VIEWPOINT: ASSESSING THE DEVELOPMENT OF A MODERN SAFEGUARDS CULTURE IN THE NIS

by James E. Doyle and Stephen V. Mladineo[1]

One of the gravest threats to international security in the post-Cold War period is posed by weapons-usable fissile materials in the newly independent states (NIS) of the former Soviet Union that could be vulnerable to theft or diversion.[2] These materials are the essential ingredients of nuclear weapons. Their acquisition could greatly accelerate efforts by terrorists or rogue states to build nuclear bombs. In contrast to the single building destroyed in the Oklahoma City bombing, a terrorist nuclear device could destroy several city blocks and cause fatalities in the tens of thousands.[3] Kilogram quantities of stolen weapons-usable highly enriched uranium (HEU) have been recovered in Russia and Europe, demonstrating the reality of this threat and highlighting the need for improved nuclear material security.[4]

Most at risk in the NIS are several hundred metric tons of weapons-usable nuclear material that exists in forms other than assembled nuclear weapons.[5] This material includes plutonium and HEU in forms such as pure metals, alloys, oxides, and solutions. This material is in use or in storage at several dozen nuclear facilities across the NIS. In light of the possible threat of diversion or theft of this material, the United States and several of the NIS that possess these materials began in 1992 to discuss programs for improving nuclear material protection, control, and accounting (MPC & A) systems at these facilities. In conjunction with the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE) began cooperative assistance programs with Russia, Ukraine, and the other NIS. In 1995, after several years of increasing contacts between technical experts and government officials, DOE began implementing a multi-year effort to address the problem of nuclear material security in the NIS.

Similar cooperative programs were begun in 1994 and 1995 between a number of other Western countries and the NIS. Among these were programs between Russia and organizations of the European Union (EU), France, the United Kingdom, Sweden, Norway, and Japan. For example, the Joint Research Centre of the European Commission has a three-phase program in progress aimed at exchanging information about nuclear security issues, collaborating on demonstration projects to test means of improving nuclear security, and subsequently moving successful demonstration projects into the large-scale implementation phase.[6] Contributors to other cooperative programs include Sweden, Finland, and Australia. These programs have been aimed primarily at improving the nuclear materials accountancy and control systems.

One of the objectives of the DOE MPC & A program and other similar international efforts is to help promote a long-term commitment to effective nuclear material security in the NIS and foster the development of a modern nuclear safeguards culture in these states. Steps to strengthen a nuclear safeguards culture in the NIS are similar to earlier and on-going international attempts to define, evaluate, and improve the nuclear *safety* culture at nuclear reactors following the Chernobyl disaster in 1986.[7] The concept of a nuclear safeguards culture, like that of a safety culture, relates to all individuals and organizations involved in safeguarding nuclear materials. The quality of a safeguards culture also depends on the resources, organizations, and technologies that provide the physical means for nuclear material security. For the purposes of this assessment the term "safeguards culture" is defined as:

> a pervasive, shared belief among political leaders, senior managers, and operating personnel that effective MPC & A is critically important, as manifested in decisions and actions, large and small.[8]

Dr. James E. Doyle is a Senior Analyst at Science Applications International Corporation. He received his doctorate in International Affairs from the University of Virginia. Stephen V. Mladineo is a Program Manager with Battelle Pacific Northwest National Laboratory and a former Professor of National Security Strategy and Associate Dean of Faculty and Academic Programs at the U.S. National War College.

Like a nuclear safety culture, a nuclear safeguards culture is not an add-on or a luxury to be pursued when convenient. It goes to the core of the operation of the nuclear complex. Managers must convey the message (and workers must understand) that this is an area that is taken very seriously, with no cutting of corners. They must demonstrate a willingness to sacrifice other important goals (such as meeting production schedules) when necessary to ensure MPC & A is effective.[9]

In order to encourage the development of a nuclear safeguards culture in the NIS, the DOE MPC & A program has emphasized the importance of modernizing nuclear security systems. Given conditions in the NIS, such modernization is critical to preventing the loss of nuclear material that could lead to nuclear proliferation or nuclear terrorism. Proceeding from a belief that current Western technology-based MPC & A systems are highly effective, the DOE MPC & A program seeks to deepen an understanding of Western approaches to nuclear safeguards in the NIS. A final set of goals is to encourage countries of the NIS to adopt internationally accepted techniques of nuclear safeguards, apply them in the context of their own historical experience, and commit themselves to building and maintaining modern national nuclear safeguards systems. These MPC & A systems should be appropriate for the new conditions these states face and compare favorably in terms of effectiveness with U.S. and international standards for nuclear materials security. Efforts by the NRC and by other international cooperative programs have been complementary to these goals.

This essay contends that the rudiments of a nuclear safeguards culture are beginning to take hold in the NIS. It proposes a set of four indicators for assessing the development of a safeguards culture in the NIS and uses them to evaluate the progress toward establishing such a culture. While progress in the areas measured by the four indicators is not uniform, the evidence indicates that steps towards institutionalizing a sustainable safeguards culture have been taken. The study then assesses the effectiveness of U.S. and other international efforts to help strengthen the commitment to nuclear safeguards in the NIS. It concludes by assessing the obstacles that remain to creating a safeguards culture and by recommending additional steps that the international community could take to foster its development.

SAFEGUARDING NUCLEAR MATERIALS: SOME BACKGROUND

There is no international convention or treaty, backed by an enforcement mechanism, which obligates all states possessing weapons-usable nuclear materials to maintain common standards for MPC & A.[10] All nations have some national or domestic system for safeguarding nuclear material, but these domestic systems vary significantly with regard to their legal mandate and the technical standards they require. Recognizing that it is in the interests of all states that nuclear materials be adequately protected, the IAEA established international guidelines containing technical standards for the physical protection of nuclear materials in 1975 and several revisions of those standards have been published.[11]

International standards for nuclear material control and accounting are more formalized in non-nuclear-weapon state (NNWS) parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) than they are in the nuclear weapon states. NNWS are obligated to sign nuclear safeguards agreements with the International Atomic Energy Agency (IAEA).[12] These agreements outline the legal requirements and technical standards for nuclear material control and accounting systems in these states. Specifically, they include a system of procedures for nuclear material control and accounting, containment, and surveillance.[13] These safeguards agreements apply to all nuclear materials within the NNWS and are designed to ensure that no diversion of nuclear material from peaceful applications has taken place and to provide “timely warning” if such a diversion has occurred. The IAEA verifies the presence of the nuclear material and the effectiveness of nuclear safeguards systems in the NNWS through periodic on-site inspections.

The IAEA guidelines on the physical protection of nuclear materials and procedures for nuclear material control and accounting contained in safeguards agreements between the agency and NNWS parties to the NPT are one component of the international standards for MPC & A. The national regulatory guidelines for safeguarding nuclear material followed in other advanced industrialized countries are another. In the United States for example, the protection of nuclear materials is required by domestic laws and regulations that establish detailed standards for MPC & A.[14] Each year DOE spends approximately $590 million on safeguards and security in the its nuclear weapons complex.[15] Together, the IAEA guidelines and the standards set by domestic safeguards systems in the nuclear weapons states and other industrialized countries provide a benchmark for assessing the adequacy of fissile material controls in the NIS.[16]

ASSESSING NUCLEAR SAFEGUARDS CULTURES IN THE NIS

The primary question addressed in this essay is whether nuclear safeguards cultures are emerging in the NIS. We have developed a set of four measures or indicators that can be used to answer this question:

1) the level of leadership awareness of the importance of effective MPC & A systems for national security and nonproliferation;
2) evidence that facility-level advocates of effective MPC & A systems and modern technology-based approaches to nuclear material security have emerged;
3) evidence that the NIS are taking actions and committing resources to create and maintain modern, effective MPC & A systems, both at the facility level and nationally;
4) the level of success in developing indigenous cadres of MPC & A experts.

These indicators provide a framework for assessing attitudes towards nuclear safeguards in the NIS. A brief explanation of why each indicator was chosen as a measure of the development of a safeguards culture follows.

Leadership awareness is a good indicator because attitudes highlighting the importance of nuclear safeguards within government-run nuclear facilities are unlikely to be sustained or strengthened if national leaders do not share these attitudes. In such nuclear facilities, improvements in nuclear safeguards require top-down management, leadership, and support for action. Such support is unlikely to arise exclusively from a grass-roots movement. If the leadership is not cognizant of the need for change, or is unwilling to reward positive changes at lower levels, then change is unlikely.

Facility-level advocates are needed because they have the technical, managerial, and organizational skills to implement changes in facility operations that result in improved nuclear materials security. In short, they have the ability to translate the objectives of government officials into necessary actions and will be responsible for seeing that those actions are sustained until national objectives are achieved.

Evidence of actions and of resource commitment is an important indicator because it demonstrates that national leaders and facility managers are not just stating their support for improved nuclear safeguards, but are actually doing something towards that end. In addition, the long-term sustainability of improved nuclear safeguards depends upon an indigenous ability to build, maintain, and repair MPC & A systems. If resources are not devoted to the upkeep of newly acquired systems, they will not remain effective.

Success in developing indigenous cadres of MPC & A experts represents an investment in the organizational infrastructure needed to maintain new safeguards equipment and procedures over time. It therefore indicates acknowledgment of a problem that requires a long-term, and largely internal solution. The development of indigenous safeguards expertise is also critical to the development of a self-sustaining nuclear safeguards culture. As nuclear facility personnel in the NIS become better skilled with modern safeguards systems they will be more likely to internalize the principles underlying them, adopt such systems permanently, and refine them according to their particular needs.

A second, equally important question is whether U.S. and other international efforts to help foster a nuclear safeguards culture in the NIS are succeeding. In addressing this question we draw upon first-hand knowledge of the status of U.S.-supported MPC & A cooperation activities in the NIS, the opinions of recipients participating in this cooperation, and independent assessments of the U.S. MPC & A program by the U.S. General Accounting Office, National Research Council, and others. In summary, our overall assessment of these two related questions is based on the following sources of evidence: personal observation, relevant anecdotal evidence, discussions with U.S. government and national laboratory personnel implementing the DOE MPC & A program, international experts involved in cooperative programs, non-governmental experts from several countries, and government officials and nuclear facility personnel across the NIS.

Leadership Awareness

There is some evidence that the top political leaders in most of the NIS recognize the importance of effective MPC & A systems for national and global security. Increasingly, political leaders in these states exhibit concern for proliferation threats related to nuclear material security and assign high priority to improving nuclear MPC & A in their public comments. For example, numerous summit statements, bilateral and multilateral ministerial agreements, and several dozen signed protocols between nuclear facilities in the NIS and DOE or U.S. national laboratories all declare a firm commitment to improving nuclear materials security.[17] Moreover, all of the NIS republics with weapons–usable nuclear materials except for Russia have joined the NPT as non-nuclear weapon states and concluded corresponding safeguards agreements with the IAEA, committing themselves to creating nuclear safeguards systems that meet IAEA standards. One of them, Georgia, has already signed a Protocol Additional to its safeguards agreement, accepting the intensified inspection regime provided for by the recent "93+2" reforms of IAEA monitoring.[18] Under these agreements, both the safeguards systems themselves and the nuclear materials they are designed to protect are subject to IAEA inspection and inventory verification.

Russia, a nuclear weapon state, has taken independent steps to address the nuclear materials security problem. In September 1994, President Yeltsin issued Executive Order No. 1923, "On Priority Measures for the Improvement of the System of Accounting and Safeguarding of Nuclear Material." Prime Minister Chernomyrdin followed this order in January 1995 with Decree No. 34, "On 1995 Priority Measures to Develop and Implement a State System of Nuclear Material Control and Accounting." The federal law "On the Use of Nuclear Energy," (signed November 21, 1995) calls for MPC & A by operating organizations and oversight by independent regulatory agencies, such as the Russian Nuclear and Radiation Safety Supervision Committee (abbreviated as Gosatomnadzor or GAN).[19] On December 1, 1997, the Russian government issued a statute (Government of the Russian Federation decree No. 1511) on the development and approval of federal rules and regulations in the use of atomic energy. These official guidelines are helping Russia implement a comprehensive federal program for improving MPC & A systems at all nuclear facilities. A major step toward institutionalizing a nuclear safeguards culture is the shift outlined in this legislation from a system that depended upon the authoritarian control of people to one that relies on objective technical measures, personal responsibility, and nationally instituted standards.[20] In this effort, the Russian government is coordinating the participation of its Ministry for Atomic Energy (Minatom), GAN, the Russian Academy of Sciences, Ministry of the Economy, Ministry of Science, and others. Moreover, in July 1995, Minatom reorganized several departments to improve security and accounting for nuclear material.[21]

Further evidence that Russia understands and is seeking to apply modern, technology-based techniques of nuclear safeguards is found in the fact that a "Concept for the System of State Accounting and Monitoring of Nuclear Materials," adopted October 14, 1996, specifically takes into account "the recommendations of the International Atomic Energy Agency (IAEA) for national systems of accounting and control of nuclear materials; the existing international and national systems of accounting and control of nuclear materials; and the Russian Federation's international commitments in the sphere of nonproliferation of nuclear weapons."[22] In fact, many of the guidelines contained in the Russian concept for implementing nuclear safeguards at the national, ministerial, and facility levels are based on similar practices recommended in IAEA, EU, and DOE safeguards documents.[23]

In general, NIS officials at the nuclear facilities level are committed to modernizing their MPC & A systems, but are hampered by lack of funding due to the continuing regional economic crisis. For example, in July 1995, Evgeny Mishin, Director-General of the Russian Physical Protection Enterprise Eleron, noted the need in Russia for improved nuclear materials security and expressed appreciation for the U.S. and international financial assistance that helps support MPC & A upgrades.[24] However, the traditional deference to authority at nuclear facilities in the NIS continues to hinder efforts at improving nuclear material security. Specifically, senior facility and government officials and their guests are sometimes allowed to pass through newly installed access controls to areas containing nuclear materials.[25] This prevents confirmation of their identity and monitoring to guarantee that they are not carrying nuclear material.

Indigenous Advocacy

The second indicator is whether or not advocates of effective MPC & A systems and modern, technology-based approaches to MPC & A have emerged in the NIS. Advocates could be facility and enterprise-level managers, senior Minatom officials with responsibilities for MPC & A, or corporate managers of institutes or firms producing MPC & A equipment. The development of a constituency of MPC & A advocates in government and industry who deal with nuclear safety issues on a daily basis is a key element of a nuclear safeguards culture.

There is evidence that senior managers are assuming responsibility for improving MPC & A in Russia. For example, a single official at Minatom headquarters, the deputy director of the Department for Protection of Information, Nuclear Materials, and Installations, now oversees MPC & A improvements throughout the Minatom complex. Also, at one of Russia's largest civilian nuclear facilities, The Institute for Physics and Power Engineering (IPPE) in Obninsk, an independent administrative department has been created that is dedicated to implementing and maintaining MPC & A improvements across the institute. This is a significant change, because previously responsibility was spread among a number of different facilities within the institute. The director of this department is developing a comprehensive strategic plan for MPC & A at IPPE. This plan has been described by senior IPPE personnel as a "living document," which acknowledges the need for a long-term commitment to nuclear material security.[26] This designation of a management official responsible for the control and accountability of nuclear materials, who is organizationally independent from other activities, mirrors one of the basic requirements for U.S. nuclear facilities contained in DOE Order 5633.3B.[27]

In another sign of indigenous advocacy of effective MPC & A, over 300 Russian officials, both from federal agencies and from various nuclear facilities, participated in a U.S.-supported international MPC & A conference at IPPE in March 1997. Because U.S. financial support was limited, several nuclear facilities used their own funds to send personnel to this conference. The proceedings of the conference have been published and include many reports by Russian and other NIS personnel advocating improved MPC & A systems, and describing some of the independent efforts towards improving nuclear material security in their institutes.[28]

Investment into modern MPC & A technologies is slowly growing in Russia and the NIS. For example, several institutes and companies have begun manufacturing portal monitors (based on Western technology) that can detect the presence of nuclear materials. Recently, portal monitors built by the All-Russian Scientific Research Institute of Experimental Physics (Arzamas-16) and the Kurchatov Institute were evaluated by U.S. national laboratory technicians and found to meet or exceed the American Society for Testing and Materials sensitivity standards. These prototype nuclear material monitors demonstrate the efforts of the Russian technical community to develop indigenous capabilities for producing modern MPC & A equipment similar to that used widely in the West. There are also several other companies which have engaged in the production and installation of physical protection equipment. Among these are the enterprises Escort Center, Soling, and some former subsidiaries of the Minatom enterprise Eleron such as Dedal and NIKIRET.

However, one expert has questioned the strength of indigenous advocacy. He has observed that most of the advocates of new safeguards initiatives in Russia are those individuals with IAEA experience.[29] His concern is that individuals without such experience may be well-trained in the use of new technologies for modern safeguards, but lack an appreciation for the broader significance of nonproliferation objectives. While it is true that those with IAEA experience seem to be the principal advocates for improved MPC & A, these individuals also appear to be well represented in positions of influence in the safeguards and security fields in their countries. Dissemination of information by those advocates about the political significance of nonproliferation, in addition to improved technical education, could further magnify their influence.

Internal Commitment

A third indicator would be evidence that NIS countries are taking actions and committing resources to create and maintain modern, effective MPC & A systems. However, budget information about MPC & A activities in the NIS is difficult to find and decipher. According to Russian Minatom chief Viktor Mikhailov, 75 percent of all money spent on MPC & A upgrades in Russia is from Russian funding.[30] In fiscal year 1996, the United States spent about $12 million for MPC & A equipment installed in Russia and on contracts for MPC & A upgrades. If Mikhailov's estimate is accurate, this would mean a Russian expenditure of upwards of $36 million on MPC & A in fiscal year 1996. Other observers, however, claim that while Russia budgeted approximately $17 million for MPC & A in 1997, only $5 million was actually allocated for these activities.[31] Whatever the actual budget figures, most nuclear facilities in the NIS are not receiving adequate funds for building and maintaining effective MPC & A systems, and national programs to improve MPC & A are competing with other priorities for scarce resources.[32]

This situation is not surprising, given the continuing economic turmoil in the NIS and the fact that in Russia, for example, federal government spending on a wide range of high priority activities—including national defense—has declined sharply in recent years. Because there is currently no accurate way to determine overall expenditure by these states on MPC & A, a better sense of whether or not the NIS are taking actions and committing at least some portion of available resources towards improving nuclear materials security can be gained by assessing indigenous efforts to improve nuclear MPC & A at the organizational and facility level.

The NIS containing the largest amounts of weapons-usable nuclear materials—Russia, Ukraine, Kazakstan, and Belarus—have all created independent nuclear regulatory agencies that have the responsibility for ensuring that nuclear materials are properly safeguarded. Their efforts to establish bureaucratic and legal structures designed to enforce nuclear materials provide evidence of both an understanding of the need for safeguarding nuclear materials and a government commitment to take steps to achieve this end. The nuclear regulatory systems in some of the NIS are more effective than in others. For example, the Kazakstan Atomic Energy Agency is creating a coherent nuclear safeguards regulatory environment, while Ukrainian regulatory structures are as yet not as clearly defined or implemented. The Kazakstani regulatory environment has so far not produced better facility safeguards than in Ukraine, but it does offer a structure upon which to base systemic improvement.[33]

In Russia, where GAN is still establishing its regulatory authority, a number of nuclear research institutes have reported making improvements to their security systems as a result of GAN inspections. For example, during the initial site visit by U.S. MPC & A personnel to one nuclear research institute in Russia, weapons-usable material was reported to have been consolidated from three locations into one central storage facility at the insistence of GAN. Personnel from another Russian nuclear facility informed U.S. laboratory officials that GAN ordered the construction of a new security perimeter around critical areas. Two other facilities initiated cooperative programs with the DOE MPC & A program because of concerns about GAN's willingness to grant the required licenses for their operations. An official from one of these facilities remarked that in order to continue operation his facility had to obtain a license from GAN and that the acquisition of that license was contingent upon compliance with nuclear safeguards regulations.[34]

Several nuclear facilities have GAN inspectors permanently assigned to them. One additional positive sign in Russia is that GAN officials were made officers of the Russian government during 1997. This has caused an increase in pay to GAN officials, who also report being paid on time.[35]

Despite the evidence that some officials are taking action to improve nuclear material security and that top government officials have declared nuclear safeguards to be a high priority, there is little concrete evidence that NIS governments have been able to devote significant financial resources to upgrading MPC & A systems. However, this may not mean that these countries are not concerned about the security of their nuclear materials. A commitment to improve nuclear material security is a key element of a safeguards culture, even if the resources to implement that commitment are limited.[36]

Developing Indigenous MPC & A Cadres

The fourth indicator is the level of progress made toward the development of cadres of qualified MPC & A specialists who design and maintain MPC & A systems. The need to train MPC & A experts is recognized across the NIS as a prerequisite for an effective nuclear material security system and a key element in developing a nuclear safeguards culture. In Russia, the Russian Methodological and Training Center (RMTC) at Obninsk has been designated as the premier MPC & A training institute both for Minatom and GAN. This facility is being co-sponsored with Minatom by DOE and the Joint Research Center of the European Commission, and has developed and taught many courses over the past two years. As evidence of a long-term commitment to developing indigenous cadres, RMTC has plans for expansion of the curriculum, for transition of the courses to exclusively Russian trainers, for the development of mobile training teams, for creating the capability to teach courses remotely via television and the internet, and for formulation of a long-term strategy for sustaining the training program. Physical protection training has historically been conducted at the Interdepartmental Special Education Center (ISEC) in Obninsk, and Western concepts are being introduced there as well as part of the international cooperation. RMTC is also involved in discussions of creating a similar MPC & A training facility east of the Urals, perhaps at Chelyabinsk-70.

In addition to dedicated training centers such as the RMTC, MPC & A training programs are an integral part of the U.S.-supported MPC & A upgrades at each nuclear facility in the NIS. This training covers the use of modern tamper-indicating devices and non-destructive assay equipment, taking physical inventory, and in some cases vulnerability assessment procedures. As the cooperative DOE MPC & A program has matured, individual facilities have expanded the training to include their own individually tailored courses. For example, the Institute of Atomic Reactors at Dimitrovgrad in Russia has instituted a training program for guards in the use of handheld radiation detectors for monitoring personnel and vehicles at entry and exit points.[37] This program demonstrates that nuclear facility managers are willing to develop training activities that meet their particular MPC & A needs.

Another indication of the recognition in Russia that MPC & A education and training programs are key to sustained nuclear materials security is the development of two graduate-level MPC & A programs in Russia. The first is at Moscow Engineering and Physics Institute (MIFI). This program started its first class in September 1997. The second is at Tomsk Polytechnic University, and, while still in its early stages, it is expected to build upon the experience of the MIFI program. Finally, dozens of MPC & A training experts from Russia and Ukraine attended an international seminar, "The Role of Training in Implementing Effective MPC & A Systems," at the RMTC in Obninsk in September 1997. Representatives from several nuclear facilities reported on the MPC & A training programs that had been initiated at their plants.[38]

IMPACT OF U.S. AND OTHER INTERNATIONAL PROGRAMS ON NUCLEAR SAFEGUARDS IN THE NIS

The United States and other international partners have been providing assistance to improve nuclear materials security in Russia, the NIS, and the Baltic states since the early 1990s. This assistance is designed to make rapid MPC & A upgrades at sites containing weapons-usable nuclear material and help establish the foundation for a nuclear safeguards culture. The U.S. MPC & A program has already had an impact on approaches to nuclear material security at the national and facility level. For example, upgraded MPC & A systems have been installed with U.S. assistance at over a dozen nuclear facilities in the NIS and over 1,000 individuals have received U.S.-supported MPC & A training. In Russia, the United States has helped to develop nuclear regulatory legislation for the federal nuclear MC & A and assisted with the drafting of general provisions for MC & A and physical protection that are contained in guidance documents from government safety regulation agencies, such as GAN.[39] Cooperative programs have provided nuclear measurement equipment and training to GAN inspectors. This assistance has exposed a broad range of government officials and nuclear facility managers to modern MPC & A concepts and practices.

The Latvian Academy of Sciences' Nuclear Research Center near Riga provides another illustration of the impact of U.S. MPC & A cooperation. Before MPC & A cooperation with the United States began there, nuclear material locations, movements, and transfers at the facility were recorded in paper notebooks. The facility could not measure the nuclear fuel items and used a paper system for nuclear material inventory and accounting. As part of the Latvian-U.S. MPC & A cooperation, a modern, computer-based gamma-ray spectroscopy system was provided for measuring nuclear items. This equipment is part of a new computerized nuclear MC & A system that helps produce accurate and timely nuclear material inventory reports.[40]

In Belarus, U.S. MPC & A program officials have been working with the Sosny Science and Technical Center, a nuclear research facility near Minsk, and Promatomnadzor (PAM), the Belarusian national nuclear regulatory agency. A computerized MC & A system for the Sosny Center was designed through this cooperation that will meet the nuclear safeguards requirements of both PAM and the IAEA.[41] Personnel from the Sosny Science and Technical Center and Promatomnadzor have also received U.S.-supported MPC & A training.

Nuclear facility personnel in Russia have confirmed the positive impact of U.S. MPC & A cooperation. For example, when queried about attending MPC & A courses at the RMTC in Obninsk, officials from one Russian nuclear facility asked whether the course was to be taught by Americans or Russians. When told that it would be Americans, their level of enthusiasm increased. This is a mixed indicator, because while enthusiasm for American MPC & A experts shows interest in the topic and high regard for American MPC & A practices, it is more important over time for indigenous MPC & A trainers to earn the respect of their peers. On a positive note, in July 1997, Pavel P. Mizin of the Luch Research and Production Association in Podolsk, Russia asserted that U.S. assistance had allowed the plant to take its efforts to improve MPC & A to a qualitatively new level. Mizin described how U.S. assistance helped reduce the number of areas that contain weapons-usable nuclear material at Luch and provided security improvements for these areas. Luch employees who received U.S.-supported MPC & A training are now teaching MPC & A courses to other plant personnel.[42]

A recent report from R. I. Ilkaev, director of the Russian Federal Nuclear Center at Arzamas-16, states that the completion of MPC & A upgrades at his institute's pulsed reactor facility were only possible due to the joint efforts of U.S. and Russian specialists. He notes that U.S. assistance was especially critical to the MPC & A design review, and to the purchasing and testing of equipment. This newly installed MPC & A system shares many features of the most modern technology-based MPC & A systems, including personnel access control, video surveillance, nuclear material detectors at all entry and exit points, and a computerized nuclear material accounting and control system. The conclusion of Mr. Ilkaev's report is that the MPC & A system at the Arzamas-16 reactor facility can serve as an example of the type of system that could be installed at many nuclear industry facilities.[43]

CONCLUSIONS: PROGRESS, BUT FURTHER STEPS STILL NEEDED

This essay presents indicators that provide a framework for analysis of progress toward establishing a nuclear safeguards culture in the NIS. Most of the evidence is anecdotal in nature. However, our analysis suggests that the rudiments of a nuclear safeguards culture are emerging in the NIS and that the U.S. and other international efforts to help foster a nuclear safeguards culture in the NIS are succeeding. Nonetheless, much work remains to be done to strengthen the commitment to nuclear materials security in the NIS. The process of institutionalizing change will be a long one. Development of a pervasive shared belief in the critical importance of effective MPC & A will take time. Western safeguards specialists should continue assisting efforts in the NIS to raise the level of protection against threats from inside facilities—in contrast to the traditional Soviet emphasis on threats from outsiders—and also promote the transition from a financial based accounting system to one based on physical measurements.

Education and training are fundamental to the process of change. Routine training and retraining by competent NIS instructors in modern MPC & A principles and practices are essential components of a long-term program. NIS officials must be willing to support the training and education infrastructure and to continue to speak out about the importance of the overall program. Western supporters of new NIS programs must recognize the long-term nature of their involvement. Success of new training and educational institutions such as the RMTC and the MIFI graduate program will require continuing outside support.

Continued support for a broad spectrum of NIS experts at symposia, conferences, and in educational programs related to nuclear safeguards and nonproliferation efforts will also be fruitful. Such activities are important for strengthening the non-technical aspects of MPC & A. Without them, there is a risk that current U.S. and international efforts will help produce an MPC & A workforce in the NIS that has excellent technical skills, but lacks a well-developed appreciation of the broader political dimension of nonproliferation.[44] Activities that might be useful in this regard include the hosting of NIS personnel at U.S. universities and non-governmental organizations with strong nonproliferation research programs, as well as the attendance of such personnel at DOE nonproliferation training seminars. The introduction of broader nonproliferation training at MPC & A training institutes in the NIS should also be considered.

Another way to strengthen a nuclear safeguards culture in the NIS might be for NIS specialists to provide information and support to public interest groups and elected officials on the need for effective nuclear safeguards. The protection of nuclear materials is as much a public safety issue as it is a national security issue. Increasing the grass roots demand for accurate information and accountability regarding nuclear activities can increase official incentives for nuclear regulatory enforcement and could lead to larger budgets for regulatory agencies.

Over the long term, the development and growth of indigenous MPC & A equipment manufacturing, maintenance, certification, and repair capability in the NIS also require Western support. Whether joint ventures, licensing arrangements, or local entrepreneurship will be the right vehicles remains to be seen. Issues of competition with U.S. and other Western industry should be faced, but an indigenous industry supplying safeguards equipment is of critical importance to the long-term prospects of a modern safeguards culture.

A major hurdle yet to be overcome is the historical deference to authority at nuclear facilities in the NIS. Senior facility and government officials must break with tradition and begin to submit personally to newly instituted access control systems and other new safeguards systems. Their actions will speak volumes to their personnel and become a strong catalyst for change.

Finally, the overall responsibility for safeguards within a country rests with that country's government. Regulatory structures and regulations that are clear, understandable, and not overly burdensome will encourage compliance. Western assistance in development of such a regulatory structure should be continued and expanded.

[1] The authors thank Debbie Ball, Les Fishbone, Fred Morris, Teri Olascoaga, William Potter, and Randy Watkins for their comments on this article. The opinions expressed are the authors' alone.

[2] Former Defense Secretary William Perry has warned that attempts by rogue nations and terrorist groups to obtain nuclear weapons are "the single most important security issue" facing the United States today. See "Perry Issues Warning on Rogue Nations," *Armed Forces Newswire Service*, May 14, 1996.

[3] See U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Partnership for Nuclear Material Security* (Washington D.C.: U.S. Department of Energy, January 1997), p. 3.

[4] For a review of the known nuclear smuggling cases see William Potter, "Before the Deluge? Assessing the Threat of Nuclear Leakage From the Post-Soviet States," *Arms Control Today* 25 (October 1995), pp. 9-16.

[5] In this essay, weapons-usable nuclear material is HEU enriched above 20 percent Uranium-235, and plutonium of any isotopic concentration. Experts believe that the Soviet Union produced as much as 1,350 metric tons of weapons-usable nuclear material, and Russia continues to produce 1.5 metric tons of plutonium per year that is being placed in storage. Most of this material resides in assembled nuclear weapons in the custody of the Russian military. Because they are strictly accounted for, difficult to transport, and heavily guarded within secure military installations, these assembled nuclear weapons are considered to be much less vulnerable to theft or diversion than weapons-usable nuclear materials in other forms. The security of Russia's newly produced plutonium, however, remains in doubt. See Graham T. Allison, *et al., Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge: MIT Press, 1996), pp. 20-43.

[6] M. Cuypers and P. Frigola, "Co-operative Support to the Russian Federation in the Field of Nuclear Safeguards. Progress and Evolution," Proceedings of the Institute of Nuclear Materials Management Annual Meeting, Phoenix, Arizona, July 20-24, 1997.

[7] International Nuclear Safety Advisory Group, *Safety Culture,* Safety Series No. 75-INSAG-4 (Vienna, Austria: International Atomic Energy Agency, 1991), p. 3.

[8] The authors thank Fred Morris, Pacific Northwest National Laboratory for his suggestions regarding this definition.

[9] Again thanks to Fred Morris for his contributions. For a more complete description of the goals of the DOE MPC & A program, see U.S. Department of Energy, *MPC & A Program Strategic Plan* (Washington, D.C.: U.S. Department of Energy, January 1998), pp. 8-9.

[10] The only relevant international accord concerning the protection of nuclear materials against theft, the 1980 Convention on the Physical Protection of Nuclear Material, covers nuclear material for peaceful purposes while in international transport. However, it has neither verification nor enforcement provisions. See National Academy of Sciences, *Proliferation Concerns: Assessing U.S. Efforts to Help Contain Nuclear and Other Dangerous Materials and Technologies in the Former Soviet Union* (Washington, D.C.: National Academy of Sciences/National Research Council, April 1997).

[11] See *The Physical Protection of Nuclear Material*, International Atomic Energy Agency INFCIRC/225/Rev. 3, September, 1993. These guidelines are advisory and not the subject of legal obligation.

[12] See *The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons,* International Atomic Energy Agency INFCIRC/153, 1972, pp. 3, 9. The nuclear weapons states, it should be noted, have placed a small number of nuclear facilities under voluntary IAEA safeguards agreements.

[13] National Academy of Sciences, *Proliferation Concerns*.

[14] Safeguards requirements for U.S. Nuclear Regulatory Commission licensed facilities are codified in *Code of Federal Regulations,* Title 10, Energy, Office of the Federal Register, Washington, D.C., 1990. Standards for U.S. Department of Energy nuclear facilities are similar to NRC regulations and are contained in U.S. Department of Energy, *Order Series 5633.3B,* Washington, DC, September 7, 1994. See also Oleg Bukharin, "Security of Fissile Materials in Russia," *Annual Review of Energy Environment* 21 (1996), p. 482.

[15] Bukharin, "Security of Fissile Materials in Russia," p. 469.

[16] See National Academy of Sciences, *Proliferation Concerns*. This benchmark has been acknowledged by Russia, and the other NIS. All of the states of the former Soviet Union except Russia are NNWS parties to the NPT and have concluded IAEA safeguards agreements. Since 1984, the Soviet Union and later Russia have followed IAEA guidelines for the design of safeguards systems for selected nuclear facilities. See Alexander Rumyantsev, "The Accounting and Control of Nuclear Material and radioactive Substances in Russia," *Yaderny Kontrol Digest* (Spring 1996), p. 6.

[17] See, for example the following press statements, "Clinton-Yeltsin Joint Statement on Nonproliferation," May 10, 1995; "U.S.-Russian Report on the Safety and Security of Nuclear Materials," exchanged at the Hyde Park Summit, October, 23, 1995; "Report on the Nuclear Safety Summit," April 26, 1996; "O'Leary-Mikhailov Joint Statement On Protection, Control, and Accounting of Nuclear Materials," June 30, 1995; "Agreement Between the Department of Energy of the United States of America and the Federal Nuclear and Radiation Authority of the Russian Federation to Cooperate on National Protection, Control, and Accounting of Nuclear Materials," June 30, 1995; "Protocol of the First Meeting of the Joint Coordinating Committee of the United States Department of Energy and the Federal Nuclear and Radiation Authority of Russia," October, 27, 1995; "O'Leary-Mikhailov Joint Statement on Guiding Principles of Cooperation Between The Ministry of Atomic Energy of the Russian Federation and the Department of Energy of the United States in the Area of Control, Accountability, and Physical Protection of Nuclear Material," January 30, 1996; "O'Leary-Mikhailov Joint Statement On Control, Accounting, and Physical Protection of Nuclear Materials," Janu-

ary 30, 1996; "O'Leary-Mikhailov Joint Statement On Control, Accounting, and Physical Protection of Nuclear Material," July 15, 1996; "O'Leary-Mikhailov Joint Statement on Safe And Secure Transportation of Nuclear Materials," July 15, 1996; "Joint Statement on Cooperation Between the Ministry of Defense of The Russian Federation and The United States Department of Energy on Control, Accounting, and Physical Protection of Nuclear Materials," September 17, 1996; and "Annex to the Report of the Committee on Nuclear Energy of the Russian-U.S. Commission on Economic and Technological Cooperation On Cooperation on Accounting, Control, and Physical Protection of Nuclear Materials at Serial Production Facilities," February 7, 1997.

[18] Belarus, Georgia, Kazakstan, Latvia, Ukraine, and Uzbekistan have all concluded Safeguards agreements. Kenji Murakami, *et al.*, "IAEA Safeguards implementation and verification of the initial inventory declarations in the NIS," Proceedings of the Institute of Nuclear Materials Management Annual Meeting, July 20-24, 1997, Phoenix, Arizona; and "General Conference Forty-First Regular Session," *IAEA Journal* (October 3, 1997).

[19] Gosatomnadzor (GAN) is the Russian nuclear regulatory agency that reports directly to the President of the Russian Federation and has been given responsibility for oversight of the security and accounting of civilian nuclear materials.

[20] See "Nuclear Security: Before and After the Moscow Summit: An Interview with Yuri Baturin, Russian Presidential Aide for National Security," *Yaderny Kontrol Digest* (Summer 1996), pp. 9-10, and "Concept for the System of State Accounting and Monitoring of Nuclear Materials," and Decree of the Russian Federation Government No. 1205 of 14 October 1996, *Rossiyskaya Gazeta,* October 29, 1996, p. 5.

[21] For example, Minatom centralized responsibility for upgrading MPC & A at its nuclear facilities under the Second Main Department for the Protection of Information, Nuclear Materials, and Installations. The Russian Federal Nuclear Research Center at Arzamas-16 was designated the overall technical integrator for this effort and several other Minatom laboratories and enterprises were given specific responsibilities. The All-Russian Scientific Research Institute of Inorganic Materials imeni Bochvar (VNIINM) is responsible for technical measurements, and the All-Russian Scientific Research Institute of Automatics (VNIIA) is responsible for the development of MPC & A instruments. Eleron, which is the physical protection technology branch of MINATOM, will take the lead in developing physical protection systems.

[22] *Rossiyskaya Gazeta*, October 29, 1996, p. 5.

[23] *Ibid*. See in particular section 6, "Basic Principles of the Functioning of the System of State Accounting and Monitoring of Nuclear Materials."

[24] Remarks by Director-General Evgeny Mishin of the Physical Protection Enterprise Eleron at the 36th Annual Meeting of the Institute of Nuclear Materials Management, Palm Desert, California, July 11, 1995.

[25] Personal observation of authors based on visits to 16 nuclear facilities in Russia.

[26] Remarks by Gennady Pshakin at the 38th Annual Meeting of the Institute for Nuclear Materials Management, Phoenix, Arizona, July 21, 1997.

[27] *DOE Order 5633.3B*, *Control and Accountability of Nuclear Materials* (Washington D.C.: U.S. Department of Energy, 1994).

[28] See the Proceedings of the Russian International Conference on Nuclear Material Protection, Control and Accounting, Vols. 1-3, Institute of Physics and Power Engineering, Obninsk, Russia, March 9-14, 1997.

[29] William C. Potter, "The Outlook for the Adoption of a Safeguards Culture in the Former Soviet Union," proceedings of the Institute of Nuclear Materials Management Annual Meeting, Phoenix, Arizona, July 20-24, 1997.

[30] Presentation by Russian Minister of Atomic Energy Viktor Mikhailov at Russian International Conference on Nuclear Material Protection, Control and Accounting, at the Institute of Physics and Power Engineering, Obninsk, Russia, March 10, 1997.

[31] Presentation by Vladimir Orlov at the Conference on Fissile Material Security in the Commonwealth of Independent States at the Research Institute of the German Society for Foreign Affairs, Bonn, Germany, April 7, 1997.

[32] See the discussions of these issues in *Yaderny Kontrol Digest* (Fall 1997), pp. 12-24.

[33] Michael F. Kelly, *et al.*, "U.S. Nuclear Regulatory Commission Safeguards Assistance to Russia, Kazakstan, and Ukraine," proceedings of the Institute of Nuclear Materials Management Annual Meeting, Phoenix, Arizona, July 20-24, 1997.

[34] Russian nuclear facility officials, interviews with authors at various locations in Russia (names and locations withheld on request), 1997.

[35] GAN official (name withheld by request), interview with author, Moscow, Russia, November 1997.

[36] More data and other analytical approaches might provide a clearer understanding of the degree of commitment that exists to improve nuclear safeguards. An assessment of how nuclear facility managers use the funds available to them, given a range of priorities, could help measure such commitment, but such an assessment is beyond the scope of this essay.

[37] Yuri I. Kharlanov *et al*., "U.S./Russia Cooperation in Material Protection, Control and Accounting at the SSC-RIAR, Dimitrovgrad," in section on "Russia: Civilian Large Fuel facilities," in U.S. Department of Energy, *United States/former Soviet Union: Program of Cooperation on Nuclear Material Protection, Control and Accounting* (Washington, D.C.: U.S. Department of Energy, December 1997), p. 29.

[38] Recommendations of the international seminar, "The Role of Training in Implementing Effective MPC & A Systems," Obninsk, Russia, September 22-26, 1997.

[39] U.S. Department of Energy, *MPC & A Program Strategic Plan* (Washington D.C.; U.S. Department of Energy, January 1998), p. 20.

[40] U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Improving Nuclear Materials Security at the Latvian Academy of Sciences Nuclear Research Center* (Washington, D.C.: U.S. Department of Energy, 1996).

[41] U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Improving Nuclear Materials Security at the Sosny Science and Technical Center* (Washington, D.C.; U.S. Department of Energy, June 1997).

[42] Pavel Mizin *et al.*, "Progress in MPC & A Upgrades at Luch," proceedings of the Institute of Nuclear Materials Management Annual Meeting, Phoenix, Arizona, July 20-24, 1997.

[43] Russian Federal Nuclear Center, *Protection, Control and Accountability* (Arzamas-16: Russian Federal Nuclear Center, 1997), p. 3.

[44] The authors wish to thank William Potter for alerting them to this concern.