. Ivanov's prepared text remarks that "due to insufficient funding, a significant number of the guards from the Ministry of Internal Affairs [were] replaced by institutional guards, whose proficiency compares badly to that of the guards from the Ministry of Internal Affairs." Similarly, Alexander Dmitriev, deputy chairman of the Russian nuclear regulatory agency, told Duma hearings in 1996 that the replacement of troops with "security personnel not affiliated with any ministry or government agency," or even the elimination of guard forces, leaving "no security whatsoever," was becoming "quite widespread," and warned that "there's simply no comparison between a real armed security officer

- Explore possible new revenue streams that could finance robust security and accounting programs for nuclear material in the former Soviet Union after international assistance declines, ranging from spent fuel storage to additional HEU purchases to "debt for security" swaps.[65]

Sustainability Incentives

Here the appropriate goal has been aptly explained by others: "everyone involved in MPC&A planning, implementation, and oversight must know what they should do, receive rewards for doing it correctly, and expect penalties for doing it poorly or not at all."[66] Toward that end, the United States should:

- Put nuclear security and accounting at the top of the U.S.-FSU nonproliferation agenda, as a fundamental requirement for preventing the spread of nuclear weapons, which all states handling weapons-usable nuclear material must meet. This issue should be accorded an importance at least comparable to that of ratification of arms control treaties and enforcement of effective export controls. The United States should make clear that this is a fundamental requirement for improved nuclear relations, something to be emphasized at every level on every occasion until the problem is adequately addressed—and work with other leading nuclear powers to convince them to take a similar approach.
- Increase the priority devoted to strengthening regulation of MPC&A. A realistic prospect of being fined or shut down if MPC&A did not meet stringent standards would create a major incentive for facility managers to invest scarce resources in ensuring adequate security and accounting.
- In particular, provide adequate funding for NRC support of MPC&A regulation in the former Soviet states; expand efforts to improve Minatom's internal regulatory capabilities; and develop regulatory support and training programs with the Ministry of Defense body responsible for regulating military-related facilities in Russia comparable in scope and level of effort to those pursued with Gosatomnadzor and Minatom.
- Write requirements for MPC&A operations and maintenance, and realistic testing, into MPC&A contracts with facilities, including incentives written into the contracts to fulfill these commitments.
- Give preference to facilities with good MPC&A in all U.S. government contracts, and use the leverage provided by such contracts to pursue MPC&A objectives. Over time, facility managers in the former Soviet Union should come to understand that excellent MPC&A is a basic "price of admission" for doing business with the United States, just as refraining from transfers of sensitive technology to potential proliferators is—and the United States should work with other leading nations to convince them to take the same approach with the FSU. At the same time, the United States should seek to use the considerable leverage that funds flowing to Russian facilities from U.S. programs provide to seek additional

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and some guy of ours who occasionally gets called out to the shooting range to take a couple of shots." See "We Cannot Preclude the Possibility of Nuclear Materials Theft," op. cit.

[65] For a discussion of such concepts and their relevance to funding key nonproliferation initiatives in Russia, see Bunn, *The Next Wave*, op. cit. pp. 86–87.

[66] Potter and Wehling, "Sustainability," op. cit.

MPC&A progress—for example, using the fact that some large Russian facilities receive most of their cash income from the HEU deal to convince them cooperate in ensuring stringent standards of security and accounting.[67]

- Make achievement of high standards of MPC&A a prerequisite for U.S. support for new efforts involving bulk processing or transport of fissile material, which would otherwise increase, rather than decrease, the risks of theft and proliferation. At the same time, the United States should place high priority on working with Russia to upgrade MPC&A for those bulk processing and transport programs that are already under way with U.S. support, such as the HEU deal.
- Consciously attempt to identify and support individuals at facilities and within organizations who are working to change their institution's approach to MPC&A for the better—known in the managerial literature as "change agents."[68]

Sustainability Organization

The United States should work with Russia and the other former Soviet states on a systemic program of reform of the organizations involved in MPC&A, designed to ensure that:

- Each facility with weapons-usable nuclear material has a designated office for MPC&A, with appropriate personnel and authority;
- Each national institution with facilities with weapons-usable nuclear material under its control has appropriate institutional procedures and regulations for managing this material, and a designated office for MPC&A, with appropriate personnel and authority;
- The facility offices communicate appropriately with each other, and with the national authorities;
- There are clear and authoritative laws and regulations in place requiring MPC&A measures which, if complied with in their entirety, would ensure an effective system;
- The regulatory authorities have the authority, independence, personnel, equipment, and procedures required to carry out effective MPC&A regulation, including the authority to impose fines or close facilities for failure to comply with MPC&A regulations;
- There are recruitment, compensation, promotion, and training procedures in place to ensure that highly qualified people are available for all aspects of MPC&A, and have incentives for good performance; and
- There are effective mechanisms in place for interagency coordination, joint action, and dispute resolution on MPC&A issues.

These are obviously long-term goals, which must be approached incrementally, and working with a foreign government on such organizational issues is far more challenging than simply providing equipment and training.

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[67] Remarkably, although some of the Russian facilities that receive most of their total income from the HEU deal have been among the least cooperative with the MPC&A program, the United States has never sought to link the two.

[68] For a useful discussion of the essential role of such indigenous "change agents" in changing how an organization deals with MPC&A, see Margaret A. Barnham, Charles F. Sanders, and Thomas A. Gafford, "Providing Technical Assistance for the Development of MC&A Systems," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, July 25–29, 1999.

But these issues are critically important to sustainability. As a first step, DOE should fund a study by non-governmental or laboratory experts to consider what measures toward these ends are most needed and what such programs might cost.

At the same time, governments rarely carry out their functions as well as they might without close oversight. In the U.S. case, embarrassing investigations by journalists, non-government advocates, and the Congress provided a major part of the impetus for substantial security improvements during the 1970s and 1980s. U.S. non-governmental organizations—perhaps with some funding from DOE—can play a critically important role in fostering the growth of non-government organizations involved in these issues in the former Soviet states, and encouraging journalists and legislators in these states to play an active role in monitoring what is being done and lobbying for change when that is necessary.[69] As far back as 1996, the Duma held a devastating hearing which laid bare the weaknesses in Russia's MPC&A and warhead security programs—but there has been insufficient follow-through to ensure that the government corrects the problems identified in the hearing.[70]

[69] Under the direction of William Potter, the Center for Nonproliferation Studies at the Monterey Institute of International Studies has already done substantial work in this area, as have several U.S. foundations, supporting efforts such as the Russian journal Yaderny Kontrol (Nuclear Control), but there is certainly more that can and should be done.

[70] For an edited transcript, see "We Cannot Preclude the Possibility of Nuclear Materials Theft," *Yaderny Kontrol Digest*, No. 5, Fall 1997.

IV. Balanced Program Management and Partnership with Russia: The Keys to MPC&A Success

Precisely because the goal of preventing the theft or diversion of Russia's bomb material is so crucial to international security, it is necessary to ensure that the MPC&A program is managed to achieve the fastest and most cost-effective reductions to this security threat. The strong Russian and American political support, and substantial funding the program has attracted to date, have been derived from the ability of the program's participants to improve security at a wide array of Russian facilities in a short period of time. In recent years, however, the approaches taken in the MPC&A program have already created substantial problems and, if uncorrected, could seriously undermine the program's prospects for future success.

To address these problems and continue to achieve success at the required pace in the future, the program requires senior strategic leadership that possesses a broad vision, energy and political savvy, a focus on clear objectives and effective implementation, and a renewed emphasis on the spirit of partnership with Russian experts. The authors are hopeful that the new MPC&A management team appointed at DOE in late 1999 will lead the program toward continued success; this section is intended to provide recommendations for how that might be done.

The MPC&A program has gone through some very distinct changes since 1994. During this evolution a number of original programmatic approaches have been abandoned, but some useful steps have also been taken (see "Phases in the History of the MPC&A Program," pp. 46-47). Some of the steps taken by the DOE managers of the MPC&A program have been important management improvements, including: (a) expanding the mission to include consolidation and sustainability (discussed in the previous section); (b) establishing objectives and guidelines for MPC&A projects at each site, and a technical review mechanism to ensure that the projects at each site fit the guidelines (see "Setting Objectives, Reviewing Progress," p. 49); (c) integrating what had previously been separate lab-to-lab and government-to-government MPC&A programs into a single effort with a single funding source; and (d) substantially improved tracking of the flow of funds to individual projects and of the status of each project.

At the same time, however, there have been a number of negative developments that could seriously undermine the program's future prospects for success, including: a seeming loss of the sense of urgency and drive present during the program's early days (addressed in Section II); the bureaucratization and insulation of the effort from broader U.S. policy objectives; a serious erosion in the partnership with Russian experts which is crucial to the program's success; a parallel decline in the role of the U.S. laboratories, which generally have substantially greater MPC&A expertise and on-the-ground experience and relationships in Russia than do DOE headquarters officials; a tendency for key policy decisions to be made by a small circle of U.S. officials without soliciting input from other Russian or American colleagues; and, perhaps most crucial, a precipitous decline in visible support and leadership from the highest levels of the U.S. government. To correct these negative trends, we believe there is a need for:

- Senior MPC&A management within DOE with the vision, authority, resources and access to higher-level officials needed to move the program forward and overcome obstacles rapidly as they arise;
- Sustained engagement and support from the highest political levels of the U.S. government;

PHASES IN THE HISTORY OF THE MPC&A PROGRAM

The implementation approaches taken in the MPC&A program, and the realities the managers face have changed as the program has evolved through several phases.

1992–93: Hitting a Brick Wall

Initial MPC&A discussions between the U.S. and Russian governments began in early 1992, following passage of the Nunn-Lugar legislation in late 1991. Russian negotiators were highly suspicious of U.S. motives and refused to allow the intrusive audits and examinations required under Nunn-Lugar at sensitive nuclear facilities containing plutonium or HEU; no agreement was reached until September 1993, and even then Russian negotiators limited cooperation to low-enriched uranium posing no substantial proliferation risk. The newly elected Clinton Administration made a series of overtures to the Russian government in late 1993 and early 1994 to expand the cooperation beyond LEU to include genuine fissile material, but these were all rejected.

1994: First Steps

In 1994, DOE launched the U.S.-Russian lab-to-lab MPC&A program, Russia agreed to begin allowing access to some facilities with HEU and plutonium, reciprocal visits to plutonium storage facilities were exchanged, and the first contracts for rapid MPC&A upgrades were issued. By the end of the year, rapid security upgrades for one building at the Kurchatov Institute containing enough HEU for a bomb were essentially complete, with a model MPC&A system at Arzamas-16 following soon thereafter. Initial discussions of much broader cooperation extending through much of Russia's nuclear complex began, based on the initial successes. Most of the effort was managed by key laboratory technical experts under the guidance of a small number of officials at DOE headquarters. The emphasis was on getting a foot in the door and getting something positive accomplished as rapidly as practical. A series of seizures of stolen weapons-usable nuclear material in 1994 kept the issue on the front pages of the world's newspapers and brought it to the top of the political agenda.

1995–96: Rapid Expansion

During 1995–96, the number of sites where MPC&A cooperation was underway expanded at a furious pace, and the effort received strong public support from both the U.S. and Russian Presidents. Following the seizures of 1994, studies from the Joint Atomic Energy Intelligence Community (JAEIC) and a panel of the President's Committee of Advisors on Science and Technology (PCAST) highlighted the dangers and the need for urgent action, leading to a Presidential Decision Directive in late 1995 intended to accelerate the effort and delineate each agency's responsibilities. A U.S.-Russian lab-to-lab MPC&A steering committee drafted a joint plan for MPC&A upgrades throughout the Russian nuclear weapons complex, and initial work at many sites began. A formal agreement on MPC&A cooperation with the Russian nuclear regulators was also signed. By late 1995, however, concerns over possible spying associated with this intense expansion of American visits to Russian nuclear facilities led Minatom and the FSB to impose more formal controls over the program, rather than leaving each site free to negotiate its own arrangements. The government-to-government and lab-to-lab MPC&A programs continued to be managed as separate efforts (though funding of the government-to-government program was shifted from DOD to DOE, so both were funded from the same accounts), and the government-to-government program struggled (ultimately successfully) to gain formal Russian agreement to expand the work to additional sites. Both the government-to-government and lab-to-lab efforts were coordinated by laboratory experts brought to DOE headquarters, under the supervision of the director of the Office of Arms Control and Nonproliferation, and with regular input from a steering committee of senior U.S. laboratory experts. The small group involved in the top-level management of the program struggled to keep up with the rapid expansion of work, while simultaneously attempting to address political-level FSB efforts to slow this expansion. U.S. project teams at individual sites had considerable latitude to develop approaches to upgrades at those sites with their Russian counterparts, and as a result, the goals of upgrades, the types of upgrades implemented, and the approaches to issues such as access, taxation, and the like varied considerably from one site to the next.

1997–98: Shift to Headquarters

During 1997–98, the expansion of the MPC&A program to cover all but a few of the sites in Russia with HEU or plutonium was completed, intensive work at these sites continued, and site-wide MPC&A upgrades began to be declared completed at a number of facilities. While senior U.S. and Russian officials continued to make supportive remarks about the MPC&A program on occasion, in the absence of major seizures or further dramatic studies, their attention largely shifted elsewhere. As described elsewhere in this report, during this period a very different management approach was instituted. In early 1997, the lab-to-lab and government-to-government programs were merged (effectively abolishing the lab-to-lab program), the lab experts who had led both parts of the effort were forced out, management was taken over by federal officials, and the role of both the U.S. and Russian labs in program management and decisions was substantially de-emphasized. During this period, the role of Russian experts in general was de-emphasized, and the joint U.S.-Russian steering committee ceased to meet. During the course of these two years, to address issues that had arisen in the period of very rapid expansion, improved computer-based financial and status monitoring of all projects was instituted, a set of consistent guidelines setting the standards for the upgrades to be implemented for all sites was drafted (which was issued in late 1998), and a Technical Survey Team (TST) was established to review the progress of projects (also in 1998). During this period, there was also increasing realization that the overall scope of work was bigger than had previously been envisioned; in particular, in additional to financing initial equipment installation, it became clear that changing the "safeguards culture" in Russia and sustaining security and accounting over time would require major efforts. The ruble crisis in August 1998, and the economic turmoil for some nuclear sites that followed, created a crisis atmosphere that led the program to finance "emergency measures" such as food and warm winter uniforms for nuclear guards, and laid the groundwork for some of the new emphases of the 1999-2000 period.

1999-2000: New Emphases

Following the ruble crisis, the MPC&A program greatly increased its emphasis on (a) consolidation of nuclear material in fewer sites and buildings, which would remove the threat from the emptied buildings regardless of what subsequently happened to the Russian economy, and lower the costs of providing security for the remaining buildings; and (b) efforts to sustain security and accounting over time, going well beyond simply installing modern safeguards and security equipment. The mission statement was rewritten to reflect these new emphases, along with the traditional emphasis on installing equipment. The implementation of the guidelines and TST reviews resulted in substantially greater consistency in the approaches taken among different sites, but also led to the U.S. side unilaterally canceling various previously agreed projects that did not meet the guidelines, or demanding substantial changes in them; the emphasis on including Russian input declined even further. Russian financial accounting, ability to meet contract deadlines, and (particularly) access to sensitive facilities became substantial sources of U.S.-Russian friction, and in September 1999, the program leadership put a halt to all further contracts for seven key Russian facilities over the access issue, walking back previously signed agreements on that subject. Despite these various problems, the Navy MPC&A program shined as the most successful star of the MPC&A effort. By this time, the MPC&A program was no longer a revolutionary effort, but a stabilized program much like many others. While that was probably inevitable after 6 years of effort, much of the sense of urgency appears to have been lost; the issue was no longer a central one for U.S. and Russian senior political leaders, and an incorrect impression arose that most of the needed work had been done. The key political-level step that was taken in this period was to extend the budget: originally, it had been envisioned that the budget would begin to fall after fiscal year 1999, and the program would be completed by 2002, and instead, the program succeeded in maintaining essentially flat funding in FY2000 and made a request for somewhat greater funding in FY2001. At the same time, however, internal bureaucratic conflicts that spilled over to Capitol Hill led to a decision to remove the program from the Office of Arms Control and Nonproliferation (NN-40), ultimately leading to it becoming a parallel office of its own, the Office of International Materials Protection and Emergency Cooperation (NN-50); and in late 1999, a new program director, Jack Caravelli, joined the program.

- An increased role for senior laboratory MPC&A experts in the shaping of the direction of the program;
- Creation of effective mechanisms for a broad discussion, review, and critique of key policy approaches affecting the MPC&A program; and
- A wide range of steps to renew the partnership with Russian MPC&A experts.

The following pages provide an analysis of each of these key issues. Recommendations for action follow.

The relationship with the Russian participants in the MPC&A program is particularly crucial. Given the intrusive nature of MPC&A cooperation at Russian nuclear sites, and the extreme sensitivity surrounding this work, the program simply cannot succeed without putting high priority on building a relationship of trust and respect among the collaborating U.S. and Russian individuals, institutions, and ministries. Without this foundation of trust, American specialists will not be allowed to continue to get so close to Russia's fissile material. We believe that in recent years, the balance between firm insistence on U.S. interests in the effort and the need to build a partnership with Russia has moved out of alignment, eroding this essential partnership. In order to ensure rapid, cost-effective, and sustainable MPC&A improvements at the many sensitive nuclear facilities in Russia, immediate action is needed to re-establish this balance.

Senior, Visionary MPC&A Management

Accomplishing the objectives of the MPC&A program as rapidly and effectively as possible requires senior leadership for the program with energy, vision, authority, and ready access to higher levels of government. Anything less will increase the bureaucratic tendencies of the program and allow problems to linger and fester.

During the early days of the MPC&A program, federal management of the effort was effectively in the hands of the Director of the Office of Arms Control and Nonproliferation who reported directly to the Secretary of Energy. The effort was clearly identified as perhaps the highest nonproliferation priority of the Department by the Secretary. As a result, there was a focus and sense of urgency, and the Director had regular access to the Secretary of Energy (for whom he also served as principal nonproliferation advisor) and Deputy Secretary (who had responsibility for overseeing non-proliferation activities) and could enlist the assistance of these offices to help resolve key obstacles as they arose both inside the U.S. government and with the Russians.

In recent years, the principal managers of the MPC&A program have been at a much lower level, and these people have only rare access to the highest levels of the Department. Also, MPC&A has come to be viewed as only one of many important nonproliferation programs. Indeed, the Department has repeatedly reprogrammed funds designated by Congress for MPC&A to other efforts considered more urgent at that moment. As a result, key policy issues have festered unresolved for months, and new initiatives conceived by laboratory experts or DOE MPC&A managers have been delayed or not acted on at all. At the same time, as was probably inevitable as the program grew and matured, it has become substantially more bureaucratized than had previously been the case, impeding the flexibility with which initiatives can be pursued.

In late 1999, the MPC&A program was eliminated as a task force and reabsorbed into the line responsibility within DOE as part of a newly created office, the Office of International Materials Protection and Emergency Cooperation. This reflected the fact that the objectives of the program would not be accomplished as rapidly as had previously been hoped. At the same time, the program was put under more senior leadership (with the title of Deputy Assistant Administrator, equivalent to a Deputy Assistant Secretary). It is to be hoped that this new arrangement will succeed in pro-

SETTING OBJECTIVES, REVIEWING PROGRESS

Two of the most important management innovations in the MPC&A program in recent years have been the establishment of a consistent set of technical objectives for MPC&A upgrades at all of the sites in the former Soviet Union, and the creation of a team to review each project's progress in meeting these objectives.

Throughout the MPC&A program, different experts on both the U.S. and Russian sides have advocated different MPC&A priorities. In the program's earliest days, when work was underway at only a handful of facilities, coordinating this small number of projects and technical decisions about them posed few difficulties. When the program expanded rapidly to a wide range of Russian and non-Russian sites, coordination of facility upgrades became much more difficult. During this period, while there was broad guidance, to a large degree the U.S. and Russian project teams for each particular site developed their own upgrade approaches.

The result was that different approaches were taken at different sites—and often, the U.S. lab experts on particular project teams emphasized those aspects of MPC&A their labs specialized in. At one facility, there would be a strong emphasis on a particular approach to computerized accounting because it had been developed by a U.S. lab that was well-represented on that project team, while at another facility, the emphasis might be much more on physical protection, because of the expertise of the members of that site's project team (though there was a conscious effort to balance these areas of expertise on the project teams). In a few cases, this tendency became extreme: one site, for example, reportedly had five different U.S. laboratories working to convince them to use nine different material measurement systems in two buildings.[1] Overall, a variety of experts who have reviewed the work of the project teams argue that because the team members were used to working in the U.S. system, where MPC&A was more advanced, they often did not pursue the most urgently needed upgrades first. As one senior expert put it in an interview, "these people were starving, and we were giving them apple pie."

During 1997–98, therefore, the MPC&A program developed a set of guidelines for the project teams, laying out for the first time a consistent set of MPC&A goals and approaches that were to be pursued at every site.[2] Unfortunately, these guidelines were developed without any Russian input. While there can be (and have been) a variety of disagreements about specifics of the guidelines, and we believe they should have been drawn up with full Russian participation, putting in place a clear and consistent set of guidance for the project teams setting out what MPC&A goals should be accomplished and how was clearly an important and useful initiative.

To provide technical peer review of the work of the individual project teams, and ensure that the work at each site was appropriately following the new guidelines, DOE also established a Technical Survey Team (TST) in late 1998. Once again this team was established without incorporating any Russian input. The TST reviews individual projects, and writes reports making recommendations for improvement. While in most peer review environments there are opportunities for those whose work is reviewed to respond, and to take some of the reviewer comments and not others, a number of U.S. laboratory participants report that in most cases DOE headquarters staff directed the project teams to implement the TST's recommendations wholesale—in effect converting peer review into peer diktat. The TST concluded that many specific projects at individual sites were not pursuing the most immediately urgent upgrades, or were not consistent with the guidelines; the end result was that project teams were ordered by DOE to drop or substantially modify a large number of projects they had already agreed on with their Russian counterparts. Here, too, creating a review team was an important and worthwhile step, which appears in many cases to have led to strengthened and more focused approaches—but at the same time, particularly with the perception among the project teams that TST recommendations became translated directly into DOE headquarters orders, it created significant turmoil within the program.

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[1] William C. Potter, remarks to the 7th Carnegie International Nonproliferation Conference, Washington DC, January 11–12 1999 (available at http://www.ceip.org/programs/npp/potter.htm).

[2] *Guidelines for Material Protection, Control, and Accounting Upgrades at Russian Facilities*, op. cit.

viding the leadership energy, vision, authority, and access needed to make the MPC&A program as effective as it can and ought to be.

Sustained Engagement from the Highest Levels

Sustained support from the highest levels of the U.S. and Russian governments was a crucial factor in the early success of the MPC&A program. High-level political intervention—from Presidents, Prime Ministers, and cabinet secretaries—often cut through bureaucratic disputes affecting the MPC&A program and brought adequate compromise on difficult questions.

During 1994–95, cooperation to improve security for nuclear materials was publicly endorsed at every U.S.-Russian summit meeting, and was sometimes discussed at some length by the two Presidents. Vice President Gore and his staff were regularly involved as MPC&A became a key subject of Gore-Chernomyrdin Commission discussions. Secretary of Energy Hazel O'Leary and Minister of Atomic Energy Viktor Mikhailov personally spent hours working in intensive discussions to overcome obstacles to cooperation and reach agreement on next steps. The 1995 report to President Clinton from a panel of the President's Committee of Advisors on Science and Technology (PCAST) played an important role in getting President Clinton, his White House staff, and other senior members of the national security team focused on the need for rapid action on MPC&A, leading directly to Presidential Decision Directive 41 in September, 1995.

During this period, an interagency group was established under the National Security Council (NSC) to deal with MPC&A and related issues; an NSC Director was given MPC&A and related programs as his principal responsibility; and the Office of Science and Technology Policy (OSTP) also designated staffers to work primarily on MPC&A. This assured that the White House would be regularly engaged in MPC&A, authorizing additional steps and helping to overcome obstacles.[71]

In recent years, such high-level attention to MPC&A has been sporadic at best. This has allowed some problems to fester. The Clinton White House, while continuing to indicate in public statements that securing nuclear material in the former Soviet Union was a priority, has effectively ceased any sustained engagement on the issue. The subject has not been addressed in any detail at any recent summit, or any of the Vice President's meetings with Russian Prime Ministers that succeeded Chernomyrdin. No interagency group on the subject any longer meets. No NSC or OSTP staffers are engaged on a regular basis. The President and his staff have allowed myriad other events to distract attention from the fundamentally important tasks of ensuring that the essential ingredients of nuclear weapons do not fall into the wrong hands via lax security in Russia. In late 1998, there was a brief period of attention to MPC&A and related subjects in preparing the budget proposal for the Expanded Threat Reduction Initiative (ETRI). This was a funding package produced by the Clinton White House to raise the profile of nuclear security issues on Capitol Hill and to keep funding for these efforts at reasonably robust levels. In fact, the ETRI did keep the MPC&A budget from declining in

[71] This high-level attention was not always positive. In particular, in 1995, a decision was taken to prepare a joint report to the U.S. and Russian Presidents on what was being done in the MPC&A program and what further steps should be taken. Because this was going to the two Presidents, and required interagency coordination, critics of MPC&A cooperation used the opportunity to try to impose increased control and restraints on lab-to-lab MPC&A cooperation. An enormous amount of time and energy was lost in preparing this report and finding ways to address these challenges, and the report ultimately had very modest, if any, value.

RESOLVING THE TRAVEL ISSUE

In recent years, the seemingly simple matter of arranging travel to Russia has become a major impediment to progress in the MPC&A program. Action is needed immediately to resolve these logjams.

The current approach to implementing the MPC&A program, with extensive reliance on U.S. laboratory experts to help design and oversee implementation of MPC&A systems at Russian sites, requires a substantial amount of travel to Russia. Physically going to these sites and working face-to-face with Russian counterparts is also essential for building up the personal relationships of trust and confidence that are crucial to getting permission to move work into more sensitive areas.

Yet a laboratory or DOE headquarters expert planning a trip to Russia for MPC&A faces a huge number of barriers. The FSB typically requires six weeks' notice of the proposed travel before granting permission, and the Russian process of reviewing such visits can be Byzantine. In the wake of the Chinese espionage scandals, tightened U.S. restrictions on contact with foreigners from "sensitive countries"—including Russia—result in an almost equally byzantine approval process within DOE. (As noted elsewhere in this report, this has also resulted in stringent restrictions on Russian access to U.S. facilities, making Russia still more reluctant to offer increased access to its facilities.) The State Department, which must approve "country clearances" for these visits, represents another independent hurdle; some officials at State have taken the view that too many laboratory experts are travelling to Russia, and have imposed substantial delays on granting country clearances. In the spring of 2000, State imposed a partial "blackout" during the period leading up to the Clinton-Putin summit, and another for the period during which many of the U.S. Moscow embassy's activities were moving from one building to another. In addition, Congress has imposed strict limits on how much DOE money can be spent for laboratory travel, and a 35 percent cap has been imposed on the portion of program funding that can go to the U.S. laboratories, for all salaries, travel, equipment, and other expenses.[1] The travel money limit is a major constraint for a program as dependent on laboratory travel as MPC&A has been, and given the costs of using U.S. laboratory experts (roughly $300,000 per person year when overhead is included) the 35 percent cap has also constrained the labs' ability to support projects in Russia. At the same time, these limits have emboldened those who must approve Russian travel within DOE to more frequently raise questions about the validity of particular trips.

While each of these constraints has its rationale, in combination, they are making it extraordinarily difficult for the program to accomplish its mission. MPC&A experts spend a substantial fraction of their time and energy arranging travel, rather than doing the work. One of the leading MPC&A managers at DOE has not been able to travel to Russia in two years. Moreover, frequent travel to Russia is already a substantial imposition on personal and family life, and the constant uncertainty about when and whether trips will take place only worsens that burden, contributing to driving some experts to work on other efforts.

Several steps should be taken to address this problem:

- The Secretary of Energy should send a clear message that MPC&A is a top nuclear security priority and that travel for the purpose of implementing MPC&A should not be interfered with. He should task a senior staffer with the job of overcoming the obstacles to MPC&A travel and greatly streamlining the process.
- Increased emphasis should be placed on establishing teams on the ground in Russia that can do much of the MPC&A design and implementation work, on the model of the Kurchatov Institute team that works with the Russian Navy programs, lessening the travel burden on U.S. experts and the portion of the program cost that must be spent at the U.S. laboratories.

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[1] Congress imposed this cap for the Initiatives for Proliferation Prevention (IPP) program, and DOE, agreeing that the majority of funds for improving security in Russia should be spent in Russia, imposed it internally on other Russian nonproliferation programs.

FY2000. However, this initiative was not followed up in a sustained way. Indeed, the degree to which the White House was really engaged on the specifics was reflected in the fact that President Clinton announced ETRI in his 1999 State of the Union address as a "two-thirds" increase in funding for programs to "safeguard nuclear materials and technologies," the actual proposal increased funding for those programs by only a few percent compared to then-current appropriations; the request for MPC&A was $7 million less than Congress had appropriated the year before.[72]

At DOE, there has been sustained engagement at the assistant secretary level. But, the level of sustained engagement at the Secretary's level has been significantly reduced compared to the early to mid 1990s, and has been much less than is necessary to achieve major increases in the pace and effectiveness of the MPC&A program.

To succeed in reducing the security threat posed by insecure nuclear material as rapidly as it is practicable to do so will require a sea-change in the level of sustained engagement from the highest levels of the U.S. government, re-igniting interest and attention in the issue and putting real priority (including time and resources, not just words) toward overcoming each major obstacle that arises.

An Increased Role for the U.S. and Russian Laboratories

All of the top-down support the MPC&A program received in 1994–95 was made possible by bottom-up relationships and trust that developed among individual U.S. and Russian technical experts, largely through the lab-to-lab program.

To understand just how crucial the laboratories' role was and continues to be, it is important to review some history. From its inception, the MPC&A program faced a formidable barrier: having spent their Cold War careers focused on keeping out American spies, Russian nuclear security officials found it hard to see that having Americans in their nuclear sites was a key part of the answer to their security problems, and had an ingrained suspicion that the program was really an effort to penetrate the country's nuclear crown jewels for intelligence gathering purposes.[73]

When MPC&A was being pursued solely through government-to-government efforts funded by the Defense Department's Nunn-Lugar program—which required negotiating formal, government-level agreements before any work could be done, and required Russian acceptance of intrusive audits of assistance provided—this barrier seemed insuperable. Russian negotiators simply would not agree to cooperation at any facilities containing actual weapons-usable plutonium or HEU.

In early 1994, however, the Department of Energy authorized its laboratories to launch an informal, lab-to-lab MPC&A initiative, based on relationships they had built up in lab-to-lab science cooperation that had been underway since 1991. Rather than formal negotia-

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[72] See Bunn, *The Next Wave*, op. cit., pp. 62–63 and *Russian Nuclear Security and the Clinton Administrations's Fiscal Year 2000 Expanded Threat Reduction Initiative: A Summary of Congressional Action*, Russian-American Nuclear Security Advisory Council, February 2000.

[73] This kind of suspicion is not unique to the Russian side. In 1994, for example, when a Russian team was going to visit sensitive areas of Rocky Flats on a "familiarization" visit laying the groundwork for future talks on a mutual reciprocal inspection regime, the site spent hundreds of thousands of dollars preparing for the Russian team's arrival—a significant part of which was spent shrouding security equipment so that the Russians would not learn how the security system worked. Ironically, this visit was occurring the same month that the United States had invited another Russian team to Hanford, precisely to see how the security system for nuclear material there worked.

tions with cautious bureaucrats in Moscow, this made it possible for U.S. and Russian technical experts to work directly together at individual sites on problems of mutual interest. In essence, the lab-to-lab approach offered Russian experts respect, money, interaction with the wider world, and interesting work to do that they saw was important to their own country's security. They then became a grass roots constituency for MPC&A progress within the Russian nuclear complex, placing pressure on their government to allow collaborations with the United States to occur and expand. The top-down agreements resulting from that bottom-up support provided formal authorization for the objectives of the work and allowed multiple Russian facilities to participate in the effort. The work was largely carried forward under lab-to-lab contractual arrangements (with the tasks in the contract usually drafted jointly by U.S. and Russian experts), not waiting for negotiation of formal government-to-government agreements.

While the early Russian suspicions were never fully allayed—and continue to pose obstacles to this day—this flexible lab-to-lab approach made it possible for real MPC&A upgrades to get underway. Other key 1994 developments that helped move progress forward included the string of confirmed seizures of weapons-usable material that kept the issue on the front pages and on policy-makers' agendas throughout the year; increased U.S. flexibility in the government-to-government discussions, including an offer in 1994 to allow reciprocal access for Russian security experts to view the security arrangements for U.S. plutonium at Hanford; a Yeltsin decree calling for rapid MPC&A improvements, which effectively gave formal Russian blessing to the objective of the program; and detailed work by senior DOE officials to allay specific Russian fears and concerns. By December 1994, just a few months from the signature of the first contract, a radically improved MPC&A system for a building holding 60 kilograms of 90% enriched HEU had been largely competed at the Russian Research Center "Kurchatov Institute" in Moscow. This effort, and parallel work at Arzamas-16 and elsewhere, provided tangible proof to U.S. and Russian policy-makers that MPC&A cooperation could work and created an example for other sites to follow. This allowed MPC&A cooperation breakthroughs to occur across the Russian nuclear complex and led to a rapid expansion of both the number of sites involved and the amount of funding provided for the program.

Key factors that were identified as central to achieving these early successes included:

- Utilization of the U.S. national laboratories as the primary interlocutors with Russian institutes and plants which possessed weapon usable nuclear material.
- Inclusion of the U.S. national laboratories in the management structure of the program, with a clear division of labor between the labs and DOE managers based on their respective strengths.
- Creation of joint U.S.-Russian technical plans which outlined the upgrade work that needed to be accomplished.
- A primary focus on making rapid security improvements for the Russian nuclear material.
- A willingness to forgo aggressive access requirements and accept some financial uncertainties at the margin to achieve the rapid upgrade goal.
- Continuous involvement by high-level officials to clear away impediments to progress.

Despite the successes of this early "lab-to-lab" model, it appears that in recent years (particularly following the integration of what had been separate "lab-to-lab" and "government-to-government" MPC&A efforts in early 1997), much less reliance has been placed on the flexible lab-to-lab approaches of the early period.

During the 1994–96 period, the laboratories played central roles in all aspects of the implementation of the MPC&A program,

senior laboratory officials had regular input into key policy decisions, and key laboratory personnel were integrated into the DOE headquarters management of the program. Laboratory specialists managed many aspects of both the lab-to-lab and government-to-government MPC&A efforts at DOE headquarters. They served to organize the growing number of labs that were participating in the program, vetted technical plans, maintained contacts with key Russian partners, and helped to integrate the policy and technical aspects of the program.

This integration of senior lab voices into management and policy had five major benefits. First, laboratory experts had (and still have) far more MPC&A technical expertise than DOE headquarters staff have, and also more experience working on the ground with the Russian nuclear sites, coupled with personal relationships of trust with key officials at those sites that were critical to program success. They brought essential knowledge, contacts, ideas, and perspectives to the effort.

Second, this approach allowed for the orderly management and division of labor among the U.S. laboratories, and for the cohesive development and implementation of technical plans for each facility. Laboratory project teams were established for each nuclear facility where upgrades were to be carried out. This provided the Russians with a consistent laboratory team that they could deal with, and freed the federal managers to deal with policy issues and generate the needed political support for the program inside and outside the government.

Third, this approach allowed new input from the U.S. laboratories on MPC&A issues to be plugged into policy decision-making at DOE on a timely and continuous basis. For example, laboratory consultations with Russian specialists often identified new opportunities for MPC&A improvements; these opportunities were rapidly brought to the attention of senior DOE officials, who were able to plug them into political documents that were signed at high levels.

Fourth, with this approach, decisions made at the political level to expand work or begin work at new facilities could be acted upon by laboratory people because they were empowered to deal with their Russian counterparts within an agreed policy framework. This was essential because the Russian system places a heavy emphasis on government-to-government interactions, and the laboratory specialists need to be viewed by the Russians as a seamless extension of U.S. government decision-making. The staff of the MPC&A program was not very large, and federal managers could not always travel to Russia to work out the details of MPC&A upgrade plans. The ability of key laboratory specialists to represent the program in an authoritative manner facilitated the rapid of expansion of the program.

Finally, this approach gave the laboratories a sense of ownership in the process. The often tense relationship between the labs and DOE management was tempered to a significant degree, and this helped build domestic political support for the MPC&A program. This is not to say that there were not difficulties or differences in opinion about tactics or approaches. But these issues were dealt with in a collaborative manner with everyone having full input to the decision-making process.

Nonetheless, in retrospect it seems clear that by the latter part of this period, the pendulum had swung quite far toward laboratory control and the laboratories' central role was chafing on some DOE federal managers. The transition between the first and second Clinton administrations provided the opportunity for these managers to gain control of the program and severely curtail the role of the labs. The pendulum then swung nearly to the opposite extreme. Then the labs effectively no longer had a strong voice in key policy decisions, and retreated into their more traditional role of technical specialists deployed at the behest of DOE management. Eventually frustration with this new role and new team drove out many of the experienced people in

AN INCREASED ROLE FOR THE PRIVATE SECTOR?

To date, the MPC&A program has relied on U.S. laboratory experts under DOE headquarters management, working with Russian counterparts to design and implement MPC&A upgrades. While the balance between headquarters and the laboratories has shifted, they have always been the dominant players. The role of U.S. and Russian private firms has been primarily in providing equipment, or in doing specific construction projects conceived and designed by the U.S. and Russian laboratory experts.

Long experience makes clear, however, that managing and integrating large technical projects is not the strong suit of most DOE headquarters' staff. It is worth at least considering, therefore, whether at those sites where the MPC&A effort is likely to be very large—lasting many years, costing tens of millions of dollars, involving a wide range of different projects—it may make sense to involve private firms as integrating contractors. This might be particularly applicable in the large complexes in the closed cities, for example. Integrating contractors could help take some of the burden off DOE staff to manage the overall flow of the work done by the U.S. and Russian laboratory experts, ensure that work is done on time, on budget, and to agreed standards; if the same contractor was involved in work at many sites, it could also contribute to ensuring greater consistency of approach at the various sites, and transferring information and lessons learned among them. Private firms can also more easily hire Russian employees, subcontract parts of the work to Russian firms, and establish permanent offices at the sites where work is being done in Russia. The Department of Defense has had some success working with such integrating contractors for large nuclear projects in the Cooperative Threat Reduction program, such as the fissile material storage facility at Mayak, and upgrades for nuclear warhead security.

On the other hand, any moves in this direction would have to be considered very carefully in the context of their potential impact on the ongoing MPC&A partnership, particularly on gaining expanded Russian agreement to work in sensitive areas of major sites. Bringing in private firms would mean confronting the Russian participants with yet another set of managers with which to get comfortable, and they would bring to the cooperative program a different perspective focused on the bottom line. Because of the potential risks involved, it might make sense to begin with a study of DOD's experience in using such contractors in work with Minatom, and follow that with bringing in private firms for one or more specific, limited projects as an initial trial. It would also be crucial, if private firms were ultimately to be brought in as integrators for the upgrades at a major site such as one of the closed cities, to work closely with the experts from that site in deciding on and preparing for the transition.

the laboratories who had been responsible for much of the program's success. They were replaced with colleagues less experienced in the MPC&A program. This also caused great animosity to develop between some of the key labs and DOE headquarters, negatively affecting the program's pace, political support, and prospects for success.

Downgrading the role of the U.S. labs had the effect of decreasing the power of the Russian labs as well—and their role was also downgraded by the insistence of Minatom and the FSB on maintaining firmer central control over the effort. Russian participants repeatedly complain that while the effort was once run by real U.S. technical experts who had earned their respect, they are now in effect being given orders by DOE managers who have little MPC&A expertise. Moreover, because of the decreased role of the U.S. and Russian laboratories, in many cases in recent years key issues have been addressed at middle levels in talks between DOE and Minatom officials, rather than by technical experts at individual sites. This often results in delays in resolving disputes, because a more cautious and antagonistic relationship exists at this level than at the technical level. At headquarters, a variety of other issues in U.S.-Russian relations can interfere with agreement, while the individual sites are typically highly motivated to find ways to move on with their work and the payment for this work, regardless of broader political issues.

Several cases demonstrate the problems posed by managing issues primarily at the political level. One is the protracted time (years) it took to complete an overall government-to-government agreement for cooperation on MPC&A (finally signed in October, 1999). Another is the continuing and destructive debate over access to facilities, described in the next section of this report.

The time now has come to once again increase the labs' voice in setting the direction of the MPC&A program, swinging the pendulum back toward a middle position. With their technical expertise, relationships with Russian experts, and experience implementing programs on the ground in Russia, the lab experts bring essential perspectives on what needs to be done not otherwise easily available at DOE headquarters. We recommend two key steps in particular:

- Bring senior lab experts back into the day-to-day management structure at DOE headquarters.
- Greatly strengthen the role of the inter-lab MPC&A advisory committee, to bring it at least part of the way back toward the role the laboratory MPC&A steering committee once had. This would include soliciting advice from this committee on all policy and implementation issues, and send a clear message that advocating changes in current approaches (if a good case could be made that other approaches would be more effective) would be not only permissible but encouraged.

Broad Participation in Key Policy Decisions

The factors affecting key policy decisions concerning the future of the MPC&A program are complex and multifaceted—how to gain Russian agreement to accelerate the effort; how much to push on the use of indigenous Russian equipment; which equipment suppliers to favor; the balance of priorities between physical protection, consolidation, accounting, and material control; the best approaches to working with the Russian experts on design and implementation; and so on. There are a variety of players, who can bring important perspectives to bear on these problems, whose consideration could improve the quality of decisions. Making sure that such decisions have the benefit of review by people with different areas of expertise (technical, policy, political, Russia-area, etc.) and different perspectives is critical to making the right choices and ensuring that decisions, once made, have a broad base of expert support. Substantial academic research has demonstrated

that increased diversity of perspectives in groups that make decisions tends to increase the quality of the decisions made.

Yet in recent years, key decisions concerning the fate of the MPC&A program have been made by a very small group of mid-level officials at DOE headquarters. While a team has been established to provide peer review of the technical progress being made in various MPC&A projects, there is no comparable mechanism for policy peer review.

Both at the political level and at the technical level the current program leadership deserves considerable credit for reaching out for advice to non-government experts who follow these issues. It would be highly desirable, however, to institutionalize this process with a standing MPC&A advisory committee of outside policy and technical experts. If established with a broad enough mandate, the right people (including some working-level experts with the time to look into the details of the program, rather than exclusively senior political figures), and sufficiently frequent meetings or discussions, such an advisory panel, in combination with the strengthened laboratory panel discussed above, could play a key role in ensuring that key policy steps are reviewed from an appropriately broad range of perspectives.

Maintaining the U.S.-Russian Partnership

A particularly central policy issue for the MPC&A program and one that has become increasingly problematic in recent years is the maintenance of a strong working partnership on MPC&A between the United States and Russia. Past practice has proven that sustainable security for Russia's nuclear material can only be achieved through a true working partnership with U.S. and Russian participants. To function effectively, the MPC&A program (and others like it) must be designed to serve both U.S. and Russian interests (as perceived by the Russians), and Russian experts must be treated as equal partners, playing leading roles in the planning and implementation of the effort.

Unfortunately, while Russian support for MPC&A cooperation remains reasonably strong, there are clear signs that the spirit of U.S.-Russian partnership in the MPC&A program is eroding. Numerous interviews and discussions with Russian MPC&A participants have revealed a wide range of bitterly felt complaints, often focusing on what is perceived as increasing emphasis on "made in America" approaches that are imposed on the Russian side. Some key specialists who were once among the most active lobbyists for additional progress within the Russian system, having taken considerable personal risks to move the ball forward, are now much less willing to do so. Of course, not all Russian complaints are equally justified (and Russian actions, as well as U.S. actions, have contributed to the reduced spirit of partnership); but interviews and discussions with U.S. participants make clear that the attitudes toward partnership of many of those in management positions on the U.S. side have indeed shifted substantially.

It is certainly true that extensive Russian involvement in the design and planning of MPC&A upgrades and programmatic implementation will result in a program that is different from what U.S. experts would have preferred if designing such a program on their own. But there are several key benefits of such a partnership approach:

- Russian "buy in." If new approaches to MPC&A are seen at Russian sites as being needless or unsustainable from the Russian perspective, they will simply not be continued for the long term. One can find this attitude frequently today in discussions with Russian officials involved in security for nuclear material; many still believe that the old "guards, guns, and gates" approach is basically adequate (with some modest modifications), that the U.S. emphasis on measures to defend against insider threats is overblown, and that detailed material accounting is an unnecessary distraction. Only by involv-

ing Russian experts in every aspect of the conception, design, and implementation of MPC&A upgrades (including both analyses and realistic tests of the vulnerability of existing security systems to various types of threats) can the United States hope to convince them (a) that a fundamentally new approach to MPC&A is in fact needed; and (b) that the specific upgrades carried out were as much their idea as the Americans' idea, and deserve continuing support even after the Americans have left. One cannot hope to influence a changing safeguards culture without offering professional respect and an equal voice in what should be done to the key participants in that culture.

- Indigenization. Building up the indigenous capability to analyze, design, install, operate, test, upgrade, and regulate modern MPC&A systems in the former Soviet Union is the key to achieving sustainable security for nuclear material there. Such indigenization is best achieved by having Russian experts play key roles in each of these tasks from the very beginning of the effort.
- Superior Russian knowledge of the facts on the ground. While U.S. experts have learned much about Russian facilities, Russian safeguards approaches, and the Russian bureaucratic structure in recent years, Russian experts will always understand these matters better than their American counterparts. Thus ideas and approaches designed entirely by Americans may turn out to require modification to adapt to Russian realities—technical, procedural, or political. (The classic technical example is American equipment that performs poorly in the harsh Russian winters.) The Russians, in short, offer an absolutely essential perspective in determining what actually needs to be done.
- Superior Russian ability to "work" the Russian system. Many of the steps needed to improve security and accounting for nuclear material in Russia require high-level decisions in Russia—by the top management of a nuclear site, at Minatom headquarters, or by FSB officials. Experience has shown that the probability of convincing these officials and managers to take a particular decision is far higher if Russian participants who they know and trust have been working to convince them ahead of time than it is if U.S. officials simply walk in "cold" and propose it. The Russian participants are able to "work" their own system in ways the U.S. participants simply would not be able to do—but they will only have an incentive to do so if they are treated as genuine partners in the effort, and feel they are working to carry out ideas and initiatives that are partly their own. This factor of Russian participants working to move the program forward is particularly crucial as the remaining work in the MPC&A program focuses on more sensitive areas. Without energetic Russian strategic partners working to figure out creative ways to overcome the many obstacles in the program's path, the pace of progress will be dramatically slower, and the probability of failure unacceptably high.

None of this is to say that initial Russian judgments as to what MPC&A steps should be taken are always (or even usually) correct. The reality is that U.S. experts have crucial insights to offer—in particular, they have long experience in the MPC&A measures needed in an open society where insider theft is a real possibility, which Russian experts generally do not. Experts from each side bring different sets of perspectives, skills, experiences, and connections to the table. Only by bringing those different strengths together in a complementary partnership can the program achieve maximum effectiveness. Nor is any of this intended to argue that U.S. participants should not be firm in negotiating agreements and contracts and seeing that the Russian parties live up to their commitments; making

clear that you are not prepared to be taken advantage of is crucial in effectively implementing programs in Russia. But there is a clear difference between firmness in working out a partnership that serves both U.S. and Russian interests and imposition of American approaches.

The approach pursued in the Navy MPC&A program (see "The Navy MPC&A Program: Lessons of Success," pp. 60-61) demonstrates the remarkable degree of success that can be achieved through a genuine partnership approach, and provides some tactics to build such a partnership. In the Navy program: (a) the U.S. participants were a small and stable group of technical experts respected by the Russian side; (b) the participants from the Kurchatov Institute (also a small and stable group of technical experts, respected by both the Russian Navy and the U.S. MPC&A experts) played almost the role of an integrating contractor, doing much of the upgrade design work that in other projects was done by U.S. experts, and being on the ground in Russia every day, able to work to overcome problems as they arose in real time; (c) flexible approaches to access and related issues were pursued, utilizing the trust built up over time; and (d) the Russian Navy was an enthusiastic partner with cooperation directed from the very highest levels.

American decisions are not the only reason for the declining sense of partnership in the MPC&A program. Russian decisions have certainly played a role as well, as have cultural misunderstandings and disagreements attributable to both sides. As the program expanded, for example, and Americans were attempting to travel to dozens of sites in Russia to work on MPC&A, Russian concerns that this approach did not offer sufficient protection against American spying increased, and in late 1995, Minatom headquarters and the FSB imposed formal control over much of the MPC&A effort. Also, at key facilities the interlocutors in charge of the cooperative effort shifted from technical experts in safeguards technologies to the security chiefs for the sites, whose responsibilities included both nuclear material safeguards and prevention of spying. This shift inevitably made a sense of partnership more difficult to maintain.

In addition, at a number of sites and for a number of different reasons (at least as perceived on the American side), contract deadlines for Russian teams to implement upgrades were not met; work was not done to the standards specified in the contracts; equipment that had been provided was not always used effectively; information was provided to the U.S. side on materials and the areas where they were stored or processed that was incomplete or misleading; and accounting procedures were used that were far from transparent and raised concerns over where funds had gone. And on both sides, there were frequent misunderstandings based on failure to understand the other side's situation and perspective—this included U.S. failures to understand the secrecy constraints under which the Russian participants labor and Russian failures to understand what the U.S. side needs to sustain funding support in the Administration and Congress. All of these issues have contributed to the eroding sense of trust and partnership.

But specific decisions made by the MPC&A management at DOE headquarters have also played a key role in this erosion. In recent years the U.S. side has focused more and more on laying out its plans and priorities itself, without consultation with the Russian side, and then seeking to get the Russians to accept these "made in America" approaches.[74] Russian experts from site after site report spe-

[74] For some of the points in this discussion, the authors are particularly grateful to the participants in a daylong workshop in Moscow in October, 1999, sponsored by the Russian-American Nuclear Security Advisory Council (RANSAC),

THE NAVY MPC&A PROGRAM: LESSONS OF SUCCESS

In contrast to the numerous problems that have developed in other areas of the MPC&A program, the effort to upgrade MPC&A at naval sites and facilities has been very successful. Facilities for highly secure storage of HEU fresh fuel have been established for both the Northern and Pacific fleets, the process of consolidating all fresh HEU fuel into these facilities is nearly complete, and the program is expanding to address a number of other highly sensitive Navy sites. This effort offers valuable lessons on how to overcome some of the difficulties in other areas of MPC&A.

In March 1995, following a demonstration of DOE-sponsored MPC&A upgrades at the Building 116 in Kurchatov Institute, the Russian Navy requested support from the Kurchatov Institute in upgrading security of fresh naval fuel, and suggested that MPC&A upgrades be implemented in cooperation with the United States. In July 1996, the Kurchatov Institute President, the U.S. Secretary of Energy, and a senior officer of the Russian Navy issued a joint statement announcing a decision "to jointly cooperate to ensure the highest possible standards of control, accounting, and physical protection for all storage locations of the Navy of the Russian Federation, containing fresh highly enriched uranium fuels for naval nuclear reactors."[1] The implementation of the U.S.-Russian MPC&A Cooperative Program to Protect Russian Navy Fuels began in 1997 in coordination between the DOE MPC&A program, the Kurchatov Institute, and the Russian Navy.

The MPC&A Navy program consists of several interconnected projects. The program's initial priority was to upgrade safeguards and security of two central land-based fresh fuel storage facilities and three naval refueling ships, and to enhance protection of fresh nuclear fuel in inter-site transit by providing armored transportation and escort vehicles. MPC&A upgrades at the Site 49 near Murmansk, the central fresh fuel storage facility of the Northern Fleet, included, for example, the construction of a storage facility annex, physical security system upgrades, and the installation of a computerized material accounting system. MPC&A upgrades at the central storage facilities have been accompanied by consolidation of fresh HEU fuel from approximately 20 to two locations. This consolidation pushed the MPC&A program onto new ground because it required that new storage facilities be constructed, rather than simply upgrading older facilities. To ensure sustained operability and effectiveness of MPC&A equipment, training and regulatory support have been provided to the Navy as well.

In 1999, the program was broadened to include safeguards and security upgrades at the naval program buildings in the Kurchatov Institute, the naval training facility in Obninsk, and central spent fuel storage facilities that contain lightly-irradiated HEU fuels that also pose proliferation risks. The installation of MPC&A upgrades at the fresh and spent fuel storage facilities, refueling ships, and other locations is scheduled for completion in FY2000. In October 1999 the parties agreed to explore the possibility of expanding the program "to additional sites with spent fuel and other materials of high proliferation concern."[2]

After three years of work, the MPC&A Navy program has made remarkable progress in reducing the vulnerability of large amounts of highly enriched uranium to theft or diversion through the material consolidation and MPC&A upgrades—all at highly sensitive military installations. These security improvements have been realized at a relatively modest cost of $43.5 million.[3] Interviews and discussions with program participants in the United States and Russia suggest that the success of the MPC&A Navy program could be attributed to the following factors:

- The Russian Navy and its regulatory oversight authority—the Inspection for Nuclear and Radiation Safety and Security—are highly motivated, constructive, and flexible participants in the program. Senior admirals of the Russian Navy personally press to overcome difficulties as they arise.[4]

- Much of the day-to-day interface between DOE and the Russian Navy is provided by the Kurchatov Institute, which thus plays the role of a trusted intermediary. The Kurchatov Institute has a long-standing relationship with the Navy because of its responsibility for designing naval propulsion reactors and providing scientific and training support to nuclear naval operations. The Kurchatov Institute also has the requisite technical expertise and an established track record of cooperation with the DOE MPC&A program—and they are present in Russia, all the time, able to address difficulties as they arise, rather than waiting months between trips.
- Program activities are supported at a high political level of the Secretary of Energy in the United States, and the Kurchatov Institute President and the Commander-in-Chief of the Russian Navy in Russia.
- Streamlined oversight of program activities on the Russian side reduces bureaucratic interference and provides for accelerated negotiation and implementation of contracts. All contracts with the U.S. DOE are signed directly by the Kurchatov Institute, which has the status of an independent research center. (In contrast, Minatom facilities have to receive permissions from several of Minatom's departments.) The Navy also works directly with the Kurchatov Institute without interference from the Ministry of Defense.[5]
- The use of Russian labor and MPC&A equipment (with the exception of surveillance TV cameras and computers) reduces security and counterintelligence concerns in Russia, provides for in-country support and maintenance, and motivates the Navy and its subcontractors economically.
- Access issues are resolved by using the Kurchatov Institute as DOE's trusted agent and contract customer. The number of U.S. personnel site visits is limited to two: one at the beginning and one at the end of every project. The size of the visiting teams is kept very small. Shrouding of HEU fuel and sensitive equipment is used during visits to protect classified information.
- The small size of the U.S. team—with virtually everyone on the team having been a participant on it for years—facilitates trust and professional partnership between U.S. and Russian experts. The U.S. team includes representatives from four national laboratories and DOE headquarters. All team members are highly knowledgeable specialists with technical backgrounds and hands-on experience in a broad range of nuclear safeguards and security applications.

Some of these positive factors—such as senior leaders of the relevant Russian organization who are powerful, flexible, and committed to progress—are difficult for the United States to replicate in other areas (though every opportunity should be taken to attempt to convince senior Minatom leaders to play a similar actively engaged positive role). But other aspects of the approach—small and stable U.S. teams; use of a Russian team as essentially an "integrating contractor"; flexibility on approaches to access, limiting demands to the minimum required; and broad use of Russian-made equipment—are clearly broadly applicable to other areas of the MPC&A program.

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[1] See, for example, Vladimir Shmelev et al "Russian Navy Fresh Fuel MPC&A Training," in Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting, Phoenix, AZ, July 25–29, 1999.

[2] DOE MPC&A Program RANSAC Briefing, October 7, 1999, DOE, Washington, DC.

[3] GAO Report, p. 18.

[4] Many experts believe that the two confirmed thefts of HEU from Navy facilities, combined with incidents such as the September 1998 case in which a heavily armed sailor killed seven people, barricaded himself in an Akula-class nuclear submarine, and held everyone at bay for 20 hours before killing himself, made the senior Navy leadership acutely aware of the potential vulnerability of their HEU fuel and highly motivated to solve the problem.

[5] Ministry of Defense's involvement is limited to clearing reports and other documentation that the Navy releases to the U.S. DOE.

cific cases of their U.S. counterparts presenting unilateral new American ideas as demands, with agreement linked to continued funding, not as items for discussion and joint development and refinement. At one major site, for example, a new U.S. project leader demanded that the entire project be redesigned, and insisted that all of the physical protection equipment used be from one American firm, whose equipment that project leader felt was particularly high quality, but was not certified for use at any Minatom facility. As one leading Russian MPC&A expert put it, this approach makes Russian participants feel that they are being treated as the "hired help." At the same time, there have been frequent changes in both U.S. MPC&A project leaders at Russian sites and the substantive approaches taken at those sites. One major Russian site reported that it had four U.S. project leaders in five years. This approach breaks up personal relationships that often take years to build. And this has been accompanied by frequent changes in the U.S. approach to upgrades at particular sites: in many cases, as a result of a change in project leaders, or a new review of the project by the U.S. team, the U.S. side will abruptly demand major changes in the previous approach, or drop support for projects that had previously been agreed, and on which substantial funds had already been spent. As one senior Russian participant complained, these frequent changes "are wasting our time and your money."[75] The U.S. handling of the issue of access to facilities, described elsewhere in this report—where the United States and Russia negotiated and signed agreements, and the United States then abandoned them and demanded far more—is a particularly extreme case of this problem of frequent shifts in U.S. approach, and one that has done grievous damage to the trust and confidence that had been built up in early phases of the MPC&A program.

The following issues are key examples of the increasingly U.S.-focused approach in the program.

Planning for the Future

In the 1994–96 period, there was a strong emphasis on joint U.S.-Russian strategic planning for the future of the MPC&A program. A joint lab-to-lab steering committee drew up plans identifying upgrade priorities at sites throughout Minatom's defense complex, with the anticipated time and cost to complete the upgrades at each site. But the elimination of the U.S. laboratories from the MPC&A management structure also resulted in the effective abandonment of the joint U.S.-Russian lab steering committee—itself a crucial partnership-building institution—and of any effort to draw up joint U.S.-Russian strategic plans for the MPC&A program. There has been no joint U.S.-Russian strategic plan for the MPC&A program since approximately 1996. Recent strategic plans have been entirely U.S. products, with no consultation with the Russian side in their development. The October, 1999 government-to-government

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which included representatives of a wide range of Russian sites involved in the MPC&A program, as well as the Ministry of Atomic Energy and Gosatomnadzor, the Russian nuclear regulatory agency. These discussions have been supplemented with a wide range of interviews with U.S. and Russian participants. For published accounts raising some similar issues, see, for example, Ruth Kempf, Stephen Mladineo, and Todd Perry, "U.S.-Russian MPC&A Lessons Learned," *Journal of Nuclear Material Management*, Fall 1999, pp. 25–26; and "U.S. Programs of MPC&A Assistance to Russia: 'Mutual Trust Has Been Questioned,' Seminar Participants Claim," *PIR Newsletter*, November 22, 1999.

[75] Similarly, other Russian participants are quoted as saying "The managers are being changed every year…and each new official starts all from the very beginning. We lose much time and efficiency of discussing the matters is lower, since a new manager will be replaced soon… much time is wasted in fruitless discussions with the U.S. working groups." Quoted in "U.S. Programs of MPC&A Assistance to Russia," op. cit.

agreement on MPC&A formalized the establishment of a Joint Coordinating Committee (JCC), whose tasks included drafting "Joint Action Plans" for MPC&A upgrades. No meeting of such a group was planned for more than 8 months after the agreement had been signed. Moreover, it is not clear what role MPC&A technical experts, as opposed to headquarters officials, will have in this committee on either the U.S. or Russian sides, or whether responsible officials from the regulatory agencies will be included on either side.

The joint lab-to-lab plans had been an essential confidence-building process for the MPC&A program. The plans assured the Russians that their technical input to the process mattered and that their security and secrecy limits were being protected. They provided a milestone-based road map for the program that was understandable to the specialist and lay person. The joint plans also provided a concrete document that the Russian laboratory specialists could use to lobby their political leadership in favor of further MPC&A cooperation. They could point to the technical actions that both sides had agreed were required to improve fissile material security, and also point to the funding that would flow into Russia to pay for the work that needed to be accomplished if the work was approved. This was a powerful tool.

The joint plans were not created without problems. In fact the Ministry of Atomic Energy never approved the last of the joint plans, produced in 1996, in part because it was viewed as being too comprehensive and intrusive. Still, the elimination of the joint plans has resulted in a more fractured implementation of the program and constrained a means of resolving problems at a technical level. This in turn has raised many disagreements to the political level where they are traditionally more difficult to resolve in a timely and positive manner.

The result has been that recently the Russians have been drafting physical protection and MPC&A upgrade plans of their own, with no coordination or integration with the U.S.-funded work.[76] Russian officials have expressed a strong desire to coordinate plans with the United States, so as to ensure that U.S. and Russian funds are directed in ways that complement each other, and money and effort is not wasted. Such joint planning would be an important step toward ensuring maximum program effectiveness and rebuilding U.S.-Russian partnership; in principle, it could be carried out under the aegis of the joint U.S.-Russian committee established by the October 1999 MPC&A agreement.

Assuring Upgrade Consistency

As described elsewhere (see "Setting Objectives, Reviewing Progress," pp. 49-50), in 1998 the MPC&A program established both a set of consistent guidelines for MPC&A upgrades, and a Technical Survey Team (TST) to review progress toward achieving the objec-

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[76] According to Russian officials, by late 1999 Minatom had developed a comprehensive physical protection upgrade program, including some funding from Minatom's own resources, but work was proceeding more slowly on a more general MPC&A upgrades program (RANSAC MPC&A workshop, Moscow, October 1999). On February 22, 2000, the Russian government approved a government-wide program (#149) for nuclear safety and security, with 20 sub-programs one of which was for upgrading MPC&A in Russia, in three stages, lasting seven years. (Remarks by Igor Khripunov, Center for International Trade and Security, University of Georgia, at "Russian Nuclear Security: Programs and Prospects," special seminar sponsored by the Institute for Nuclear Materials Management and the Nonproliferation Project of the Carnegie Endowment for International Peace, April 26, 2000, Washington DC.) According to Khripunov, the approved program calls for only $3.5 million in spending on MPC&A upgrades, but it is not yet clear what this figure includes and excludes; Russia spends far more than that annually on day-to-day operations of security and accounting systems for nuclear material in its complex.

BOX: THE IPPE "NUCLEAR ISLAND" PROJECT

The Institute of Physics and Power Engineering (IPPE) in Obninsk is among Minatom's largest reactor development and nuclear research centers. There are approximately 30 buildings that contain from a few hundred grams to hundreds of kilograms of weapons-useable HEU and plutonium at the IPPE site.

The IPPE became involved in U.S.-Russian cooperative MPC&A work in February 1995. The initial effort was focused on upgrading security at the so-called "BFS" building, which contains fast reactor critical assembly facilities and very large amounts of weapons-useable fissile materials. This work culminated in two MPC&A upgrades demonstrations that were held at the BFS building in August and September 1995 for U.S. and Russian MPC&A experts and governmental officials. Concurrently, the IPPE and U.S. national laboratories began to expand cooperation to upgrade nuclear safeguards at other IPPE buildings, and to improve material security site-wide. Because IPPE was one of several Russian institutes where the cooperative effort was progressing rapidly (led by an IPPE expert with IAEA experience who was fully familiar with modern safeguards, as was also the case at the Kurchatov Institute), it was hoped that IPPE's achievements would serve as a model for improvements at other Russian facilities.

One of the projects initiated in 1995 was to evaluate the possibility of consolidating many of IPPE's fissile material activities in a limited number of buildings. A decision was made to move high-grade fissile materials from the existing central storage facility and several other buildings to Building 215, adjacent to the BFS building. It was decided that the two buildings would comprise a "nuclear island" and would share a common security perimeter, intrusion detection and surveillance systems, and several other physical protection elements. (The third nearby building with significant nuclear material operations—the Technological Laboratory where fuel elements for research facilities are fabricated—was at that time not included in the "nuclear island" because doing so would require an expensive relocation of the nearby rail line.)

The "nuclear island" project was the first major material consolidation effort planned under the MPC&A program in Russia. It would place over 90 percent of all weapons-usable material at IPPE in one secure location. It also would drastically limit the number of personnel that have direct access to HEU and plutonium.

The initial design of the "nuclear island" was developed by IPPE personnel in cooperation with the Alpha-Pribor company in Tula (which specializes on CCTV surveillance systems, intrusion detection sensors, and alarm monitoring equipment), and the Texco company in Arzamas-16 (working in the area of access control equipment). The design was reviewed by Sandia National Laboratory (SNL) experts and was altered to incorporate their recommendations.

The construction of the "island" perimeter and other security elements was largely completed in 1997. Much of the equipment (manufactured by Eleron, Alpha-Pribor, Texco, and other Russian companies)

was installed or procured and placed in storage. It was expected that the "nuclear island" would be ready to accept nuclear materials in 1998.

In late 1997- early 1998, however, the U.S. team leader and many of its members were replaced. After reviewing the project and discovering a number of construction flaws, the new team decided that virtually everything agreed to before was unacceptable and needed to be done over. Specifically, the new team argued that:

- the "nuclear island" project had to be redesigned fundamentally;
- the construction, which had been done by a construction division of the IPPE, had been done badly, and new construction needed to be done by some other firm; and
- no Russian physical protection equipment should be used in the project.
- Russian team members reported that they felt the U.S. team presented these as directives, not negotiable suggestions.

Many of the already built or installed security system elements were torn down, dismantled and removed. The new design was developed almost exclusively by U.S. specialists. The DOE MPC&A program designated the Orlando-based company Advantor as the lead designer, equipment provider, and system integrator for the project. It also hired a local company to carry out the construction. These decisions resulted in numerous problems, because Advantor equipment was not certified for use at Minatom facilities, the construction company was not certified to do construction at a nuclear facility, and Minatom's security specialists were opposed to bringing outside construction workers on-site. The permission to proceed with the project, which Minatom eventually granted, would not have been possible without the vigorous personal intervention by IPPE's director and the institute's other top managers.

As of the spring of 2000, the project was nearing completion. The redesigned "island" offers a number of significant security improvements over the original project. In addition to the BFS and Building 215, the "nuclear island" now includes the Technological Laboratory and IPPE's central alarm station. The quality of construction and of the installed equipment is also reportedly better.

These improvements, however, come at a cost. Considerable resources were wasted. The "island" will be completed at least two years later than it otherwise would have been. An additional 2-3 years are likely to elapse before the nuclear material is actually moved from other buildings into the "island," to allow time for the material to be measured, tagged, and sealed. And perhaps most importantly, the whole episode—combined with DOE accusations of financial mismanagement that arose at about the same time, and took most of a year to resolve—provoked a sense of resentment and bitterness among Russian safeguards specialists, seriously undermining the partnership between Russian and U.S. MPC&A experts which is crucial to the program's long-term success.

tives established in the guidelines. While these were important and worthwhile steps, both were done without the inclusion of any Russian voices. U.S. teams were instructed not to provide their Russian counterparts with copies of the guidelines for their review. Russian specialists were given no opportunity to have any regular input into the assessments of progress made by the TST. Yet at the same time, the U.S. teams were told to inform their Russian counterparts that many specific projects that had previously been agreed would now have to be canceled or greatly modified because they did not meet U.S. guidelines. This greatly contributed to the negative perceptions on the Russian side. As a result, this effort to impose consistency resulted in widespread cancellations or modifications of previously agreed work and exacerbated the Russian view that the U.S. side was inconsistent and constantly changing its mind.

Focusing Only on U.S. Interests

The new attitude in the program is reflected in some versions of its mission statement. What was once seen as a joint effort to protect Russia's vulnerable fissile material for the benefit of U.S., Russian, and world security is now described as a program "to reduce the threat to U.S. national security posed by unsecured Russian weapons-useable nuclear material"[77]

As just one example, although the Russians see sabotage of nuclear facilities as the most important threat they face (particularly given recent fears of Chechen terrorism), the MPC&A program has made very clear to the Russian side that its mission is focused only on preventing theft of nuclear material that could be made into nuclear weapons that could threaten the United States, so upgrades that are principally useful to prevent sabotage will not be supported.[78]

Assuring Financial Accounting

Another area that continues to create problems in the U.S.-Russian MPC&A relationship is the need to account for the expenditure of program funds. The MPC&A effort was conceived as a program different from DOD's CTR program, with its strict audit and examinations carried out by the On-Site Inspection Agency. Instead, the MPC&A program negotiates contracts with Russian entities to provide specific demonstrable deliverables—a monitor installed here, a report analyzing a problem completed there—and provides funds when the contracted deliverables have been completed. The method used was a system of laboratory-to-laboratory contracts. The contracts laid out in detail the work to be done, the group that would perform the work, and the amount to be paid for the Russian component of the work. Money was not transferred to the Russians until the work was completed to the satisfaction of the U.S. laboratory in charge of the project.

The demonstrable deliverable concept was viewed as effectively protecting U.S. taxpayers' interests, and a decision was made that the goal of the MPC&A program—rapidly

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[77] DOE MPC&A Program RANSAC Briefing, October 7, 1999, DOE, Washington, DC. There are, however, a variety of different renditions of the mission statement that appear in different documents, some of which have a broader conception. In one version attributed to Deputy Administrator Rose Gottemoeller, the goal is to "reduce the threat" posed by vulnerable weapons-usable material, and it is explicitly emphasized that "cooperating with Russia" is the means by which to achieve this goal (a point not mentioned in other versions of the mission statement). For this version, see Sheely and Hayward, "New Strategic Directions in the MPC&A Program," op. cit.

[78] A major nuclear accident in Russia caused by sabotage would affect a broad range of U.S. interests, as the Chernobyl accident did, and the U.S. program to support safety improvements at Russian facilities is supporting some anti-sabotage security upgrades.

improving fissile material security—was of sufficient importance as to outweigh financial uncertainties at the margin. This tradeoff was discussed in advance with key members of Congress and deemed to be an acceptable risk.

While every effort was made to ensure that all funding was accounted for and that all the necessary work was completed, each Russian facility typically had contracts with several U.S. labs for different aspects of the work, and each U.S. lab generally had different contracting procedures, approaches to accounting for overhead and other costs. Thus it became extremely difficult to determine how much had actually been spent at each site, and what fraction of the total work at that site had been completed. During 1997–98, a new tracking system was implemented that makes it possible to rapidly determine what projects are underway at a particular site, what their status is, and how much has been spent on each of them—a clear improvement over the previous level of tracking, reflecting the growing maturity of the MPC&A program.

Despite the ability to provide reasonable confidence in monitoring confidence of taxpayer funds through lab-to-lab contracting, there has been a growing call for movement toward more stringent, CTR-like approaches to confirm expenditures by the Russian facilities. This has become a major issue, hammered home in internal DOE reports, in assessments by the General Accounting Office (GAO), and in congressional hearings. In part, this concern has been driven by the lack of transparency in the financial accounts of Russian facilities. This financial opaqueness, however, has been driven by realities in Russia. For example, funds deposited into a facility's account are in danger of being seized by the local bank to repay the facility's debts, or by the tax authorities to repay back taxes. Therefore, the facilities have become creative in establishing shell organizations and the like to manage their funds so as to have some money available to do their ongoing work—including MPC&A work. But the structures established for such legitimate purposes are often suspect from the western perspective, and facilities have in general resisted prying into their finances. This resistance has further fueled suspicions and concerns have been highlighted by organizations such as GAO. This congressional auditing agency has a special focus on financial management and has not focused in detail on the complex factors involved in making a sensitive program such as MPC&A work under the difficult circumstances that exist in Russia, especially in locations such as the closed nuclear cities. At some Russian facilities, U.S. questions about potential financial improprieties and related issues have caused DOE to cut off funding for months at a time. This has also contributed to undermining the sense of partnership necessary to achieve joint objectives.

There is no doubt that the United States has the right and responsibility to account for how its MPC&A program funds are spent. Today, however, auditing appears to have become such an intense focal point as to distract attention from focusing on the speed and success of the overall effort. And Russian participants complain, with some legitimacy, that DOE has not been willing to accommodate the circumstances that have driven some of them to the accounting arrangements they use. There is some significant hope for improvement in this area, however: with the August 1998 financial crisis receding into the past, many facilities have been able to pay off their back debts and taxes, and have less need for financial opacity. And working with organizations such as the ISTC (which has the right to audit the books of each recipient organization), and with Western commercial firms, is increasingly leading Russian nuclear facilities to learn the practices and benefits of financial transparency.

Similarly, a related long-standing irritant, Russian efforts to impose taxes, customs duties, tariffs, and the like on U.S. assistance, now appears to be largely (though not entirely) resolved. For years, these miscellaneous

forms of tax posed a significant obstacle to progress: U.S. insistence that MPC&A funds should not be taxed delayed the ability to sign contracts and start work, and in other areas, taxation drained funds from the agreed work and undermined political support for MPC&A funding in Washington.[79] During the financial crisis of 1998, Russian tax authorities attempted to argue that the tax agreement under which various programs had been operating for the previous several years was only a deferral, and that with the expiration of that deferral sites that had received MPC&A assistance owed years of back taxes, which threatened to force some of them into bankruptcy. An enormous quantity of senior management time was expended on tax and financial accounting issues, rather than on actually accelerating MPC&A upgrades. In 1999, however, the Russian government approved a new law exempting foreign aid from most taxes (albeit with moderately onerous paperwork requirements), and in early 2000, the MPC&A program received its official certification as tax-exempt. While constant efforts are still required to make the tax exemption work in practice, it appears that in principle, the issue is now largely resolved.

MPC&A Partnership in a Larger Context

The trust and cooperation built up through the MPC&A program has played a crucial role in opening up the Russian nuclear complex, building relationships, and thereby laying the groundwork for a wide range of other cooperative efforts now underway, from warhead dismantlement transparency to plutonium disposition to the Nuclear Cities Initiative. It is hard to imagine, for example, that Russian officials would have allowed joint cooperation to occur on the development of measures for the transparent dismantlement of nuclear warheads without there having first been a solid lab-to-lab relationship developed though the MPC&A program. This fundamental contribution of the MPC&A effort to many other critical national security efforts that depend on at least a minimum level of openness in the Russian nuclear complex appears not to be fully appreciated in many quarters of the U.S. government.

Unfortunately, the reverse is likely also to be true: suspicions and distrust built up through disagreements and the erosion of partnership in the MPC&A program are likely to increase the difficulties faced by other U.S. government nuclear initiatives with Russia as well, potentially contributing to slower progress in other sensitive areas. Certainly the U.S. failure to live up to its agreements on access (see next section) has already raised questions concerning the credibility of other U.S. commitments. It is important to keep in mind that while on the U.S. side there are separate groups of officials in charge of each of these separate programs, on the Russian side separate program offices have often not been established and hence the same handful of officials at Minatom headquarters (or the FSB) are overseeing them all. As a result, attitudes arising from experiences working with the United States in one program spill over into others. Hence, rebuilding a strong MPC&A partnership is likely to be essential to future success not only in preventing theft of nuclear material, but in achieving a broad range of other U.S.-Russian cooperative security objectives as well.

RECOMMENDATIONS

- The President, the Vice President, the Secretary of Energy, and other senior members of the national security team

[79] For a review of this issue, see Nicole Nelson, "The Impact of the Russian Taxation System on the MPC&A Program," in *Proceedings of the Institute of Nuclear Materials Management, 40th Annual Meeting*, Phoenix, AZ, july 25-29, 1999 (available at http://www,nn.doe.gov/mpca/pubs/frame_tec.htm).

should make reducing the threat posed by insecure nuclear material a top priority, and should devote the sustained time and effort needed to ensure that the MPC&A program is carried out as rapidly and effectively as possible, and that obstacles to progress are quickly overcome.

- The U.S. national laboratories should be given a stronger voice in key policy decisions on the future of the MPC&A program. Specifically, senior laboratory experts should be brought back into the DOE management structure, and the laboratory advisory committee should be given a greater role, with its input solicited on all key policy and technical decisions.
- In addition to this strengthened laboratory committee, DOE should establish an independent committee of outside experts to advise on the best approaches to carrying out the MPC&A program.
- The MPC&A program should adopt as a fundamental principle that every objective will be achieved in partnership with the Russians, with programs designed to serve both U.S. and Russian interests, and Russian experts integrated into all phases of program design and implementation; the mission statement should make unambiguously clear that the goal of the program is to serve *both* U.S. and Russian interests.
- The MPC&A program should work with Russia to build a central policy role for the joint coordinating committee and ensure that senior technical experts (as well as regulators) are represented on both sides of that committee.
- The MPC&A program should work with Russian experts to develop a new joint strategic plan for the MPC&A effort—a greatly accelerated one. In particular, the U.S. side should work with the leaders of key Russian sites with large quantities of material and ask for their perspectives on how best to rapidly consolidate and upgrade security for the material at their sites. The U.S. side should seek a political-level mandate—perhaps from the U.S. and Russian Presidents—to work out such an accelerated joint plan.
- The MPC&A program should develop a new joint version of the program guidelines and objectives, giving Russian experts an important voice in the final product.
- The MPC&A program should establish mechanisms for integrating Russian perspectives into the work of the Technical Survey Team. Potential options include encouraging the establishment of a parallel Russian team, or even integrating Russian participants into what has until now been a U.S.-only team.
- The MPC&A program should seek to establish Russian teams that can play key roles in designing and carrying out upgrades, on the model of the work the Kurchatov Institute experts have done on the Navy projects. This could ultimately include encouraging the establishment of additional private Russian firms that would receive MPC&A contracts on a for-profit basis, giving them an incentive to find ways to overcome obstacles and expand cooperation.
- The MPC&A program should seek to increase the management and problem-solving roles of both the U.S. and Russian laboratories and facilities, de-emphasizing reliance on talks between DOE and Minatom headquarters officials to the extent possible.
- U.S. project leaders should be instructed not to present new ideas as U.S. demands, but rather to seek to work with their Russian counterparts to jointly develop MPC&A approaches and modify them as necessary, with the goal of achieving maximum Russian "buy-in" and support

for upgrades and changes in procedures and culture.

- Where possible, experts selected to be U.S. project leaders should have previous successful international experience (ideally experience working with Russian nuclear experts), and project and team members should be given at least introductory training in Russian culture and negotiating in a Russian context.
- The MPC&A program should avoid sudden drastic changes in technical approaches taken at individual sites, and should seek to keep the same U.S. project leaders for individual MPC&A sites for several years at a time, to improve program consistency and allow personal relationships and trust to build up over time.
- As recommended in the next section, the United States should resolve the access issue quickly, returning to its past commitments in this area.

V. Access: A Case Study of How *Not* to Maintain a Partnership

The issue of gaining appropriate access to the facilities where security and accounting needs to be upgraded has been a difficult one since the earliest days of the MPC&A program. It has now come to a crisis, as DOE decided in September 1999 to cut off all further contracts at several of the most important nuclear facilities in Russia—the two nuclear weapons design laboratories, all four of the nuclear weapons assembly and disassembly facilities, and the fuel fabrication facility at Electrostal—over Russian refusal to grant access to sensitive areas of these sites. At this writing (Summer 2000), while some additional progress has been made at the two weapon design facilities (partly through increased U.S. flexibility), no work has resumed at the warhead assembly facilities. The basic U.S. policy of refusing to support upgrades where access is not available appears to remain in place, and no resolution to the issue yet appears to be in sight.

Access is undeniably important for the MPC&A program. Being able to actually enter a facility, observe its layout, and see where the material is located and how it is handled, makes it dramatically easier to assist in improving security and accounting. It is useful to assess first hand what buildings are the highest priority for upgrades, what particular improvements are most important, what kinds of changes in the way the material is currently stored and handled might contribute to easing the security and accounting task, and other factors. Moreover, having direct physical access to the facility after equipment that the United States paid for has been installed is the highest-confidence approach to ensuring that U.S. assistance is being used appropriately.

But many of the buildings in question are critical components of Russia's nuclear weapons complex and among the most sensitive nuclear installations in Russia. The activities that take place there remain closely guarded secrets—just as the comparable activities in the United States are. Russian experts have indicated clearly and repeatedly that though they might like to be able to allow their U.S. colleagues into these facilities, Russian security rules forbid this. There has never been a visit by a foreigner to Russian nuclear weapons assembly and disassembly facilities, and Russian experts have indicated that such visits are forbidden by Russian law. The flexibility that the Ministry of Atomic Energy and its experts can show in this area is limited by the FSB, which tightly controls all issues of access to sensitive facilities in Russia.

The approach that was taken early on in the MPC&A program—initiating contracts for joint work primarily at facilities where some access was possible, building trust through genuine cooperative work and long-term building of personal relationships, and then pushing for access to additional locations—worked extraordinarily well. From a situation in early 1994 where U.S. experts were not allowed into any location in Russia where actual plutonium and HEU were stored and handled, even civilian facilities—largely because of the sensitivity of the access issue—the program has now reached a point where U.S. experts have access to the vast majority of sites in Russia where these materials exist (though not necessarily to all the buildings at those sites). One key aspect of this trust-building was a degree of reciprocity, convincing Russian experts that the kinds of visits the United States wanted were not unacceptably intrusive by accepting similar visits to U.S. facilities. In mid-1994, for example, the log-jam over Russian refusal to grant access to plutonium facilities was broken in part by bringing Russian experts to see the security arrangements for plutonium at the major U.S. plutonium site at Hanford, which then led the Russians to agree to cooperation for the 30

tons of weapons-usable civilian plutonium at Mayak.

From very early on, however, it was clear that some buildings—particularly at the nuclear weapons design laboratories and the entire territory of the nuclear weapons assembly and disassembly facilities—would be very difficult for U.S. specialists to enter and that many buildings at these sites would be entirely off-limits to non-Russians under current Russian regulations. But it was equally clear that there was a very large amount of potentially vulnerable nuclear material at these off-limits locations, and that finding a way to be able to cooperate to improve security and accounting for this material was critical to the success of the overall effort to reduce the risk of nuclear theft in the former Soviet Union.

Hence, from the earliest days of the lab-to-lab MPC&A program in 1994, the U.S. laboratories, under instruction and guidance from DOE headquarters, began working with their Russian colleagues on an approach to cooperate to improve security and accounting at buildings where direct access by U.S. personnel would not be possible, while providing effective confirmation—"assurances" was the term used—that U.S. assistance was being used as intended. By the fall of 1995, the two sides had prepared a unified U.S.-Russian lab-to-lab plan for MPC&A cooperation in the Minatom defense complex, which included several pages outlining the measures needed for the U.S. laboratories to "be able to assure the Department of Energy, the U.S. Congress, and the American people that equipment, funding, and technical support provided to Russia under the Lab-to-Lab MPC&A program are accounted for and are used for their intended purposes" in cases where direct access by U.S. personnel would not be possible.[80] The methods described in this joint document include written certifications of work done by Russian officials, technical reports on that work by relevant institutes, and photographs and videotapes of the equipment in use after installation. The sides agreed in that plan that the written certifications by themselves would in general not be sufficient, but would have to be supplemented by the photographs and videotapes of the installed equipment, and that the specific measures for assurances would be specified in the contracts for MPC&A upgrades at each site.

Following up on that agreement, the U.S. laboratory project leaders for Arzamas-16 and Chelyabinsk-70, again with the knowledge and approval of DOE headquarters, began negotiating arrangements for implementing MPC&A upgrades for buildings at sites where direct access by U.S. personnel would not be possible. Because the FSB remained convinced that the real U.S. goal was to collect intelligence on sensitive facilities, not just to cooperate on MPC&A, these discussions required enormous efforts to build personal trust and confidence between the U.S. and Russian project leaders, using creative means to overcome obstacles, and some considerable courage on the part of the Russian project leaders to lobby their own system for progress on these sensitive issues. "Patience, persistence, and prudence," as one participant put it, were the essential watchwords. Ultimately, agreements were reached for both sites, signed by the U.S. and Russian project leaders, and upgrades under their terms began to be carried out. While the terms varied from one facility to the other, the basic approach was that the Russian experts would do an assessment of the vulnerabilities of the facility in question and a design of appropriate security

[80] *Unified U.S.-Russian Plan for Cooperation on Nuclear Materials Protection, Control, and Accounting (MPC&A) Between Department of Energy Laboratories and the Institutes and Enterprises of the Ministry of Atomic Energy (Minatom) Nuclear Defense Complex*, Revision 0, Joint U.S.-Russian MPC&A Steering Group, September 1, 1995.

and accounting upgrades (based in part on software and techniques provided by the U.S. side), the two sides would have discussions of what equipment was needed and why, the U.S. side would pay for the purchase of the agreed equipment, the Russian side would install the equipment, and the Russian side would then provide written assurances, reports, photographs, and videotapes to document that the U.S.-funded equipment was installed and being used appropriately.

Efforts to make progress on MPC&A at the nuclear weapons assembly and disassembly facilities—known in Russia as the "serial production facilities"—were proceeding in parallel. After some promising early discussions with representatives of these facilities in late 1994 and early 1995, the FSB put a stop to the effort in the fall of 1995. For several years, DOE and the U.S. laboratories labored to build up the personal relationships and trust with Russian counterparts needed to reengage on the issue. Ultimately, in 1997, the experts at the Russian nuclear weapons laboratories were able to convince Minatom and the FSB to allow an initial project focused on installation of Russian-made portal monitors at these facilities to move forward (with a clear understanding that this initial step would lead directly to negotiation of a more comprehensive joint effort to upgrade MPC&A at these facilities). In the winter of 1997–98, an agreement on providing assurances that equipment was used appropriately at these facilities without U.S. access to them was signed by DOE and Minatom. The methods specified in that agreement were basically the same as those that had already been worked out for Arzamas-16 and Chelyabinsk-70.

In short, it had taken years of painstaking effort and building of personal trust and confidence to allow urgently needed MPC&A upgrades to proceed at these six highly sensitive facilities (the two weapons labs and the four assembly and disassembly plants), and the two sides had ultimately reached agreement, in writing, on measures that would provide effective assurance that U.S. assistance was being used appropriately, even without direct access by U.S. personnel to the buildings where the equipment was installed. These arrangements and their continuing implementation at Arzamas-16 and Chelyabinsk-70 were regularly briefed to DOE headquarters.

Despite this signed agreement, during the course of 1997–99, DOE headquarters officials came to take a harder and harder line on access issues, taking the view that the program could spend its money most effectively where the best access was available and where U.S. teams could make their own judgments as to what upgrades deserved highest priority, rather than relying on Russian expert judgment for such choices. This access concern was one part of a broader set of concerns about ensuring the appropriate use of U.S. assistance. With Russian corruption and charges that international aid money might have been stolen filling the newspapers, Russian sites using very complex accounting and money transfer systems to avoid having the money taken for back taxes or back debts of the facility, and Russian teams in some cases being unable to complete upgrades on the schedule and budget originally agreed, DOE headquarters officials became acutely focused on the need to ensure that all U.S. assistance was really being used as intended. They realized that the documented misuse of funds could spell the death of the program.

The concern over access in particular was highlighted by the Technical Survey Team, which was established in 1998. These specialists 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. Moreover, during this period, there were also a small number of incidents (at facilities other than the weapons design labs and the nuclear weapons assembly and disassembly facilities) which suggested that Russian experts might have misled their U.S. col-

leagues concerning how much material or what types of activities were in particular buildings, provided an argument for demanding more access to ensure that the situation in buildings to be upgraded really was as described.

The access issue became even more problematic in early 1999, when FSB restraints on access and provision of sensitive information increased quite perceptibly, affecting a wide range of programs. At this time, access for the MPC&A program became more difficult, several aspects of joint lab-to-lab work on warhead dismantlement transparency were stymied, and permissions for entry into the closed cities became more difficult to obtain. Both U.S. and Russian participants attribute this shift to a combination of factors, including the sharp down-turn in U.S.-Russian strategic and political relations following the start of the bombing of Yugoslavia, and the U.S. clamp-down on access to U.S. facilities in the wake of the Chinese espionage scandals. These factors and internal Russian political factors led the FSB to interfere with those aspects of cooperation it considered suspect.

In the early fall of 1999, an internal DOE Inspector General (IG) report on the use of funds in the MPC&A program highlighted the fact that some work was being done to support activities at sites where no U.S. access was available. It argued that "access to facilities and information is critical" in order to "fully establish the nature of proliferation concerns; determine upgrade priorities and designs; and ensure that upgrades are properly installed, operated, and maintained"; and recommended that DOE "develop a new policy to provide clear and consistent guidance to laboratory project managers on the appropriate level of access" required to proceed with cooperative MPC&A upgrades.[81]

The MPC&A managers at DOE headquarters utilized the pressure of the IG report, coming in the midst of the broader concern over ensuring appropriate use of U.S. assistance, as a reason to deliver what amounted to an ultimatum to the Russian side: more access, or no more contracts for these sensitive facilities.[82] The U.S. lab project leaders who had signed the access agreements were told to tell their Russian counterparts that the agreements were no longer satisfactory, and when the Russian side did not deliver additional access in response to the U.S. request, all further contracts for work at the nuclear weapons design laboratories, the nuclear weapons assembly and disassembly facilities, and the Electrostal fuel fabrication plant were cut off in September, 1999.[83] This was a significant

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[81] *Audit Report: Nuclear Material Protection, Control, and Accounting Program*, U.S. Department of Energy, Office of Inspector General, Office of Audit Services, September 1999.

[82] According to DOE's new policy, an increased level of access is required to assure that the following criteria are met for every building and facility where upgrades are conducted: a) there is high-grade material; b) a safeguards system is designed and installed; and c) the material remains in the building or facility and the safeguards system is operational.

[83] The Electrostal case is quite different than the others. In 1993, in the days when the Russian side would not allow access to any facilities with actual HEU or plutonium, the LEU fabrication line at Electrostal became the first U.S.-Russian cooperative MPC&A upgrade project, on the philosophy that it could serve as a model facility whose lessons could be transferred to work on real HEU and plutonium later. Despite repeated promises to expand the work to the HEU line, however, the Russian side never gave the U.S. side any access at all to the HEU line, and work never began there. The HEU line fabricates naval fuel, which is admittedly highly sensitive—the U.S. Navy has been very clear that Russian experts are not going to be given access to the comparable facilities in the United States—but the program to work with the Russian Navy to upgrade MPC&A for its naval fuel has been highly successful, developing reasonable ways to permit access to buildings without revealing sensitive characteristics of the naval fuel itself. Why this could not be accomplished for Electrostal remains a

deviation from past practice in the MPC&A program. The goal of upgrading fissile material security in Russia as rapidly as possible has suffered immeasurably as a result of this policy decision.

Nevertheless, the two sides went forward with the signature of a new government-to-government agreement on MPC&A on October 2, 1999 (whose provisions had already been negotiated before DOE's September contract action), which included, in Article IV, a provision specifying that while Russia would take steps to permit access to sites where joint work was being performed, this would be limited by Russian legislation, and where access "is restricted by the legislation of the Russian Federation, the Executive Agents shall jointly develop alternative flexible, nonintrusive and mutually acceptable methods that do not require access by the representatives of the U.S. Party."[84] The DOE position that no upgrades can be carried out without access by U.S. representatives is directly contrary to the terms of this government-to-government agreement.

There are legitimate differences of opinion about how hard to press for additional access, and what negotiating tactics are most appropriate. But the steps taken in September 1999 represented bad faith on the U.S. side, plain and simple. In effect, the DOE managers unilaterally decided to rip up signed U.S.-Russian agreements, painstakingly negotiated through years of personal trust-building, and demand steps going far beyond what had been agreed—steps which were precisely the ones the Russian side had made clear from the beginning were not legally within their power to take. Russian participants report that the FSB saw the U.S. action in revoking these agreements as confirmation of their suspicion that the United States was on an intelligence gathering expedition and as a result its position hardened even further. As many had predicted, the net effect of DOE's precipitate action, at least in the short term, was not to accomplish the goal of greater access, but to harden the Russian position on access, cut off cooperation at sensitive facilities, undermine the personal credibility of the Russian experts who had negotiated with the United States within their own system, and critically undermine the trust and confidence between U.S. and Russian experts that has been crucial to the MPC&A program's success. Key Russian MPC&A experts had taken significant personal political risks to lobby their own system to move this sensitive cooperation forward, and had the rug pulled out from under them, destroying whatever incentive they may have had to provide similar support in the future. Whether they can ever be re-engaged as energetic supporters and lobbyists on the program's behalf within the Russian system remains in doubt. This was, in short, a policy blunder of colossal proportions.

Having cut off further contracts to these facilities, DOE then designated the Senior Policy Advisor to the Secretary of Energy for Russian Affairs as the special ambassador for access issues, dealing not only with access related to the MPC&A program, but also with

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mystery; one possible explanation is different attitudes of a different regional FSB office, combined with less enthusiasm on the part of Electrostal's own management. Whatever the case, the cut-off of work at Electrostal did not represent a U.S. decision to rip up a previously agreed access arrangement, but rather a U.S. decision that in the absence of Russia living up to past promises to cooperate on the HEU line, there was little point in throwing more money at the LEU line at Electrostal, which contains no weapons-usable material.

[84] *Agreement Between the Government of the United States Of America and the Government Of The Russian Federation Regarding Cooperation In The Area Of Nuclear Material Physical Protection, Control And Accounting*, October 2, 1999 (available at http://www.nn.doe.gov/mpca/frame05.htm).

the quite different access issues associated with the Nuclear Cities Initiative. DOE proposed an approach which demanded direct access by U.S. personnel to all the facilities where MPC&A upgrades were to take place, but would limit access to a small "access team," so that only a few individuals would be able to see these sensitive Russian facilities. Months of back and forth discussions, however, made little progress on this until the spring of 2000. Indeed, in the spring of 2000 the Russian side put forward a proposal to "resolve" the access issue which represented a major step backward: while still not guaranteeing access at the facilities in question, it would in effect put all movements of U.S. MPC&A personnel in Russia under the direct supervision of the FSB, even at civilian sites where access has not previously been a serious problem.[85] Fortunately, that proposal appears to have been dropped. By May, 2000, the two sides reached agreement at least on a limited protocol granting limited access and allowing new work to go on at some additional areas of the two warhead design facilities. No work has resumed at the warhead assembly facilities, however, and the two sides' approaches to access remain a key obstacle to progress.

Even if an accommodation is ultimately reached that offers greater access than was available under the previous agreements, the damage to the spirit of joint partnership so crucial to the program's success caused by DOE's precipitate unilateral action in this case is likely to be grievous and long-lasting. Nevertheless, DOE has now further restricted its room to maneuver on this issue, with DOE officials providing assurances to Congress "that sites that do not grant U.S. access do not receive contracts for work."[86]

The Navy MPC&A projects have had much better success on the access issue, though naval fuel, like nuclear weapons, is highly sensitive. In that case, there was a small and stable U.S. team, allowing the build-up of relationships of trust and confidence with their Navy counterparts; there was a Russian team from the Kurchatov Institute which was able to play almost the role of an integrating contractor, on the ground all the time, working issues as they arose; there was very high-level support within the Russian Navy; and the U.S. team was willing to accept a variety of flexible access approaches, visiting sensitive locations only infrequently, allowing sensitive areas to be shrouded or blocked, and so on.

The DOD has also faced similar issues in its efforts to work with Russia to improve security for nuclear warheads under the Cooperative Threat Reduction program. Like the warhead assembly and disassembly facilities, Russian experts report that foreign visits to nuclear warhead storage facilities are forbidden by Russian law—yet helping to correct whatever security deficiencies may exist at these facilities is also clearly a high priority for U.S. security. (In 1997, Gen. Eugene Habiger, then commander of the U.S. Strategic Command, was the first American to be allowed to visit an active nuclear weapon storage facility in Russia, and allowed Russians to visit U.S. nuclear weapon storage facilities for the first time, but this apparently involved some one-time exemption to the legal prohibition on

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[85] This proposal presumably results in part from the concern held by Minatom and the FSB that the frequent U.S. visits at the sites where access has been made available, coupled with the constant turnover on the U.S. teams (which means that new people are frequently being introduced) represents an effort on the U.S. part to collect a near-constant flow of intelligence on Russian nuclear sites.

[86] Testimony to the House Armed Services Committee, Subcommittee on Military Procurement, March 21, 2000. Rose Gottemoeller emphasized that U.S. experts did have access at many other sites, so that overall, "we have more access than we have money to spend at particular sensitive sites."

foreign visits and has not led to a broader breakthrough on the question of access to weapon sites.) Unfortunately, there has been little coordination between DOE and DOD over the years in their efforts to address the similar problems they face in these cases.

The traditional DOD approach to "audits and examinations" designed to ensure the proper use of U.S. assistance is quite intrusive, and indeed relies on arms control inspectors from the On-Site Inspection Agency. (It was partly concern over the likelihood of such intrusive procedures that caused Russia to limit the MPC&A program to sites without HEU and plutonium in its early days.) In some sensitive cases, however, where only equipment and not its installation has been paid for with U.S. money, DOD has negotiated special procedures in which photographs or videotapes rather than actual visits were used to document that Russia had in fact installed and was using the equipment, as had been envisioned under the DOE-Minatom agreements. In addition, in the case of confirming that secure railcars provided by the United States were in fact being used to transport warheads to dismantlement facilities, DOD and its Russian counterparts developed a system of "trusted agents"—Russian citizens with authorization from the Russian side to visit the relevant locations, but who are employees of U.S. contractors in Russia and certified as trustworthy by the U.S. side—who provide reports on the appropriate use of the U.S.-provided equipment. This approach does not appear to have been considered by DOE. Like DOE, DOD has not yet fully solved the problem, despite intensive discussions led by senior DOD officials. "Quick fix" initial security upgrade kits for 50 nuclear weapon storage sites have been procured, but U.S. financing for their installation has not yet been provided, pending agreement on an access approach to make it possible to confirm that installation work paid for with U.S. funds was carried out as agreed.

Several key points should be kept in mind in considering the best path forward. First, access is not an end in itself. The goal is to achieve the fastest, most cost-effective reductions in the threat posed by possible theft of nuclear material. Access to facilities is only one of the factors that contributes to meeting that goal—though an important one. When tactical approaches to the access question are clearly moving in a direction away from this larger goal, they should be changed. Second, while ensuring appropriate use of U.S. taxpayer dollars is clearly a high priority, preventing nuclear material from falling into the hands of hostile states or terrorist groups is even more important. If attempts to gain a small increment in confidence in our understanding of how U.S.-provided equipment is used result in a large decrease in our ability to upgrade security for nuclear material, we are clearly headed in the wrong direction. On the other hand, it is essential to have an approach to providing assurances that U.S. assistance is used appropriately that can pass muster on Capitol Hill, if support for these efforts is to be maintained. Third, the impact of reciprocity, and in particular of U.S. restraints on Russian access to U.S. facilities in the wake of the Chinese espionage scandals, is substantial. While Russian experts have definitely had access to a broader array of facilities within the U.S. weapons complex in the past than Russia has offered to U.S. experts, restraints on Russian access at U.S. facilities are very real. Although the United States is, of course, receiving no Russian MPC&A assistance, it is nevertheless very difficult for the United States to argue that Russia is being unreasonable in denying access when the United States is denying Russian experts access to comparable facilities in the United States.

Access: Recommendations

- DOE should immediately lift the cutoff of further contracts at the two weapons design laboratories and the four weapons assembly and disassembly facilities. DOE should send the message to Russia that new management is taking a new

approach, and return to implementing the agreements previously reached.

- At the same time, DOE should continue to work with the Russian side, in a problem-solving spirit, to work out improved approaches to provide sufficient information to prioritize MPC&A upgrades and confirm the appropriate use of U.S. assistance. The use of trusted Russian citizens, as in the DOD program, should be explored.
- DOE should offer Russian experts reciprocal access at U.S. facilities engaged in comparable activities. Offering to let the Russians see the same things the U.S. wants to see will help build trust, undermine the argument that the United States is spying through such visits, familiarize additional Russian experts with how similar security and accounting issues are addressed in the U.S. system, and make clear to U.S. officials just how difficult and sensitive it is to arrange the kinds of access they are seeking in Russia.
- DOE should work closely with Congress to demonstrate that it is possible to have confidence that U.S. assistance is being used appropriately even in the absence of direct U.S. access to these sensitive facilities, and to emphasize that the cooperation at these sensitive sites is crucial to reducing the threat of nuclear material theft.

Appendix: U.S.-Russian Cooperation to Establish an MPC&A Performance Testing Program in Russia

As described in the text, realistic performance testing is an essential component of an effective, sustainable system of nuclear safeguards and security. It is particularly important for the purposes of identifying and fixing key system weaknesses that may not show up in paper and computer analyses, strengthening safeguards against a knowledgeable and trained adversary, increasing awareness of the threat among personnel involved in MPC&A, and developing and maintaining a modern safeguards culture. This appendix is intended to provide suggestions on how the United States can help establish an effective MPC&A performance testing program in Russia.

A performance-based approach to nuclear safeguards requires nuclear facilities to demonstrate their ability to defend against a postulated security threat (design basis threat). The latest revision of the IAEA physical protection guidelines document (INFCIRC/225/Rev.4) specifically calls for evaluations of technical systems, procedures, and response forces "[T]o ensure that physical protection measures are maintained in a condition capable of meeting the State's regulations and of effectively responding to the design basis threat."[1] When conducting a performance evaluation, evaluators look at a nuclear facility from the perspective of a potential adversary: "if I wanted to steal material from this facility, how would I do it?" They then seek to identify its vulnerabilities through systematic and realistic testing. If the tests identify serious weaknesses, resources should be allocated to correct them, and new tests conducted. Testing should be conducted regularly to ensure that the security system remains effective.

The development of performance testing in Russia is an important and urgent task. Prior to discussing potential cooperative approaches to this problem, however, it is useful to review briefly performance testing programs in the United States, and to summarize public information about security testing procedures at Russian facilities.

U.S. Experience

In the Department of Energy's complex, there are two levels of performance evaluation. Individual sites and the program offices responsible for them are required to carry out performance testing of the physical protection system, and of the material accounting and control systems, to ensure that these systems meet Department requirements and are capable of defeating the design basis threat. Full-scale performance tests of the security systems against realistic threats are required at least every year, for facilities handling Category I or II nuclear materials.[2]

In addition to these required self-evaluation programs, the second type of performance evaluation in DOE is the independent evaluation program carried out by the Office of Independent Oversight and Performance Assurance (until recently the Office of Security Evaluations within the Office of the Deputy Assistant Secretary of

[1] *The Physical Protection of Nuclear Material and Nuclear Facilities*, Information Circular INFCIRC/225/Rev.4, IAEA, Vienna, Austria, March 1999, p. 9.

[2] See *DOE Order 470.1: Safeguards and Security Program*, Chapter III: Performance Assurance Program, September 28, 1995; for a discussion of the requirements for performance testing of the material control and accounting elements, see *DOE Manual 474.1: Control and Accountability of Nuclear Materials*, August 11, 1999 (both available at http://www.explorer.doe.gov:1776/htmls/currentdir.html).

Energy for Oversight).[3] Since the inception of the program in 1982, the Office has conducted over 100 inspections at major DOE facilities. Security evaluation inspections are carried out by a group of experts from DOE headquarters and contractor personnel from other governmental and private organizations. Inspections are site specific and are designed to evaluate each of the principal components of the physical protection system, including detection, assessment, communication, and response.[4]

The Office also conducts performance evaluations of each facility's material control and accounting system by testing MC&A equipment, personnel and procedures against the established site-specific threat. According to the Office's Material Control and Accountability Inspectors Guide, for example, "[P]ersonnel performance tests are intended to determine whether personnel know and follow procedures, whether procedures are effective, and whether personnel and equipment interact effectively."[5] A typical MC&A performance test scenario would involve a clandestine attempt by an insider to remove simulated nuclear material outside of the material access area. Inspectors would evaluate the ability of security personnel to detect the contraband as well as their response to the smuggling incident.

Performance-testing has played a crucial role in commercial facilities regulated by the U.S. Nuclear Regulatory Commission as well. In 1982, the Commission initiated the Regulatory Effectiveness Review (RER) program that primarily addressed security hardware systems such as intrusion detection sensors and assessment systems.[6] In 1991, the NRC established the Operational Safeguards Response Evaluation (OSRE) program with a focus on armed response at nuclear power reactors. Similar programs have been developed for NRC-licensed Category 1 facilities.

In the 1980s, the DOE and NRC performance evaluation programs identified safeguards vulnerabilities at virtually every tested facility. It was not uncommon for an "adversary" to defeat a facility's intrusion detection system at multiple sectors of its perimeter. Likewise, it was demonstrated that at many facilities, guard force response was based on flawed strategies, erroneous assumptions regarding adversary capabilities, and unrealistic expectations about security personnel tactical skills and physical abilities. In 1986, inspections revealed that there were no portal monitors to prevent nuclear material from being carried out at some of the exits to Pantex, the U.S. nuclear weapons assembly and disassembly facility, perhaps the most sensitive facility in the entire U.S. complex. (Monitors were installed within days of the inspection, along with other new measures.) In that time period, in a test at the Savannah River Site, the guard force failed to prevent a mock terrorist force from

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[3] With recent security concerns at DOE, this office has been elevated to report directly to the Secretary of Energy. For a description of its current activities and conclusions, see Office Of Independent Oversight and Performance Assurance, *Strength Through Leadership, Confidence Through Security: Year-End Status of Safeguards and Security in the Nuclear Weapons Complex* (Washington DC: Department of Energy, January 2000). For a description of the DOE requirements for such independent evaluation, see *DOE Order 5630.12A, Safeguards and Security Inspection Program*, June 23, 1992 (available at http://www.explorer.doe.gov:1776/htmls/currentdir.html).

[4] *Intrusion Detection System: Performance Testing: LessonsLearned* (Nuclear Security Services Corporation for DOE Office of Security Evaluations, no date).

[5] *Inspectors Guide: Material Control and Accountability*, January 1994, Department of Energy Office of Deputy Assistant Secretary Security Evaluations, p. 15.

[6] In 1991, the RER program was replaced by the Regional Assistance Program. Under the Regional Assistance program, performance evaluation inspections are conducted at a request from NRC regional office.

gaining access to the facility and making off with mock plutonium—even though the guard force had received unauthorized warning as to exactly when and where the terrorists would attack—and the guards were still shooting at each other 45 minutes after the terrorists had left.[7]

Incidents such as these, combined with Congressional pressure, and the successful attack on the U.S. Marine barracks in Lebanon, convinced senior policy-makers that more resources really were needed to upgrade security within DOE's complex, provoking a large-scale effort to improve security (and later, material control and accounting). (An early and fast-paced part of this effort was dubbed "Operation Cerberus," after the mythical guardian of the gates of hell.) Similarly, within the NRC system, observations by managers from other utilities of the weaknesses revealed in performance tests at nuclear reactors led to greatly increased awareness of the need for security upgrades, which were accomplished at many reactors throughout the United States.

As a result of such upgrade programs, the security situation for nuclear materials in the United States has improved considerably in the intervening two decades, and U.S. nuclear materials are probably among the most secure in the world. Nevertheless, serious problems continue to arise. In 1997, independent evaluations and whistleblowers at particular sites revealed such severe problems in DOE's efforts to secure nuclear material that Congress felt called upon to create a new "Department of Energy Security Management Board," including senior officials of the Energy and Defense Departments, the CIA, and the FBI.[8] Congress' concerns were only exacerbated by the subsequent allegations of Chinese nuclear espionage, which led to major changes in DOE's approach to safeguards and security, and the organizational structures tasked with implementing it; the new emphasis (including intensive independent evaluations and tests at several sites) is believed to have resulted in substantial improvements in security.[9] Similarly, the NRC OSRE program found that the security systems failed to defeat the test adversaries at 47 percent of the plants tested (despite the fact that licensees were given long periods to prepare and beef up their security, and the tests used less than the maximum design basis threat); after industry complaints, the NRC terminated the OSRE program (over the objections of the staff who

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[7] See *Nuclear Weapons Facilities: Adequacy of Safeguards and Security at Department of Energy Nuclear Weapons Production Facilities*, hearings before the U.S. House Committee on Energy and Commerce, H. Hrg. 99-143, 99th Congress, 2nd Session, March 6, 1986 (Washington DC: Government Printing Office, 1986); and *Safeguards at DOE's Nuclear Weapons Facilities*, hearings before the U.S. House Committee on Energy and Commerce, H. Hrg. 101-77, 101st Congress, 2nd Session, July 20, 1989 (Washington DC: Government Printing Office, 1986).

[8] See, for example, Peter Eisler, "Reduced Budgets Erode Security at Nuke Plants," USA Today, October 22, 1997; Peter Eisler, "Unit to Probe Nuke Safety is Approved." *USA Today*, November 7, 1998; and U.S. Department of Energy, Office of Oversight, *Interim Report on the Status of Safeguards and Security in the Department of Energy* (Washington DC: DOE, November 1997). The current director of the Office of Independent Oversight and Performance Assurance recently told Congress that "in general, protection of our most critical assets, such as nuclear weapons components and special nuclear materials, has improved significantly since the 1980s. While problems are still evident, they are generally degradations in one layer of a multi-layered security system rather than gaping holes of the type frequently noted in the 1980s." Glenn S. Podonsky, testimony to the House Commerce Committee, Subcomittee on Investigations, October 26, 1999. For a depressing account, year by year, of evaluations over decades that all found serious security weaknesses at DOE, see President's Foreign Intelligence Advisory Board, *Science at Its Best, Security at Its Worst: A Report on Security Problems at the U.S. Department of Energy* (Rudman Commission report), June 1999 (available at http://www.fas.org/sgp/library/pfiab/index.html).

[9] See *Strength Through Leadership*, op. cit.

ran it) in late 1998.[10] It was quickly revived after a Los Angeles Times story caught President Clinton's interest and he called then-Chairman Shirley Jackson, who had also received vociferous complaints from Rep. Edward Markey (D-MA).[11] OSRE, however, may now be replaced with a voluntary industry self-assessment program designed to be less costly to the licensees (though more frequent than the OSRE tests) in which NRC regulators will act only as "observers."[12]

Nonetheless, overall, performance testing has become a crucially important tool for maintaining and regulating nuclear safeguards and security in the United States. At present, virtually every U.S. facility has an internal performance-testing program. Every several years, an independent performance evaluation is also conducted by specialized programs that are directed from the DOE (or NRC) headquarters and are independent from normal inspection organizations.

Designing and executing a realistic, safe, and meaningful test of safeguards performance is often a difficult task. To a large extent, the success of performance testing programs in the United States could be attributed to the following factors:

- Nuclear safeguards regulations are performance-oriented, at least in part. In particular, the regulations establish a design basis threat, which serves as a foundation for performance-testing activities.
- The headquarters-based programs, while limited in the number of evaluations they conduct, provide for a consistency of testing methodology nation-wide.
- There is a commitment to performance testing within at least some quarters of the DOE and NRC leadership.
- There is an effective performance testing methodology.
- There are highly-trained and knowledgeable personnel with unique expertise encompassing such areas as tactical response, security hardware, nuclear technologies and operations, and general safeguards issues and regulations. The programs also utilize outside contractors with expertise in small group armed combat and intimate knowledge of adversary tactics and capabilities.

Situation in Russia

While information on Russian safeguards practices remains sketchy, it appears that that Russian facilities are not subjected to the same level of systematic performance testing. Nor do Russia's federal regulatory agencies have institutionalized performance testing programs or capabilities. The broad physical protection requirements issued by the Russian government in Basic Rules for Physical Protection do not include requirements for performance testing designed to demonstrate the overall system's ability to defeat a design-basis threat, in contrast to DOE orders or NRC regulations (and IAEA recommendations), though the rules do require limited testing of the guard forces at individual sites.

Minatom headquarters does not appear to have a unit that performs evaluations comparable to those of the Office of Independent Oversight and Performance Assurance at DOE. Individual facilities reportedly carry out some tests of some aspects of their security systems,

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[10] See Paul Leventhal, testimony to the Nuclear Regulatory Commission, May 5, 1999 (available at http://www.nci.org/t5599.htm).

[11] See discussion in "Interview with David Lochbaum on Nuclear Energy and Safety Policy," Washington DC: Numark and Associates, January 2000 (available at http://wwww.numarkassoc.com).

[12] Jenny Weil, "Commission Okays Plant Security Reg Revisions and Industry Program," *Inside NRC*, April 24, 2000.

but this appears to vary from site to site, and there is little evidence that any site carries out comprehensive performance tests that really reveal the MPC&A system's capability to deal with both insider and outsider threats.

Gosatomnadzor inspections are largely based on compliance with rules, rather than performance of systems in achieving a specified objective (such as defeating a design-basis threat). Although Gosatomnadzor inspectors occasionally conduct limited performance testing of security hardware, they typically do not have the requisite training and knowledge to do this very effectively. The MVD guard forces are believed to train in conventional military operations to protect a facility's perimeter, but there are concerns that these tests do not involve realistic scenarios of outsider attempts to enter the facility.

More creative and performance-oriented exercises at nuclear facilities are run by the FSB, and involve national counterterrorist units. Some of these exercises are apparently intended to test perimeter intrusion detection capabilities. For example, during the first phase of the Atom-97 exercise in 1997, the "Vympel" team of counterterrorist experts of the FSB Anti-Terrorism Center infiltrated the protected area of the Kola nuclear power plant.[13] Other drills are intended to train FSB special forces in hostage-rescue missions in a nuclear facility setting. For example, during the second phase of Atom-97, FSB counterterrorist personnel exercised in recapturing the nuclear icebreaker Sibir' with the purpose of freeing hostages and preventing radiological sabotage.

Although useful, these activities are no substitute for an institutionalized performance testing program that systematically tests every major safeguards element under realistic scenarios and threat assumptions.

As noted in the main text of the report, the MPC&A program has sought to sponsor performance tests both in Russia and in other former Soviet states, and U.S. teams have been allowed to carry out such tests at a small number of sites. As was the case when U.S. facilities first began to undergo performance testing of their security systems, the results were generally that glaring vulnerabilities were found, requiring significant corrective actions, even at facilities where the MPC&A systems had been "completed." The need for a regular, institutionalized performance testing program in Russia is clear.

Cooperative Approaches to Establishing Performance Testing Programs in Russia

The primary goals of U.S.-Russian cooperation on performance testing should be to:

- demonstrate, through realistic tests, that U.S.-sponsored MPC&A upgrades are effective; and
- help ensure that nuclear safeguards remain effective and sustainable over time, by establishing formal facility-level and national-level performance testing programs that would reveal any major decline in performance.

In addition, as in the U.S. case, realistic performance testing programs can (a) serve to highlight security problems to senior policymakers, resulting in allocation of additional funding to correct the weaknesses identified; (b) serve as a focus and information source for legislative oversight, further increasing the incentive for senior policymakers to devote attention to correcting any problems that may be identified; (c) provide an avenue of communication between sites dealing with similar issues, through observation of tests at other sites and other mecha-

[13] Sergey Gorlenko, "Law and Order: 'thScreen Against Terrorism: Special Teams Alfa and Vympel Go Out More Often on Assignments Than for Exercises'," *Nezavisimoye Voyennoye Obozreniye*, September 5–11, 1997, (FBIS-SOV-97-267, 24 September 1997).

nisms.

For these reasons, the MPC&A program should place high priority on working to establish effective performance-testing programs both at individual facilities, and within agencies with regulatory responsibilities including Minatom, Gosatomnadzor, and MVD. The difficulties of cooperating to establish a serious MPC&A performance testing program throughout Russia should not be underestimated, however. First and most important is the enormous sensitivity of any testing that reveals serious security weaknesses and demonstrates specific tactics by which nuclear material could be stolen. Perhaps with a few exceptions at sites that are not considered at all sensitive, Russia is extremely unlikely to be willing to allow U.S. experts to participate directly in or even observe realistic performance tests at Russian facilities. Tests in general will have to be carried out by Russians, and their results kept primarily to Russians. Indeed, many facility and security managers are likely to resist even an indirect U.S. involvement in performance evaluations, for fear of embarrassment. At the same time, the FSB presumably plays a major role in the area of security evaluations, and the lack to date of any ongoing relationship between the United States and the FSB could be a significant difficulty in designing and conducting cooperative activities. On the U.S. side, some higher-level performance testing techniques are classified, and hence not every aspect of U.S. performance testing approaches can be shared with Russian experts.

If the United States is to provide financial support to a performance testing program, as it should, these intense sensitivities will require creative approaches to confirming that the performance tests paid for with U.S. funds were in fact conducted, and conducted properly. This will likely require some degree of information exchange about the conduct of the tests, and the MPC&A program will have to work hard to build the level of trust and partnership that would make such information exchange possible. Other key obstacles to establishing effective performance testing programs in Russia include:

- Russian funding for performance testing programs is likely to remain inadequate.
- Russian nuclear regulations are compliance-based and do not contain a design basis threat.
- No performance testing methodology comparable to what has now been developed in the United States is in place.
- Gosatomnadzor and presumably other nuclear regulatory authorities in Russia do not have personnel with hands-on expertise and training in adversary tactics and operations.
- All high-security facilities are protected by MVD forces. There are several problems with this arrangement. Because of high turnover rates, MVD conscripts are hard to train and motivate. The existing MVD guidelines reportedly call on protective forces to defend the facility's outer perimeter—an unrealistic objective under most circumstances (unless an advanced intelligence warning is available or very large troop formations are used). The interaction between MVD guards and operations personnel is minimal. Finally, the nuclear regulatory authorities do not have authority to regulate MVD guards.
- Serious deficiencies of baseline security systems and procedures ("holes in fences") at some facilities make performance testing at such locations largely irrelevant until the basic problems are fixed.[14]

[14] Similarly, in a spring 1999 inspection at the Lawrence Livermore Laboratory in the United States, evaluators judged that "the weaknesses were so self-evident that performance testing was not needed to prove that special nuclear materials were not adequately protected." *See Strength Through Leadership*, op. cit., p. 7.

Despite this daunting array of obstacles, there are a series of steps the MPC&A program should pursue to facilitate the development of performance testing in Russia. In conducting these measures, the program should work with DOE's Office of Independent Oversight and Performance Assurance, performance testing programs of the U.S. NRC, and their contractors. Specifically, the program should:

- Work with Russia to develop performance-oriented safeguards regulations. In particular, the MPC&A program could work with Minatom, Gosatomnadzor and other organizations to encourage the development and use of a practical design basis threat as a part of the regulatory process. (For example, the NRC has had a number of successful workshops on the development and maintenance of a design basis threat for nuclear regulators in former Soviet republics.)
- Sponsor performance testing methodology workshops. Performance testing workshops could be conducted at the RMTC, other training centers, and regional Gosatomnadzor offices. (The NRC had a very successful performance testing workshop in Kazakhstan in 1998.)
- Conduct inspector-accompaniment missions for performance testing inspections in the United States as well as (possibly simulated) inspections in Russia. Because of access difficulties at DOE facilities, it might be easier to organize Russian visits to nuclear power plants. Russian experts have already observed some of NRC's OSRE evaluations.
- Write requirements for facility-level performance testing programs into MPC&A contracts at individual sites and facilities.
- Provide limited training in performance testing techniques to selected personnel from nuclear facilities, Gosatomnadzor, Minatom, and MVD.
- Provide equipment that enhances the effectiveness of performance testing (for example, MILES[15] equipment for force-on-force drills).
- Support and sponsor the development of a performance testing core group at Gosatomnadzor and/or Minatom headquarters.

Finally, it is crucial to work to establish in Russia a group that is professionally in the business of conducting such performance tests, with appropriate knowledge of MPC&A systems and adversary tactics and characteristics, comparable to the contractors in the United States who support performance testing at DOE facilities and work with NRC-licensed facilities to help them prepare for OSRE tests. Such a group might be established as a private firm, possibly associated with Gosatomnadzor or Minatom (as Eleron is) or with an established industrial security firm. This group would receive contracts from agencies of the Russian government and from the MPC&A program to conduct performance testing at Russian facilities, especially testing of the performance of U.S.-sponsored MPC&A upgrades. The group would consist of qualified Russian personnel with appropriate security clearances. To provide assurances that U.S. funds had been expended appropriately, it might make sense to work out an arrangement in which one or more of the participants on each performance-testing team was a Russian citizen holding Russian security clearances but employed by a U.S. contractor, serving as a "trusted agent" (as has been done to provide similar assurances for U.S. financial

[15] Multiple Independent Laser Engagement System (MILES)—in essence guns that fire lasers rather than bullets, coupled with clothing that can detect a "hit"—is routinely used at DOE facilities. It considerably increases the objectivity and realism of force-on-force drills and other types of tactical response tests and training.

support for the transport of nuclear warheads to dismantlement sites, for example). As the proliferation of private security forces in Russia makes clear, there is no shortage of highly trained former Spetznaz or KGB personnel available for such missions.

Such a Russian entity or firm could partner with a counterpart company in the United States that would provide methodology, training, and guidance. One possible strategy would be to establish a joint U.S.-Russian inspection team or teams. Team members would train together. The team would conduct joint inspections at NRC facilities in the United States and at less-sensitive facilities in Russia. Under a DOE contract, the Russian component of the team would test facilities in Russia with U.S.-sponsored MPC&A upgrades where testing by U.S. personnel is not possible.

As noted above, establishing a credible and continuing performance testing program in Russia is crucial to achieving the goal of effective and sustainable security for nuclear material in Russia—but it will not be easy to do. It may turn out that approaches somewhat different from those suggested above will be the most effective. But by whatever means is chosen, it is essential that the MPC&A program work as rapidly as practicable to create a comprehensive facility-level and national-level performance testing program in Russia.

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About the Russian-American Nuclear Security Advisory Council

The Russian American Nuclear Security Advisory Council (RANSAC) was founded in 1997 with the purpose of developing new U.S.-Russian cooperative nuclear security initiatives, and ensuring the timely and effective implementation of existing programs. The Council consists of members drawn from both Russian and American institutions who possess significant experience in the policy and technical fields, and who have first-hand knowledge of the substance and implementation of cooperative nuclear security programs.

RANSAC focuses on five key thematic areas:

- Stabilizing, transforming, and downsizing the Russian nuclear weapon complex
- Securing Russian nuclear material, warheads, and technologies
- Limiting production of fissile material
- Disposing of excess U.S. and Russian fissile material
- Establishing transparency in nuclear security programs and the nuclear weapons reduction process

Toward these ends, RANSAC works with government officials in both countries, produces and disseminates reports, and interacts with academic institutes, non-governmental organizations, and the media around the world.

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