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The regulation and technology of Chinese nuclear material accounting

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Abstract

Nuclear security practices have been a part of the development of China's nuclear industry from the beginning, and they remain an important part of nuclear operations. The Chinese government pays close attention to nuclear security and has set up laws and regulations to govern the use of nuclear materials. The companies and operators that use nuclear materials have developed operational manuals and regulations to ensure the protection and control of nuclear materials based on national laws and regulations. These measures explain why there are no reported losses of nuclear materials from Chinese facilities. In light of recent reforms and the "opening" of China, which has increased communication with foreigners and has led to other changes in the international environment, threats to nuclear material security are changing and posing new challenges to Chinese nuclear management. The Chinese government is working to improve regulations to confront these new threats.

Nuclear material accounting is one of the most important parts of nuclear material security. China has set up a nuclear material accounting system to account for nuclear materials, to track material inventories, to report inventory changes, and to help detect unexpected increases or decreases in inventories. This paper analyzes Chinese nuclear material accounting systems and the regulations that guide their implementation, from a technical viewpoint.

Introduction

China developed nuclear weapons in the 1950s and 1960s in direct response to other states' development of nuclear weapons. Chinese leaders believed that nuclear weapons should not be used as tools of war and can only be used to deter other states from using nuclear weapons against China. As such, China also limited its development of nuclear power.

At the time, states primarily developed their domestic nuclear industries in support of military purposes. For both economic and technical reasons, China adopted the policy of "no-first-use" of nuclear weapons, which has restrained Chinese production of nuclear weapons and nuclear materials. Former Chinese leader Zhou Enlai once instructed the leaders of China's nuclear weapons development complex to pay great attention to their work and to not waste money, as the weapons were to be destroyed in the future. Chinese stockpiles of nuclear materials for use in nuclear weapons are small, just large enough to defend Chinese national security.

China has also always opposed the proliferation of nuclear weapons. In a 1984 report, former Premier Zhao Ziyang reiterated the government's stance that China would not participate in the "discriminatory" Nuclear Non-Proliferation Treaty (NPT), but that it "does not advocate nuclear proliferation, nor engage in nuclear proliferation, not helping other countries to develop nuclear weapons."

Chinese nuclear materials management and IAEA safeguards

China's nuclear industry is highly centralized and led by the state. Special government committees make decisions relevant to the industry, and assigned tasks and requests rely primarily on various administrative departments.

During the early development of China's nuclear industry, some major powers imposed a blockade on trade to China and adopted repressive policies; this nearly shut down the industry. Starting in 1978, international cooperation on China's nuclear industry entered a new period of development. As it adjusted its foreign policy, China took a more flexible attitude to the international safeguard system that prevailed globally. In 1984, China become a formal member of the International Atomic Energy Agency (IAEA), and in 1986, China participated in the development of and signed the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency. In September 1988, China and the IAEA formally signed a voluntary offer safeguards agreement ("Agreement of the People's Republic of China and the International Atomic Energy Agency for the Application of Safeguards in China") and submitted a list of nuclear facilities to make available for safeguards. The IAEA currently conducts inspection activities at the Qinshan Nuclear Power Plant, the Tsinghua University HTGR, and the Hanzhong uranium enrichment plant.

To improve its technical capacity to implement safeguards on nuclear materials, China subsequently signed onto a series of international agreements and commitments: In December 1988, it signed the Convention on the Physical Protection of Nuclear Material (CPPNM); on June 22, 1990, China signed a technical assistance agreement with the IAEA; in September 1994, China signed the Convention on Nuclear Safety; in December 1998, China agreed to an IAEA Additional Protocol, which entered into force on March 28 2002; in April 2006, China's acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; and in September 2009, China approved the amendment to the CPPNM.

China also enacted a series of domestic policies and regulations to secure nuclear materials and reinforce its commitment to nonproliferation. In May 1996, China declared that it would not export nuclear technology or otherwise assist foreign nuclear facilities until they were put under IAEA safeguards. In support of this pledge, in September 1997, the Chinese government promulgated new export control regulations, "Regulations of the People's Republic of China on Nuclear Export Control." China maintains a licensing system for nuclear exports and a nuclear export control list that is similar to the generally accepted international nuclear export control list. On November 9, 2006, China's State Council issued Order No. 480, which codified and refined the state export control system. On June 10, 1998, China also promulgated an ordinance on export controls for nuclear dual-use items and related technologies. Nearly a decade later, on January 26, 2007, the State Council issued Order No. 484, which amended the ordinance.

On August 16, 2010, China and the IAEA signed a nuclear security cooperation agreement to develop a China Atomic Energy Authority (CAEA)/ IAEA Joint Training Center with the goal of strengthening nuclear security domestically and globally. The center is meant to promote the implementation of the CPPNM and its amendment, and to support the promotion, translation, and publication of a new series of reports on nuclear security and cooperation. Building on the nuclear security cooperation that preceded the 2008 Beijing Olympics, the center also aimed to strengthen cooperation on the development of regulations and standards for nuclear security broadly defined and for nuclear security at large public events, and to build domestic capacity to implement nuclear security goals and train personnel. In collaboration with the United States, China also established the National Nuclear Security Technology Center, which builds off of Sino-U.S. cooperation on "centers of excellence."

In March 2012, President Hu Jintao attended the Seoul Nuclear Security Summit. At the summit, he reiterated China's comprehensive nuclear security policies and initiatives, and expressed support for the IAEA playing a central role in ensuring nuclear security.

Chinese nuclear material accounting

In 1987, China's State Council promulgated a nuclear material control ordinance that established a relatively complete national nuclear material control system to ensure the safety and security of legitimate-use nuclear materials. The ordinance outlines the scope of a material management and licensing system and determines the responsibilities and basic requirements for government and commercial units that hold nuclear materials.

China's system for nuclear material management includes a licensing system, reporting systems, and an inspection system. On September 25, 1990, the Chinese government issued a document, "Rules for the Implementation of the Regulations on Nuclear Materias Control," which defined the responsibility of the Office of Nuclear Material Management, the responsibility of units licensed to hold nuclear materials, the procedures for applying for such licenses, the basic nuclear material accounting requirements, the hierarchical structure of nuclear materials management, and the corresponding physical protection requirements.

Specific nuclear material control and accounting requirements are based primarily on the "Implementation Details" of the nuclear material control ordinance, which was enacted in 1990. These requirements are necessary to ensure the national interest and law, to guarantee the security of the country and the people, and to ensure national control of nuclear materials. If necessary, the state can expropriate all nuclear material.

The main purpose of nuclear material control and accounting is to detect the loss or theft of nuclear material, to prevent the illegal transfer and illegal use of nuclear material, and to ensure the security of nuclear material. Chinese nuclear material accounting systems require that a facility establish a full-time or designated person to be responsible for the custody of nuclear materials. They also require strict procedures for the handover of those materials from person to person, the establishment of accounting and reporting systems, and for balancing the material accounting books. Nuclear material accounting relies on measurement systems that use approved analytical methods and measurement standards. These are necessary to meet balance error requirements and to maintain nuclear material balances.

Entities that hold nuclear material licenses are required to establish original records for materials under their control and enter them into a reporting system. These records need to be clear, correct, systematic, and complete, and they must be maintained for at least five years. These records include measurements of opening and closing stocks, logs of internal transfers, and dates when materials were input or output from stockpiles. Each licensed entity establishes its own format for recording its statistics, statistical procedures, and internal audit systems, according to the characteristics of their materials and operations. Material custodians are also in charge of maintaining the records for the nuclear material under their supervision.

If the quantity of a nuclear material at a facility is less than the specified limit, the Chinese government does not require the acquisition of nuclear material licenses, but those facilities must

register their nuclear material with authorities. When these materials are transferred or re-transferred, these facilities must complete "transfer of nuclear material" reports. Units that produce nuclear materials but are not registered must also fill out these reports and make known the variety and quantity of their sales.

When establishing a nuclear material accounting system, license holders designate material balance areas according to facility characteristics. Accounting requirements depend on the classification of nuclear material. Each balance area needs to account for all materials within its purview, and personnel within each area should implement material accounting requirements independently. License holders need to conduct physical inventories of nuclear materials within balance areas at least annually. Physical inventories are conducted at least twice annually for specific materials—Plutonium 239, Uranium with an abundance of Uranium 233 or with Uranium 235 in concentrations greater than 20 percent, and other nuclear materials. To fulfill this requirement, license holders need to develop physical inventory plans and work programs.

In order to ensure that a physical inventory is accurate and reliable, operators are expected to: take inventories of materials according to material types and physical-chemical forms; base inventories on measured values; develop strict measures to ensure the integrity of in-process inventories; and measure nuclear material content in waste gasses, waste water, and chemical waste. Measurement systems used in nuclear material accounting are expected to be accurate enough to meet stipulated requirements. The systems are expected to provide accurate data about the nuclear material transceiver, inventory losses, and material balances. Measurement errors should be analyzed, and the reliability of measurement systems should be regularly assessed. This involves maintaining standard materials and standard sources, rules for sample preparation, methods for instrument calibration and measurement, requirements for data and records, and the ability to evaluate statistical processing and errors.

When material accounting records contain material unaccounted for (MUF) greater than two times the standard error, operators are required to keep open the material balance for a given area. This MUF could mean a nuclear material loss, theft, or illegal transfer. In response to such a situation, the accountancy unit needs to evaluate the error of the measurement system and calculate the actual measurement error of MUF. When the results of calculations exceed the limit standard, accounting units are expected to improve analytical measurement systems.

Accountancy officials should regularly evaluate inventory records and the integrity of material items. They should analyze material balances, including transceiver differences and explanations for MUF produced. Changes in physical inventories and changes of morphology should be reported. Officials also need to calibrate and verify measurement systems, and license holders should develop a framework for quality assurance and procedures.

Author bio

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