Viewpoint

China's Fissile Material Protection, Control, and Accounting: The Case for Renewed Collaboration

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The September 11, 2001, terrorist attacks have increased concerns that terrorists may use weapons of mass destruction (WMD)—including chemical, biological, or nuclear devices—to achieve their goals. [1] While chemical and biological agents probably remain a more likely means of attack,[2] U.S. officials have stated they have little doubt that the Al Qaeda network is trying to acquire nuclear and radiological weapons.[3] Indeed, Osama bin Laden has declared obtaining nuclear weapons to be a religious duty, and Al Qaeda has reportedly attempted to acquire stolen nuclear materials on several occasions.[4] Recognizing the seriousness of these risks, President George W. Bush has stated that our "highest priority" is to prevent terrorists from acquiring weapons of mass destruction, including nuclear weapons.[5] Because the most difficult hurdle to developing nuclear weapons is acquiring the necessary "fissile materials" such as highly enriched uranium (HEU) and plutonium,[6] President Bush has announced that "urgent attention must continue to be given to improving the physical protection and accounting of nuclear materials of all possessor states."[7]

For good reason, the majority of international attention has focused on potential risks of inadequately secured fissile materials in several countries, such as the newly independent states of the former Soviet Union (NIS) and Pakistan. In particular, experts have been quite concerned about a possible breakdown in Russian nuclear security following the collapse of the Soviet Union in 1991.[8] Plunging salaries at Russian nuclear facilities, combined with a deterioration of security systems, have increased risks of loose nukes, a term used to describe the possibility that nuclear warheads or fissile materials could be stolen for sale on the black market. In an effort to mitigate such risks, the United States has created the Cooperative Threat Reduction (CTR) program, which has helped Russia secure the warheads and materials from dismantled nuclear weapons, and the Material Protection, Control, and Accounting (MPC&A) program, designed to improve the MPC&A at Russia's civilian and military nuclear facilities.[9] Questionable nuclear security is also a consideration in Pakistan, particularly following the 9/11 terrorist attacks and U.S. military actions in Afghanistan. Reports of public riots, a close affiliation among some elements of the Pakistani military with Islamic militants, and the tenuous hold that President Musharraf of Pakistan appeared to have in Pakistan, caused analysts to worry that Pakistan could face serious difficulties controlling and protecting its nuclear weapons and fissile materials.[10]

In its efforts to improve nuclear security in key countries, however, the United States should not overlook potential vulnerabilities in the People's Republic of China (PRC). Because Chinese officials have stated that their system of nuclear material control is similar to that used in the former Soviet Union,[11] many experts believe that the Chinese system could reveal the same weaknesses during domestic crisis that the Soviet system has exhibited since 1991.[12] As a result, in 1994 scientists at U.S. national laboratories, working within guidelines established by the U.S. government, began discussions with their counterparts at Chinese nuclear laboratories over possible lab-to-lab collaborations.[13] These discussions resulted in the U.S.-China Lab-to-Lab Technical Exchange Program (CLL), or as it was renamed in 1998, the China Arms Control Exchange (CACE).[14] Policymakers and arms control experts hoped that the CACE program would help build a strong foundation of trust and cooperation between the United States and China on issues of nonproliferation and arms control. The collaborations were to encourage increased transparency and mutual understanding of the nuclear programs in both countries—while protecting national security interests—and to help build a strong basis for future MPC&A programs in China.[15]

The aftermath of the controversial 1999 Cox Report[16] and its allegations of Chinese espionage targeted against U.S. nuclear facilities, however, gave rise to a complete cessation of contacts under CACE. Although the CACE program was cleared of any involvement in the espionage scandal,[17] previously planned visits were canceled and no new events have yet been scheduled. As a result, the continued existence and nature of the program are very uncertain at this time. Indeed, in spite of continuing interest among parts of the U.S. government in the continuation of the program, no authorization exists for renewing lab-to-lab contacts with China.[18]

In light of the current war on terrorism and the high priority that the United States has placed on ensuring the protection of nuclear materials and facilities throughout the world, it is appropriate to revisit the importance of the CACE program. This viewpoint assesses the current risks associated with the Chinese fissile material stockpile by examining what is known about China's MPC&A systems at its nuclear facilities. The study identifies a number of potential weaknesses in China's MPC&A, particularly during times of domestic upheaval. Because of the potentially serious repercussions of a security breach in China, the United States has a major interest in improving the security of Chinese fissile materials. One step toward realizing this interest would be to revive the CACE program.

CHINA'S CURRENT NUCLEAR WEAPON AND FISSILE MATERIAL STOCKPILES

Although China is reported to have ended production of HEU in 1987 and weapons-grade plutonium (Pu) in 1991, it is estimated to have a significant stockpile of weapons-usable fissile material.[19] According to most current assessments, China has accumulated between 2 and 6 metric tons of plutonium and between 15 and 25 metric tons of HEU.[20]

Alongside this fissile material, China is currently estimated to possess about 400 nuclear warheads.[21] Of these, more than 100 are deployed operationally on ballistic missiles, while the remainder are stored in multiple facilities across the country.[22] A major storage facility is believed to be the Lop Nur test site, which might contain as many as 150 tactical nuclear weapons (See Table 1).[23]

Because China's nuclear warheads are assembled at several nuclear facilities, these sites must also contain some nuclear weapons. Information on the specific facilities is scarce, but nuclear weapons assembly is believed to have taken place at Harbin in Heilongjiang, the Jiuquan Atomic Energy Complex in Gansu, and Plant 821 in Sichuan, though the latter two facilities may have been closed down.[24]

China is believed to store its stocks of fissile materials at a number of civilian and military nuclear facilities across the country. Historically, the same facilities have been used for both civilian and military programs, but China recently converted large sections of its nuclear complex to strictly civilian use.[25] According to some estimates, approximately 14 sites associated with China's nuclear weapons program contain significant quantities of weapons-usable fissile material.[26] The primary locations of nonweaponized fissile materials are believed to be China's plutonium production and uranium enrichment facilities, nuclear weapons research institutes, and other nuclear fuel cycle facilities.[27]

CHINA AND INTERNATIONAL MPC&A STANDARDS

The standards and recommendations for MPC&A systems published by the International Atomic Energy Agency (IAEA) reflect a consensus among international specialists in nuclear security.[28] The IAEA generally divides MPC&A into two distinct, though interrelated, systems: physical protection, and material control and accounting (MC&A). The IAEA recommends specific standards for physical protection in its information circular INFCIRC/225/rev.4 and establishes regulations for nuclear MC&A in INFCIRC/153.[29]

Physical protection systems are designed to prevent theft of fissile materials and sabotage of nuclear facilities by deterring, delaying, or defeating direct attacks by groups or individuals. The first step in designing a physical protection system is to determine the attractiveness of given fissile materials for theft or diversion. Materials stored at nuclear facilities can range from Category I (the most attractive) to Category III, depending the type of material, its physical and chemical form, the degree of dilution, the radiation level, and the quantity of the material present.[30] Once a given state has categorized the fissile materials at one of its facilities, it must design a physical protection system proportionate to their level of attractiveness. These systems should include a carefully designed, integrated arrangement of guards, alarms, sensors, and physical barriers.

MC&A systems are designed to detect a theft of nuclear materials by closely measuring the amounts of materials in each facility and ascertaining whether any materials are moved or taken. Materials must therefore be "controlled" through technologies and procedures intended to verify the precise location and storage condition of the materials. There must be effective accounting systems in place to provide "a regularly updated, measured inventory of nuclear weapons usable material, based on routine measurements of material arriving, leaving, lost to waste and remaining within the facility."[31] All states that have signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as nonnuclear weapons states are required to follow the MC&A guidelines outlined in INFCIRC/153 and to provide detailed accounting records for their fissile materials to the IAEA. However, because China is one of the five nuclear weapon states recognized by the NPT, it is not bound by most of the IAEA regulations for fissile material controls. Thus, to a large degree, China is responsible for implementing its own standards for fissile material control. Nevertheless, China has voluntarily bound itself to some IAEA standards.

China signed an agreement in 1998 with the IAEA to voluntarily place some of its facilities under IAEA safeguards. This agreement is published in INFCIRC/369 (See Table 2). China currently has three facilities under IAEA safeguards: the Qinshan-1 nuclear power reactor, a research reactor at the China Institute of Atomic Energy (CIAE), and a gas-centrifuge uranium enrichment plant, which was purchased from Russia and will be used to produce low-enriched uranium (LEU).[32] Operation of the first stage of the uranium enrichment facility began in 1998 and the second in 2001. The third and final stage of the facility is expected to be completed in 2005.[33] China is also building two CANDU (Canadian deuterium uranium) reactors as the third stage of the Qinshan power station. These plants are being built with Canadian assistance and will also be placed under IAEA safeguards.[34]

In addition to its voluntary agreement to place some facilities under IAEA safeguards, China has signed several international agreements that relate to controls over nuclear materials. The first of these was the 1979 Convention on the Physical Protection of Fissile Materials (codified in INFCIRC/274, rev.1).[35] Although this agreement is important, it has a relatively limited scope. It applies only to transports of fissile materials used for peaceful purposes across international borders. It is silent about both defense-related fissile materials and physical protection inside a country's borders. In addition, the treaty contains no method of verification or enforcement.

Another important international standard that China has signed is the Guidelines for the Management of Plutonium (INFCIRC/549).[36] These guidelines establish requirements for the management and disposition of civil plutonium and other plutonium no longer necessary for defense. They establish MC&A standards similar to those outlined in INFCIRC/153 and say that states should implement physical protection regulations "taking into account" INFCIRC/225, rev.3.[37] These guidelines are limited, however, by the fact that they do not require the physical protection regulations established by INFCIRC/225. Nor do they say anything about the management of uranium or plutonium not used for peaceful purposes.[38]

Overall, therefore, the international arrangements to which China has committed itself are of relatively lim-

TABLE 1
CHINESE FACILITIES BELIEVED TO CONTAIN WEAPON-USABLE FISSILE MATERIAL[1]

Name/Location	Type/Details
Nuclear Weapons Design and Test Facilities	
Chinese Academy of Engineering Physics (CAEP), Mianyang, Sichuan	Work related to the research, development, and testing of nuclear weapons; 12 institutes
Institute of Applied Physics and Computational Mathematics, Beijing	Research for CAEP on design computations for nuclear warheads
Jiuquan Atomic Energy Complex, Gansu	Plutonium production, processing, and warhead fabrication facilities; possibly closed down and being decommissioned
Lop Nur Nuclear Weapons Test Base, Xinjiang	Nuclear weapons test site; possible nuclear weapons stockpile
Northwest Institute of Nuclear Technology, located near Malan, Xinjiang	Diagnostic support work for China's nuclear weapons testing
Harbin, Heilongjiang	Possible site for final assembly and dismantlement of nuclear weapons
Guangyuan, Sichuan	Reportedly China's largest nuclear weapons production facility; possibly closed down
Plutonium Production Reactors	
Guangyuan, Sichuan	China's largest plutonium production reactor; 1,000 megawatts (MW) (thermal); possibly shut down
Jiuquan Atomic Energy Complex, Gansu	Plutonium production reactor (Plant 404); had an initial power output of 250 MW (thermal), which was doubled in the early 1980s; shut down
Plutonium Reprocessing	
Guangyuan, Sichuan	Large-scale reprocessing facility; capable of producing 300–400 kilograms (kg) of plutonium per year; closed
Jiuquan Atomic Energy Complex, Gansu	Large-scale reprocessing facility, a pilot reprocessing facility, and a plutonium processing facility to refine plutonium metal for weapons; capable of producing 300–400 kg of plutonium per year; closed
Lanzhou Nuclear Fuel Complex, Gansu	Pilot-scale reprocessing facility for separating plutonium from civil spent fuel; completion expected in 2002
Yibin Fuel Plant (also known as the Nuclear Fuel Component Plant), Sichuan	Plutonium fuel rod fabrication, production, and processing of weapons-grade plutonium
Uranium Enrichment	
Heping Uranium Enrichment Plant, Heping, Sichuan	Gaseous diffusion facility; capable of producing 750–2,950 kg of highly enriched uranium (HEU) per year
Lanzhou Nuclear Fuel Complex, Gansu	Gaseous diffusion facility; capable of producing at least 150–330 kg of HEU per year; shut down and being decommissioned
China Institute of Atomic Energy, Tuoli, near Beijing	Laboratory-scale gaseous diffusion facility
Russian-supplied centrifuge enrichment plant, Chengdu, Sichuan	Large-scale gas centrifuge; under construction; will probably only produce Low-Enriched Uranium (LEU); will be under IAEA safeguards.

TABLE 1 (CONTINUED)
CHINESE FACILITIES BELIEVED TO CONTAIN WEAPON-USABLE FISSILE MATERIAL[i]

Research Reactors	
Name/Location	**Type/Details**
Zero Power Fast Reactor, China Institute of Atomic Energy, Beijing	Fast critical reactor; fuel: 90% HEU; .05 kilowatt (kW)
MNSR-IAE, China Institute of Atomic Energy, Beijing	Tank-in-pool; fuel: 90% HEU; 27 kW
HFTER, Southwest Reactor Engineering Research and Design Academy, Jiajiang, Sichuan	Tank; fuel: 93% HEU; 125 MW (thermal)
HFTER Critical, Southwest Reactor Engineering Research and Design Academy, Jiajiang, Sichuan	Critical assembly; fuel: 90% HEU; 0 kW
PPR Pulsing, Southwest Reactor Engineering Research and Design Academy, Jiajiang, Sichuan	Pool; fuel: 20% medium-enriched uranium (MEU); 1 MW
MJTR, Southwest Reactor Engineering Research and Design Academy, Jiajiang, Sichuan	Pool; fuel: 90% HEU; 5 MW
MNSR-SD, Shandong Geology Bureau, Jinan, Shandong	Tank-in-pool; fuel: 90% HEU; 27 kW
MNSR-SZ, Shenzhen University, Guangdong	Tank-in-pool; fuel: 90% HEU; 27 kW
Nuclear Power Reactors	
Guangdong-1, Daya Bay, Shenzhen, Guangdong	Pressurized water reactor (PWR); 944 MW electric (e); operational
Guangdong-2, Daya Bay, Shenzhen, Guangdong	PWR; 944 MWe; operational
Lingao-1, Daya Bay, Shenzhen, Guangdong	PWR; 935 MWe; operational
Qinshan-1, Zhejiang	PWR; 935 operational; under International Atomic Energy Agency (IAEA) safeguards
Lingao-2, Daya Bay, Shenzhen, Guangdong	PWR; 935 MWe; under construction, expected completion 2003
Qinshan 2-1, Zhejiang	PWR; 935 MWe; under construction, expected completion 2002
Qinshan 2-2, Zhejiang	PWR; 935 MWe; under construction, expected completion 2002
Qinshan 3-1, Zhejiang	PHWR; 935 MWe; under construction, expected completion 2003; will be under IAEA safeguards
Qinshan 3-2, Zhejiang	PHWR; 935 MWe; under construction, expected completion 2003; will be under IAEA safeguards
Tianwan 1 (Lian Yungang-1), Jiangsu	PWR; 935 MWe; under construction; expected completion 2004
Tianwan 2 (Lian Yungang-2), Jiangsu	PWR; 935 MWe; under construction; expected completion 2005

[i] This includes HEU and plutonium, including reactor-grade plutonium. The plutonium at the nuclear power reactors would presumably be unseparated from

Sources: Joseph Cirincione, with Jon B. Wolfsthal and Miriam Rajkumar, Deadly Arsenals: Tracking Weapons of Mass Destruction (Washington, D.C.: Carnegie Endowment for International Peace, 2002), pp. 158–161; China Profiles Database, Center for Nonproliferation Studies, available on the Nuclear Threat Initiative website, <http://www.nti.org>; "Chinese Nuclear Power Reactors," Power Reactor Information System, IAEA website, <http://www.iaea.org/programmes/a2/>.

TABLE 2
INTERNATIONAL AGREEMENTS RELATING TO CHINESE FISSILE MATERIALS

Date	International Agreement	Requirements and Types of Materials Covered
1988	INFCIRC/369	Places certain facilities under IAEA safeguards
1979	Convention on the Physical Protection of Fissile Materials (codified in INFCIRC 274, rev.1)	Applies to transports of fissile materials for peaceful purposes across international borders
1997	Guidelines for the Management of Plutonium (codified in INFCIRC/549)	Applies only to civil and other plutonium deemed not for defense; recommends implementing physical protection systems for these materials "taking into account" INFCIRC/225

ited use in establishing uniform, rigorous, and enforceable MPC&A standards in China, and do not apply to military-use material at all.

CHINESE DOMESTIC MPC&A REGULATIONS

China's legal framework for the protection of fissile materials is complicated by an unclear division of authority among the agencies and organizations in the Chinese nuclear sector. There are several reasons for this. First, the division of authority is confusing to outside observers because China has made public very little information about its nuclear industry. Second, in 1998 and for the next several years, China conducted a major restructuring of its nuclear bureaucracies, and it is not clear that the dust has completely settled.[39] Finally, although "formal authority," determined by one's bureaucratic position, is probably the most important factor in determining responsibility for fissile materials, "informal authority," determined by personal connections, can also play an important role.[40]

Before China restructured its nuclear industry in 1998, the China National Nuclear Corporation (CNNC) was responsible for the control of nuclear materials for the whole country. Within the CNNC, the National Office of Nuclear Material Control was responsible for the implementation aspects of MPC&A.[41] The China Academy of Engineering Physics (CAEP) also apparently had some responsibility for production, storage, and control of fissile materials intended for military purposes.[42] After the restructuring, the responsibility for MPC&A for civilian and military fissile materials was given to the China Atomic Energy Agency (CAEA).[43] Within the CAEA, the Bureau of Nuclear Material Control is the main institution that regulates fissile materials.[44]

China's domestic regulations for fissile material controls are established in two documents: the 1987 "Regulations on Nuclear Materials Control of the People's Republic of China" (hereafter: 1987 "Regulations") and the 1990 "Rules for Implementation of the Regulations on Nuclear Materials Control of the People's Republic of China" (hereafter: 1990 "Rules"). Although the responsibilities given to specific bureaucracies were changed by the 1998 restructuring, these documents continue to outline the licensing procedures for Chinese nuclear facilities, the legal responsibilities of these facilities, and the basic requirements for China's fissile material security and accounting systems.

MC&A Measures

From the 1960s to the late 1980s, China reportedly adopted a "nuclear material ledger system" in its nuclear facilities, where paper records were used to maintain inventories of nuclear materials.[45] By 1990, however, China's MC&A regulations had become much more systematic. The 1987 Regulations established laws requiring strict licensing procedures for nuclear facilities. As a result, before a license is granted, the facility must "establish and maintain a nuclear materials balance system and an analysis and measurement system, and use the approved analysis and measurement method to attain specified requirements of measuring error."[46]

The 1990 Rules gave the CNNC responsibility for "establishing the accounting system of nuclear materials of the whole country," though this responsibility appears to have been transferred to the CAEA after the 1998 bureaucratic restructuring.[47] The 1990 document also clarifies the MC&A requirements that nuclear facilities must satisfy. It requires a new accounting system that calculates MUF (materials unaccounted for or a measure of materials lost during normal facility operations) in the same way as that required by IAEA INFCIRC/153. It also establishes regulations for an acceptable standard of error for MUF in Chinese nuclear facilities.[48]

In addition to these legal requirements, China revised its nuclear materials accounting forms in 1991. These forms now conform to those used internationally. The new forms are the following:

- NMF-R01: Nuclear Material Transfer (similar to U.S. Department of Energy form 741)
- NMF-R03: Nuclear Material Inventory Change (similar to IAEA Form ICR)
- NMF-R04: Physical Inventory (similar to IAEA Form LPI)
- NMF-R05: Nuclear Material Balance (similar to IAEA Form)
- NMF-R06: Annotation
- NMF-R07: Nuclear Material Accident[49]

Physical Protection Measures

By and large, China's legal framework incorporates the physical protection standards established by INFCIRC/225. The Chinese regulations not only use the same method of categorization of fissile materials outlined in INFCIRC/225, but they also require similar physical protection measures.[50] (See Table 3 for the specific physical protection measures that these documents require for each category of fissile materials.)

China's legal regulations match international standards for MPC&A fairly well. If China's nuclear facilities had equipment and procedures that conformed to these regulations, its MPC&A would probably be quite resilient. Unfortunately, most reliable sources indicate that China's actual MPC&A is characterized by rigor-

TABLE 3
PHYSICAL PROTECTION STANDARDS ESTABLISHED BY CHINESE LAW

Category	Standards[i]
For using or storing Category I nuclear material	· Materials contained in at least two complete, reliable physical barriers and stored in a vault or special security container · Alarm or surveillance protection equipment · Technical protection system with alarming and monitoring installations, etc. · 24-hour armed guards · Special passes or badges for all people entering the site; strict control of non-site personnel's entrance with registration procedure, and full-time escort by site personnel after access · A "double-men and double-lock" regime[ii]
For Category II nuclear materials	• Two physical barriers; one barrier must be complete and reliable; actual materials stored in a "strong room" type storage area • Alarm or surveillance protection equipment • 24-hour guards (preferably armed) • Special passes for all people entering the site
For Category III nuclear materials	• A complete and reliable physical barrier • Materials placed in security containers or with personnel assigned to watch material

[i] 1990 Rules, pp. 10-13.
[ii] This means that no one can have access to nuclear material without another person present. Procedures to enforce this regulation include, for example, requiring that doors to nuclear material storage vaults need two keys and that no single person has both keys. Also known as two-man rule.

ous laws but lax enforcement.[51] Indeed, according to Wen Hsu, a China expert at Sandia National Laboratories, while the two documents regulating China's nuclear controls specify the materials to be regulated, the responsibilities of the supervising authorities, the licensing process, the manner in which nuclear material accounting should be performed, and guidelines on the physical protection of nuclear materials, they do not specify how these measures are to be enforced, who should enforce them, or the criteria by which compliance should be measured.[52] As a result, there is significant evidence that China's actual MPC&A typically falls short of its legal regulations.

CHINA'S ACTUAL SYSTEM OF MPC&A

It has become clear that China has traditionally protected its nuclear facilities and controlled its fissile materials primarily by means of the "three Gs"—guards, guns, and gates.[53] This system mainly controls fissile materials by using intimidation to keep out anyone who might attempt to steal nuclear materials.[54] The guards at smaller nuclear facilities are reportedly provided by the facility itself, while the guards at major facilities are members of China's armed forces.[55] It is not known, however, whether China has taken all appropriate steps to ensure that these guards are properly armed or trained.

Because China is a member of the IAEA and has some facilities under IAEA safeguards, it must certainly have a general knowledge of what is required for a modern MPC&A program. In addition, it has purchased several nuclear power facilities that contain modern MPC&A systems. But there is little evidence that China has significantly redesigned the MPC&A systems at its indigenous nuclear facilities.[56]

Fissile Material Control and Accounting

China did reportedly develop a computer accounting system for its nuclear fuel cycle in 1996 to help detect loss or theft of fissile materials.[57] China claimed that this system met international standards for accountability. These computer systems have reportedly been installed at roughly a dozen nuclear facilities.[58] If this information is true, this number of systems may not improve China's overall material accountability significantly, because as indicated in Table 1, many more than 12 facilities in China contain fissile materials. It is possible that China has subsequently installed computer systems at additional facilities, but nuclear materials accountability will necessarily be limited by the number of computers China has purchased and incorporated into its accounting systems.

Moreover, these computer systems are useful only to the extent to which China's indigenous facilities have been set up to isolate strategic monitoring points, where one can measure the amounts of fissile materials moving through the systems. While these facilities presumably have some sort of accounting system for inventory purposes, they were not designed with rigorous IAEA safeguards in mind. As a result, they "may lack designs that specifically facilitate an overview of material flows, define strategic points, provide access for taking samples, designate measurement points, contain installations that enable the application of tags and seals, and restrict human entry."[59] Despite the quality of a country's accounting computers, its MC&A will be seriously defective unless its facilities are designed to measure the amounts of fissile materials accurately, easily, and frequently. Given its apparent reliance on designs and procedures derived from those used in the Soviet Union, there is no reason to believe China has designed its facilities in this manner.

In addition, although the Chinese are likely aware of the specific equipment necessary for a modern, Western-style MC&A system, it is not clear that they have installed much of this equipment at their own facilities.[60] Nor is it clear that China has undertaken the extensive designing and testing necessary to assemble MC&A equipment into an integrated system capable of detecting thefts of fissile materials. This shortcoming was a major weakness in the Soviet system and is probably mirrored in the Chinese system.

To the extent that Chinese nuclear facilities lack systematic MC&A systems, they presumably have a limited ability to detect thefts by insiders. Indeed, because Chinese nuclear facilities were probably not designed to take reliable physical inventories, China may not even have a precise inventory of the amount of nuclear materials in its facilities. This is the most basic step in any MC&A system, for without this knowledge there is no way to detect the disappearance of any material. Instead, available evidence indicates that China mainly relies on social controls and the loyalty of workers to prevent thefts of materials by insiders.

Physical Protection Systems

The most important aspect of a physical protection system is the ability to assess whether a given nuclear facility can deter or defeat a potential threat. In order to do this, a state needs to carry out five steps:[61]

1. Design a basic physical protection system
2. Create scenarios for potential attacks on a given nuclear facility
3. Test the ability of the facility's current defenses to counter an attack
4. Fix any weaknesses discovered in the tests
5. Repeat steps three and four until the defenses can defeat all types of attack.

Whereas there is a small but growing literature on China's MPC&A, very little specific information is available on the physical protection of Chinese facilities. We simply do not know whether China has engaged in systematic designing and testing of its physical protection systems. Nor do we know whether China has created a legal structure that specifically outlines how a facility would put a physical protection system into place. Given the Soviet model for physical protection, however, it is unlikely that China has taken any of the critical steps for the design and implementation of Western-style physical protection systems.[62] We therefore cannot be certain that the physical protection systems at China's nuclear facilities would be able to repel a dedicated attack.

IDENTIFYING POTENTIAL THREATS TO NUCLEAR FACILITIES

Thefts of Fissile Materials by Insiders. Until recently, there were few reasons to worry about thefts of fissile materials from Chinese facilities. As in the Soviet Union before its collapse, Chinese central authorities maintained massive social controls that pervaded every aspect of the society. But this situation has changed in recent years, and could change more in the future. China's economic reforms launched in the 1970s have given rise to a significant erosion of societal controls and central government authority. Crime rates in China have soared in recent years, and many people in China, including local government officials, routinely evade government dictates.[63] Given these trends, it is possible that an insider might be tempted to steal nuclear materials for sale on the black market or for other purposes.

Moreover, recent governmental restructuring and budget cutbacks have cost many government officials their jobs, including many in the nuclear sector and the military.[64] It is difficult to determine how these cutbacks will affect the nuclear sector, but one result could be a larger pool of disgruntled former employees who might be tempted to steal nuclear materials and sell them, who might be vulnerable to recruitment by terrorist or organized crime groups, or who might provide information on security measures to support an attack. These restructuring problems are likely much less severe than those in the Russian nuclear complex—people in China are probably still being paid regularly—but they do exist in an incipient form.[65] Chinese nuclear materials presumably remain under tight central government control, but these personnel problems, which are clearly widespread in other sectors of the Chinese economy and government, could eventually spread to the nuclear sector.

Direct Terrorist Attacks. All states with nuclear facilities, civil or military, can be vulnerable to nuclear terrorism. China is no exception. Terrorists are becoming increasingly international. If they want to obtain fissile materials or sabotage a nuclear facility, they may choose to target facilities with the weakest MPC&A system. For this reason, among others, uniform international standards for MPC&A are desirable.[66] Of course, international terrorist groups would have difficulties operating in China because foreigners typically stand out visibly, few speak Chinese well, and they would be easy to spot in the remote areas where most of China's nuclear facilities are located.[67] But as China's borders continue to open up, international terrorism will increasingly become a problem.

In addition to the potential for international terrorists to attempt an attack on Chinese nuclear facilities is the risk of domestic terrorism in China. In particular, separatists in the western province of Xinjiang (where portions of the predominantly Islamic Uighur population have reportedly received arms and training in places like Afghanistan and Pakistan) have engaged in a number of acts of domestic terrorism in recent years.[68] Although Beijing has engaged in severe crackdowns on these movements—Western-based monitoring groups have recorded more than 200 death sentences and 200 executions of Xinjiang separatists since 1997—it has been surprisingly unsuccessful in quelling the unrest.[69] The possibility that these separatists might attempt to sabotage a nuclear facility or obtain fissile materials for terrorist purposes cannot be ruled out.[70]

One intriguing incident did reportedly occur in March 1993 at the Lop Nur site, located in Xinjiang.[71] On this occasion, some 1,000 protestors stormed the site in protest over China's nuclear testing. They were dispersed after the People's Liberation Army (PLA) fired shots. A spokesman for the Chinese Defense Ministry reportedly described the protestors as "barbarians" and claimed that they had done serious damage to the test site.[72] Additional reports, from Uighur sources citing the Chinese-language paper *Singtao*, suggested that military equipment, airplanes, and tanks were destroyed in the fighting that ensued between the Uighurs and the PLA. These sources also alleged that the attackers had stolen radioactive material from the test site, though this claim has proved impossible to substantiate.[73] While it is quite likely that radioactive material does exist at the Lop Nur site, it is unclear whether the attack took place near any sensitive locations. Given the size and the defenses at the site, it seems more likely that this incident was a violent protest-and-trespass action in clear contempt of Chinese authorities, rather than a dedicated attack or a credible threat to the security of Chinese nuclear materials or facilities.

The separatist movement in Xinjiang is not the only separatist movement in China; ethnic unrest in Tibet and Inner Mongolia could eventually erupt into domestic violence.[74] In fact, the sheer resilience of the Xinjiang separatist movement has helped to encourage Tibetans and Mongolians in their struggles against the central government.[75] While the Tibetan independence movement certainly has not erupted in the terrorism that has characterized the Xinjiang conflict, one cannot be certain that it never will.[76] And nuclear facilities and military bases located in provinces near Tibet could be targets for terrorism.

As we have seen, there are significant questions about the extent to which the physical protection systems at Chinese nuclear facilities would be able to defend against dedicated outsider attacks. China appears to lack carefully designed, integrated security systems; rigorous performance tests of these systems; and highly trained and well-armed guards at its nuclear facilities. Its heavy reliance on social controls and the isolation of its facilities for protection may not be adequate, particularly in the future, whether an attack is conducted by terrorists, rogue elements within the Chinese military, or even another country.

Weakened Nuclear Controls During Domestic Upheavals. The most significant weaknesses in China's system of MPC&A could arise during times of political, social, or economic crisis. Clearly, the events in Russia show the limitations of an authoritarian type of control during domestic crises. If such crises were to occur in China, the government's controls over its fissile material stockpiles could become significantly disrupted or collapse altogether.[77]

Indeed, China's nuclear controls have been affected during political upheavals in the past. For example, during the Cultural Revolution in the late 1960s and early 1970s, several radical factions within the nuclear complex reportedly engaged in fierce battles with each other, a regional military leader threatened to take over the Lop Nur nuclear test base (which is also believed to be the location of a nuclear weapons stockpile), and a group of radicals attacked a nuclear facility at Lop Nur.[78] More recently, Chinese officials reportedly admitted to U.S. officials that during the Tiananmen Square crisis, Beijing's leaders had feared their army might split over the decision to crush student protests, causing the central government to lose control of its nuclear arsenal.[79] Although these are particularly severe cases, it is quite possible that future upheavals could also disrupt China's nuclear controls.

Several different kinds of crises could potentially undermine China's controls over its fissile material stockpiles. Should China experience a severe economic downturn, it could face the same kinds of problems that Russia is now facing. If the wages of the scientists and guards at Chinese nuclear facilities were reduced, they might be increasingly tempted to supplement their incomes by selling fissile materials on the black market. Given China's apparent lack of a systematic MC&A system, it would probably have difficulties detecting this kind of insider theft. A decentralization of power in China could also weaken the country's MPC&A, because China relies heavily on strict social controls to deter any insider theft or terrorist attempts. If these controls were to weaken, we could see a dramatic increase in these illicit activities. A similar pattern in Russia and the other NIS appeared following the collapse of the Soviet Union.

Finally, a sustained leadership conflict or political crisis could undermine China's MPC&A. As we have seen, the Cultural Revolution disrupted nuclear production and caused violent clashes in Chinese military research facilities. While it may be unlikely that another political crisis on the scale of the Cultural Revolution will occur again in China, a leadership conflict could distract attention away from and interfere with close supervision of the Chinese nuclear complex.[80]

Working in favor of continued stability is the location of China's major nuclear weapons facilities. Because they are based in isolated areas, they tend to be less affected by weakened societal controls.[81] In fact, it would be easier for the government to maintain strict oversight of these facilities and much more difficult for outsiders to attack the facilities. Still, a general loosening of societal controls would be very troubling because of China's overreliance on these controls to discourage attacks on its nuclear facilities.

THE U.S.-CHINA LAB-TO-LAB COLLABORATIONS, 1995-1998

Partially in an effort to better understand and address some of these security concerns, the directors of nuclear laboratories in the United States and China began a formal letter exchange in 1995, following informal contacts under careful government oversight the previous year. It was determined that Department of Energy nuclear laboratories and their counterpart research facilities in China had many mutual scientific interests, and that laboratory-level collaboration was desirable in specific areas.[82] The CLL programs that resulted covered topics ranging from nuclear materials management (MPC&A), to verification technologies critical to the Comprehensive Test Ban Treaty (CTBT), to additional efforts in export controls. The following discussion will focus specifically on MPC&A collaborations.[83]

CLL Meetings and Workshops on MPC&A

The first meeting in which U.S. and Chinese scientists discussed MPC&A technologies occurred in 1995. In this meeting, American scientists from Lawrence Livermore, Sandia, and Los Alamos National Laboratories met with Chinese scientists from CAEP and the Institute of Applied Physics and Computational Mathematics (IAPCM). The second round of discussions began in January 1996, when American scientists from Livermore, Sandia, and Los Alamos met with Chinese scientists at IAPCM for a workshop on MPC&A technologies. During the workshop, scientists from both countries presented papers discussing the current MPC&A practices, technologies, and methodologies in use in each country.

In 1997, Sandia National Laboratories held a two-week course in China on the design of physical protection systems for nuclear facilities. It was held at the China Institute of Atomic Energy in Beijing from March 29 to April 10. These workshops helped train Chinese scientists in Western methods for designing and installing integrated physical protection systems.

In 1998, Sandia National Laboratory held a workshop in China on MC&A techniques. This workshop helped the Chinese develop strategies for identifying strategic monitoring points, installing measurement gauges, and the like. If implemented in Chinese nuclear facilities, these MC&A procedures and technologies would help the Chinese take precise physical inventories of the fissile materials in their nuclear facilities and subsequently detect any theft of these materials.

Integrated Demonstration of MPC&A

The principal Los Alamos activity, and a flagship CLL project, was to build a model MPC&A system in China to demonstrate Western-style MPC&A techniques and technologies. Work on this project began in 1996 and was completed in 1998. The opening of the demonstration took place in July 1998. The purpose of this MPC&A demonstration was to "provide an important foundation for building future activities for nuclear materials management in China."[84] It was hoped that the model facility would help China and the U.S. achieve this end "through development of common approaches and deployment of integrated systems of modern technologies."[85]

A great deal of modern MPC&A technology was installed at the model facility. The new equipment included access-control devices such as motion detectors, cipher-activated locks, magnetic card readers, and hand-geometry readers. Screening and monitoring devices were installed, such as metal detectors, portal radiation detectors, and an NTvision camera remote-monitoring system. Equipment for materials measurement and tracking systems was also installed, including gamma spectrometers for nuclear materials assay, a complete bar-code inventory system, and tamper-resistant seals.[86] The United States provided most of the equipment except the facility itself, the security fence, and the nondestructive assay equipment, which were provided by China.

These lab-to-lab collaborations were designed to help create a "safeguards culture" in China by showing the Chinese the advantages of modern MPC&A systems. The CACE program made some progress in this area, but more remains to be done. Unfortunately, the program was put on hold before it could make significant improvements to China's MPC&A. Indeed, plans for actual implementation of some MPC&A measures at

Chinese nuclear facilities were curtailed as a part of the reduction in U.S.-Chinese contacts.

OBSTACLES TO CHINA'S MPC&A MODERNIZATION

While it is possible that the Chinese have continued to upgrade MPC&A on their own, there is reason to doubt that they have made significant improvements without U.S. cooperation—even though China knows many of the basic requirements for rigorous MPC&A systems. There are several reasons for this. First, in spite of its economic growth over the last decade, China remains a resource-limited country.[87] Stringent physical protection regulations are very expensive to implement.[88] Although expenses would presumably be lower in China than in the United States, Chinese scientific facilities are often underfunded and therefore may have difficulties meeting the physical protection regulations established by Chinese law.

In addition, Chinese officials often have difficulty justifying the high cost of modern MPC&A systems typically in use by Western countries. Because China is a comparatively poor country, it could either use its resources to feed its citizens, strengthen its economy, and improve its military, or it could use them to improve its MPC&A. China's limited financial resources have often caused it to place safety and security as lower priorities than other objectives.

Furthermore, the Chinese may not have improved their MPC&A because of an historical lack of coordinated policy among the different bureaucracies that have responsibility over China's nuclear complex. One could characterize the Chinese nuclear complex as "stove-piped," without much communication among the different bureaucracies or coordination of their nuclear policies. According to Wen Hsu, "the government departments [in China's nuclear establishment] have continued to act as fiefdoms that jealously guard their prerogatives, to the extent that their possessiveness has discouraged interdepartmental exchanges."[89] Moreover, each of the bureaucracies has limited resources, and each might be unwilling to pay for MPC&A technologies that it believes another agency should pay for.

But the main reason that China may not have improved its MPC&A significantly in recent years is that many Chinese officials simply have not seen the need for the stringent MPC&A implemented by Western countries. The Chinese have stated publicly that their method of MPC&A is "similar to that of the Russians," which was mostly dependent in the past on security personnel.[90] Although it has become clear that such a system can become particularly weak during political and economic crises, the Chinese consider these methods to be adequate for now because, they maintain, their current political, social, and military situation is relatively stable.[91]

The U.S.-China collaborative programs worked to help change these perspectives on nuclear security and promoted significant progress in security upgrades at Chinese facilities. Without these or similar programs, it is likely that potential vulnerabilities will remain at Chinese nuclear facilities, at least for some time. Such vulnerabilities are cause for concern, particularly because China is currently not as stable as many would like to believe. Growing sources of instability in China could eventually disrupt its nuclear controls.

POTENTIAL FOR FUTURE INSTABILITY

Fundamental changes in China in recent years present significant instabilities that the regime may not survive. Indeed, it appears that the Chinese Communist Party (CCP) is rapidly losing influence in China.[92] This situation is due partly to the liberalization of China's economy, partly to the CCP's increasing inability to solve many of China's internal difficulties (such as the separatist movements and the pressures of liberalization), and partly to the large dissatisfaction in the populace with widespread government corruption. After years of denials by the government and the government-controlled press, these problems have become severe enough to force the CCP to admit them. According to a June 2, 2001, article in the *New York Times*, "A startlingly frank new report from the Communist Party's inner sanctum describes a spreading pattern of 'collective protests and group incidents' arising from economic, ethnic and religious conflicts in China and says relations between party officials and the masses are 'tense, with conflicts on the rise.'"[93]

Economic Changes and Political Stagnation

The most foundational changes have resulted from China's transition to an open economy. With a reported sustained yearly growth rate of nearly 8 percent, China's economy has grown dramatically in the last decade.[94] Its entry into the World Trade Organization (WTO) will guarantee that China's economy will continue to open in the future.[95] However, as Minxin Pei, a senior associate at the Carnegie Endowment for International Peace, has argued, "in both the short and long term, China's entry into the WTO—and the radical economic reforms likely to accompany it—will generate powerful shocks to the country's existing political system.…It remains highly uncertain, however, whether the Chinese regime is resilient enough to withstand such shocks."[96]

China's economic restructuring has largely benefited only a small, highly educated elite and has actually worsened conditions for rural farmers and workers in traditional industries.[97] The worsening economic conditions in these two groups, combined with increasing frustration with widespread corruption in the CCP, have caused these groups to become immense reservoirs of social discontent. In recent years, an increasing number of riots have occurred over government corruption, excessive taxation, and the CCP's inability to ease the economic hardships among industrial workers and rural farmers. According to some reports, more than 100,000 protests took place in China in 1999, many of which led to violent clashes.[98] The following are just a few recent examples of such incidents:

- In the largest labor protests since 1949, tens of thousands of displaced workers protested every weekday in March 2002 in Daqing in China's northeast.
- In February 2000, tens of thousands of workers staged a violent protest at China's largest nonferrous metal mine, burning cars and holding police at bay for several days. The workers were protesting against what they said was an unfair and corrupt handling of the mine's bankruptcy.
- In August 2000, up to 20,000 farmers rioted for five days in the Jiangxi province in southern China, with some attacking government buildings and looting officials' homes in protest over government fees and taxes.
- On October 18, 1999, more than 2,000 protesters took over a Sichuan railway station in grievance over the government's investing funds in illegal companies.
- In late 1998, the people of Shao village in southern Hebei rioted for the right to vote, and more than 700 riot police surrounded the village.[99]

A number of scholars have expressed concern that the growing discrepancy between the rapid economic reforms and the lack of political reforms could be a major source of political upheavals and possibly even collapse of the regime.[100] As Hua Di has noted, "The real threat to the PRC's current regime comes not from foreign military intervention…but from the Chinese people's pervasive dissatisfaction with the regime's corruption."[101] Hua concludes that "unless a political reform is launched and succeeds, in which the current regime in China takes initiative to change itself from a one-party dictatorship to a multi-party democracy, the corruption will not end but the regime will be finished."[102]

Regionalism and Separatist Movements

According to numerous reports, increasing regionalism and separatist movements have developed, which could threaten to break China apart. For example, there are large economic disparities between the rich, southeastern provinces and poor, western provinces. Chinese leaders are reportedly worried that the southeastern provinces will some day refuse to finance the western provinces and attempt to leave China.[103] But the western provinces are even more likely to want to break away from China. As discussed, there are several separatist movements within China, most notably in Tibet, Xinjiang, and Taiwan (which Beijing still considers part of mainland China).[104] China is quite worried that if one area were to achieve independence, the other areas would increase their efforts to secede. This is reportedly a major reason that Beijing is so determined to prevent Taiwan's separation from mainland China.[105] If these separatist movements were to gain momentum, they could disrupt central controls over dispersed nuclear facilities or even sever these controls altogether.

THE NEED FOR RENEWED MPC&A COLLABORATIONS

China's current system of MPC&A has apparently worked well so far, but there is no guarantee that it will do so in the future. In light of possible terrorist threats, by both domestic and international groups, as well as potential actions by angry and disenfranchised groups within China that could endanger China's nuclear facilities, it is possible that a well-organized terrorist attack could be successful, especially at the smaller facilities, which reportedly supply their own protective forces.[106]

But much more troubling are the weaknesses in nuclear security that could arise during political, social, and economic upheavals. As we have seen in Russia, domestic upheavals can weaken loyalties of workers and guard forces, diminish resources for maintenance of basic security systems such as alarms and fences, and undermine government oversight of nuclear facilities. From what is known of China's current nuclear security systems, it is likely that domestic upheavals would have similar effects in China. It is therefore critically important that China improve its MPC&A now to reduce risks to its nuclear controls.

As Kenneth Lieberthal has argued, U.S. policymakers must take seriously the possibility of a weaker, disorganized China.[107] Despite the uncertainties that remain in our knowledge about Chinese MPC&A, the risks of losing material, as well as the opportunities for improved controls, strongly suggest that the United States take a vital interest in encouraging China to improve the MPC&A for its nuclear facilities. The United States must also help create a safeguards culture in China, where everyone from high-level politicians to the lowest-level guard recognizes the importance of rigorous MPC&A procedures and technologies.

The most direct way to address these potential threats would be to restart MPC&A collaborations with China. There have been few prospects for such cooperation in recent years, but an improvement in U.S.-China relations after the 9/11 attacks may allow opportunities for reintroducing such a program in the future. U.S. and Chinese officials have stated that they "stand side-by-side" in the war on terrorism and have committed to promoting international anti-terrorism cooperation.[108] This position may provide an opportunity to renew lab-to-lab collaborations in the context of the antiterrorism campaign.

These efforts will have to proceed carefully, however, in order to allay Chinese suspicions that this is a merely cynical approach to gain information on China's nuclear program. Also, China will need some reassurance that such cooperation will not trigger future espionage scandals. By including the U.S.-China MPC&A program among the various programs intended to bolster the war on terrorism, however, it may be possible to avoid some of the political difficulties that affected the CACE program last time around—for instance, to strictly segregate the MPC&A program from other issues of nuclear cooperation to make it more palatable to political authorities on both sides.[109]

As a first step to renewing MPC&A collaborations, the United States should attempt to re-establish the contacts with officials within the CNNC and the CAEA that were severed after the publication of the Cox report. This step can be achieved by renewing engagement with officials at international conferences, and by inviting Chinese officials to the United States to meet with U.S. policymakers, scientists, and academics.

The United States could also consider initiating other lab-to-lab collaborations dealing with less sensitive issues. These collaborations could focus on safety and security issues at civilian facilities, for instance. They could engage, at least at first, such Chinese agencies as the National Nuclear Safety Administration (NNSA).[110] If these programs were to achieve success, then U.S. and Chinese officials could consider expanding them to include all of China's nuclear facilities.

A shortcoming of such an approach, however, is that the largest stockpiles of HEU and separated plutonium are presumably located at China's military facilities. It would mean that the most attractive materials for theft would be the last to be the subject of U.S.-Chinese collaboration. Thus, while this approach has the greatest chance of being acceptable to leaders on both sides, it should be expanded as soon as politically feasible. In the meantime, however, beginning with civilian facilities would by no means be wasted time. Improving MPC&A at China's civilian and research reactors would reduce risks of sabotage and help protect the sensitive materials at these facilities. Through collaborative efforts at civilian facilities, China could become more familiar with Western approaches to designing and installing MPC&A systems, thus setting the stage for rapid progress when the program is expanded to military facilities.[111]

While these programs will inevitably progress slowly, they can help increase transparency and mutual understanding between the two counties. It is only from such a position of trust that the United States could hope to encourage China to improve the security of its nuclear facilities and hence mitigate the risk of leakage from these facilities.

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[2] Joseph F. Pilat, "The New Terrorism and NBC Weapons," in Brad Roberts, ed., *Hype or Reality?: The "New Terrorism" and Mass Casualty Attacks* (Alexandria, VA: Chemical and Biological Arms Control Institute, 2000), p. 231; Walter Laqueur, "Post-Modern Terrorism," *Foreign Affairs* 75 (September-October 1996), p. 29.

[3] George J. Tenet, "Worldwide Threat - Converging Dangers in a Post 9/11 World," Testimony before the Senate Select Committee on Intelligence, 107th Cong., 2nd sess., February 6, 2002, p. 2; Barton Gellman, "Fears Prompt U.S. to Beef Up Nuclear Terror Detection," *Washington Post*, March 3, 2002, p. A1; Mike Boettcher and Ingrid Arnesen, "Al Qaeda Documents Outline Serious Weapons Program: Terrorist Group Placed Heavy Emphasis on Developing Nuclear Device," <www.cnn.com>, January 25, 2002.

[4] See, for example, Tenet, "Worldwide Threat"; Kimberly McCloud and Matthew Osborne, "WMD Terrorism and Usama Bin Laden," web report, Center for Nonproliferation Studies, Monterey Institute for International Studies, <www.cns.miis.edu/pubs/reports/binladen.htm>; Boettcher and Arnesen, "Al Qaeda Documents Outline Serious Weapons Program"; White House, Office of the Press Secretary, "President Delivers State of the Union Address," White House Press Release, January 29, 2002, <http://www.whitehouse.gov/news/releases/2002/01/print/20020129-11.html>, p. 2.

[5] George W. Bush, press conference following Bush-Putin Summit, White House Transcript, November 13, 2001, quoted in Joseph Cirincione, with Jon B. Wolfsthal and Miriam Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington, D.C.: Carnegie Endowment for International Peace, 2002), pp. 114–115. See also Gellman, "Nuclear Terror Detection," p. A01.

[6] The primary fissile materials that could be used in nuclear weapons are highly enriched uranium (uranium with a fissile isotopic content of 20 percent or more) and plutonium, though some alternative materials could be used, including certain isotopes of neptunium and americium.

[7] Bush, press conference, quoted in Cirincione et al., *Deadly Arsenals*, pp. 114–115; "Text: U.S., Russia to Step-up Efforts to Safeguard Nuclear Materials," *Washington File*, U.S. Department of State, December 4, 2001, pp. 1-2.

[8] For example, see Oleg Bukharin, "Security of Fissile Materials in Russia," *Annual Review of Energy and the Environment* 21 (1996), pp. 467–496; Matthew Bunn, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Materials* (Washington, DC: Carnegie Endowment for International Peace and Harvard University, 2000); Amy F. Woolf, "Nuclear Weapons in Russia: Safety, Security, and Control Issues," Congressional Research Service, Report to Congress, March 5, 2001.

[9] For summaries and assessments of these programs, see Bunn, *The Next Wave*, pp. 29-108; Department of Defense, *Cooperative Threat Reduction*, <www.defenselink.mil/pubs/ctr/>; U.S. Department of Energy, *MPC&A Program Strategic Plan* (Washington, DC: U.S. DOE, July 2001); U.S. General Accounting Office, *Nuclear Nonproliferation: Security of Russia's Nuclear Material Improving; Further Enhancements Needed*, GAO-01-312 (Washington, DC: February 2001).

[10] Steven Mufson, "U.S. Worries About Pakistan Nuclear Arms," *Washington Post*, November 4, 2001, p. A21; Corey Hinderstein, "The First Casualty of the War on Terrorism Must Not be Pakistan: Pakistan's Nuclear Weapons must not fall into Terrorists' Hands," ISIS Issue Brief (September 18, 2001); David Albright, Kevin O'Neill, and Corey Hinderstein, "Securing Pakistan's Nuclear Arsenal: Principles for Assistance," ISIS Issue Brief (October 4, 2001), <www.isis-online.org/publications/terrorism/pakassist.html>; Jon Wolfsthal, "U.S. Needs A Contingency Plan For Pakistan's Nuclear Arsenal," *Los Angeles Times*, October 16, 2001, p. B17; Seymour M. Hersh, "Watching the Warheads: The Risks to Pakistan's Nuclear Arsenal," *New Yorker* 77 (November 5, 2001), pp. 48-54; Mansoor Ijaz and R. James Woolsey, "How Secure is Pakistan's Plutonium?," *New York Times*, November 28, 2001, p. A25; Bryan Bender, "Pakistan: U.S. Visit Finds Continuing Obstacles to Nuclear Cooperation," *Global Security Newswire*, <http://www.nti.org/d_newswire/issues/2002/10/8/4s.html>, October 8, 2002.

[11] Nancy Hayden Prindle, "U.S. and China on Nuclear Arms Control and Nonproliferation: Building on Common Technical Interests," in James Brown, ed., *Arms Control Issues for the Twenty-First Century* (Albuquerque, NM: Sandia National Laboratory Publication, SAND97-2619, 1997), p. 322.

[12] U.S. government officials (names withheld by request), interviews by author, February 1999.

[13] Although this program was loosely based on the U.S.-Russia lab-to-lab program, there were important differences. For example, unlike the U.S.-Russia programs, each side paid its own way. Moreover, the scope of the program was much more limited, with authorization only initially covering MPC&A and arms control activities. U.S. national laboratory official (name withheld by request), correspondence with author, October 2002.

[14] Nancy Prindle, "The U.S.-China Lab-to-Lab Technical Exchange Program," *Nonproliferation Review* 5 (Spring/Summer 1998), p. 111.

[15] Ibid., pp. 111–118.

[16] To view the allegations of Chinese espionage in "U.S. National Security and Military/Commercial Concerns with the People's Republic of China," otherwise known as the "Cox report," see <www.access.gpo.gov/congress/house/hr105851/VI-06-Chap2.pdf>.

[17] U.S. national laboratory official (name withheld by request), correspondence with author, October 2002.

[18] Ibid.

[19] U.S. Department of Defense, *Proliferation: Threat and Response*, January 2001 (Washington, D.C.: U.S. Government Printing Office, 2001), <www.defenselink.mil/pubs/ptr20010110.pdf>, p. 14; Cirincione et al, *Deadly Arsenals*, p. 145; Lisbeth Gronlund, David Wright, and Yong Liu, "China and a Fissile Material Production Cut-off," *Survival* 37 (Winter 1995–1996), p. 148.

[20] Rodney Jones, Mark McDonough, with Toby Dalton and Gregory Koblentz, *Tracking Nuclear Proliferation: A Guide in Maps and Charts, 1998* (Washington, DC: Carnegie Endowment for International Peace, 1998), p. 54; David Albright and Kevin O'Neill, "China," Institute for Science and International Security, <www.isis-online.org/mapproject/china.html>. David Wright and Lisbeth Gronlund estimate that China has a plutonium stockpile of roughly 2-6 tons. See David Wright and Lisbeth Gronlund, "Estimating China's Production of Plutonium for Weapons," Technical Working Paper, Union of Concerned Scientists and Security Studies Program, MIT (paper provided by authors, January 7, 1999), p.13. Because China has provided no independent verification of the size of its fissile materials stockpile, the stockpile could be significantly larger or smaller than these estimates.

[21] William Arkin, Robert S. Norris, Hans Kristenson, and Joshua Handler, "NRDC Nuclear Notebook: Chinese Nuclear Forces, 2001," *Bulletin of the Atomic Scientists* 56 (September–October 2000), pp. 71–72.

[22] Office of the Secretary of Defense, *Proliferation: Threat and Response* (Washington, D.C.: U.S. Government Printing Office, November 1997); William M. Arkin, Robert S. Norris, Joshua Handler, *Taking Stock: Worldwide Nuclear Deployments 1998* (Washington, D.C.: Natural Resources Defense Council, 1998), p. 89.

[23] Robert S. Norris, Andrew S. Burrows, and Richard W. Fieldhouse, *Nuclear Weapons Databook, Vol V: British, French, and Chinese Nuclear Weapons* (Boulder: Westview Press, 1994), p. 375. See also Jones et al., *Tracking Nuclear Proliferation*, p. 65.

[24] "Nuclear Weapon Related Facilities," Nuclear Threat Initiative database, <www.nti.org/db/china/nwfac.htm>.

[25] For a detailed discussion of this conversion, see Yitzhak Sichor, "Peaceful Fallout: The Conversion of China's Military-Nuclear Complex to Civilian Use," *Brief 10* (Bonn International Center for Conversion, November, 1997), <www.bicc.de/industry/brief10/brief10.pdf>, pp. 1-60.

[26] Cirincione et al, *Deadly Arsenals*, p. 145.

[27] Ibid.

[28] Mohamed ElBaradei, Director General of the IAEA, preface to INFCIRC/225/rev.4, May 1999.

[29] For the texts of INFCIRC/225, rev.4 and INFCIRC /153, see the IAEA web sites: <www.iaea.org/worldatom/program/protection/inf225rev4/rev4_content.html> and <www.iaea.org/worldatom/Documents/Infcircs/Others/inf153.shtml>.

[30] INFCIRC/225/rev.4, sec. 5.2, May 1999.

[31] Jason Ellis and Todd Perry, "Nunn-Lugar's Unfinished Agenda," *Arms Control Today* 27 (October 1997), p. 16.

[32] International Atomic Energy Agency, *IAEA Annual Report for 2001*, <www.iaea.org/worldatom/Documents/Anrep/Anrep2001/table_3.pdf>; "China and the International Atomic Energy Agency," <www.nti.org/db/china/iaeaorg.htm>.

[33] Cirincione et. al, *Deadly Arsenals*, pp. 160, 162 n8.

[34] Sichor, "Peaceful Fallout," p. 25.

[35] INFCIRC/274, <www.iaea.org/worldatom/Documents/Infcircs/2000/infcirc274r1a7.pdf>.

[36] INFCIRC/549, <www.iaea.org/worldatom/Documents/Infcircs/1998/infcirc549.pdf>.

[37] INFCIRC/153 and INFCIRC/225, <www.iaea.org/worldatom/Documents/Infcircs/Others/inf153.shtml> and <www.iaea.or.at/worldatom/program/protection/inf225rev4/rev4_content.html>.

[38] These guidelines also state that the officially recognized NWSs should transfer to IAEA safeguards the plutonium that they no longer consider necessary

for their national defense purposes. But it requires only that they take these steps as soon as it is "practicable" and places no deadline by which this transfer should occur.

[39] For excellent discussions of the bureaucratic restructuring as of 1999, see Harlan Jencks, "COSTIND is Dead. Long Live COSTIND!," in James C. Mulvenon and Richard H. Yang, eds., *The People's Liberation Army in the Information Age* (Santa Monica: RAND Corporation, 1999), p. 59; and Wen Hsu, "The Impact of Government Restructuring on Chinese Nuclear Arms Control and Nonproliferation Policymaking," *Nonproliferation Review* 6 (Fall 1999), pp. 152–167. Both scholars indicate that the full restructuring would continue for several years after they wrote their articles, however.

[40] In the case of China's nuclear reactors and MPC&A issues, formal authority is usually more important. However, informal authority may nevertheless be relevant to some key issues, such as acquiring resources for MPC&A improvements and on an individual plant or factory's ability to market services. (The author thanks an anonymous reviewer for this clarification.)

[41] "Rules for Implementation of the Regulations on Nuclear Materials Control of the People's Republic of China," National Nuclear Safety Administration, Ministry of Energy, and the Commission of Science, Technology, and Industry for National Defense, September 25, 1990.

[42] Lawrence Livermore National Laboratory, Sandia National Laboratories, Los Alamos National Laboratory, *Foreign Trip Report*, Beijing, China, June 23-July 2, 1995, pp. 5-6.

[43] Hui Zhang, research fellow, Belfer Center for Science and International Affairs, Harvard University, Cambridge, MA, telephone conversation with author, October 4, 2002. The CAEA currently has authority for "carrying out nuclear material control, nuclear export supervision and management," CAEA website, <www.caea.gov.cn/english/index.htm>.

[44] Wen Hsu, Distinguished Member of the Technical Staff at Sandia National Laboratory, Livermore, CA, telephone conversation with author, August 6, 1999.

[45] Quinsheng Zhu, *A Brief Overview on State Systems of China Nuclear Material Control*, China Atomic Energy Authority, Office of Nuclear Material Control, June 1994, p. 1.

[46] 1987 Regulations, p. 3. Responsibility for issuing the licenses was originally given to the China National Nuclear Corporation (1990 Rules, p. 1). It is not entirely clear what agency will be responsible for licensing after China's recent restructuring of its nuclear bureaucracy, but it will probably be the CAEA.

[47] 1990 Rules, p. 2.

[48] MUF is calculated by the following formula:
MUF = BI (beginning inventory) + A (additions) – EI (ending inventory) – R (removals) – KL (known loss).
The 1990 document also establishes regulations for acceptable standard error of MUF. The following are the acceptable standards of error of MUF for the different types of nuclear facilities:

Facility Type	Relative Standard error of MUF (%)
Uranium enrichment	0.2%
Uranium processing	0.3%
Plutonium processing	0.5%
Uranium reprocessing	0.8%
Plutonium reprocessing	0.1%

[49] "China's Attitudes Toward Nuclear Material Protection, Control, and Accounting," Nuclear Threat Initiative database, <www.nti.org/db/china/mpcapos.htm>.

[50] To view the specific categories of fissile materials (Category I, II, and III) and the physical protection measures for each category recommended by INFCIRC/225, see the IAEA web site: <www.iaea.or.at/worldatom/program/protection/inf225rev4/rev4_content.html>.

[51] U.S. government officials, (names withheld by request), interviews by author, February 1999.

[52] Hsu, "The Impact of Chinese Government Restructuring," p. 158.

[53] Prindle, "U.S. and China on Nuclear Arms Control and Nonproliferation," p. 322.

[54] Albright, Berkhout and Walker, *Plutonium and Highly Enriched Uranium 1996*, p. 422.

[55] Xingqiang Zhang, "China's Practice of Nuclear Materials Control," *A Comparative Analysis of Approaches to the Protection of Fissile Materials*, Proceedings of the Workshop at Stanford University, July 28-30, 1997, (Livermore, CA: Lawrence Livermore National Laboratory, 1998), p. 87.

[56] U.S. government officials, (names withheld by request), interviews by author, February 1999.

[57] Tang Bin, "Major Advances Realized in Nation's Nuclear Fuel Accounting System," *China Nuclear Industry News*, September 11, 1996, in FBIS-CTS-96-019 (September 11, 1996).

[58] Jones et al., *Tracking Nuclear Proliferation*, p. 55.

[59] Annette Schaper, "The Case for Universal Full-Scope Safeguards on Nuclear Material," *Nonproliferation Review* 5 (Winter 1998), p. 75. For a similar argument, see Gronlund et al., "China and a Fissile Material Production Cut-off," p. 160.

[60] The three Chinese nuclear facilities that are under full IAEA safeguards would have this MC&A equipment, but those facilities that China designed indigenously probably do not have similar MC&A systems.

[61] See, for example, the discussions in INFCIRC/225/rev.4, section 4.4.1, May 1999; and Oleg Bukharin, Matthew Bunn, and Kenneth Luongo, *Renewing the Partnership: Recommendations for Accelerated Action to Secure Nuclear Material in the Former Soviet Union*, (Washington, DC: Russian American Nuclear Security Advisory Council, August 2000), pp. 79–86.

[62] U.S. government officials, (names withheld by request), interviews by author, February 1999.

[63] The author would like to thank an anonymous reviewer for this suggestion. See Patrick Tyler, "Crime (and Punishment) Rages Anew in China," *New York Times*, July 11, 1996, p. A1; John Pomfret, "Chinese Executions Top Rest of World," *Washington Post*, February 2, 2000, p. A17; Kenneth Lieberthal, *Governing China: From Revolution Through Reform* (New York: W.W. Norton & Company, 1995), pp. 262, 267-269, 299, 301; Austin, "China's Public Order Crisis," pp. 7-14; Elizabeth Rosenthal, "China's Fierce War on Smuggling Uproots a Vast Hidden Economy," *New York Times*, March 6, 2000, p. A1.

[64] Hsu, "The Impact of Chinese Government Restructuring," p. 159.

[65] The author would like to thank an anonymous reviewer for this suggestion. See also Jones et al., *Tracking Nuclear Proliferation*, p. 54

[66] Mathew Bunn, "Security for Weapons-Usable Nuclear Materials: Expanding International Cooperation, Strengthening International Standards," in *A Comparative Analysis of Approaches to the Protection of Fissile Materials*, Proceedings of the Workshop at Stanford University, July 28-30, 1997, p. 16.

[67] The author would like to thank an anonymous reviewer for this suggestion.

[68] Yossef Bodansky, "Beijing Prepares for a New War Front in Xinjiang," *Defense and Foreign Affairs Strategic Policy* 28 (September 2000), p. 4; George Gilboy and Eric Heginbotham, "China's Coming Transformation," *Foreign Affairs* 80 (July/August 2001), pp. 26-39.

[69] Evan A. Feigenbaum**,** "China's Strategy of Weakness," *Far Eastern Economic Review* 164 (March 1, 2001), p. 29. There are numerous examples of the resilience of the separatist movement in Xinjiang. For example, on February 4, 1999, 9,000 armed police were sent to Xinjiang to suppress anti-Beijing rioting. Official Chinese reports said that 10 people died in the rioting, but overseas reports place the death toll at more than 100. See "China Sends 9,000 Armed Police to Xinjiang Riot Town," AFP February 4, 1999. See also John Pomfret, "Separatists Defy Chinese Crackdown," *Washington Post*, January 26, 2000, p. A17. For additional accounts of the continuing violence associated with the Xinjiang separatist movement, see Ahmed Rashid and Susan V. Lawrence, "Joining Foreign Jihad," *Far Eastern Economic Review* 163 (September 7, 2000), p. 24; "Jiang Says Hard Work Still Needed to Counter Separatism," BBC News, March 7, 1998; Duncan Hewitt, "China Clampdown on Muslim Region," BBC News, May 29, 2000; Ahmad Faruqui, "China-Pakistan: Fraying Ties," *Far Eastern Economic Review* 164 (January 18, 2001), p. 33; Schlevogt, "China's Western Campaign," p. 29; Susan V. Lawrence, "Where Beijing Fears Kosovo," *Far Eastern Economic Review* 163 (September 9, 2000), p. 24.

[70] For a similar argument that Uighur separatists could become interested in WMD, see Feigenbaum, "China's Strategy of Weakness," p. 29.

[71] The author would like to thank Dr. Gavin Cameron of the University of Salford, United Kingdom, for bringing this incident to his attention. The following section is based on a unpublished, untitled discussion paper by Dr. Cameron.

[72] Hermann-Josef Tenhagen, "Uiguren Gegen Atomtests," *Die Tageszeitung*, August 17, 1995, p. 7.

[73] "Nuclear Test Site Attacked," *Eastern Turkestan Information* 3 (June 1993), p. 1. See also Andre Grabot, "The Uighurs—Sacrificed On Central Asia's Chess

Board," AFP, April 25, 1996.

[74] George, "Islamic Unrest," p. 2. See also Greg Austin, "The Strategic Implications of China's Public Order Crisis," *Survival* 37 (Summer 1995), pp. 7–23.

[75] George, "Islamic Unrest," p. 2.

[76] See Bhuchung K. Tsering, "Tibetan Problem Defies Solution," *Washington Times*, July 6, 1996, p. A7.

[77] Jones et al., *Tracking Nuclear Proliferation*, p. 54.

[78] John W. Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1988), pp. 202–206; Donald G. Brennan, "The Risks of Spreading Weapons: A Historical Case," *Arms Control and Disarmament* 1 (1968), pp. 59-60; Dan Caldwell and Peter Zimmerman, "Reducing the Risk of Nuclear War with Permissive Action Links," in Barry M. Blechman, ed., *Technology and the Limitation of International Conflict* (Washington D.C.: John Hopkins Foreign Policy Institute, School of Advanced International Studies, 1989), pp. 151-175.

[79] Steve Coll and David Ottaway, "Will the United States, Russia and China be Nuclear Partners or Rivals in the 21st Century?," *Washington Post*, April 11, 1995, p. A01; Steve Coll, "The Man Inside China's Bomb Labs: U.S. Blocks Memoir of Scientist Who Gathered Trove of Information," *Washington Post*, May 16, 2001, p. A01.

[80] The author would like to thank an anonymous reviewer for this suggestion. For questions about difficulties in China's current leadership transition, see John Pomfret, "Chinese Leader Throws a Curve: Jiang's Reluctance to Retire Could Spark a Power Struggle," *Washington Post*, July 21, 2002, p. A 01; Susan V. Lawrence and Chang Chun, "Jiang Finds it Hard to Let Go," *Far Eastern Economic Review* 165 (September 12, 2002), pp. 34-36.

[81] This was certainly the case during the Cultural Revolution, though the political crisis did eventually affect the nuclear sector as well. See Lewis and Xue, *China Builds the Bomb*, pp. 203-204.

[82] *Integrated Demonstration of Materials Protection, Control, and Accountability*, LALP-98-65, Los Alamos National Laboratory, Albuquerque, NM, June 1998, , p.1.

[83] Since this section discusses collaborations that went on *prior* to the program's re-naming in 1998, it refers to the program by its former name, the CLL program, rather than CACE.

[84] Prindle, "The U.S.-China Lab-to-Lab Technical Exchange Program," p. 114.

[85] *Integrated Demonstration of Materials Protection, Control, and Accountability*, Los Alamos National Laboratory Unclassified Publication, p.2.

[86] Ibid., pp. 7-22.

[87] According to the CIA Factbook, China's per capita GDP in 2000 was $3,600. To put this figure in perspective, the per capita GDP of the United States was $36,200 in 2001 and Russia's was $7,700 (even after Russia's financial collapse in 1998, its per capita GDP was $4,000). See the CIA Factbook: <www.cia.gov/cia/publications/factbook/indexgeo.html>. These amounts are derived from purchasing power parity (PPP) calculations rather than from conversions of official currency exchange rates.

[88] For example, in the United States, a perimeter intrusion detection and assessment system (PIDAS) for the physical protection of facilities containing Category I materials costs nearly $1,000 per foot. A PIDAS would include the following: (a) fences and intrusion sensors, (b) alarm assessment video cameras and lights, (c) central and secondary alarm stations, (d) an access control portal with nuclear material detection sensors.

[89] Hsu, "The Impact of Chinese Governmental Restructuring," p. 165; see also pp. 152, 154

[90] Prindle, "U.S. and China on Nuclear Arms Control and Nonproliferation," p. 322.

[91] Ibid., p. 322

[92] See, for example, Gerald Segal, "China Changes Shape: Regionalism and Foreign Policy," *Adelphi Paper* 287 (London: IISS, 1994), pp. 3-72; Hua Di, "China's Security Dilemma to the Year 2010," *Studies in International Security and Arms Control* (Stanford, CA: Stanford University Press, October 1997), <http://cisac.stanford.edu/docs/hua.pdf>, p. 3; Jones et al., *Tracking Nuclear Proliferation*, p. 54; and Greg Austin, "The Strategic Implications of China's Public Order Crisis," *Survival* 37 (Summer 1995), pp. 7-23.

[93] Eric Eckholm, "China Inner Circle Admits Big Unrest," *New York Times*, June 2, 2001, p. A14.

[94] There are, however, serious questions about the veracity of economic data provided by the Chinese government. According to research conducted by Thomas G. Rawski at the University of Pittsburgh, China's economy may have actually been contracting since 1998. Indeed, Chinese Premier Zhu Rongji reportedly stated that China's economy would have collapsed in 1998 without the state stimulus spending program that is driving China's debt to record levels. See Arthur Waldron, "China's Economic Façade," *Washington Post*, March 21, 2002, p. A35; Frederik Balfour, *Business Week* 3777 (April 8, 2002), p. 52; Thomas G. Rawski, "What's Happening to China's GDP Statistics?," *China Economic Review* 12 (December 2001), pp. 347-354.

[95] David E. Sanger, "Bush Plans to Prolong Trade Benefits for China," *New York Times*, May 30, 2001, p. A4; Christopher McNally, "WTO Entry, Capitalist Inclusion Will Reshape China," *Washington Times*, November 20, 2001, p. A19.

[96] Minxin Pei, "Future Shock: The WTO and Political Change in China," *Policy Brief* 1 (Washington D.C.: Carnegie Endowment for International Peace, February 2001), p. 1.

[97] Ibid., p. 4.

[98] This estimate was issued by the Hong Kong-Based Information Center of Human Rights and Democracy, reported in "Drought Fuels Violence in China," *Washington Post*, July 16, 2000, p. A21. Official Labor Ministry statistics, which were reportedly passed to a Western diplomat, indicated that there were 120,000 labor disputes in 1999—14 times the number of disputes in 1992 (reported in John Pomfret, "Chinese Workers Are Showing Disenchantment," *Washington Post*, April 23, 2000, p. A23).

[99] These incidents were reported in: Erik Eckholm, "Leaner Factories, Fewer Workers Bring Labor Unrest to China," *New York Times*, March 19, 2002, p. A1; John Pomfret, "In Rural China, Democracy is Not All It Seems," *Washington Post*, August 25, 2000, p. A01; "Angry Investors Take Over Sichuan Railway Station," *Hong Kong AFP*, October 18, 1999, in FBIS-CHI-1999-1018 (October 18, 1999); Pomfret, "Chinese Workers Are Showing Disenchantment," p. A23; John Pomfret, "Miner Riot Symptom of China's New Direction," *Washington Post*, April 5, 2000, p. A01; "Regional Briefing," *Far Eastern Economic Review* 163 (September 14, 2000), p. 13; Erik Eckholm, "Chinese Raid Defiant Village, Killing 2, Amid Rural Unrest," *New York Times*, April 20, 2001, p. A1; John Pomfret, "Seeds of Revolt in Rural China: 'Farmers' Heroes' Give a Voice to Besieged Taxpayers," *Washington Post*, May 8, 2001, p. A01. For additional reports of widespread public dissatisfaction with increasing economic difficulties, widespread corruption, and the impotence of the CCP, see Elizabeth Rosenthal, "Beijing Gets a Scolding for Official Corruption, and Applauds," *New York Times*, March 6, 2000, p. A10; "Social Combustion in China," *New York Times*, April 7, 2000, p. A22; John Pomfret, "Party Expels Top Official in Chinese Bribe Case," *Washington Post*, April 21, 2000, p. A17; Erik Eckholm, "Unrest Grows in China's Old State Plants," *New York Times*, May 17, 2000 p. A12; John Pomfret, "Many Chinese Distrust Party's Idea of Reform," *Washington Post*, July 1, 2000, p. A18; Erick Eckholm, "Chinese Find Power Abuse Isn't Limited to the Cities," *New York Times*, December 3, 2000 p. A4; Phillip Pan, "Top Judicial Officials Say China's Corruption Is Deep," *Washington Post*, March 11, 2001, p. A18.

[100] For excellent discussions of many of these risks, see Gordon Chang, *The Coming Collapse of China* (New York: Random House, 2001) and Minxin Pei, "China's Governance Crisis," *Foreign Affairs* 81 (September-October 2002, pp. 96-109). See also Minxin Pei, "Will China Become Another Indonesia?," *Foreign Policy* 116 (Fall 1999), pp. 94-109; Gerry Groot, "Crises in China and Potential Dangers for Asia," in P. Jain, G. OLeary, F. Patrikeeff, eds., *Crisis and Conflict in Asia: Local Regional and International Responses* (Commack, NY: Nova Science Publishers, 2002, pp. 115-136); William H. Overholt, "China's Economic Squeeze," *Orbis* 44 (Winter 2000), pp. 13-33; Arthur Waldron, "The Making of Contemporary China," *Orbis* 46 (Spring 2002), pp. 391-407; Col. Robert Forte and Paul J. Smith, "Executive Summary of the Seminar on 'China's Internal Challenges and Their Implications for Regional Stability,'" Asia-Pacific Center for Security Studies, Honolulu, Hawaii, February 25, 2000, <www.apcss.org/Publications/pub.html>.

[101] Hua, "China's Security Dilemma," p. 3.

[102] Ibid., p. 3.

[103] Kal-Alexander Schlevogt, "China's Western Campaign," *Far Eastern Economic Review* 163 (August 17, 2000), p. 29. See also Segal, "China Changes Shape," pp. 3-72.

[104] For excellent summaries of the Xinjiang separatist movement, see Paul George, "Islamic Unrest in the Xinjiang Uighur Autonomous Region," *Com-*

mentary 73 (Spring 1998), pp. 1-9; P.B. Sinha, "Islamic Militancy and Separatism in Xinjiang," *Strategic Analysis* 20 (June 1997); "Asia: Glimpse of a Troubled Land," *Economist* 351 (May 1, 1999), p. 39.

[105] Susan Lawrence, "Breathing Space," *Far Eastern Economic Review* 163 (June 1, 2000), pp. 17-18.

[106] Zhang, "China's Practice of Nuclear Materials Control," p. 87.

[107] Kenneth Lieberthal, "U.S. Policy Toward China," Brookings Policy Brief, No. 72 (March 2001), pp. 3-4.

[108] Willy Wo-Lap Lam, "China, U.S. boost ties against terrorism," <www.cnn.com>, October 19, 2001; Embassy of the People's Republic of China in the United States, "China, US Reach Consensus on Anti-Terrorism," December 6, 2001, <http://www.china-embassy.org/eng/22013.html>; "What the Presidents Said," <http://www.cnn.com>, October 19, 2001.

[109] Alternatively, it might be possible to expand the Cooperative Threat Reduction program to include countries other than Russia. Richard Lugar, one of the original co-sponsors of CTR Program, has proposed precisely this plan, particularly in order to improve nuclear security in India and Pakistan. (See Kerry Boyd, "India-Pakistan: Analysts Propose to Safeguard South Asian Arsenals," *Global Security Newswire*, March 18, 2002.) But it might be possible to include MPC&A collaborations with China under such a proposed plan as well. Indeed, in some ways, it might be easier to justify expanding CTR to include MPC&A collaborations with China, since these collaborations would not be complicated by risks of condoning the nuclear programs in non-NPT states, as it would with India and Pakistan.

[110] The author would like to thank Wen Hsu for these suggestions.

[111] This was the experience in the U.S.-Russia collaborative programs. After long denying U.S. scientists access to Russia's most sensitive facilities, Russia signed an agreement with the United States in 2001 to open most of its remaining facilities to rapid MPC&A improvements. Following on these provisions, U.S. Department of Energy Secretary Spencer Abraham and Russian Minister of Atomic Energy Alexander Rumyantsev announced an agreement on November 29, 2001 to expand and accelerate efforts to improve Russia's MPC&A. See Matthew Bunn, Oleg Bukharin, and Kenneth Luongo, "Renewing the Partnership: One Year Later," in *Proceedings of the 42nd Annual Meeting of the Institute for Nuclear Materials Management* (Northbrook, IL: INMM, 2001), pp.1-2; and "U.S., Russia to Step-up Efforts to Safeguard Nuclear Materials," pp. 1-2.