EVALUATING CHINA'S MPC&A SYSTEM*

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ABSTRACT

The September 11 large-scale terrorist attack shows the threat of nuclear terrorism is real. Recent seizures of stolen weapons-usable fissile materials (HEU and plutonium) make clear that establishing modern, well-designed nuclear material protection, control, and accounting (MPC&A) systems to secure nuclear material everywhere is critical to prevent against nuclear proliferation and nuclear terrorism. This work will assess the current status of China's MPC&A system, analyze existing regulations and administrative systems, and recommend steps for improvement, including international cooperation.

INTRODUCTION

China began its nuclear industry for defense purposes in the 1950s. Since the 1960s, China has established a complete military nuclear fuel cycle for plutonium and HEU production. Since 1963 China produced HEU at Lanzhou and Heping gaseous diffusion plants (GDP). Both plants stopped HEU production in 1987. It is estimated that both GDPs produced between 15-25 metric tons of HEU.[1] Since the late 1960s, China produced its plutonium at Jiuquan Atomic Energy Complex (closed down in 1984) and Guangyuan plutonium production complex (shut down in 1991). It is recently estimated that China produced between 2 and 5 metric tons of plutonium.[2] Approximately 1 to 2 tonnes plutonium and about 9-13.5 tonnes of weapon-grade uranium could be contained in Chinese about 400 nuclear warheads.[3] Chinese non-weapon uses of HEU and plutonium are very limited. Its nuclear-power submarines are reported to be fueled with LEU.[4] In addition, China is operating two centrifuge enrichment plants at Hanzhong and Lanzhou, which produce LEU for civilian purpose.

Since 1979 China's nuclear industry switched its focus to civilian nuclear power. China's first nuclear power reactor- Qinshan-I went on-line in 1991. Now China is operating three PWRs providing 2.1 GW of nuclear capacity. Another eight reactors are under construction and will be on line before 2005. Since mid 1980s, China planned to use a closed fuel cycle strategy to reprocess the resulting civilian spent fuel.[5] In July 1997 China began construction of a multi-purpose reprocessing pilot plant (50 tHM/a) at Lanzhou. This plant will start operations soon. Moreover, in May 2000 China started construction on the 25 MWe China Experimental Fast Reactor (CEFR), located near Beijing. It will be in commission around 2005. In short, currently China has little use of weapon-usable fissile material for civilian purpose, except a small amount of HEU to fill its several research reactors. Thus, beyond those HEU and plutonium contained in weapons, the remaining China's weapon-usable fissile material could be mainly contained at approximately a dozen of sites including those HEU and plutonium production facilities, nuclear weapon design and production facilities, and some research reactors. Therefore, HEU and plutonium at these facilities should be adequately secured and accounted for.

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CHINA'S MPC&A SYSTEM

From the beginning, China's nuclear materials production and management was strictly controlled by the military sector. After China became an IAEA member in 1984, it has established material control and accounting (MC&A) systems in accordance with IAEA safeguard guidelines (INFCIRC/153) and physical protection system based on INFCIRC/225 recommendations. Until today, nuclear material sabotage and stolen events never had been found in China.[6] Moreover, China has signed a number of international agreements related to fissile material control. In 1988 China signed an agreement (INFCIRC/369) with the IAEA to voluntary place some of its facilities under IAEA safeguards. Currently, China has three facilities under IAEA safeguards: the Qinshan-1 nuclear power reactor, a high temperature research reactor, and a CEP at Hanzhong.[7] In 1989 China acceded to the 1980 Convention on the Physical Protection of Nuclear Material. In 1994, China formulated the "Regulations for Physical Protection of Nuclear Materials in International Transport of the People's Republic of China". In 1998,China signed the Guidelines for the Management of Plutonium that establish requirements for the management and disposition of civil plutonium and other plutonium no longer necessary for defense. China signed an additional protocol with the IAEA in January 1999.

Legal/Regulatory Structure. In 1987, China approved and issued the "Regulations for Control of Nuclear Materials of the People's Republic of China"(1987 "Regulations").[8] China's Ministry of Nuclear Industry (MNI) was authorized to implement the "Regulations". In order to facilitate the implementation of the "Regulations", in 1990 China approved and issued the "Rules for Implementation of the Regulations on Nuclear Materials Control of the People's Republic of China"(1990 "Rules").[9] The China National Nuclear Corporation (CNNC) established on the ground of MNI in 1988 was authorized to implement the "Rules". The State Council charges the CNNC with certain governmental function in the nuclear issues under the name of the China Atomic Energy Authority (CAEA). The National Office for the Nuclear Material Control (ONC) under CAEA was responsible for the control of nuclear material in the concrete. Following the government reorganization begun in March 1998, the CAEA was independent from CNNC. Now the CAEA is responsible for the control of nuclear material for the whole country.[10] ONC under the CAEA is responsible to elaborate the rules and regulations, and specifications for the control of nuclear materials; to exercise nuclear materials control nationwide, establishing the nationwide accounting system of nuclear materials, and to check the accounting balance management, physical protection, and secrecy of the licensee.

The current legal framework for China's MPC&A is based on the 1987 "Regulations" and the 1990 "Rules". As stated, the goal of the "Regulations" are to ensure the safety and lawful uses of nuclear materials; to prevent theft, sabotage, loss, unlawful diversion, and unlawful use; to protect the security of the state and the public; and to facilitate the development of nuclear undertakings. Concrete measures are formulated in the 1990 "Rules". As stated, the "Rules" are applied to the application, renewal, assessment, approval, and issuing of nuclear material license; to accounting for and control of nuclear material, and to the physical protection of nuclear material.

The ONC has adopted a licensing system for control of nuclear material including plutonium, uranium, tritium, and lithium-6. As required, the operator of the nuclear material facilities must apply a "nuclear material license" provided that it holds more than 10 effective grams U-235 or any quantities of plutonium. The accumulated amounts of allocation or production that are less than specified may be exempted from applying licenses, but must be registered. To get the license, the operator must established MPC&A systems met with the regulation guidelines provided by CAEA. After the ONC accepts the application of license, it offers the reviewer comments, and the license is issued after being reviewed and approved by the NNSA for civilian use or the COSTIND (now the new COSTIND) for military use.

The license is valid for three years**.** The ONC will then thoroughly review the practice of the nuclear material control in each facility every 3 years. The ONC is responsible to organize professional experts to inspect nuclear facilities to ensure that effective security and accounting measures for weapons-usable materials are in place.[11] If a facility is found in violation of regulations, it would be punished by warning, penalty, or revoking the license-- depending on the seriousness of the violation. The extent of punishment is effected by one of the followings, e.g. to produce, use, store and dispose of nuclear material without approval or in violation of the provisions of regulations; to make a report not in accordance with the rules or make a false report of facts and information; to reject supervision; to manage not in accordance with rules, thus brings about accident. If accident with a serious consequence occurs, such as, stealing, plundering, sabotaging nuclear material, the juridical organ shall investigate and determine the criminal responsibility according to legislation.

MC&A Measures. As the 1990 "Rules" required, the licensee must establish a material balance system which includes that, the licensee must divide the nuclear facilities into separate material balance areas in according with their respective feature; the balance will be preformed according to the classification of nuclear material, each balance area shall have a complete accounting system and perform the independent material balance. Also, the licensee must establish nuclear material physical inventory procedures with requirements including conducting a complete and strict physical inventories at least once a year and conducting physical inventory for such material as Pu-239, U-233 and HEU at least twice a year; prescribing a closing time for record and report, and conducting physical inventories during the prescribe time; establishing the physical inventory plan and procedures, and supervising in the course of inventory; ensuring the accuracy and reliability of inventory. Moreover, the licensee must establish a record and reporting system, which requires that the record of nuclear material accounting must be clear, accurate, systematic and complete, and must be maintained at least for five years.

Since 1991, the nuclear material accounting forms had been revised in accordance with international standards (see table 1).[12] Moreover, since mid 1990 each facility began to use computer system for material accounting.[13] Recently, China is developing a national computerized accounting system to maintain physical inventory.

Table 1: The main forms used in China for accounting report

Code of form	**Name of form**	**Notation**
NMF-R01	Nuclear Material Transaction Report	Similar to the US DOE/NRC Form-741 (which requests information necessary for documenting and reporting transactions involving nuclear material)
NMF-R03	Nuclear Material Inventory Change Report	Similar to IAEA Form ICR (which provides details of all receipts and shipments of nuclear material in each category)
NMF-R04	Physical Inventory Taking	Similar to IAEA Form PIT **(**which includes a detailed list of nuclear material existing in a facility's inventory at a given point in time)
NMF-R05	Nuclear Material Balance	Similar to IAEA Form MBR (showing the material balance based on a physical inventory of nuclear material actually present in the material balance area)

Physical Protection Measures. China's legal framework incorporated the physical protection standards were based mainly on INFCIRC/ 225. After September 11, China has taken some measures to strengthen physical protections, in particular in its management approach aspects. Moreover, CAEA is

considering to upgrade its MPC&A regulations.[14] China divides its protection requirements for nuclear material into three categories, based on type, quantity, and harmfulness of the nuclear material. These categories are even stricter than that of IAEA guidelines in terms of the limit of material quantity. Based on China's regulation, the fundamental requirement for using and storing nuclear material include: persons designated for access to nuclear material must be examined, and those unqualified persons should be replaced timely; to inspect regularly the implementation of measures, to remove a hidden danger, to stop up the weakness and to ensure security; to report the local public security organ the protection measures of nuclear material and to consult and coordinate emergency programs with the organ; security personnel must be strictly trained, equipped with necessary equipment and instruments, and must quickly interfere, stop the malevolent action, and promptly report in case of sabotage, plunder and theft.

Table 2: Categorization of fissile material and physical protection measures for fissile material at fixed sites

	Categorization of fissile material	**Physical protection measures**
Category I	*2 kg or more unirradiated Pu; *5 kg or more HEU	*At least two complete, reliable physical barriers; vault or special security container for storing Category I nuclear material *The technical protection system with alarm and monitoring installations *24-hour armed guard * Special pass for all people entering the site; Strict control on non-site personnel to access with the procedure of registration, and full time escorted by the site-personnel after access. *Vault is performed by "double men and double lock" system
Category II	*Less than 2 kg but more than 10 g unirradiated Pu *Less than 5kg but more than 1kg HEU *20 kg or more unirradiated U-235 (10% but less than 20%) *300 kg or more unirradiated U-235 (enriched to less than 10%; not including NU&DU)	*Two physical barriers with one is complete and reliable; a "strong room" or "solid container" type storage area *Alarms or surveillance protection equipment provided in vital areas *Armed guards or specially assigned persons watching out day and night *Special pass for all people entering the site
Category III	*10 g or less unirradiated Pu; *1kg or less but more than 10 g HEU *1kg or more but less than 20 kg unirradiated U-235 (10% but less than 20%) *10 kg or more but less than 300 kg unirradiated U-235 (enriched to less than 10%; not including NU&DU)	*One complete and reliable physical barrier *Specially assigned persons for watching or letting nuclear material be placed in security containers

Besides the concrete protection measures for nuclear material at fixed sites (see table 2), the domestic transport of nuclear material has also required some protection measures. For instance, shipments of Category I nuclear material must be accompanied by an armed escort; details with information regarding the route, time, starting point, and arrival point kept secret.

SOME CONCERNS ABOUT CHINA'S MPC&A SYSTEM

Some security experts are concerns about the potential weakness of China's MPC&A system. In general, China's MPC&A system is thought to be similar to Russia's, which in the past depended chiefly on "guards, guns, and gates" instead of application of modern safeguard technologies.[15] The nuclear security crisis in Russia since 1991 has raised concerns that China's MC&A system would be vulnerable to an "insider" threat.[16] Moreover, even China regulates its system in accordance with NPT safeguard guidelines, the NPT safeguards was not designed to prevent thieves who want to steal weapons-usable nuclear material and sell it on the black market.

Indeed, the possible theft of fissile material by an insider cannot be ruled out. The approach of nuclear material control which mainly relies on social controls and the loyalty of workers was very effective in China to prevent insider thieves in the past. However, this situation has changed in recently years. For example, two decades ago the central government strictly controlled the flow of people through the strict registered permanent resident system that made constant surveillance of personnel easily by the public security department. There was relatively little difference of worker's wages at verified fields. The people were encourage to focus on spirit education. All these would lead to low criminal rate and low criminal technique. Since China's economic reforms launched in 1978, however China's society has become more open and market-oriented, which results in a greater flow of people and a bigger gap between the rich and the poor. All these changes would increase the criminal threat and offer more opportunities for theft and smuggling by criminal elements.

Outside terrorist attacks may someday pose another threat to China's nuclear facilities. The terrorist forces of the so-called "East Turkestan", which have close links with international terrorism, have long been recipients of training, financial assistance and support from international terrorist groups. Recently they have created a lot of incidences of terror and violence in China with bomb attacks and assassinations. The possibility that these terrorist forces might attempt to attack nuclear material facilities might not be excluded in the future. Moreover, China's existing physical protection system for nuclear material (possibly based on INFCIRC/225 rev.2) could not be designed to defeat the 911-type threat. In addition, China's physical protection regulations could lack of vulnerability assessments and realistic tests procedures. Indeed, as some Chinese scholars have pointed out, before 1998 the concept of vulnerability analysis of physical protection did not receive attention. As they pointed out, before that time, there was no evaluation and theoretical analysis about physical protection systems. Such physical protection systems "mainly relied on people (especially the PLA or armed police)."[17]

Finally, an effective MPC&A system needs modern equipment and techniques, such as, portal monitors to detect fissile materials or weapons leaving or entering a site, and tamper-indicating seals on nuclear material containers. However, these modern MPC&A techniques would be very expensive. As a developing country, China is focusing on its economic development. Thus, although China could have recognized the importance of the mixed approach combining personnel with techniques, China lacks the resource (including money, appropriate equipment, and techniques) needed for effective security and accounting for all its nuclear material facilities.[18] Also, some analysts are further concerned that China's limited financial resources have often caused it to place safety and security as lower priorities as

compared to other objectives when allocating its financial and personnel resources. In addition, some officials even do not realize the need of stringent MPCA standards ensuring the security of nuclear material because they are satisfied with the current systems that worked well in the past. Moreover, Some scholars are concerned that China's MPC&A regulations could in practice be difficult to be enforced.[19] In particular, the decentralization and pursuit of economic interest could encourage nuclear operators to be unwilling to follow the strict nuclear regulations. Meanwhile, economic reform and the decentralization could decrease the ability of the government control on those nuclear facility operators.

RECOMMENDATIONS FOR IMPROVING CHINA'S MPC&A SYSTEM

China should take necessary steps to develop and install comprehensive, effective, technology-based MPC&A systems ensuring that all its stockpiles of HEU and plutonium are secured and accounted for to standards adequate to defeat the threats it is likely to face. It is recommended here and suggested that the following measures should be taken to improve China's existing MPC&A systems.

Using proven and modern methods and technologies for its MC&A systems. For example, all sites with HEU or separated plutonium should be equipped with portal monitors at every entry/exit point which detect attempts to remove nuclear material. All weapons-usable materials should be stored in containers closed with unique, identifiable, and traceable tamper-indicating seals that would be difficult to break and replace without detection. All areas where weapon-useable fissile materials are stored should be continuously monitored (e.g., with television cameras, motion detectors, and alarms). Each facility doing bulk processing (e.g., fuel fabrication, enrichment, and reprocessing) of weapons-usable materials should conduct detailed and accurate measurements of the material that arrives, the material produced, the in-process inventory, and all of the material lost to scrap and waste. Reliable and accurate measurement methods and equipment for material accounting should be used.

Reexamining and updating its guideline for physical protection for those sites with HEU and plutonium. For example, it should review and upgrade its basis used for designing physical protection for nuclear material facilities to ensure that it reflects the threat as perceived after September11. To protect from outsider attacks, feasible and cost-effective physical protection systems should be developed and used. For example, all sites with weapon-usable fissile material should be equipped with perimeter intrusion detection systems to ensure that any outside attackers entering the protected area would be detected.

Developing vulnerability assessments. A system of regular vulnerability assessment and realistic performance tests should be established to monitor each site's ability to protect itself against the threat it is designed for. For example, such a system of regular vulnerability assessment would be designed to find the weakest points in the security system; to identify the highest-priority and most cost-effective security and accounting improvements that could be made; and to consider whether the security system in place would work successfully against the threat it was designed to counter. Moreover, occasional tests should be conducted to examine whether the security system succeeds in blocking a particular attempted theft.

Trained personnel. To ensure that modern MPC&A systems are actually implemented effectively, trained personnel and the safeguards culture is imperative. China should have regular training programs performed, not only to improve the worker's professional skills, but also to make workers understand that security and accounting for nuclear materials is a matter of the highest national security priority. Moreover, it is necessary to have a program to ensure the reliability of the personnel who will be operating the system, including security screening.

Strengthen cooperation. Insecure nuclear material anywhere is a threat to everyone, everywhere. International cooperation should be strengthened to secure and account for nuclear material anywhere. This is essential to prevent nuclear terrorism and proliferation. To improve China's MPC&A system as quickly as possible, China needs cooperation with countries with advanced MPC&A safeguards and techniques. The US and China conducted a Lab-to-Lab Collaborative Program from 1995 to 1998, which was designed to help create a "safeguards culture" in China by demonstrating the advantages of a modern MPC&A system.[20] The program held several workshops at Beijing on MPC&A techniques and in 1998 a demonstration facility for modern MPC&A technology was installed at the China Institute of Atomic Energy in Beijing, which demonstrated to attending Chinese government and nuclear industry officials how technologies could be integrated in a comprehensive system for protecting nuclear materials. However, the program ceased in the aftermath of the 1999 Cox Committee Report and allegations of Chinese espionage at U.S. nuclear weapons laboratories.

Since September 11, the cooperation between the US and China on fighting against terrorism should provide an opportunity to restart the lab-to-lab program on MPC&A. Since September 11, President Bush has stated that keeping WMD out of terrorist hands is his administration's "highest priority." In his 2003 State of Union address, he pledged: "We will do everything in our power to make sure that day never comes."[21] In practice, the US has begun exploring MPC&A cooperation with other states outside the former Soviet Union, including China, India, and Pakistan.[22]Congress has moved to authorize MPC&A cooperation with any country where it may be needed. Meanwhile, since September 11, the Chinese government stated clearly that, Chinese government fights against all kinds of terrorism including nuclear terrorism. China believes that every government has the duty to protect against nuclear terrorism, and the international community should strengthen the cooperation in activities of anti-nuclear terrorism. As the Chinese official stated, "We looks forward to cooperating with other member states and the International Atomic Energy Agency in the protection against nuclear terrorism."[23] In practice, since the Lab-to-Lab stopped in 1999, China has never given up the chances for international cooperation on nuclear security issues.[24] Recently China have been involved in a number of activities on MPC&A safeguards, including an IAEA workshop held on December 2002 at Beijing discussing approaches to securing nuclear material, in which US experts gave some lectures.

The Lab-to-Lab program between the US and China should take a step-by-step approach starting from less sensitive issues. As a first and an important step, it should initiate a program to train Chinese MPC&A operators, managers, and regulators. This could involve seminars, workshops, and site visits to demonstrate to them the advanced MPC&A techniques and methods. The U.S. government has accumulated invaluable experience (including successes and mistakes) over the last two decades on improving its MPC&A systems. For example, the US has developed techniques for comprehensively assessing the vulnerabilities of security and accounting systems for all its nuclear sites, and then fixing those weaknesses.[25] The US experience should be very helpful to China to quickly modernize its nuclear material security and accounting. Moreover, the program should help China to introduce modern technical standards and norms for improving China's MPC&A system, to develop and apply modern MPC&A techniques and methods, and to establish inspection techniques.

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