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Nuclear Security and Nuclear Emergency Response in China

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The rapid expansion of China's nuclear industry poses a security challenge not only for the Chinese government, but also the international community. China's nuclear regulators and nuclear emergency responders face a shortage of human resources and expertise. China's nuclear emergency responders are overwhelmingly focused on nuclear reactor safety issues and have only begun to prepare for acts of nuclear terrorism. While the political leadership is seeking to strengthen nuclear security in light of international attention and the risk that a single incident could pose for future growth, these efforts are complicated by limited inter-agency coordination, an outdated and at times contradictory legal structure, and ambiguities in the division of regulatory responsibilities. This article outlines the major players in Chinese civilian nuclear security and nuclear emergency response, then discusses their responsibilities, plans, and interactions.

INTRODUCTION

The nuclear accidents at Fukushima in early 2011 have dramatically highlighted the vulnerability of nuclear reactors to specific, successive equipment failures. These weaknesses, though made evident by a failure of nuclear safety, are equally applicable to the field of nuclear security.[1] As Duyeon Kim of the Center for Arms Control and Non-Proliferation has observed, "a person with malicious intent and access to nuclear power plants could re-create similar conditions . . . lead[ing] to a meltdown and radiation leaks."[2] The difficulty of nuclear security and nuclear emergency response preparations are particularly magnified in China, where rapid growth of the nuclear industry—a planned

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Table 1: Profile of China's nuclear program.[1] Source: World Nuclear Association

Power Plant	Province	Units	Capacity (ea.)	Entered service
Daya Bay	Guangdong	2	944 MWe	1994
Qinshan I	Zhejiang	1	279 MWe	1994
Qinshan II	Zhejiang	3	610 MWe	2002–2010
Qinshan III	Zhejiang	2	665 MWe	2002–2003
Ling Ao I	Guangdong	2	935 MWe	2002–2003
Ling Ao II	Guangdong	2	1037 MWe	2010–2011
Tianwan	Jiangsu	2	1000 MWe	2007

Note: [1]In addition, China has 27 nuclear reactors in various stages of completion, plans for another 51, and proposals for roughly 150 more. Source: World Nuclear Association, "Nuclear Power in China," 15 September 2011, <http://www.world-nuclear.org/info/inf63.html>.

fourfold increase in installed capacity by 2015[3]—has strained the capabilities of inspectors and regulators[4] (see Table 1).

Recently announced plans to rigorously inspect nuclear reactors in operation and under construction, as well as to freeze approval of new reactors, may begin to address these challenges, but their effectiveness and sustainability remains to be seen.[5]

In light of these challenges and growing international concern about nuclear terrorism, Chinese leaders have made widely publicized commitments to strengthening nuclear security.[6] Industry leaders and the political leadership are well aware that a breach of nuclear security could jeopardize ambitious plans for further expansion. A series of high-profile, high-attendance events across China, such as the 2008 Beijing Olympics, have drawn attention to the need to prevent and respond to nuclear or radiological terrorism. However, China's current nuclear security and nuclear emergency response is primarily centered around existing nuclear power plants, and it is unclear whether local governments in more remote provinces are adequately prepared for acts of nuclear or radiological terrorism, or for accidents as the wave of new reactors comes online. Moreover, Chinese efforts to strengthen nuclear security and nuclear emergency response have been complicated by repeated government reorganizations and a legal system that is at times contradictory.

Despite the bureaucratic competition between national nuclear security organizations and the principal-agent problems inherent in their relationships with the local agencies that implement most nuclear security policy, the challenges to nuclear security in China should not be exaggerated. In general, Chinese nuclear security experts and practitioners at the national level are capable, intelligent, and well-informed about international developments in nuclear security best practices. Nuclear security officials are eager to interact with and learn from their international counterparts. They are keenly aware

of heightened expectations and international scrutiny due to China's increasingly prominent role in the global nuclear industry and, more generally, the international order. At the same time, they expect foreigners to take China's nuclear experience seriously and treat China as an equal partner; in particular, they are sensitive to being portrayed as aid recipients rather than as a responsible nuclear power, and they are reluctant to adopt foreign policy prescriptions without first adapting such policies to fit what they consider to be a uniquely Chinese regulatory system. Finally, interactions with foreigners are not infrequently tinged with a hint of suspicion—Chinese representatives, particularly technical experts and lower-level officials, are wary of disclosing too much about Chinese plans and practices and tend to err on the side of caution.

Little concrete information is currently available about the foundation of nuclear security in China, how it is implemented, and what vulnerabilities may exist. Given recent events, it behooves the international nuclear community to develop a basic understanding of the major players in Chinese civilian nuclear security and nuclear emergency response, as well as their responsibilities, plans, and interactions. Such an understanding is critical to engagement by foreign governments and non-governmental organizations. This article begins by mapping key actors in Chinese civilian nuclear security and placing them in the legal and organizational context in which they operate. On this basis, it outlines the licensing system used to enforce nuclear security requirements. The article then discusses China's nuclear emergency response system. It concludes by highlighting challenges to nuclear security in China and exploring how the international community can facilitate the exchange of best practices between foreign and Chinese nuclear regulators, technical support organizations (TSO), and operators. This discussion is based on extensive research conducted from late 2009 to early 2011 primarily in China, including interviews and interactions with over 40 Chinese representatives of nuclear regulators and operators and close readings of nearly 200 Chinese-language laws and regulations governing the nuclear industry.

Several constraints are imposed by the exploratory nature of the subject. Notably, this article does not attempt a systematic evaluation of or propose an analytical framework for the Chinese nuclear security system's effectiveness, focusing instead on existing plans and how organizational and legal constraints may impede implementation. Nevertheless, it may provide a foundation for further research at the structural, operator, and facility levels. Moreover, this article focuses almost exclusively on civilian nuclear security. While the People's Liberation Army (PLA) has also intensified its focus on and made strides in the field of nuclear security, this article only touches superficially on military nuclear security due to divergence between the implementation of civilian and military nuclear security, a general consensus that Chinese military nuclear facilities and materials do not face the security challenges posed by their civilian counterparts because of the presence of military forces and

the absence of rapid expansion, and the extreme difficulty of obtaining detailed and reliable information on military nuclear security practices in China.

ACTORS IN CHINESE NUCLEAR SECURITY

As in other countries, authority over nuclear security in China is distributed widely across the official bureaucracy. The government, military, and Communist Party all play a role in setting priorities, legislating, regulating, implementing, and enforcing nuclear security. However, continuous restructuring over the past two decades has concentrated most responsibility in the China Atomic Energy Authority (CAEA), the Ministry of Environmental Protection (MEP), and the Ministry of Public Security (MPS). While this ongoing reorganization has in some ways resulted in a more efficiently configured nuclear security system, it has also contributed to short-term lapses in expertise and ambiguity in division of labor, lines of command, and inter-agency coordination—both within the central government and among the military units and local government bureaus that are tasked with responding to nuclear emergencies.[7] The following section offers a simplified overview of the major players; more complex overlaps and interactions are explored in subsequent sections.

It should be noted that military nuclear security is a more complex issue: while the PLA autonomously implements physical security measures for its nuclear weapons and facilities, responsibility for control and accounting of military nuclear materials has been repeatedly transferred among military, government, and corporate entities as a result of organizational restructurings (see below).

National Regulators

The CAEA, the nuclear regulatory body that is formally tasked with managing nuclear materials and security in China, is a semi-autonomous organization under the Ministry of Industry and Information Technology's (MIIT) State Administration for Science, Technology and Industry for National Defense (SASTIND). The CAEA's mandate is broad and includes nuclear material accounting and control (NMA&C), physical protection of nuclear material, nuclear material transportation, nuclear security training, and designating design-basis threats (DBT).[8] However, the CAEA shares authority with other organizations, particularly the MEP. Repeated, major reorganizations have generated some ambiguity in the division of responsibilities. The CAEA grants licenses that allow use of nuclear materials and maintains records for accounting and control of all civilian nuclear materials, based on advice from its technical support organization, the China Institute of Atomic Energy. In addition, it is the lead organization in the State Committee for Nuclear Emergency

Coordination and assists nuclear emergency response efforts through its Nuclear Emergency Response Technical Support Center. The CAEA's current role in military nuclear security is unclear. In its previous incarnations as an arm of the Ministry for Nuclear Industry (MNI)—subsequently privatized as the China National Nuclear Corporation (CNNC)—it was responsible for NMA&C in the military nuclear complex. It retained this role when it was transferred to the military's Commission for Science, Technology, and Industry for National Defense (COSTIND). However, it is unclear whether it retained authority over military NMA&C when COSTIND was split from the military and reorganized as the governmental SASTIND.

Ministry of Environmental Protection

A number of organizations within the MEP bureaucracy participate in Chinese nuclear security and nuclear emergency response. The National Nuclear Safety Administration (NNSA, a relatively autonomous organization nominally administered by the MEP), has primary authority over nuclear and radiological safety—fields which overlap extensively with nuclear security. It oversees most activities at nuclear power plants, as well as all activities involving radioactive material. In the nuclear security realm, it regulates the physical protection of nuclear facilities, designation of design-basis threats, and management of spent fuel. These tasks frequently overlap with those of the CAEA—for example, when nuclear materials (under CAEA authority) are stored at nuclear facilities (under NNSA authority),[9] when NMA&C requirements (CAEA) must be taken into account during facility construction (NNSA), or when spent fuel containing nuclear material (CAEA) poses a radiation hazard (NNSA).

In addition to its looser relationship with NNSA, the MEP also administers six regional inspection stations that inspect nuclear facilities for compliance with nuclear and radiation safety requirements. The MEP also oversees an extensive nationwide network of local environmental bureaus which, among other tasks, provide continuous radiation monitoring near nuclear facilities and play a major role in nuclear emergency response (see Figure 1 and Table 2).

Despite its prominent role, the MEP and its local bureaus suffer from a relative lack of authority as the organization was only promoted to a ministry in 2008.[10]

Ministry of Public Security

The MPS is responsible for countering nuclear terrorism and other malicious activities. It oversees and advises nuclear facility operators on their security plans and systems, and it also manages the People's Armed Police

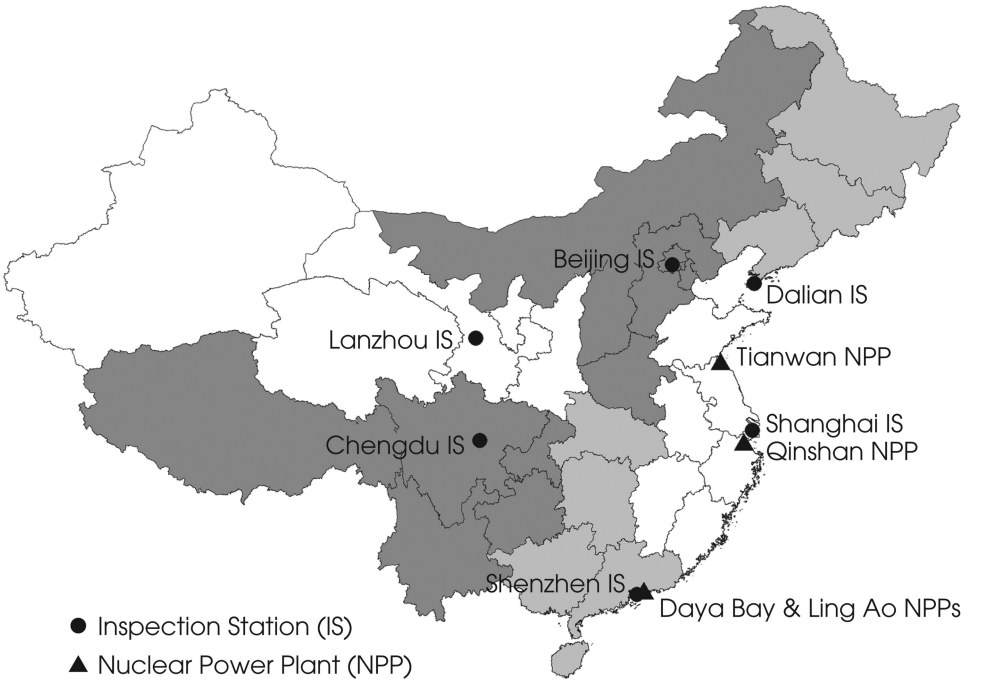

Figure 1: Locations of China's existing nuclear power plants and nuclear inspection stations.

(PAP), which provides on-site armed guards for sensitive nuclear material and facilities as Chinese law prohibits private security forces from bearing arms. Its local public security bureaus play a major role in nuclear security; they are the first (along with local environmental protection bureaus) to be notified of and respond to nuclear security incidents.[11] Local public security bureaus also coordinate with the CAEA to secure transportation routes for nuclear material and with the MEP to secure radioactive materials within their jurisdiction. In

Table 2: Nuclear and radiation safety inspection stations

The six nuclear and radiation safety inspection stations are based in the following cities:
Shanghai: handling Shanghai city and Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong provinces
Shenzhen: handling Hubei, Hunan, Guangdong, Guangxi and Hainan provinces
Chengdu: handling Chongqing City, Sichuan, Guizhou, Yunnan and Tibet provinces
Beijing: handling Beijing city, Tianjin city, and Hebei, Shanxi, Inner Mongolia and Henan provinces
Dalian: handling Liaoning, Jilin and Heilongjiang provinces
Lanzhou: handling Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang provinces

addition, they respond to nuclear security incidents that leave the boundaries of nuclear facilities, help recover missing nuclear or radioactive material with the help of CAEA or MEP, and apprehend and prosecute perpetrators of crimes related to nuclear security.[12] Local public security officers are reportedly barred from entering nuclear facilities, and interviewees have been unaware of mechanisms for coordination with on-site PAP units.[13]

National Coordination and Advisory Bodies

The State Committee for Nuclear Emergency Coordination, which reports directly to China's cabinet-like State Council, manages national-level preparation and response to nuclear incidents, including breaches of nuclear security. It provides a mechanism for inter-agency coordination and manages nuclear emergency training, high-level exercises, assessment of emergencies, and the provision of assistance to on-site responders.[14] The coordination committee is the highest-level body involved in nuclear security and consists of 18 government and military organizations (see Appendix 1). The committee is led by high-level nuclear regulatory and military officials, and brings together all Chinese organizations that would contribute technical expertise or participate in a nuclear emergency response.[15] Committee members provide assistance to local governments in areas such as medical response, emergency traffic controls, radiation monitoring, meteorology, engineering measures, emergency supplies, and equipment in the event of a nuclear emergency. At the same time, the inclusion of the State Council Information Office and the Ministry of Foreign Affairs (MFA) reflects a desire to manage news coverage and the international response to nuclear incidents.[16] The committee is advised by a group of prominent governmental and academic technical experts; its day-to-day operations and support facilities are managed by the CAEA.

Other National Organizations

The People's Liberation Army's chemical defense corps has conducted extensive planning for nuclear emergency response and possesses capabilities that are unlikely to be matched by local responders; once mobilized, it would almost certainly be the largest contributor of response forces.[17] However, because of the military's autonomy from the government, governmental regulations rarely mention a military role in nuclear emergency response, potentially contributing to difficulty in coordination.[18] The Ministry of Health (MOH) is tasked with providing emergency care for radiation sickness during nuclear emergencies, and the planning for these contingencies is conducted in the Office of Health Emergency and the Center for Public Health Emergency. Emergency responders from local health bureaus would likely be the first medical personnel to arrive at the site of a nuclear emergency. The Communist Party

handles reliability assessments and background checks on for prospective employees at nuclear facilities; these activities are likely conducted by its Organization Department.[19]

Local Governments

Local governments, particularly at the provincial level, are theoretically responsible for providing and organizing nuclear emergency response forces. Provinces containing nuclear power plants have established nuclear emergency committees, organizations, and advisory bodies; these groups supervise and conduct regular nuclear emergency exercises and have extensive emergency powers. Smaller administrative units near nuclear power plants, down to county-level local governments, take part in preparations and are tasked with overseeing local public security, environmental protection and health bureaus.[20] These preparations are designed for emergencies at nuclear power plants but can also be adapted to nuclear security incidents. However, Chinese experts readily admit that the plant-centric emergency response system leaves major gaps in preparedness for nuclear incidents that occur elsewhere, such as radiation dispersal devices in densely-populated areas.[21]

Operators

China's two major nuclear operators are China National Nuclear Corporation, which spans the full nuclear fuel cycle, and the China Guangdong Nuclear Power Group (CGNPC), which operates nuclear power plants. Chinese nuclear facility operators and users of nuclear material employ private security forces and, if using sensitive nuclear material, also contract PAP units. To qualify for and retain various operating licenses, operators must conduct regular training, maintain NMA&C and physical protection systems, and formulate emergency plans and conduct regular exercises.[22] Beyond these license requirements, however, operators have limited incentive to strengthen nuclear security: operator liability is capped at 300 million renminbi per incident (roughly $50 million, compared with over $12 billion for U.S. operators). Chinese laws are vague on liability for nuclear terrorism: operators are not responsible for harm caused by hostile action, armed conflict, or riots but would be responsible for the actions of employees (insider threats).[23]

LEGAL BASIS OF NUCLEAR SECURITY AND NUCLEAR EMERGENCY RESPONSE

China, like many countries, has no national laws that are exclusively devoted to nuclear security. Therefore, to understand the legal basis of nuclear security and nuclear emergency response in China, it is necessary to consider a host of

laws and licenses that are not directly targeted at these issues, but touch upon various aspects of nuclear security.

Due in part to the difficulties of securing passage of statutory law (that is, approved by the National People's Congress) in China, the vast majority of nuclear security is handled through administrative law. There are only three statutory laws that touch upon the subject, none of which are directly targeted at nuclear security. The 2007 Emergency Response Law defines general categories for classifying the severity of emergencies (including nuclear and radiological emergencies) and provides specific requirements on how emergency responders should prepare, when and how emergencies of varying severity should be reported to the next level in the chain of command, and how separate command hierarchies should coordinate and cooperate (e.g., by establishing a unified emergency response center).[24] The 2003 Law on Prevention and Control of Radioactive Pollution assigns responsibilities for preventing and responding to a wide variety of events that would release radioactivity (including breaches of nuclear security). For example, the law mandates radiation monitoring by operators and local governments, establishes a restricted zone around nuclear facilities, and importantly, creates a legal mechanism for fines and other sanctions.[25] Finally, the 2001 amendment to the criminal law represents the first time that two key issues, the spread of radioactive materials and participation in terrorist organizations, are explicitly criminalized.[26] The amended criminal law offers detailed guidelines on punishments up to the death penalty for the above and for a host of ancillary activities, including illegal manufacture, trade in, transportation, storage, theft, or seizure of radioactive material as well as hoaxes involving radioactive substances and support of terrorist organizations. The first two laws are recent enough to remain applicable; the third is sufficiently important to be regularly updated in response to major developments such as the 11 September 2001 terrorist attacks on New York City and Washington, D.C.

Administrative laws rank below statutory laws, but they are nevertheless authoritative. These are the primary mechanisms for implementing most key aspects of nuclear security that will be dealt with in subsequent sections, particularly (*a*) China's nuclear safety licensing system for nuclear facilities, including physical protection requirements;[27] (*b*) China's NMA&C system, including licensing and security requirements;[28] (*c*) the nuclear power plant emergency response system;[29] and (*d*) an oversight and licensing system for radioactive isotopes that delineates responsibilities and mandates preparations for radiological emergencies.[30] These laws, with the exception of the last one, are roughly two decades old. The law establishing China's NMA&C system, for example, was written in 1987 and assigns major responsibilities to two organizations that no longer exist. While subsequent departmental rules that elaborate on administrative laws sometimes offer a more recent

perspective, these have more limited authority and a narrower scope than State Council documents. Following major reorganizations, State Council internal documents should theoretically reallocate responsibilities, but this task is not always adequately implemented. One interviewee complained that the MEP is legally obligated to consult with multiple nonexistent organizations and, without a counterpart for dialogue, is forced to make decisions without external input.[31] One representative of a nuclear power plant operator also complained of the difficulty of complying with overlapping and occasionally contradictory requirements set down in the vast number of relevant laws, some of which are long outdated.[32]

Departmental rules of implementation are issued by various ministry level organizations. These elaborate numerous aspects of administrative laws and provide the substance of the nuclear security regulatory structure. Departmental rules specify, for example, the specific actions to be taken at the various levels of nuclear emergency alert or the procedures for transport of spent nuclear fuel. Finally, a host of guidelines, standards and manuals provide technical details and requirements. These are not necessarily legally binding, but noncompliance can be grounds for license denial or revocation. In part because requirements for inter-agency review and consensus are more relaxed when revising rules of implementation, guidelines, standards, and manuals, these are updated more regularly than statutory and administrative laws.

International nuclear security treaties to which China is party, specifically, the Convention on the Physical Protection of Nuclear Material (CPPNM, along with its recent amendment) and the International Convention on the Suppression of Acts of Nuclear Terrorism, occupy an ambiguous place in the Chinese legal system. In practice, treaties to which China is party are regarded as the law of the land, although Chinese reservations apply. Strictly speaking, there is no constitutional basis for this.[33] A number of nuclear security regulations explicitly reference international treaties and some state that treaty obligations take precedence over domestic law.[34] Nevertheless, realistically, it is only after treaty obligations are codified and disseminated domestically in the form of revised laws and regulations that operators, regulators, and local governments are aware of and able to enforce them. For example, China ratified the amended CPPNM in 2008, but the requirements have not been implemented as CAEA has yet to finish drafting new regulations for its implementation.[35]

LICENSING AND INSPECTION SYSTEM

Oversight and control over civilian nuclear security in China is primarily exerted through separate licensing systems for possession of nuclear

material, the safe operation of nuclear facilities, and possession of radioactive material. The license application process seeks to determine whether operators have adequate plans and preparation to handle the responsibility of nuclear/radioactive material use and nuclear facility operation. Once the license is granted, ongoing inspections oversee the implementation of and continued adherence to relevant rules and regulations. However, the mere existence of this oversight mechanism does not imply adequate enforcement; this can only be assessed by thorough on-the-ground investigation.[36]

Nuclear Material License

A nuclear material license from CAEA is required to handle quantities of any of the following, above a low threshold: uranium-235; uranium-233; plutonium-239; tritium; or lithium-6. Nuclear material is divided into three categories depending on quantities and suitability for direct use in nuclear weapons, in line with the CPPNM.[37] For bomb-quantities and qualities of plutonium, highly enriched uranium, and tritium, stringent Category I measures apply. Category I nuclear material (above 2 kilograms of plutonium, 5 kilograms of highly enriched uranium, or 10 grams of tritium) requires strong personnel control and physical protection (both in terms of guards and technical systems). For personnel control, facilities with Category I nuclear material must implement identification checks for entry and exit and strict control of access by non-employees (i.e., visitors must be approved by management, registered, and accompanied by employees). In terms of physical protection, facilities with Category I material must have at least two complete and reliable physical barriers, a completely secure storage room with at least two locks, at least two security personnel at all times (one of which must be an armed guard), an alarm system, monitoring cameras, and additional technical systems. For lesser quantities or less directly usable forms of nuclear materials, standards are substantially relaxed. Category II nuclear material requires identification checks for entry and exit, two physical barriers (only one of which must be complete and reliable), a secure storage room, security personnel or armed guards at all times, and an alarm system or monitoring cameras or other technical systems. Category III nuclear material requires one complete and reliable physical barrier, either a secure storage room or a dedicated watch, and a technical system that rapidly alerts to unauthorized access.[38] The licensing system is intended, among other purposes, to ensure that that nuclear material remains under national control and can be reclaimed at any point.[39] According to one interviewee, all nuclear material is owned by the government and leased to users.[40] Organizations that apply for a license must first designate an individual or unit to oversee safeguards and security; propose a NMA&C system in line with national standards and outline plans for its

implementation, including division of the facility into multiple independent material balance areas; propose a physical protection system after consultation with the local public security bureau; and describe steps that will be taken to maintain secrecy regarding nuclear material stocks.[41] If transfer of nuclear material is required, it is the responsibility of the transferor to verify the nuclear material license of the transferee.[42] The initial application must be submitted six months prior to the first intended use of nuclear materials. In the case of license renewals, application three months in advance is required.[43] Once received by the CAEA, the application is passed to the China Institute of Atomic Energy, which reviews it and recommends approval or denial.

Nuclear Safety License

Separate nuclear safety licenses from the NNSA are required for construction, operation, and decommissioning of nuclear power plants. License review includes physical protection, personnel reliability, and emergency response. The licensing process includes three checkpoints for review of nuclear security preparations.[44] First, reports on the feasibility of candidate sites, including the possibility of "human activities in the area that could endanger the nuclear power plant," must be submitted six months prior to selection.[45] These considered activities include an analysis of aircraft traffic in the area, which provides important planning information in an era in which the impact of terrorist-piloted aircraft into nuclear reactors is a serious concern. Second, the operator's application for a construction permit, containing an initial safety analysis, is evaluated against design-basis threats that constitute an assessment of the greatest adversary against which the operator is expected to defend.[46] While specific design-basis threats are highly classified, one interviewee stated that they can vary between regions due to "socioeconomic factors"—a formulation that can best be interpreted as an oblique reference to social instability, including riots in minority regions and increasingly prominent mass protests.[47] The nuclear safety license approval process is the only phase in which social instability and the activities of non-state actors are considered. Third, operators must apply for a license for initial fuel loading, at which point they must provide a final safety analysis and demonstrate possession of a nuclear material license. Before fuel can be loaded into reactors, operators and local governments must each establish their own nuclear emergency organizations and contingency plans and conduct one off-site combined nuclear emergency exercise under the supervision of the national nuclear emergency organization.[48] After a one-year trial period, operators can apply for a full operating license.[49] Each step may take six to twelve months in order to allow the NNSA adequate time to review, request recommendations, and issue the license.

For nuclear safety license applications, the NNSA is advised by the Nuclear Radiation and Safety Center (NRSC, a TSO), and six regional inspection stations. In addition, these organizations also carry out regular inspections of operating nuclear power plants, including annual reviews of physical protection and emergency response systems as well as unscheduled inspections. Inspections were previously handled by NRSC, but in response to the surge in nuclear power plant construction, the nuclear and radiation safety inspection stations were established in 2006. The personnel allocated to the management and administration of standards and licensing is expected to increase from 160 to 600; the NNSA as a whole will grow from 300 to 1600 within several years. This growth poses a major challenge for the NNSA and its support organizations, which are struggling to recruit experienced operators from higher-paying industry jobs.[50] While the inspection stations are now operational, responsibility for the subfield of nuclear security inspections has remained with NRSC due to understaffing and the sensitivity of the subject; this is expected to change as more inspectors are hired.[51]

Radiation Safety License

A radiation safety license is required for the manufacture, sale, use, or storage of radiation generators or radioisotopes. These licenses do not explicitly consider nuclear security risks such as sabotage, but are nevertheless important because they provide the only mechanism by which the security of radioactive material can be mandated and monitored. License requirements include highly security-relevant issues: physical protection requirements including barriers, alarms and monitoring devices; personnel qualifications such as training and operator licensing; and administrative issues such as a dedicated organization to the material or equipment, systems for classifying and coding radioactive sources, procedures for examination and approval for transfer of material and equipment, record keeping, and emergency plans. Facilities handling high-level (Category I) radioactive material or radiation generators must have a guard, an alarm, and radiation detection equipment at all access points. As part of their license obligations, operators are required to carry out annual security evaluations and carry out regular training and testing of personnel. Licenses must be renewed every five years.

The approval process is handled by the MEP and depends on the type, quantity, and purpose of the material or equipment in question. For high-level radioactive material or powerful radiation generators, the license is granted by the NNSA following review by the NRSC.[52] Some responsibilities are being shifted from the NRSC to the regional inspection stations, although progress is unclear. The NNSA also has authority over outdoor use of radioactive materials and equipment that could cause trans-provincial harm. For all other

material, equipment and applications, licenses are granted by provincial-level environmental protection bureaus.

NUCLEAR SECURITY REQUIREMENTS

Design-Basis Threats and Risk Assessment

Interviewees have been reluctant to provide specifics about nuclear security design-basis threats for nuclear power plants or other nuclear facilities, and what information is provided has at times been contradictory. Nevertheless, Chinese experts have been willing to discuss general guidelines in interviews. Design-basis threats vary regionally depending on a number of factors, including the socioeconomic situation in the surrounding area.[53] Design-basis threats for nuclear power plants are based in part on discussions with local public security officials that provide a baseline threat that the facility must be able to handle.[54] For threats that exceed the design-basis threats, an operator expert on nuclear security stated that the state should be responsible for all damages that occur. The expert stated that heavy weapon attack or deliberate aircraft impact into a nuclear power plant exceeded China's design-basis threats.[55] This is in line with recent reports that China will not revise the design of the Westinghouse AP1000 reactor, which it plans to use as the basis of its expanding nuclear industry, in response to U.S. Nuclear Regulatory Commission concerns about such a scenario.[56] Despite this vulnerability, the interviewee stated that a CGNPC analysis of hypothetical terrorist attacks, including a rocket strike and plane crash, found that the overall risk is low since there was little chance of a nuclear terrorist attack occurring in China, and that any attempt would have little chance of success.

As part of the license-granting process, the various "human activities" in the area that could endanger the facility are classified according to perceived threat level.[57] However, the methodology used is relatively rudimentary.[58] Interviews and official documents also reveal a regulatory culture that is only beginning to acknowledge insider threats. While regulations on nuclear power plant design discuss the need to include "threats caused by operators' actions," the concept of sabotage is entirely absent from extensive lists of potential threats.[59] One interviewee stated that operators tend to trust employees that have passed extensive background checks, but that China has recently had some instances of insider security breaches that have drawn attention to the problem.[60] Incidents that have been privately related to foreigners have been concerning but limited in scope, although more serious cases cannot be ruled out. In one typical account, a disgruntled employee of a nuclear operator hid radioactive material in the office of a coworker, resulting in radiation sickness from long-term exposure.

Nuclear Material Accounting and Control

China's NMA&C system was originally developed in the 1980s when all nuclear activities in the country were controlled by the MNI. The system has since been extensively restructured and has grown substantially more complex. When the ministry was restructured as CNNC, a state-owned enterprise with a monopoly on virtually all nuclear activity in China at the time, it retained oversight over the entire Chinese NMA&C system—a serious conflict of interest. The reorganization also had the peculiar effect of delegating oversight of military nuclear material and research reactor fuel to a nominally corporate entity. While the office with this responsibility has since been split off into an independent regulator (CAEA), some CNNC employees reportedly draw upon old relationships for influence and information.

Uranium mines, ore, and primary products of ore are exempted from nuclear material license requirements, but extractors are subject to oversight from the Ministry of Land and Resources and must meet annual reporting requirements. Users of nuclear materials in quantities below the threshold value are not required to possess a license, but must register with and report regularly to CAEA. For all other uses of nuclear material, a nuclear material license from the CAEA is required. The China Institute of Atomic Energy (CIAE) advises the CAEA on technical issues related to the nuclear material license and the NMA&C system. The license application process takes into account the intended use of the nuclear material, the types and quantities of the nuclear material, procedures for the use of nuclear material, measures for its control, and compliance with other regulations.[61]

License holders are required to divide facilities into nuclear material balance areas in which inflows and outflows are measured, and must have at least one dedicated employee to maintain separate accounts for each type and chemical form of nuclear material. This material must be tracked until it is burned in a reactor, undergoes radioactive decay, is transferred to another organization, or undergoes final disposal. Small quantities of nuclear material lost in industrial processes or waste may also be taken off NMA&C records. To ensure accuracy, license holders are required to measure the nuclear material content of waste gases, liquids, and solids. NMA&C records must be retained for a minimum of five years. These accounting records and measurements are supplemented by annual physical inventories that are conducted at the end of the year.[62] If unaccounted material is found to exceed standard levels by a factor of two, regulations require the operator to report the possibility of loss, theft, or illegal transfer to the CAEA.[63] The CAEA, advised by the CIAE, provides assistance in locating the cause of the discrepancy and formulating a response. Regulations also mandate continuing training of NMA&C personnel to maintain up-to-date qualifications and familiarity with potential changes in procedure.

Physical Protection

Chinese regulations place most of the burden for the physical protection of nuclear materials on operators, who must adopt all reasonable preventative measures to protect against malicious actions that could endanger safety. This is interpreted as prevention of and protection against unauthorized access, intrusion, theft, ground attack and internal or external sabotage of systems related to safety or security, or of nuclear material. Operators must have plans and procedures for the deployment of security forces and other physical protection measures in response to "rapidly occurring, external, man-made developments."[64] In addition, Chinese regulations require that physical protection plans be coordinated with response plans for fires and other emergencies as well as report physical protection measures to local public security bureaus.[65] This is an important consideration since many elements of emergency response, such as rapid access to reactors, must be balanced against the need to restrict entry to sensitive areas. The NNSA also reviews the physical protection of nuclear installations on a continuing basis for changes such as the alterations of entrances.[66]

Much of China's current physical protection system is based on regulations issued following its ratification of the Convention on the Physical Protection of Nuclear Material. China's physical protection principles are also in line with international norms, focusing on the prevention of, delay of, and response to intrusions. The level of required physical protection depends on two separate, three-tiered classification systems: the nuclear material classification level and the nuclear facility classification level.

Category I nuclear material and facilities must be protected by armed guards which, due to Chinese restrictions on private ownership of weapons, requires nuclear power plant operators to contract the PAP for security.[67] According to one interviewee, this service is required because all nuclear material is formally owned by the state.[68] Interviewees emphasized that the jurisdiction of local police does not extend to sensitive nuclear facilities such as power plants; these are exclusively guarded by the PAP. However, they have been unwilling to discuss whether there are special allowances for nuclear emergencies or immediate pursuit.

While Chinese physical protection forces undergo continuing training, they do not utilize on-site force-on-force (live training) exercises to detect potential weaknesses.[69] Indeed, there appears to be a fundamental lack of understanding of nonlethal simulation technology, such as laser engagement systems, that can mimic combat without causing harm to sensitive facilities.[70]

Training

China faces a shortage in nuclear security training programs and intends to build a nuclear security center of excellence to meet rising domestic demand.

Even so, it intends to continue its regional training assistance programs and will dedicate part of this new center of excellence to international nuclear security training.[71]

Transportation

Transporting nuclear material in China requires substantial coordination between operators, transporters, local governments, and ministries. The burden of compliance falls primarily on the transporter, which must seek licenses and permissions from a host of government organizations. The CAEA has a lead role in approving transfers, procedures for secrecy during transport, and emergency response plans of the transporter.[72] The MPS appears to share responsibility for physical protection during transport with the CAEA.[73] The MPS also issues transit permits for the transporter and coordinates with local public security bureaus, including overseeing response plans for an accident in its area.[74] The NNSA is responsible for approving designs for nuclear fuel shipping containers and other safety-related issues.[75] The relevant national authorities over specific modes of transportation (e.g., the Ministry of Transportation, the Ministry of Railways, and the Civil Aviation Administration of China) handle detailed issues such as certification of transport companies and drivers. For international transport of nuclear material, Chinese law explicitly references international agreements, granting them the force of domestic law.[76]

Transporters of nuclear material go through a multistaged process to obtain the necessary permissions. Companies seeking to transport dangerous materials on public roads must have five or more specially licensed vehicles to ensure a minimum level of expertise and discourage rogue operators. Such companies must be specially insured and are required to register with the State Administration for Industry and Commerce. They must also employ specialized drivers, loaders, and escorts.[77] Category I nuclear material must be accompanied by armed guards, which are presumably drawn from the PAP. Detailed regulations govern behavior during transportation of nuclear material: transportation can only commence if all the required equipment is in place and fully functional; personal communications (such as mobile phone calls) are prohibited; secrecy of the intended route must be maintained; no passengers beyond the transportation team are permitted; necessary permits must verified at each stage before transferring material; and guards must be in place during stops and transfers.[78] In the case of rail transport, nuclear material can only be handled at certain facilities with specialized training and systems for loading, physical protection, radiation and fire safety, inspection, and emergency response.

The determination of a transport route is the most complex element of nuclear material transport, requiring coordination with the CAEA for

permission to move the material, the NNSA for safety permits, the MPS for security arrangements and transit permits, and the national transport authority for route approval. Authorities seek to avoid densely populated regions or areas where the public security situation is "complicated."[79] In addition, local transportation bureaus and public security bureaus must approve the route. For Category I and II material, local public security bureaus must be informed of security plans.[80]

EMERGENCY RESPONSE

China's nuclear emergency responders are closely involved with nuclear security and would generally be the first government personnel on the scene of a nuclear security incident. The nuclear emergency system was put into its current form as the result of attention from the Chinese political leadership following the 1986 Chernobyl nuclear accident. Overall, nuclear emergency response is guided by one overarching directive: "be ever-prepared and untiring, proactively seek compatibility [with other responders], have a unified command system, vigorously coordinate [with other responders], protect the public, and protect the environment."[81] Nuclear emergency responders were initially tasked with handling safety-related incidents at nuclear power plants, but focus shifted to security-related incidents at nuclear power plants as a result of the 2001 terrorist attacks in the United States and a newfound recognition that nuclear terrorism has the potential to cause even more damage than nuclear accidents.[82] Now, as China has begun rapid construction of new nuclear power plants in areas that do not have existing nuclear emergency response systems, these areas are developing nuclear emergency response capabilities. The plant-centric approach to nuclear emergency response has, however, been criticized by Chinese experts as insufficiently flexible to respond to other nuclear security threats, such as radioactive dispersion devices.[83] A string of high-profile international events including the 2008 Beijing Olympics and the 2010 Shanghai World Expo has drawn attention to the need for nuclear emergency response mechanisms in areas other than the immediate vicinity of nuclear power plants. While the rapid expansion of nuclear power will in the long term increase the number of provinces with nuclear emergency response structures, it will increase the exposure of relatively inexperienced local governments in the short term. Furthermore, it is unclear whether inland provinces with no active or planned nuclear power plants will be able to organize an effective response to other complex nuclear security incidents, such as terrorist use of radiation dispersal devices, without prior preparation.

Emergency Response Structure

The Chinese nuclear emergency response system is comprised of three tiers: (*a*) national level responders; (*b*) local government level responders (potentially ranging from provinces down to counties); and (*c*) facility level responders. Facility level responders are the first activated in a crisis, and progressively higher levels are activated as the severity of the crisis (as reflected by the emergency classification) escalates. Generally speaking, the Chinese nuclear emergency response system assigns the bulk of the responsibility to local governments and facility operators.

On the national level, the response is led by a specialized national nuclear emergency response committee under the State Council, the State Committee for Nuclear Emergency Coordination, chaired by the CAEA. The four vice chairs of the national committee are the vice ministers of public security, civil affairs, and environmental protection, and the head of the PLA operations command under the General Staff Department; committee members essentially represent all government organizations that could be called upon for expertise and manpower in case of a nuclear emergency. In theory, this committee holds ultimate authority over almost all decisions involving nuclear emergencies.[84] It is supported by a national emergency response organization, which is essentially a department under the CAEA. This organization is responsible for handling day-to-day preparations, coordinating the response of national and local government organizations and communications in times of crisis. In 2010 the government established a nuclear emergency response technical support centre that houses various technical task forces and is intended to provide specialized, in-house expertise on issues such as radiation dispersion modeling.[85] In addition, the national nuclear emergency committee can call on an independent advisory committee of external experts, many of which are drawn from national laboratories and universities. Chinese nuclear security plans largely envision the national government playing a supporting role: monitoring the situation, facilitating communication, and providing technical expertise and advisors as requested by provincial governments. National government organizations are legally obligated to possess the necessary facilities and communication systems to provide command and control during a nuclear emergency and to have stockpiles of relevant equipment and supplies in case the crisis exceeds the abilities of provincial government.[86]

Local government responders fall into two categories: immediate responders from the nearest city or county and more specialized provincial-level responders.[87] To a large extent, the structure of each province's nuclear emergency response system parallels that of the national system. The provinces with or near established nuclear power plants—namely, Guangdong, Jiangsu, and Zhejiang, along with some surrounding areas—have their own nuclear emergency response committees that include leaders from the provincial

environmental protection bureau, the public security bureau, the health bureau, and the greater military region with responsibility for that province. These provincial nuclear emergency response committees are supported by provincial nuclear emergency response organizations and can also draw upon a provincial advisory committee. However, the extent to which these provincial organizations are funded and whether they are dedicated to nuclear emergency response (as opposed to serving multiple functions and only handling nuclear emergency response on a part-time basis) are questions that require much more in-depth research. Within each province, those prefectures and counties in close proximity to nuclear power plants are required to undertake certain preparations and emergency exercises. Certain prefectures and counties may have nuclear emergency response committees and organizations and can handle small nuclear emergencies that extend beyond nuclear facility boundaries. They are also required to prepare certain emergency equipment and plans based on proximity to a nuclear power plant.[88] The bulk of the burden for responses to larger nuclear emergencies falls on provincial governments, which are required to formulate extensive emergency plans and have primary responsibility for command-and-control facilities and communication systems. Provincial governments also manage the mobilization and deployment of nuclear emergency response equipment and supplies from outside the immediately affected area. Provincial governments can call upon the central government for additional assistance if necessary.[89]

The operator's nuclear emergency organization is tasked with drafting emergency response plans and procedures during the facility's construction, establishing a command-and-control system for operator personnel during emergencies, communicating with national and provincial nuclear emergency response organizations, and coordinating with other responders. This organization also maintains maps and records of relevant nuclear emergency facilities, equipment and other capabilities.[90]

Nuclear Emergency Response Training

As the number of nuclear facilities in China grows, the demands on existing training resources are being strained. Representatives of regulatory organizations have privately commented on the challenges of training a growing number of operator personnel and local government responders and have sought international expertise in training methodologies.[91] A planned center of excellence on nuclear security, announced by Hu Jintao at the 2010 Nuclear Security Summit, is intended to help alleviate this pressure.[92] With U.S. support, CAEA is developing a center that will provide training on NMA&C and nuclear material security systems to nuclear site personnel in China and other Asian states. The facility will expand upon existing Chinese initiatives to provide regional training on International Atomic Energy Agency (IAEA) nuclear

safeguards and inspections. Promisingly, plans for the center also include the training of protective forces with realistic exercises, a development which has the potential to significantly enhance China's capabilities in this field.

The national nuclear emergency response organization is responsible for organizing and keeping records on the training (including continuing education) of leaders from central government organizations, the military, and provinces. This includes assessing training needs, formulating curricula, setting annual training plans, and readying resources and facilities. At the national level, relevant personnel in organizations that are part of the national nuclear emergency committee must receive training every three to five years. At the provincial level, a number of nuclear emergency-related actors must undergo emergency response training every one to three years, including the provincial emergency response committee; representatives of the public security bureaus and fire departments; and personnel tasked with consequence assessment and forecasting, radiation monitoring and analysis, communications, evacuation and placement, medical response, pollution clean-up, transportation and logistics, publicity and information, and meteorological forecasts.[93]

In turn, provincial governments are responsible for overseeing and assisting in the training of operator personnel. All operator personnel must receive initial training before the reactor is first loaded as well as subsequent annual emergency response training. Staff in the emergency control centre; nuclear reactor operators; technical support staff; and those tasked with radiation monitoring and assessment, emergency repairs, communications, logistics, publicity, security, and medical response receive additional training.[94]

Nuclear Emergency Exercises

Chinese regulators classify nuclear emergency exercises into several groups: communications, integrated, and combined. Communications exercises simply test equipment and lines of communication between nuclear emergency responders and are the most frequent exercises. Single-unit exercises, or drills, involve only one organization—for example, an operator's emergency repair team, a province's environmental protection bureau, or the Ministry of Health. Integrated exercises, on the other hand, involve multiple organizations at the same level (operator, provincial, or national)—for example, a single province's public security bureau, health bureau, and environmental protection bureau. Integrated exercises are intended to verify and assess response capabilities as well as strengthen cooperation between organizations. Finally, combined exercises require the participation of multiple organizations at multiple levels; these add a level of difficulty to the coordination process. Chinese laws outline reporting and approval processes for various exercises and provide detailed requirements for the frequency of each type of exercise, depending on the responder level (see Table 3).

Table 3: Frequency of nuclear emergency exercises

At the national level:
•Integrated exercises should be held once every 3–5 years. They must be approved by the national nuclear emergency committee and reported to the State Council.
•Single-unit exercises should be held once every 2–3 years. They must be reported to the State Council.
•Communications exercises should be held at least once per year.
At the provincial level:
•Integrated exercises should be held once every 2–4 years. They must be approved by the provincial nuclear emergency response committee and be reported to the national nuclear emergency response organization. However, if they involve evacuating civilians, inter-provincial communications or operations, or military participation, exercises must be approved and coordinated by the national nuclear emergency response committee.
•Single-unit exercises should be held once every 1–2 years. They must be reported to the provincial nuclear emergency response organization.
•Communications exercises should be held at least once per year.
At the operator level:
•Integrated exercises should be held once every 1–2 years. They must be reported to the national nuclear emergency response organization.
•Single-unit exercises should be held at least once per year.
•Communications exercises should be held more than once per year.

Note: Combined exercises are to be held in consideration of practical needs and other issues. They must be approved by the national nuclear emergency response committee and reported to the State Council.

China recently conducted its first national combined exercise, Sacred Shield 2009, simulating a radiation leak at the Tianwan nuclear power plant. The exercise—involving over 150 responders from the CNNC, Jiangsu province's nuclear emergency response organization, the Nanjing military region, and the Beijing nuclear emergency response organization along with 2000 evacuees—provided insight into how an actual crisis might unfold.[95] As might be expected for the first large-scale exercise, organizers reported serious challenges in communication and coordination. Japanese and South Korean observers were invited to Sacred Shield 2009.[96]

Oversight for exercises at nuclear power plants appears to be provided by the NNSA, and other exercises are likely to be overseen by the national nuclear emergency response organization. Operators and provincial governments must submit their plans for nuclear emergency exercises to the national nuclear emergency response organization by the end of March annually.[97] In addition, the operator must hold an initial combined nuclear emergency exercise with the local government before nuclear power plants can receive their first load of fuel.[98] Subsequently, emergency response plans must be upgraded and updated every two years to take into account previous lessons learned.[99]

Classification and Notification of Nuclear Emergencies

Emergency alerts, radiological emergencies, and nuclear emergencies are classified according to separate scales. However, because some IAEA documents have been translated into Chinese and issued as departmental rules without reconciliation with the existing system, Chinese regulations on the subject are at times contradictory.[100] Chinese-formulated regulations are more commonly referenced and may supersede translated IAEA documents, but the ambiguity could potentially lead to confusion during crises.

Local governments are given wide latitude to declare alerts and early warnings based on radiation data collected by local environmental protection bureaus or information reported by other organizations, including facility operators. Blue alerts, the lowest level, can be issued by county governments; yellow alerts can be issued by prefecture governments; orange alerts can be issued by provincial governments; and red alerts can be issued by provincial governments after receiving State Council approval. Because emergency alerts are so closely tied to the rank of the local government, operators and responders have the ability to break protocol and report directly to higher-ranked local governments if necessary.[101]

Actual declarations of emergency status are governed by a set of more stringent guidelines. Radiological incidents fall under the wide-reaching environmental emergency system, rather than the separate nuclear emergency system. An incident is classified as a "normal" (Category IV radiological emergency) if it involves the loss, theft, or loss of control of low level (class IV–V) radiation sources or if people are exposed to radiation above their annual exposure limits. The classification changes to a "large" (Category III) radiological emergency for medium-strength (class III) radiation sources or if up to nine people suffer severe radiation poisoning. These are handled at a local level where possible. If a high-strength (class I–II) radiation source is lost, or if over ten people suffer severe radiation poisoning, or if up to two people die, the provincial environmental protection bureau must be notified within an hour; the province then declares a "severe" (Category II) radiological emergency and MEP must notify the State Council. If the high-strength radiation source has caused (or has the potential to cause) large-scale harm, three or more deaths, or environmental contamination, a "very severe" (Category I) radiological emergency is declared. Operators must report directly to the MEP within one hour. The provincial government immediately activates its environmental emergency command centre, issues a warning to the affected area, establishes a restricted-traffic zone, and deploys provincial experts on-site to provide advice and guidance to local responders. The national advisory committee is contacted for expert analysis, and the national environmental emergency command centre can also be activated if requested.[102]

Nuclear emergencies are classified according to a separate scale. "Localised" incidents contained to a single area within the nuclear facility are

handled by the operator's nuclear emergency response organization. The provincial nuclear emergency response centre is placed on standby, and the national nuclear emergency organization is notified. If the incident expands to a "site-wide" nuclear emergency, members of the provincial nuclear emergency response committee activate the provincial response centre, and the national nuclear emergency response centre is put on standby. Non-essential site personnel are evacuated, and peripheral radiation monitoring is intensified. If the extent of the contamination extends beyond facility boundaries, the facility operator recommends that the provincial committee declare an "off-site" nuclear emergency. The provincial committee must generally seek permission from the national committee, although the province can declare an off-site emergency in dire straits. If needed, the operator and provincial government can request national assistance in radiation monitoring, meteorology, consequence evaluation, engineering assessments, medical assistance, or traffic management. At this stage, the provincial government notifies surrounding provinces if there is potential harm. Finally, if the emergency crosses provincial borders or affects major transportation corridors, the national nuclear emergency response organization can declare a "national" emergency with the approval of the national committee. National nuclear emergency response committee members coordinate with PLA headquarters to execute emergency response plans, activate facilities and communication systems, deliver equipment, and distribute supplies.[103] Perhaps in an indication of China's past focus on nuclear accidents rather than malicious activity (or perhaps due to the sensitive nature of such plans), similarly explicit guidelines for the theft or loss of nuclear material are not available, at least in the public domain.

Preparation and Response

After a nuclear security incident, emergency responders have a predefined and prioritized set of tasks to carry out. Responders seek to first rescue and evacuate people; quickly control the situation by sealing the area and controlling traffic flow; conduct emergency repairs to the necessary infrastructure; restrict access to emergency response control facilities and equipment to ensure their availability for responders; and prohibit gatherings or other activities in case the situation worsens. Provincial governments are granted wide latitude under emergency laws to carry out these tasks and, if necessary, borrow resources, equipment, facilities and tools from surrounding areas. Where applicable, emergency responders are trained to organize citizens to assist in the response through simple tasks such as the distribution of supplies. They seek to establish secure food, water, and fuel supplies, potentially a major challenge if radioactive contamination is extensive. This may include steps to stabilize markets and prices. Finally, responders seek to prevent recurrence of the emergency.[104]

CONCLUSION

The body of laws and regulations governing China's nuclear industry is extensive and covers more or less all of China's international nuclear security obligations. However, it is convoluted and at times outdated. The difficulty of issuing and revising laws in China means that older laws are generally not updated. While changes in policy are reflected in more recent departmental rules and technical guidelines, this can also lead to small-scale internal inconsistency and a large number of potentially conflicting documents.

The Chinese government's tendency to restructure bureaucracies in order to reflect new priorities or to improve effectiveness has had mixed results in the nuclear security arena. The redistribution of nuclear security responsibilities has not always been clearly defined, conflicting relationships between regulators and operators have been created and key participants in inter-agency coordination meetings have been eliminated. While such reorganizations undoubtedly have their benefits, they have also contributed to some confusion in the nuclear security establishment.

At the same time, growth of the nuclear industry has created a serious shortage of adequately trained operators, regulators, inspectors, and emergency responders. China is rapidly expanding its training capabilities, but the government has struggled to compete with better-paying private-sector nuclear power plant operators on the job market.

Finally, China's nuclear emergency response system is almost entirely focused on a small number of provinces containing nuclear power plants. In these areas, provincial governments are required to conduct extensive preparations for potential mishaps. Farther inland provinces far from existing nuclear power plants, however, are not subject to these requirements. The central government places the burden for nuclear emergency response on provincial governments and does not maintain a major centralized nuclear emergency force; the structure of this system means that China may be ill-prepared for acts of nuclear terrorism in areas far from nuclear power plants. While the construction of nuclear power plants in new areas has led to a broadening of the nuclear emergency response system's coverage, it also poses a challenge in terms of training and conducting emergency exercises with relatively inexperienced responders.

Chinese nuclear security experts freely admit that China can learn from the international community in many aspects of nuclear security. At the same time, they are reluctant to disclose potentially sensitive information and tend to err on the side of caution. They are particularly wary of engaging on issues that they interpret as political and are reluctant to engage directly with foreign government representatives in settings that appear official. As a rule of thumb, while officials at regulatory organizations such as the CAEA and the NNSA may be willing to engage bilaterally with their direct counterparts, it

will prove more difficult to establish initial contact with technical experts at institutions such as CIAE and NRSC without working through intermediaries such as World Institute of Nuclear Security or the International Atomic Energy Agency. Chinese nuclear security experts expect China to be treated with respect for its national security sensitivities and its experience in managing a large nuclear industry. In areas such as joint research and nuclear security assistance to third countries, China expects to be treated as a partner on par with other states with advanced nuclear power industries.

China's willingness to discuss international cooperation in nuclear security depends to an extent on how the subject is approached. First, when broaching sensitive issues, foreign nuclear security experts should initially discuss their own national experiences in a general manner that demonstrates that it is possible to discuss sensitive issues without revealing potentially classified details. Second, foreign experts should not only seek to share Western best practices but accept that China's approach may be just as effective. International partners must keep in mind that Chinese nuclear security experts are sensitive to being portrayed as aid recipients rather than equal partners. Third, Chinese experts are more responsive to discussions of common threats and general principles, rather than specific policy prescriptions. This allows Chinese experts to digest information and devise a nuclear security system "with Chinese characteristics."

China is keen to benefit from international expertise in nuclear emergency consequence evaluation, nuclear emergency exercises, and nuclear waste transportation and management. Engagement in these fields is likely to establish relationships that may carry over into other elements of nuclear security. In addition, China seeks to cooperate with international partners in nuclear security training for countries with nascent nuclear industries as well as in technical nuclear security research. At the same time, there are also fields in which cooperation must be carefully managed, if it is at all possible. While Chinese experts seek to learn more about foreign approaches to nuclear technology security and cybersecurity, they are reluctant to discuss Chinese methods even in general terms. Regulators are also unwilling to consider international assistance in revising nuclear security laws. Finally, Chinese nuclear security experts are cynical about, if not suspicious of, international nuclear forensics data-sharing. Despite these reservations, however, China is aware of heightened international expectations given its place in the global nuclear industry, and it is generally eager to engage with the international nuclear security community.

NOTES

1. This article adheres to the IAEA definition of "nuclear security": "prevention and detection of, and response to, theft, sabotage, unauthorised access, illegal transfer,

or other malicious acts involving nuclear material, other radioactive substances, or their associated facilities." IAEA, 5th meeting of Director General's Advisory Group on Nuclear Security (AdSec), 1–5 December 2003. It excludes Chinese nuclear nonproliferation and export control, both of which have been addressed extensively elsewhere. The term "nuclear emergency response" is understood to refer to preparedness for a wide variety of nuclear and radiological emergencies ranging from general emergencies at nuclear power plants to emergencies involving lost, stolen, or found radioactive material, consistent with IAEA, "Arrangements for Preparedness for a Nuclear or Radiological Emergency Safety Guide," GS-G-2.1, (2007).

2. Duyeon Kim, "Fukushima and the Seoul 2012 Nuclear Security Summit," *Bulletin of the Atomic Scientists*, 18 March 2011, <http://www.thebulletin.org/web-edition/op-eds/fukushima-and-the-seoul-2012-nuclear-security-summit>.

3. National People's Congress, "国民经济和社会发展第十二五年规划" [12th Five-year Plan for National Economic and Social Development], 14 March 2011.

4. TSO nuclear safety expert, interview with author, October 2010; high-level nuclear safety official, interview with author, September 2010.

5. "温家宝听取应对日本福岛核电站核泄漏有关情况汇报" [Wen Jiabao briefed on Fukushima nuclear power plant leak], *Xinhua*, 16 March 2011, <http://news.xinhuanet.com/politics/2011-03/16/c_121195881.htm>.

6. Hu Jintao, "Join Hands to Meet Nuclear Security Challenge and Promote Peace and Development" (paper presented at the Nuclear Security Summit, Washington, D.C., 13 April 2010).

7. Nuclear safety technical expert, interview with author, October 2010.

8. Design-basis threats constitute the greatest contingency for which operators must prepare. The state bears responsibility for handling threats beyond DBT, such as armed conflict.

9. In this case, the most stringent physical protection requirements would take precedence (e.g., if Category II nuclear material were stored at a Category I facility, CAEA requirements would hold)—although both organizations could send inspectors to verify compliance.

10. In announcing the promotion, state media quoted a local environmental official as saying, "The elevation is surely a good thing, but when it comes to grassroots level, enhancement of authorities in environmental protection would not be that easy." *Xinhua*, "China Upgrades Environmental Administration to Ministry," 11 March 2008, <http://news.xinhuanet.com/english/2008-03/11/content_7766369.htm>. Indeed, Li, Miao, and Lang note that "Sub-provincial Environmental Protection Bureaus (EPBs) remain institutionally weak and find it difficult to act independently of the pervasive influence of development-minded cadres and officials." Yu-wai Li, Bo Miao, and Graeme Lang, "The Local Environmental State in China: A Study of County-Level Cities in Suzhou," *China Quarterly* 205 (2011): 115–132.

11. National People's Congress, "放射性污染防治法" [Prevention and Control of Radioactive Pollution], 28 June 2003.

12. MPS, "关于加强放射性物品安全管理严防被盗,散失的通知" [Communication on Strengthening the Security Management of Radioactive Substances to Prevent Theft or Loss], Notice No. 76, 8 August 1990; COSTIND, MPS, Ministry of Transport, and Ministry of Health, "核反应堆乏燃料道路运输管理暂行规定" [Interim Rules on Road Transport of Spent Nuclear Fuel], Law No. 520, 2003; high-level corporate official, Beijing, interview with author, December 2010; high-level nuclear safety official, Beijing, interview with author, December 2010; NNSA, Ministry of Energy, and COSTIND, "核材料管制条列实施细则" [Implementation Rules for the Law on Nuclear Material

Control], Law No. 129, 25 September 1990; and State Commission Office for Public Sector Reform, "关于放射源监管部门职责分工的通知" [Communication on the Division of Responsibilities among Regulators of Radioactive Sources], Law No. 17, 8 December 2003.

13. Nuclear security official, interview with author, October 2010; and nuclear emergency response official, interview with author, October 2010.

14. Commission for Science, Technology, and Industry for National Defense (COSTIND), "核电厂核事故应急培训规定" [Rules on training for nuclear power plant nuclear emergency response], Law No. 449, 24 July 2001.

15. State Council General Office, "关于调整国家核事故 应急协调委员会组成单位及其成员的通知" [Communication on adjustment of constituent organizations and members of the State Committee for Nuclear Emergency Coordination], Communication No. 87, 19 December 2003.

16. Corporate nuclear security expert, interview with author, March 2010; and nuclear emergency response official, interview with author, October 2010.

17. Li Huacheng [李华成], Zhou Huasheng [周华胜], and Li Dongwei [李冬伟], "浅谈武警防化兵分队对核与辐射恐怖事件的处置" [Introduction to the Handling of Nuclear and Radiological Terrorism Events by Armed Chemical Defence Units], 辐射防护通讯 [Radiation Protection Bulletin], vol. 1, 2006.

18. State Council, "核电厂核事故应急管理条列" [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

19. Nuclear security official, interview with author, October 2010

20. State Council, "核电厂核事故应急管理条列" [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

21. Pan Ziqiang [潘自强], Ye Changqing [叶常青], and Chen Zhuzhou [陈竹舟], 核与辐射恐怖事件管理 *[Management of Nuclear and Radiological Terrorism Incidents*] (Beijing: Science Press, 2005).

22. National People's Congress, "放射性污染防治法" [Law on the Prevention and Control of Radioactive Pollution], 28 June 2003; State Council, "放射性同位素与射线装置安全和防护条列" [Law on Safety and Protection of Radioactive Isotopes and Radiation Generators], Order No. 449, 31 August 2005; State Council, "核材料管制条列" [Law on Nuclear Material Control], 15 June 1987; State Council, "民用核设施安全监督管理条列" [Law on Safety Oversight and Management of Civilian Nuclear Facilities], 29 October 1986; NNSA, Ministry of Energy, and COSTIND, "中华人民共和国核材料管制条列实施细则" [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

23. State Council, "国务院关于核事故损害赔偿责任问题的批复" [State Council Response on the Issue of Responsibility for Compensation for Damages in Nuclear Incidents], Communication No. 64, 30 June 2007.

24. National People's Congress, "突发事件应对法" [Emergency Response Law], 30 August 2007.

25. National People's Congress, "放射性污染防治法" [Law on the Prevention and Control of Radioactive Pollution], 28 June 2003.

26. National People's Congress, "刑法" [Criminal Law], third revision, 3 December 2001.

27. State Council, "民用核设施安全监督管理条列" [Law on Safety Oversight and Management of Civilian Nuclear Facilities], 29 October 1986.

28. State Council, “核材料管制条列” [Law on Nuclear Material Control], 15 June 1987.

29. State Council, “核电厂核事故应急管理条列” [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

30. State Council, “放射性同位素与射线装置安全和防护条列” [Law on Safety and Protection of Radioactive Isotopes and Radiation Generators], Order No. 449, 31 August 2005.

31. TSO nuclear safety expert, interview with author, October 2010.

32. Corporate nuclear security expert, interview with author, March 2010.

33. Chen Guangzhong [陈光中], “‘公民权利与政治权利国际公约’与中国人权法制建设” [“International Treaties on Civil Rights and Political Rights” and the Establishment of the Chinese Human Rights Law], 中国法学网 [China Legal Science Online], <http://www.iolaw.org.cn/showArticle.asp?id = 2356>.

34. Military nuclear expert, interview with the author, March 2010.

35. Of course, China is not yet bound by the amendment’s requirements, since the amendment has not entered into force. Nuclear security official, interview with author, October 2010; and Huang Wei, “Ratification and Implementation of Amendment to CPPNM in China,” CAEA presentation at IAEA, 18 November 2010, < http://www-ns.iaea.org/downloads/security/cppnm/reg-infr-process-china-huang.pdf>.

36. In research conducted for this article, regulatory officials—understandably—declined to provide such an assessment. Evaluation of the effectiveness of oversight and comparison to other countries are the logical next steps in understanding China’s nuclear security, although there are formidable challenges to conducting such research in China.

37. For an excellent account of China’s physical protection, Material Protection, Control, and Accounting (MPC&A), and nuclear material transport practices, as well as nuclear material threshold values and accompanying physical protection requirements, see Yun Zhou, “The Security Implications of China’s Nuclear Energy Expansion,” *Nonproliferation Review* 17: 2 (2010), 347–363.

38. NNSA, Ministry of Energy, and COSTIND, “中华人民共和国核材料管制条列实施细则” [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

39. State Council, “核材料管制条列” [Law on Nuclear Material Control], 15 June 1987.

40. Nuclear security official, interview with author, October 2010.

41. Nuclear safety official, interview with author, March 2010.

42. NNSA, Ministry of Energy, and COSTIND, “中华人民共和国核材料管制条列实施细则” [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

43. NNSA, Ministry of Energy, and COSTIND, “中华人民共和国核材料管制条列实施细则” [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

44. NNSA, “核电厂安全许可证件的神情和颁发” [Nuclear Power Plant Safety License Application and Issuance], Implementation Rule for Law on Safety Oversight and Management of Civilian Nuclear Facilities, 31 December 1993.

45. Author’s translation. NNSA, “核电厂厂址选择安全规定” [Safety Rules on the Selection of Nuclear Power Plant Sites], Order No. 1, 27 July 1991.

46. The preliminary review covers design principles, design basis threat, identification of protected targets, a chart of physical protection arrangements, physical barriers, access control, perimeter detection and alarm systems, the central alarm station, and communication systems. Regulator and nuclear safety expert, interview with author, October 2010.

47. Nuclear security official, interview with author, March 2010.

48. The final review spans security plans, the security organization, design and measures for physical protection during construction, a list of protected facilities, security personnel selection and training programs, maintenance of physical protection equipment, emergency response strength, and testing of the physical protection system.

49. NNSA, "核电厂安全许可证件的神情和颁发" [Nuclear Power Plant Safety License Application and Issuance], Implementation Rule for Law on Safety Oversight and Management of Civilian Nuclear Facilities, 31 December 1993.

50. Growth plans are from 2010 to 2013. NNSA is seeking to recruit operators with at least two years of experience in nuclear power plants. TSO nuclear safety expert, interview with author, Beijing, 14 October 2010.

51. High-level nuclear safety official, interview with author, December 2010.

52. Radioactive material is classified into five categories; radiation generators are classified into three categories. NNSA grants licenses for Category I radioactive material and Category I radiation generators. State Environmental Protection Administration, "放射性同位素与射线装置安全许可证管理办法" [Management Measures for Radioactive Isotope and Radiation Generator Safety Licenses], Order No. 31, 30 December 2005.

53. Nuclear security official, interview with author, October 2010; and TSO nuclear safety expert, interview with author, October 2010.

54. High-level nuclear safety official, interview with author, September 2010.

55. Corporate nuclear security expert, interview with author, October 2010.

56. However, there appears to be some ambiguity, since Chinese rules on nuclear power plant siting state that "design-basis threats related to plane crashes must include impact, fire, and explosion." The discrepancy may stem from varying aircraft or direction of impact considered in threat scenarios. NNSA, "核电厂厂址选择安全规定" [Safety Rules on the Selection of Nuclear Power Plant Sites], Order No. 1, 27 July 1991; and Hibbs, M., "Pakistan Deal Signals China's Growing Nuclear Assertiveness," Carnegie Endowment Nuclear Energy Brief, 27 April 2010, <http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=40685>.

57. Chinese laws and regulations do not specifically reference terrorism or actions by non-state actors. For example, see NNSA, "核电厂厂址选择安全规定" [Safety Rules on the Selection of Nuclear Power Plant Sites], Order No. 1, 27 July 1991.

58. TSO nuclear security technical expert, interview with author, September 2010.

59. NNSA, "核1160;力1378;设计安全规定" [Nuclear Power Plant Design Safety Rules], Law No. 81, 18 April 2004.

60. Nuclear security official, interview with author, September 2010.

61. TSO nuclear safety expert, interview with author, October 2010.

62. Inventories are held biannually for users of plutonium-239 or highly-enriched uranium (with a combined enrichment of uranium-233 and -235 of over 20 percent. NNSA, Ministry of Energy, and COSTIND, "中华人民共和国核材料管制条列实施细则"

[Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

63. Chinese NMA&C regulations define MUF as the stored quantity at beginning of accounting period, plus measured inflows, minus the stored quantity at end of accounting period, minus outputs, minus known losses.

64. NNSA, "核动力厂运行安全规定" [Nuclear Power Plant Operation Safety Rules], Law No. 81, 18 April 2004.

65. NNSA, Ministry of Energy, and COSTIND, "中华人民共和国核材料管制条列实施细则" [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

66. NNSA, "2009 Annual Report," <http://english.mep.gov.cn/standards_reports/nuclearsafetyAR/AR2009/201101/P020110105325549842424.pdf>.

67. Yun Zhou, *op. cit*.

68. Nuclear security official, interview with author, October 2010.

69. Nuclear security official, interview with author, October 2010; and TSO nuclear safety expert, interview with author, October 2010.

70. TSO nuclear safety expert, interview with author, October 2010.

71. Nuclear security official, interview with author, October 2010.

72. COSTIND, MPS, Ministry of Transport, and Ministry of Health, "核反应堆乏燃料道路运输管理暂行规定" [Interim Rules on Road Transport of Spent Nuclear Fuel], Law No. 520, 2003.

73. NNSA, "2009 Annual Report," <http://english.mep.gov.cn/standards_reports/nuclearsafetyAR/AR2009/201101/P020110105325549842424.pdf>; and COSTIND, MPS, Ministry of Transport, and Ministry of Health, "核反应堆乏燃料道路运输管理暂行规定" [Interim Rules on Road Transport of Spent Nuclear Fuel], Law No. 520, 2003.

74. COSTIND, MPS, Ministry of Transport, and Ministry of Health, "核反应堆乏燃料道路运输管理暂行规定" [Interim Rules on Road Transport of Spent Nuclear Fuel], Law No. 520, 2003.

75. NNSA, "2009 Annual Report." <http://english.mep.gov.cn/standards_reports/nuclearsafetyAR/AR2009/201101/P020110105325549842424.pdf>.

76. NNSA, "核电厂放射性废物管理安全规定" [Nuclear Power Plant Radioactive Waste Management Safety Rules], Order No. 2, 29 August 1991.

77. State Council, "道路运输条列" [Road Transportation Law], Order No. 406, 30 April 2004.

78. NNSA, Ministry of Energy, and COSTIND, "中华人民共和国核材料管制条列实施细则" [Implementation Rules for the Law on Nuclear Material Control], Law No. 129, 25 September 1990.

79. COSTIND, MPS, Ministry of Transport, and Ministry of Health, "核反应堆乏燃料道路运输管理暂行规定" [Interim Rules on Road Transport of Spent Nuclear Fuel], Law No. 520, 2003.

80. NNSA, Ministry of Energy, and COSTIND, "中华人民共和国核材料管制条列实施细则" [Implementation Rules for the PRC Law on Nuclear Material Control], Law No. 129, 25 September 1990.

81. "常备不懈,积极兼容,统一指挥,大力协同,保护公众,保护环境." Author's translation. State Council, "核电厂核事故应急管理条列" [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

82. Nuclear emergency response official, interview with author, October 2010.

83. Pan Ziqiang [潘自强], Ye Changqing [叶常青], and Chen Zhuzhou [陈竹舟], 核与辐射恐怖事件管理 [Management of Nuclear and Radiological Terrorism Incidents], (Beijing: Science Press, 2005).

84. In practice, it is likely that top political leaders will feel the need to assert their authority in times of crisis, as was demonstrated in the 2008 Sichuan earthquake. One nuclear emergency response official stated that this intervention, along with the ensuing breakdown of command-and-control plans, was the greatest fear of nuclear emergency responders. Nuclear emergency response official, interview with author, October 2010.

85. Nuclear emergency response official, interview with author, October 2010.

86. State Council, "核电厂核事故应急管理条列" [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

87. In the nuclear emergency response context, local governments (地方政府) include provincial-level (省级), prefectural-level (地级), and county-level (县级) governments. It excludes governments at the township-level (乡级) and below.

88. Out to a 3–5 km radius, local governments must prepare fallout shelters, iodine stocks, and evacuation plans. Out to a 7–10 km radius, local governments are subject to the same requirements, but requirements for evacuation plans are less stringent. Out to a 30–50 km radius, local governments must have plans for emergency food and water supplies. State Council, "国家核应急预案" [National Nuclear Emergency Plans], 24 January 2006.

89. State Council, "核电厂核事故应急管理条列" [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

90. NNSA, "核电厂应运单位的应急准备和应急响应" [Nuclear Emergency Preparations and Nuclear Emergency Response of Nuclear Power Plant Operating Organizations], 12 May 1998.

91. TSO nuclear safety expert, interview with author, October 2010; and nuclear security official, interview with author, October 2010.

92. Nuclear security official, interview with author, October 2010.

93. COSTIND, "核电厂核事故应急培训规定" [Rules on Training for Nuclear Power Plant Nuclear Emergency Response], Law No. 449, 24 July 2001.

94. COSTIND, "核电厂核事故应急培训规定" [Rules on Training for Nuclear Power Plant Nuclear Emergency Response], Law No. 449, 24 July 2001.

95. CAEA, "我国首次核事故应急演习'神盾-2009'成功举行" [China Successfully Holds First Nuclear Incident Response Exercise, "Sacred Shield 2009"], 10 November 2009, <http://www.caea.gov.cn/n16/n92022/n92037/n92067/96385.html>.

96. CAEA, "我国首次核事故应急演习'神盾-2009'成功举行" [China Successfully Holds First Nuclear Incident Response Exercise, "Sacred Shield 2009"], 10 November 2009, <http://www.caea.gov.cn/n16/n92022/n92037/n92067/96385.html>; and CAEA nuclear emergency response official, interview with author, Brussels, 22 October 2010.

97. COSTIND, "核电厂核事故应急演习管理规定" [Nuclear Power Plant Nuclear Incident Emergency Exercise Management Rules] Law No. 169, 28 February 2003.

98. NNSA, “核动力厂运行安全规定” [Nuclear Power Plant Operation Safety Rules], Law No. 81, 18 April 2004.

99. NNSA, “核动力厂运行安全规定” [Nuclear Power Plant Operation Safety Rules], Law No. 81, 18 April 2004.

100. For example, COSTIND and Ministry of Health, “放射源和辐射技术应用应急准备与相应” [Emergency Preparations and Response in Use of Radiation Sources and Radiation Technology], Law No. 147 offers a conflicting five-tier scale for nuclear and radiological emergencies. Corporate nuclear security expert, interview with author, March 2010.

101. State Council, “国家突发环境事件应急预案” [National Environmental Emergency Response Plans], Order No. 34, 24 January 2006.

102. National People’s Congress, “突发事件应对法” [Emergency Response Law], 30 August 2007; and State Council, “国家突发环境事件应急预案” [National Environmental Emergency Response Plans], Order No. 34, 24 January 2006.

103. State Council, “核电厂核事故应急管理条列” [Law on Nuclear Power Plant Nuclear Emergency Response], Order No. 124, 4 August 1993.

104. National People’s Congress, “突发事件应对法” [Emergency Response Law], 30 August 2007.

APPENDIX 1

Composition of the State Committee for Nuclear Emergency Coordination

The committee is composed of deputy directors of the following organizations (except the China Atomic Energy Authority, which is represented by its director):

China Atomic Energy Authority (chairman)

Ministry of Public Security (vice chairman)

Ministry of Civil Affairs (vice chairman)

Ministry of Environmental Protection (vice chairman)

PLA General Staff Department Operations Department (vice chairman)

Ministry of Foreign Affairs

National Development and Reform Commission

Ministry of Finance

Ministry of Transport

Ministry of Industry and Information Technology

Ministry of Health

State Administration of Work Safety

Hong Kong and Macau Affairs Office

State Council Information Office

China Meteorological Administration

State Oceanic Administration

PLA General Staff Department Service Arms Department

PLA General Logistics Department Health Department