

Full Text: Nuclear Safety in China

国务院新闻办公室网站 www.scio.gov.cn 2019-09-03 来源：国新网

Nuclear Safety in China

The State Council Information Office of the People's Republic of China

September 2019

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Preface

The discovery of the atom and the subsequent development and utilization of nuclear energy have given a new impetus to the progress of humanity and greatly enhanced our ability to understand and shape the world. Yet nuclear energy has associated risks and challenges. To better utilize nuclear energy and achieve greater progress, we must properly respond to the challenges it poses and ensure nuclear safety.

In the early days of the People's Republic of China, due to the requirement for national development, the Chinese government made a major decision to develop and utilize nuclear energy, officially launching its nuclear industry.¹ Over the past 70 years, China's nuclear industry has grown from scratch, developed steadily, and formed a complete system, which has made an

important contribution to ensuring energy security, protecting the environment, improving people's living standards, and promoting high-quality economic development. China has always regarded nuclear safety as an important national responsibility, and integrated it into the entire process of nuclear energy development and utilization. It has always developed the nuclear industry subject to considerations of safety, implemented regulation in accordance with the strictest standards, and adapted to the new requirements of the nuclear industry. China's nuclear industry has always developed in line with the latest safety standards and maintained a good safety record, pursuing an innovation-driven path of nuclear safety with Chinese characteristics.

Since the 18th National Congress of the Communist Party of China, China's nuclear industry has entered a new period of safe and efficient development. President Xi Jinping proposed a rational, coordinated and balanced nuclear safety strategy, placing equal emphasis on development and safety, and advocating building a community of shared future for global nuclear safety – he has pointed out the direction for China's nuclear safety for a new era, and provided the Chinese approach to international cooperation in the development and utilization of nuclear energy, and to lasting global nuclear safety. Under the guidance of this strategy, China has gradually built a nuclear safety governance system with legal norms, administrative regulation, industry self-discipline, technical support, personnel support, cultural guidance, public participation, and international cooperation as the pillars. The guarantee of nuclear safety is stronger.

China is an important advocate, promoter and participant in building a fair, collaborative and mutually beneficial international nuclear safety system. It has done a good job in ensuring its own nuclear safety, fulfilled its international obligations, and promoted bilateral and multilateral cooperation on nuclear safety. We have actively promoted the peaceful use of nuclear energy for the benefit of all humanity and contributed China's wisdom and strength to global nuclear safety governance.

This white paper is being released to introduce China's approach to nuclear safety, elaborate on its basic principles and policies, share the concepts and practices of regulation, and clarify China's determination to promote global nuclear safety governance and the actions it has taken to achieve this.

I. Following a Rational, Coordinated and Balanced Nuclear Safety Strategy

On March 24, 2014, at the third Nuclear Security Summit in The Hague, the Netherlands, President Xi Jinping proposed a rational, coordinated and balanced nuclear safety strategy. China's nuclear safety strategy is the embodiment of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era in the nuclear field, an important element of China's overall national security framework, and a major innovation in the theory of nuclear safety governance. The strategy is an important milestone in promoting international nuclear safety. It lays out the principles and methods for addressing the fundamental issues of global nuclear safety governance and building a community of shared future for nuclear safety.

The kernel of China's nuclear safety strategy is the "Four Emphases". Systematically promoting nuclear safety in an all-round way is the main purpose of China's nuclear safety strategy, which is embodied in equal emphasis on development and safety, rights and obligations, independent efforts and coordination, and symptoms and root causes.

– We should place equal emphasis on development and safety, and develop the nuclear industry in a context of guaranteed safety. Development is the foundation of safety, while safety is a precondition of development. Development and safety are the basic requirements of humanity for the peaceful use of nuclear energy. We should uphold the concept of seeking safety for development and promoting development with safety, so that the two objectives can be integrated and mutually reinforcing. Only by achieving better development can we truly control safety risks; and only by guaranteeing safety can nuclear energy achieve sustainable development.

– We should place equal emphasis on rights and obligations, and promote international nuclear safety on the basis of respect for the rights and interests of all countries. States should effectively fulfill their obligations under the international legal instruments on nuclear safety, fully implement the relevant resolutions of the United Nations Security Council, and consolidate and develop the existing legal framework for nuclear safety. At the same time, we should adhere to the principle of fairness and uphold pragmatism in respecting the right of all countries to adopt their own nuclear safety policies and measures suited to their national conditions, and respecting their right to protect sensitive nuclear safety information.

– We should place equal emphasis on independent efforts and coordination, and seek universal nuclear safety with a mutually beneficial approach. Nuclear safety is first and foremost a national issue, and the primary responsibility should be borne by the government of each country. Governments should understand and undertake their responsibilities, and be responsible not only to themselves but also to the world. They should strengthen coordination, make joint efforts, share achievements, and seek mutual benefit. We should benefit from and contribute to nuclear safety, and endeavor to globalize nuclear safety.

– We should place equal emphasis on symptoms and root causes, and comprehensively promote nuclear safety by eliminating the root causes of risk. We will improve nuclear safety policy measures, develop modern and low-risk nuclear energy, maintain a balance between supply and demand in nuclear materials, strengthen non-proliferation efforts and export control, further international cooperation against nuclear terrorism, and eliminate potential dangers to nuclear safety and risks of nuclear proliferation. All countries should work together to develop harmonious and friendly relations, create a peaceful and stable international environment, and solve the problems of nuclear terrorism and proliferation from the root, thus realizing the lasting safety and development of nuclear energy.

China practices peaceful use of nuclear energy on the basis of ensuring safety, which responds to the needs of the people today and will not leave any risk or cause harm to future generations. This practice will guarantee the sustainable development of human civilization.

The basic principles of China's nuclear safety are: putting safety first and exercising nuclear safety governance in accordance with the law, focusing on risk prevention and implementing defense-in-depth, ensuring clear lines of responsibility and independent regulation, and practicing strict management and providing comprehensive guarantees.

– Putting safety first and exercising nuclear safety governance in accordance with the law. We should establish the concept that safety is of the utmost importance and ensure that nuclear safety is the paramount consideration in decision-making. We will continue to improve the system of laws and regulations on nuclear safety, and ensure that nuclear energy is developed and utilized in accordance with the law.

– Focusing on risk prevention and implementing defense-in-depth. We should concentrate our efforts on eliminating potential risks and preventing nuclear accidents through mature design, high-quality construction, and sound operational management. Following the principle of defense-in-depth, we set up multiple barriers and multiple forms of protection, and strengthen the integrity, independence, and effectiveness of preventative measures.

– Ensuring clear lines of responsibility and independent regulation. Nuclear facility operating organizations shall take overall responsibility for safety. The national nuclear safety regulatory body implements independent regulation; the nuclear industry and energy authorities, and other relevant authorities are responsible for the management of nuclear safety in accordance with the division of duties.

– Practicing strict management and providing comprehensive guarantees. We should strictly implement nuclear safety laws, regulations and standards, and carry out regulation through administrative licensing, technical review, surveillance, and law enforcement. We will establish a coordination mechanism for nuclear safety, improve the relevant policies and regulations, formulate and implement relevant plans, foster a nuclear safety culture, and strengthen resource allocation and capacity building, so as to ensure comprehensive nuclear safety.

II. Building a Policy and Legal Framework on Nuclear Safety

China is a leading country in the application of nuclear energy and technologies. Nuclear safety is critical to national security, and the corresponding policies and laws are the cornerstone of nuclear safety. To achieve optimal management of nuclear safety, China employs the highest standards and strictest requirements in shaping the policy and legal framework, implementing a national strategy, making medium- and long-term plans, and improving laws and regulations concerning nuclear safety.

Formulating a national nuclear safety strategy. China treats the development and utilization of nuclear energy as an important strategy to boost economic and social development and build a beautiful China, including it in the country's medium- and long-term plans for national economic and social development. Since the founding of the People's Republic of China, and particularly since reform and opening up, China has committed itself to prioritizing nuclear safety and

maintaining a balance between safety and development throughout the stages of initial, early, active, and safe and efficient development.

Making medium- and long-term development plans for nuclear safety. China makes medium- and long-term development plans for nuclear safety every five years under the framework of the Five-year Plan for National Economic and Social Development. It has released the 12th Five-year Plan for Nuclear Safety and Radioactive Pollution Prevention and Control and Vision for 2020, and the 13th Five-year Plan for Nuclear Safety and Radioactive Pollution Prevention and Control and Vision for 2025, analyzing the situation, clarifying guidelines and principles, and defining goal indicators, key tasks and projects, and supportive measures for nuclear safety. These plans have helped to coordinate all efforts to ensure nuclear safety and effectively improved our nuclear safety and regulatory capacity.

Table 1 China's Nuclear Energy Development and Safety Strategy

Development Stage	Plans for National Development	Goals for Nuclear Energy Development	Nuclear Power Projects Launched	Nuclear Safety Strategic Goals
Initial development stage	The Sixth Five-year Plan for National Economic and Social Development (1981-1985)	<ul style="list-style-type: none"> Building a 300 MW nuclear power station Developing equipment for this nuclear power station 	<ul style="list-style-type: none"> Qinshan Nuclear Power Plant, Unit 1 	A nuclear safety regulatory system in line with international standards and regulatory models is put in place to exercise independent regulation.
	The Seventh Five-year Plan for National Economic and Social Development (1986-1990)	<ul style="list-style-type: none"> Building nuclear power stations step by step with a targeted focus 	<ul style="list-style-type: none"> Daya Bay Nuclear Power Plant, Units 1, 2 	
Early development stage	The Ten-year Program (1991-2000) and the Eighth Five-year Plan for National Economic and Social Development (1991-1995)	<ul style="list-style-type: none"> Encouraging the balanced development of hydropower and thermal power and the proper development of nuclear power based on local conditions Focusing on building Qinshan Nuclear Power Plant Phase II in the five years from 1991 Developing 600 MW nuclear power units Building, expanding and transforming large and medium-scale hydropower, thermal power, and nuclear power stations step by step 	<ul style="list-style-type: none"> Qinshan Nuclear Power Plant Phase II, Units 1, 2, 3, 4 	The principle of safety and quality first, and prioritizing safety in the development of nuclear energy is always upheld.
Early development stage	The Ninth Five-year Plan for National Economic and Social Development (1996-2000) and Vision for 2010	<ul style="list-style-type: none"> Implementing the principle of supporting the balanced development of hydropower and thermal power and the proper development of nuclear power based on local conditions Promoting the peaceful use of nuclear technologies with a focus on developing nuclear power and the nuclear fuel cycle Carrying out R&D into the application of low-temperature nuclear heat 	<ul style="list-style-type: none"> Ling'ao Nuclear Power Plant, Units 1, 2 Qinshan Nuclear Power Plant, Phase III, Units 1, 2 Tianwan Nuclear Power Plant, Units 1, 2 	The principle of safety and quality first, and prioritizing safety in the development of nuclear energy is always upheld.
	The 10th Five-year Plan for National Economic and Social Development (2001-2005)	<ul style="list-style-type: none"> Properly developing nuclear power Supporting the development of new and efficient power generation equipment such as large gas turbines, pumped storage units, and nuclear power units 	<ul style="list-style-type: none"> Ling'ao Nuclear Power Plant, Units 3, 4 	
Active development stage	The 11th Five-year Plan for National Economic and Social Development (2006-2010)	<ul style="list-style-type: none"> Actively developing nuclear power 	<ul style="list-style-type: none"> Hongyanhe Nuclear Power Plant, Units 1, 2, 3, 4 Ningde Nuclear Power Plant, Units 1, 2, 3, 4 Fuqing Nuclear Power Plant, Units 1, 2, 3, 4 Yangjiang Nuclear Power Plant, Units 1, 2, 3, 4 Fangjiashan Nuclear Power Plant, Units 1, 2 Sanmen Nuclear Power Plant, Units 1, 2 Haiyang Nuclear Power Plant, Units 1, 2 Taishan Nuclear Power Plant, Units 1, 2 Changjiang Nuclear Power Plant, Units 1, 2 Fangchenggang Nuclear Power Plant, Units 1, 2 	The sustainable development of nuclear energy can only be achieved by ensuring nuclear safety which is an important part of national security.
Safe and efficient development stage	The 12th Five-year Plan for National Economic and Social Development (2011-2015)	<ul style="list-style-type: none"> Ensuring efficient development of nuclear power on the basis of safety Giving priority to the development of nuclear power in eastern coastal and some middle regions while strengthening regulation to ensure nuclear and radiation safety 	<ul style="list-style-type: none"> HTGR pilot project Tianwan Nuclear Power Plant, Units 3, 4 Yangjiang Nuclear Power Plant, Units 5, 6 Hongyanhe Nuclear Power Plant, Units 5, 6 Tianwan Nuclear Power Plant, Units 5, 6 Fuqing Nuclear Power Plant, Units 5, 6 Fangchenggang Nuclear Power Plant, Units 3, 4 	China upholds a rational, coordinated and balanced nuclear safety strategy with commitment to strengthening the country's nuclear safety capacity and the government's capacity for nuclear safety regulation, invest more in R&D of nuclear safety technologies and human resources, and foster a nuclear safety culture.
	The 13th Five-year Plan for National Economic and Social Development (2016-2020)	<ul style="list-style-type: none"> Building independent nuclear power pilot projects and programs along the coastal nuclear power belt Accelerating the development of new-generation nuclear power equipment, small nuclear power systems, and civil nuclear analysis and imaging technologies Starting a group of nuclear power projects along the coastal regions and accelerating the construction of Tianwan Nuclear Power Plant in phase III while advancing the preparation for inland nuclear power projects and the feasibility study for building large-scale commercial reprocessing plants. The future generating units are expected to have a total installed capacity of 58 GW, and those under construction have a total installed capacity of 30 GW. Improving the safety of nuclear facilities and prevention and control of radioactive contamination, and strengthening the regulatory system and capacity for nuclear and radiation safety 		

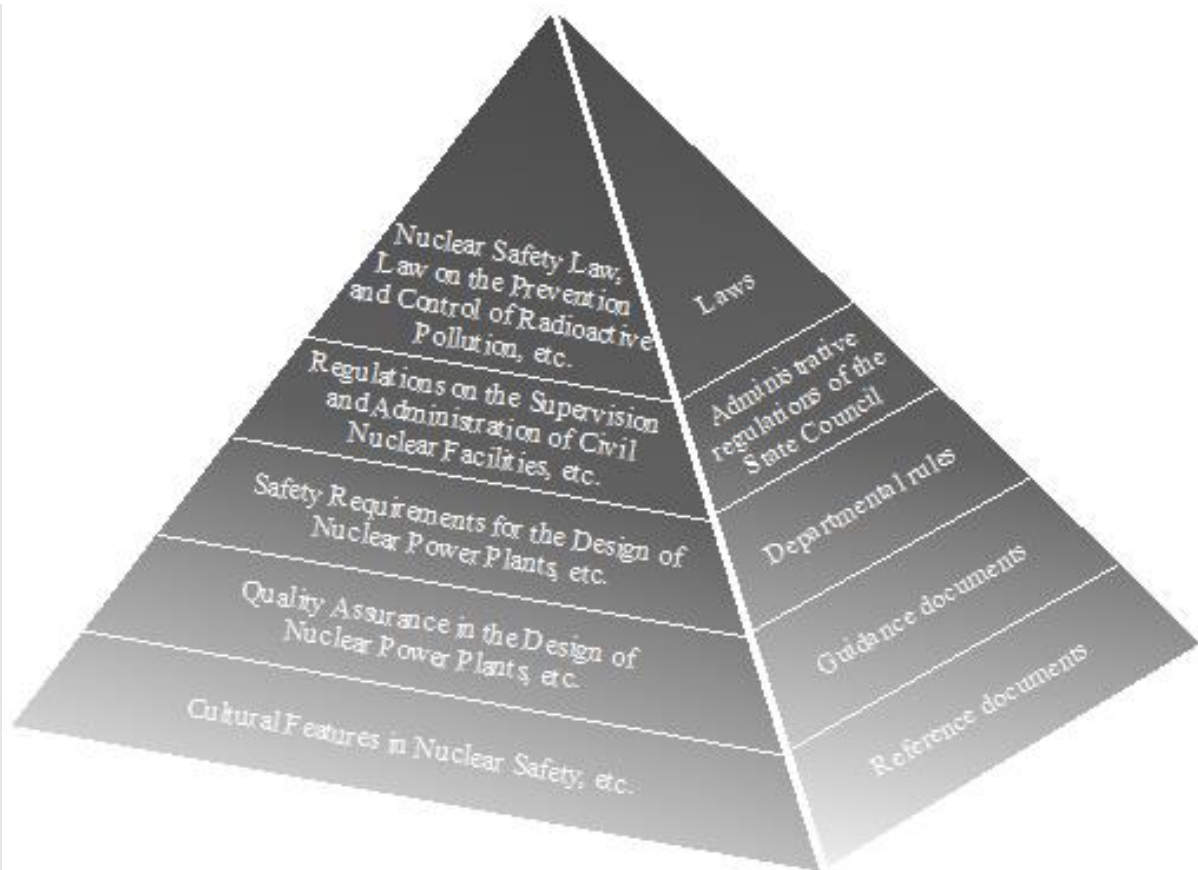


Figure 1 Legal Framework for China's Nuclear Safety

Establishing a sound system of laws and industrial standards. China continues to strengthen the formulation of the laws on nuclear safety, under which administrative regulations and departmental rules dovetail with the law, the provisions of laws and regulations and technical standards complement each other, and central and local regulations combine to the best effect. This makes the full regulation of nuclear energy development and utilization possible, laying the foundations for the rule of law in this sector. In June 2003, the Law of the People's Republic of China on the Prevention and Control of Radioactive Pollution was promulgated; in September 2017, the Nuclear Safety Law of the People's Republic of China was issued. By June 2019, China had enacted nine administrative regulations such as the Regulations on the Supervision and Administration of Civil Nuclear Facilities, the Regulations on the Supervision and Administration of Civil Nuclear Safety Equipment, the Regulations on Nuclear Material Control, and the Regulations on Emergency Management of Nuclear Accidents at Nuclear Power Plants. It had issued over 30 sets of departmental rules and 100 sets of safety guidelines, and formulated over 1,000 national and industry standards related to nuclear safety. Over 200 local regulations have

been formulated by China's 31 provinces and equivalent administrative units. To update legal standards and keep abreast with the most advanced international developments, we have reviewed and summarized domestic and overseas experience in nuclear safety, and closely tracked the latest safety standards of the International Atomic Energy Agency and countries with advanced nuclear technologies.

III. Ensuring Effective Regulation of Nuclear Safety

China treats nuclear safety as an important obligation of the state, and exercises unified regulation through special organizations and a regulatory system underpinned by independence, openness, the rule of law, rationality, and effectiveness. To ensure independent regulation of nuclear safety and enhance its authority and effectiveness, China has strengthened technical support and developed a professional team while modernizing the system and the regulatory capacity.

A three-pronged regulatory system. In China, unified regulation over the surveillance of nuclear safety, radiation safety, and the radiation environment is exercised independently, and a three-pronged regulatory system consisting of headquarters, regional offices and technical support organizations is in place. Established in 1984, the National Nuclear Safety Administration is responsible for the regulation of civil nuclear facilities, the formulation of nuclear safety policies, laws, regulations, standards, and plans, the implementation of nuclear safety license management, and the coordination of nuclear safety regulation across the country. To perform nuclear and radiation safety surveillance it has six regional offices in the north, east, south, southwest, northwest, and northeast of China. Professional technical support organizations such as the Nuclear and Radiation Safety Center and the Radiation Monitoring Technical Center provide technical support for nuclear safety review, independent verification, surveillance, law enforcement, and assessment of the radiation environment. Local governments at all levels regulate regional radiation safety through regulatory organizations or full-time/part-time regulators according to local conditions.

Comprehensive review and license management. The government has strengthened safety control of nuclear facilities, materials and activities and radioactive materials through comprehensive safety licensing and rigorous technical review. It exercises full life-cycle and

phased license management over the siting, construction, operation, and decommissioning of nuclear power plants, research reactors, nuclear fuel cycle facilities, and facilities that handle the treatment, storage, and disposal of radioactive waste. The government implements license management over licensees that have nuclear materials, and over licensees that produce, sell and use radioisotope and radiation-emitting devices based on categories and levels of radiation. It performs approval and online monitoring over the transport of radioactive materials and implements license management over licensees that design, manufacture, install, and perform nondestructive testing of civil nuclear safety equipment, and licensees that design and manufacture containers for the transport of radioactive materials. A risk-informed and problem-oriented review system has been established, and efforts are being made to enhance the capacity of independent verification and calculations, probabilistic safety assessment, and risk assessment.

Whole-process surveillance and law enforcement. The government performs rigorous surveillance of nuclear facilities and units that are engaged in nuclear activities in accordance with the law, to ensure compliance with nuclear safety laws, regulations, standards, and licensing requirements. It carries out regular surveillance of units that operate nuclear facilities, manufacture nuclear safety equipment, and utilize nuclear technologies, covering all matters and activities in relation to nuclear safety such as design, purchasing, manufacturing, construction, operation, and decommissioning. The government performs on-site safety surveillance of key nuclear facilities and activities, urges enterprises in violation of relevant regulations to rectify, and punishes those that violate the law. It has initiated special programs to handle major cases caused by quality issues, taking resolute action against operations involving falsification and violation of regulations. A national platform has been set up for nuclear power plants and research reactors to share experience and information, to effectively ensure the safe operation of nuclear facilities.

Round-the-clock radiation environment monitoring. China has established a three-tier radiation environment monitoring system at state, provincial and municipal level, and three networks – national radiation environment monitoring, surveillance monitoring of radiation environment in the vicinity of key nuclear facilities, and nuclear and radiation emergency

monitoring – to monitor radiation environment round-the-clock in all areas. As of June 2019, the state radiation environment monitoring network had 1,501 monitoring sites: 167 automatic monitoring sites for atmospheric radiation, 328 land sites, 362 soil sites, 477 inland water sites, 48 seawater sites, 85 electromagnetic radiation sites, and 34 marine life sites. There were also 46 radiation environment surveillance monitoring systems set up in the vicinity of key nuclear facilities as well as sites set up to monitor radioactivity in food.

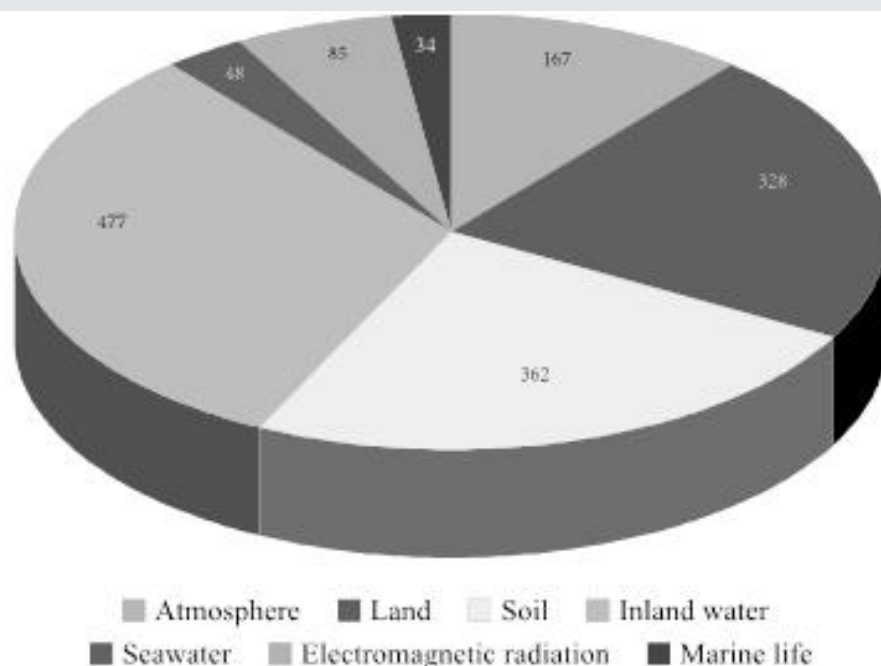


Figure 2 Number of Monitoring Sites in the State Radiation Environment Monitoring Network by Category

Improved nuclear and radiation emergency response. China has set up the National Nuclear Accident Emergency Coordination Committee, and formed a three-tier emergency response system at state and provincial level and also at nuclear facility operating organizations, to organize emergency response to nuclear and radiation accidents. The state has established an emergency management system and a response and action mechanism for radiation accidents, and an emergency monitoring and dispatch platform that covers the whole country. All provinces and equivalent administrative units have carried out radiation response drills to enhance their capacity in rapid response and proper action to different types of radiation accidents. China has a 300-member national nuclear emergency rescue team and 25 professional rescue units, 8 types of national nuclear emergency technical support centers, 3 fast support bases for nuclear

accidents at nuclear power plants, and 17 medical centers for treating nuclear radiation injuries.

Regular joint nuclear emergency drills are carried out to improve preparedness and response.

Stronger professional teams. To meet the requirements of the development of the nuclear sector and nuclear safety regulation, China has given top priority to strengthening the professional teams, to develop an “iron army” with strong political convictions, professional capacity, impeccable conduct and a strong sense of responsibility. They will work under pressure, persevere, and dedicate themselves to the cause of nuclear safety. A nuclear and radiation safety regulation team has been formed, consisting of 100 persons at the headquarters, 1,000 persons at the central level, and nearly 10,000 persons nationwide. To cultivate leading figures in nuclear safety, the state has set up a national nuclear safety expert commission composed of 25 academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering, and more than 100 leading experts on nuclear safety. To develop the professional teams, China has enforced qualification management of nuclear safety professionals, strengthened the qualification management of nuclear facility operators, nuclear safety equipment welders, nondestructive testers, and other special posts, and required registered nuclear safety engineers for critical posts. China has established an education and training mechanism involving institutions of higher learning, research institutes, and enterprises, to expand the channels of professional training, strengthen the cultivation of nuclear safety professionals, and enhance their technical competence and safety awareness. As of June 2019, there were 72 universities in China running programs on nuclear engineering, of which 47 had separate schools on nuclear science, enrolling some 3,000 undergraduates in nuclear engineering each year.

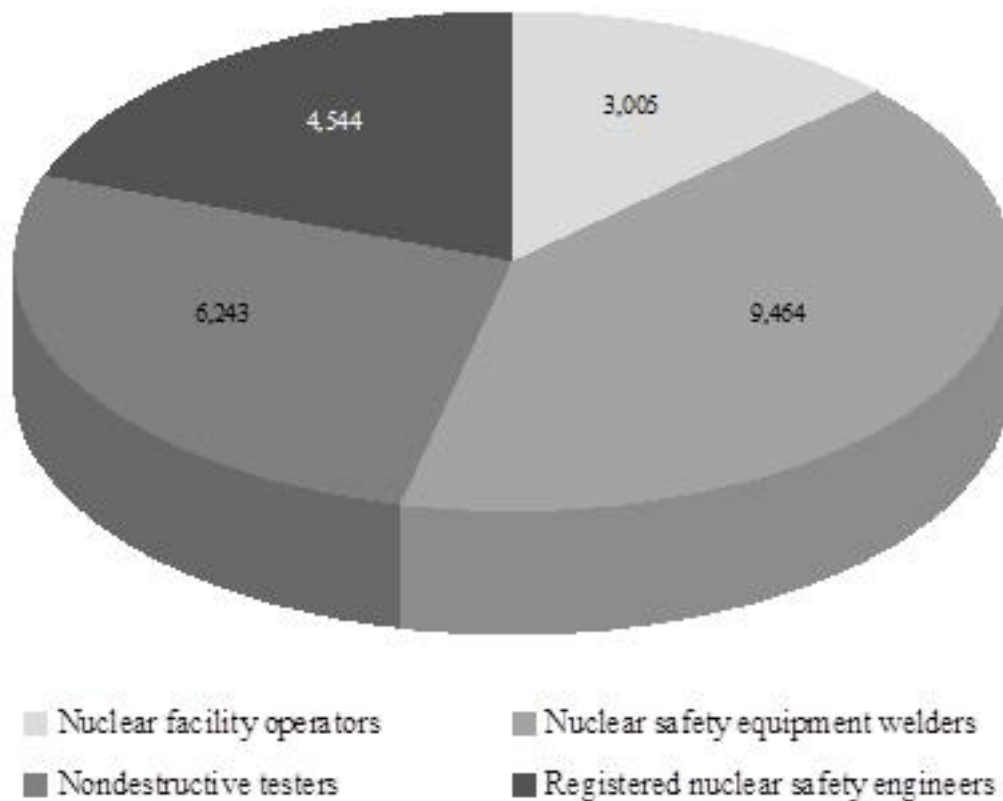


Figure 3 Number of Nuclear Safety Professionals by Category

Enhancing R&D in nuclear safety technology. China has included R&D in nuclear safety into national planning for scientific and technological programs, with a focus on work of a strategic nature for basic application and public good. China has established a National Research and Development Center for Nuclear and Radiation Safety Regulation, conducted research on key technologies of radiation environment monitoring and technical review, and employed new technology in review and surveillance. The state encourages the nuclear industry to develop and apply advanced and reliable nuclear safety technology. Important results have been achieved in the technological research and demonstration projects on advanced reactors and supporting systems. A proprietary distributed control system (DCS) for nuclear power plants has been applied in the

Hualong-1 demonstration project. The pressurized water reactor CAP1400 has made important breakthroughs. Demonstration projects in high temperature gas-cooled and sodium-cooled fast reactors are making headway, and R&D in small reactors for different applications are progressing smoothly. China is using more nuclear power equipment manufactured domestically, and working hard to increase its manufacturing capacity in nuclear power equipment. It has

made steady progress to independently produce key equipment of GW-class nuclear power units, achieving key successes in the independent R&D and manufacturing of pressure vessels, steam generators, main pipelines, advanced nuclear fuels, nuclear-grade welding materials, and other key nuclear safety equipment and materials.

Full implementation of nuclear safety improvements. In the wake of the Fukushima nuclear accident in Japan, the Chinese government organized a nine-month safety inspection of the country's operating nuclear power plants, those under construction, research reactors, and other key nuclear facilities. The result showed a minimal possibility of nuclear accidents, as the sites of China's nuclear facilities had been selected with full consideration of extreme natural disasters such as earthquake, flood, and tsunami. Learning from Japan's lesson, the Chinese government has further enhanced its nuclear facility safety by implementing improvement plans for the short, medium, and long terms and by increasing nuclear facilities' capacity to resist external events and prevent and mitigate serious accidents.

IV. Maintaining High-Level Safety

China has maintained a good nuclear safety record for a long time – it ranks among the highest of all countries in terms of nuclear power safety operation indicators. Its safety level in the use of nuclear technology continues to improve, its nuclear material control is strong, and public health and environmental safety are fully guaranteed. In 2000, 2004, 2010 and 2016, the International Atomic Energy Agency conducted four comprehensive reviews of China's nuclear and radiation safety regulation, giving full recognition to China's good practices and experiences.

Safe and efficient nuclear power development. In accordance with the concept of multiple protective barriers and defense-in-depth, and with the aim of ensuring that they are completely safe and reliable, China uses the most advanced technology and the most stringent standards for the development of nuclear power, and strictly manages the entire life cycle of nuclear facilities from siting, design, construction, and operation to decommissioning. Since 1985, when the first nuclear power plant on the Chinese mainland, the Qinshan Nuclear Power Plant, began construction, China has adopted safe and reliable reactor technology, and learned from the experiences and lessons of major nuclear accidents abroad to make safety improvements. The safety performance of the units is better guaranteed. After more than 30 years, China has

achieved independent design, construction and operational capability in nuclear power, and entered a new stage of safe and efficient development. China took the lead in the construction and operation of the GW-class pressurized water reactor, AP1000, using advanced passive safety systems, and the European advanced pressurized water reactor, EPR. The Hualong-1 nuclear reactor, a product of independent research and development, ranks among the highest in the world in terms of safety design. Construction of the demonstration project is being carried out in accordance with the highest quality standards, making the Hualong-1 a highlight of China's "going global" strategy. By June 2019, China had 47 nuclear power units in operation, ranking third in the world, and 11 nuclear power units under construction, ranking first in the world. The performance indicators of nuclear power units are generally good. By June 2019, the industry had operated safely and stably for more than 300 reactor-years, and there had been no incidents or accidents at or above Level 2 under the International Nuclear and Radiological Event Scale (INES). The incidence of Level 0 deviations and Level 1 anomalies had also decreased. In the comprehensive ranking of similar units of the World Association of Nuclear Operators (WANO) in recent years, operating units in China have performed above the world median for more than 80 percent of the indicators, and have reached the world advanced level for more than 70 percent of the indicators. In 2018, China led the world with 12 operating units achieving full marks in WANO composite index.

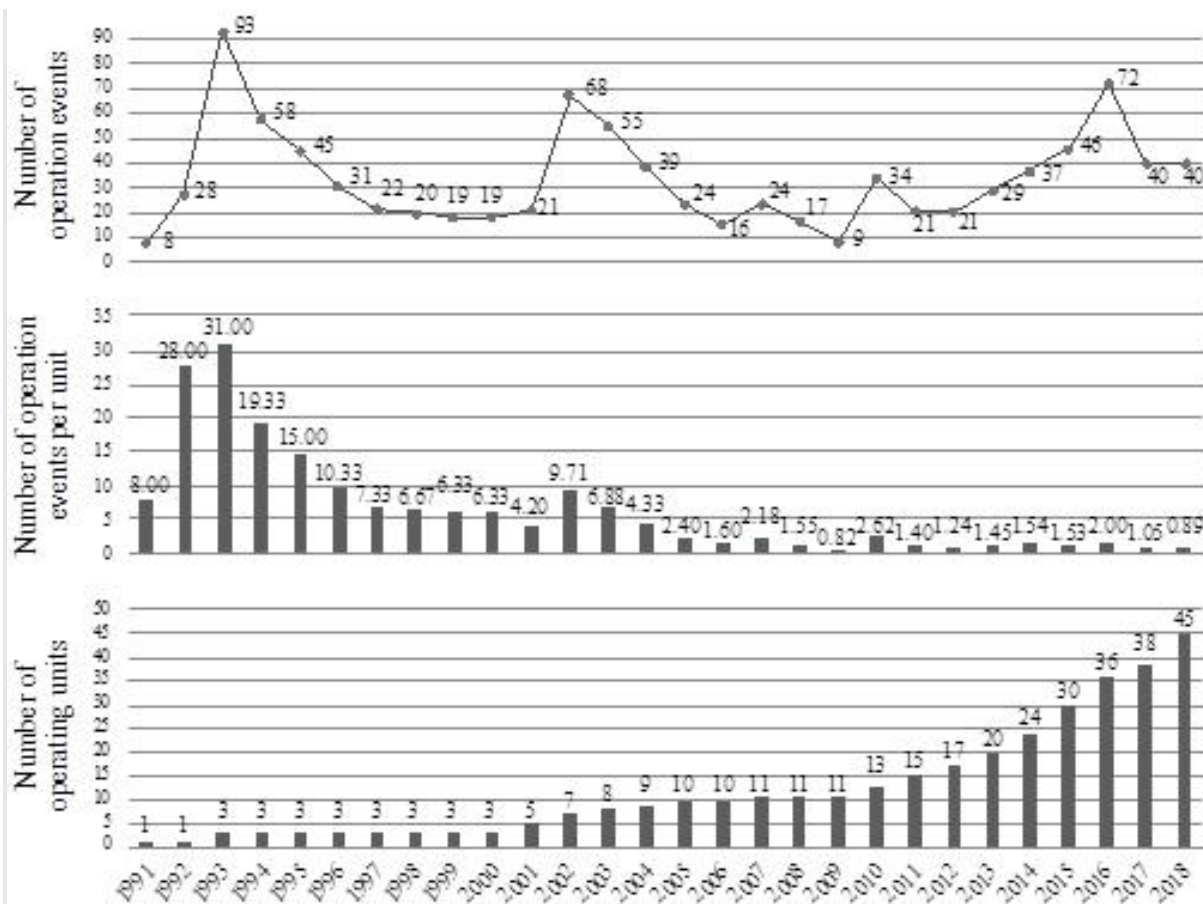


Figure 4 Number of Operating Nuclear Power Units and Operation Events

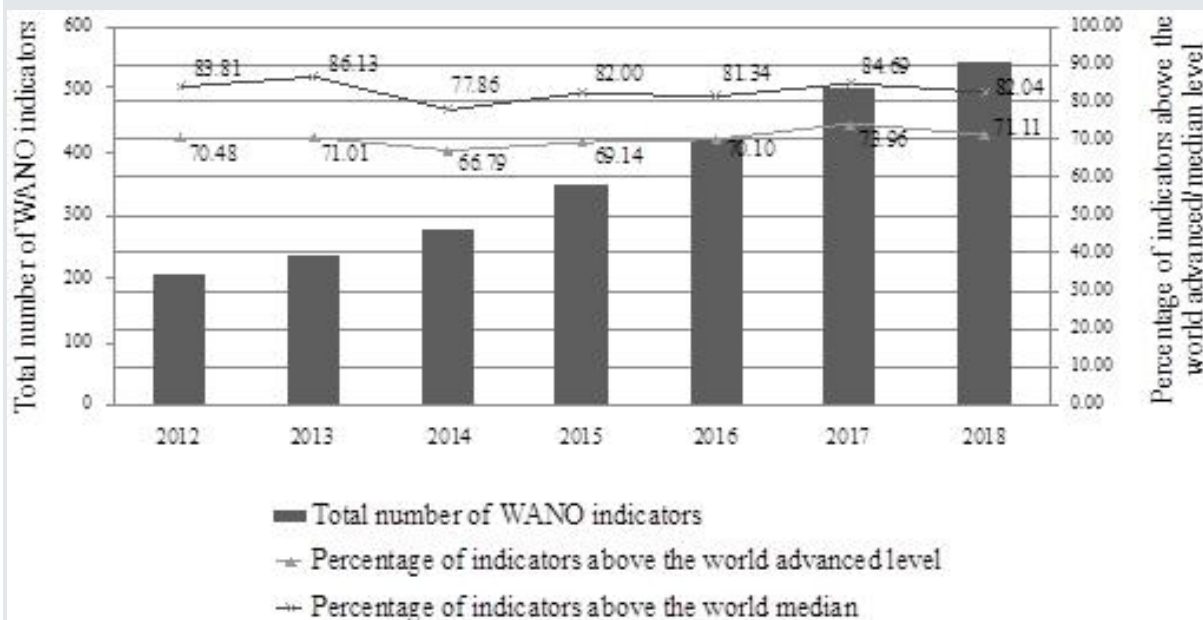


Figure 5 WANO Indicators of China's Nuclear Power Units

Safe operation of other key nuclear facilities. Based on its own strength and drawing on advanced international experience, China has designed and developed research reactors such as

high-temperature gas-cooled reactors, fast reactors, small nuclear power reactors, molten salt reactors, and transmutation devices. Nineteen operating civil research reactors and critical assemblies maintain safe and stable operation. We have implemented the strategy of a closed nuclear fuel cycle and gradually established a complete nuclear fuel cycle system, including uranium mining and metallurgy, uranium conversion, uranium enrichment, processing of nuclear fuel elements, spent fuel reprocessing, and treatment and disposal of radioactive waste. Eighteen civil nuclear fuel cycle facilities and two low- and intermediate-level radioactive solid waste disposal sites have a good safety record.

Classification and safe disposal of radioactive waste. China implements radioactive waste classification: near-surface or medium-depth disposal of low- and intermediate-level radioactive waste in locations that meet the requirements of nuclear safety, and deep geological disposal of high-level radioactive waste in centralized locations. To ensure permanent safety, nuclear facility operating organizations and radioactive waste disposal organizations carry out minimization and decontamination of radioactive waste in accordance with the law. All provinces and equivalent administrative units have built urban radioactive waste repositories for centralized storage and proper disposal of radioactive waste produced by nuclear technology. We will continue to promote the safe storage and treatment of spent fuel, enhance our capacity in the treatment and disposal of radioactive waste, carry out the decommissioning and environmental restoration of uranium mining and metallurgical facilities, and standardize the environmental management of waste rock, waste water, tailings and slag in uranium mining and metallurgy, so as to ensure that radiation is maintained at safe levels.

Markedly improved safety in the use of nuclear technology. China implements dynamic management of radioactive sources from cradle to grave, and brings all source-related units into the scope of government regulation. We have established a national database for the management of nuclear technology utilization, taken measures to enhance the safety of radioactive sources, realized the real-time online monitoring of high-risk mobile sources, and improved the safety level of nuclear technology utilization. As of June 2019, 142,607 radioactive sources and 181,293 radiation-emitting devices were in use in China, and a total of 73,070 units were engaged in the production, sale and use of radioisotopes and radiation-emitting devices.

One hundred percent of radioactive sources and radiation-emitting devices are subject to licensing management, and 100 percent of waste radioactive sources are safely stored. The annual incidence of radiation accidents from radioactive sources has continued to decline, from 6.2 per 10,000 sources in the 1990s to less than 1.0 per 10,000 sources at present, the lowest level in history.

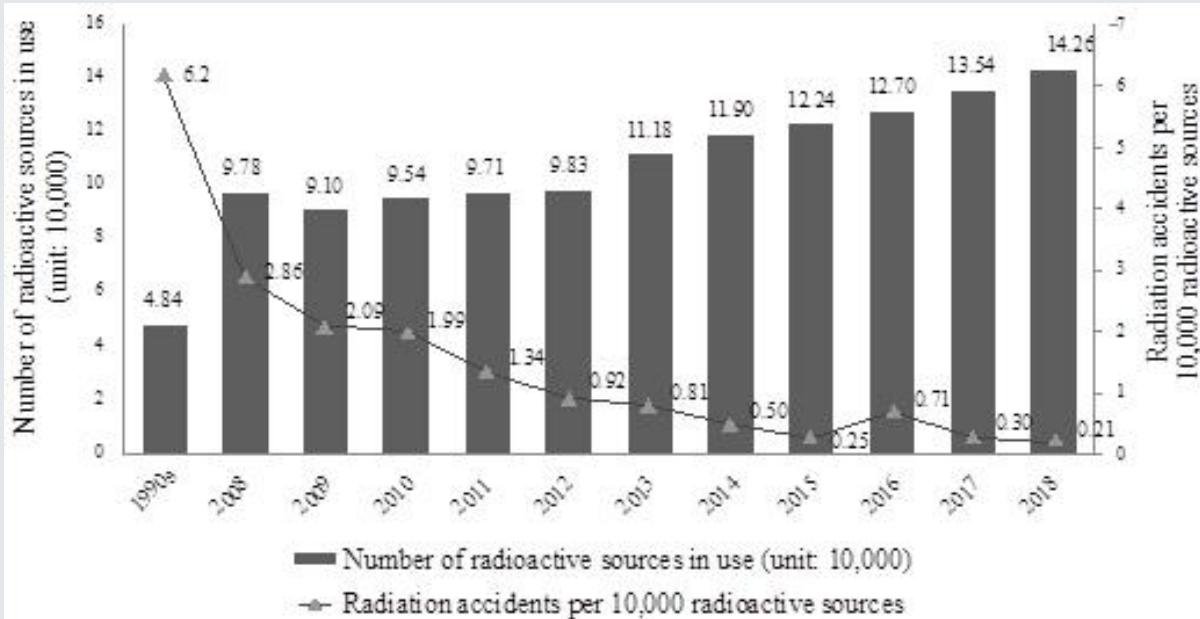


Figure 6 Number of Radioactive Sources in Use and Radiation Accidents from Radioactive Sources in China

Upgraded nuclear security. China regards nuclear security as an important protective screen for nuclear safety and controls nuclear materials in accordance with the strictest standards. Nuclear power plants, nuclear fuel cycle facilities, and radioactive source security systems are in line with international standards. The rules and regulations are sound and complete, and the mechanisms for non-proliferation and nuclear terrorism prevention are improving. We are building a nuclear security system for new nuclear facilities in accordance with the latest international standards, and have invested billions of yuan in special funds to upgrade the security system of the original nuclear facilities, thus greatly strengthening our prevention capabilities. To date there have been no incidents of theft, loss or illegal use of nuclear materials.

Good radiation environment quality. The radiation environment monitoring data in China show that the radiation environment quality across the country is within the range of natural environmental radiation, and the activity concentration levels of artificial radionuclides are

normal. Surveillance monitoring data show that radiation in the environment around national nuclear facilities and nuclear technology utilization projects has not changed significantly compared with the level prior to construction, and the individual public dose is far lower than the national limit. Public health and environmental safety are fully guaranteed.

V. Co-building and Sharing Nuclear Safety

Human factors are the most important in effectively ensuring nuclear safety. China is committed to strengthening nuclear safety culture. It has established a public communication mechanism for nuclear safety that combines supervision by the central government, guidance by local governments, implementation by enterprises, and participation of the public. It regulates and guides the professional attitude and conduct, and encourages extensive public participation.

It has created a positive atmosphere in which everyone shoulders responsibility, everyone participates, and the whole industry and society work together to safeguard nuclear safety.

Government guidance. Government departments give full play to the role of policy guidance and supervision, and promote an awareness of the paramount importance of nuclear safety, a sense of weighty responsibility, a rigorous and meticulous approach to regulation, and a spirit of collaboration for further progress. We should actively cultivate and develop a culture of nuclear safety, and through education, regulations, and positive influences, instill the core values of awareness of the rule of law, vigilance, self-discipline, and cooperation into the thoughts and actions of professionals, so as to fully mobilize and stimulate the positive role of human factors.

We have issued the Policy Statement on Nuclear Safety Culture, carried out special actions to promote this culture, and established an assessment mechanism so that nuclear safety culture can be internalized in the mind, externalized into practice, and further transformed into conscious action by professionals. We have increased transparency in the operations of the government in accordance with the law, established a press spokesperson system and a mechanism of regular communication with the media, providing explanations on major nuclear safety policies, and promptly releasing information on licensing examination and approval, surveillance and law enforcement, the overall safety situation, radiation environment quality, and incidents and accidents, with the aim of enhancing the transparency of government work and protecting the public's right to know, to participate and to supervise.

Positive action by the industry. Nuclear-related enterprises, public institutions, research institutes, and trade associations have attached great importance to and actively cultivated nuclear safety culture, setting up special institutions, allocating full-time personnel, and exploring innovative new ideas. We have strengthened quality management, education and training, feedback on experience, evaluation, and improvement, and effectively integrated nuclear safety culture into production, operation, scientific research, and management. Some excellent safety concepts have been generated, such as “rules must be in place; lines of accountability be clear; verification be performed, and documentation be available to refer to”, and “put nuclear issues first, cherish cooperation, and take peace and harmony as the foundation”. We publicize important information in accordance with the law, including nuclear safety management rules and regulations, the safety status of nuclear facilities, radiation monitoring data on effluents and the environment around nuclear facilities, and annual nuclear safety reports, and actively respond to public concerns about nuclear energy and nuclear safety.

Extensive public participation. We organize and carry out various activities to popularize nuclear science, such as “National Security Education Day”, “Public Open Day (Week)”, “Nuclear Safety Culture on Campus and in the Community”, and “Popularizing Science in China, Green Nuclear Energy”. Through discussions, field experiences, media publicity and other channels, understanding of nuclear safety is enhanced throughout society. Based on the principles of equality, extensiveness and convenience, we have established a mechanism for broad public participation, and fully solicit opinions on major nuclear safety issues concerning the public interest in the form of questionnaires, hearings, seminars, and feasibility study meetings. We have provided extensive publicity and education on nuclear safety for the whole of society, set up science popularization networks and new media platforms, built national education bases to popularize nuclear science, and developed public publicity facilities and industrial tourism projects. We have included nuclear safety education into the training of officials and the education system for young people, and guided the public to understand, contribute to, and maintain nuclear safety.

VI. Building a Community of Shared Future for Nuclear Safety

The peaceful development and utilization of nuclear energy is the common aspiration of all countries, and ensuring nuclear safety is their shared responsibility. China advocates the development of an international nuclear safety system characterized by fairness, cooperation, and mutual benefit. It facilitates the global effort on nuclear safety governance through fair and pragmatic cooperation, works together with the rest of the world to build a community of shared future for global nuclear safety, and promotes the building of a community of shared future for humanity.

Faithfully fulfilling international obligations and political commitments. China has ratified all international legal instruments in the field of nuclear safety. It has strictly implemented UN Security Council resolutions and supported and participated in international initiatives on nuclear safety. It faithfully fulfills its duties as a signatory of the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, the Convention on the Physical Protection of Nuclear Material, the Convention on Nuclear Safety, the International Convention for the Suppression of Acts of Nuclear Terrorism, and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. China has actively participated in the formulation and implementation of the Vienna Declaration on Nuclear Safety, and Chinese representatives chaired the Fifth Review Meeting of the Contracting Parties (2011) and the Second Extraordinary Meeting of the Contracting Parties (2012) to the Convention on Nuclear Safety, contributing to global governance on nuclear safety.

Upholding multilateral efforts to strengthen nuclear safety. China upholds the central role of the International Atomic Energy Agency in international cooperation on nuclear safety, and has provided all-round support to the IAEA, including political, technical and financial support.

China makes continuous contributions to the IAEA Nuclear Security Fund, with a view to enhancing the nuclear security capacity of countries in Asia. To strengthen international non-proliferation cooperation, China has joined the Zangger Committee, the Nuclear Suppliers Group, and other multilateral mechanisms and international organizations. It has enacted the Regulations on Nuclear Export Control and the Regulations on the Export Control of Dual-Use Nuclear Items and Technologies, and released the Nuclear Export Control List and the Export

Control List of Dual-Use Nuclear Items and Technologies. China has expanded international cooperation in the fight against nuclear terrorism, and works closely with such international organizations and multilateral mechanisms as the International Criminal Police Organization, the Nuclear Security Contact Group, and the Global Initiative to Combat Nuclear Terrorism.

Strengthening international exchanges and cooperation on nuclear safety. China attaches great importance to nuclear safety policy exchanges and cooperation between countries. It maintains close contacts with France, the United States, Russia, Japan, the Republic of Korea and other countries, as well as emerging nuclear energy countries along the Belt and Road, and has signed more than 50 cooperation agreements on nuclear safety to facilitate all-round cooperation in exchange of high-level visits, communication between experts, review, consultation, and joint research. China and the United States have established an annual dialogue mechanism on nuclear safety, a Nuclear Security Center of Excellence, and the China Customs Radiation Detection Training Center. Chinese and Russian customs have held joint exercises to prevent illicit trafficking of nuclear and other radioactive materials. China, Japan and the ROK arrange meetings between regulators to share their experiences in nuclear safety regulation. China has strengthened exchanges and cooperation with the Nuclear Energy Agency of the Organization for Economic Cooperation and Development, the European Union, WANO, and other international organizations. It is an active participant in international peer reviews of nuclear safety directed to common progress against global standards. In order to expand participation in global cooperation platforms and enhance its nuclear safety capabilities, China continues to take part in activities under the frameworks of the Global Nuclear Safety and Security Network and the Asian Nuclear Safety Network.

China contributes its wisdom and strength to the world by promoting its nuclear safety regulatory system and sharing advanced technology, experience, resources, and platforms. It has taken part in the Multinational Design Evaluation Program for nuclear power plants, and a working group on the Hualong-1 has been established. Through its National Research and Development Center for Nuclear and Radiation Safety Regulation, China has continued to help developing countries to train nuclear safety personnel and carry out technical drills, lending

support to their efforts to enhance their regulatory capacity and providing more public goods for improving global nuclear safety.

Conclusion

As Chinese socialism enters a new era, China's nuclear industry has reached a stage of safe and efficient development, ushering in a new phase of high-quality progress to ensure nuclear safety. Guided by Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, China will uphold a rational, coordinated and balanced nuclear safety strategy and fulfill its mission of maintaining and improving nuclear safety. It will reinforce its commitment to protecting public health and maintaining a safe environment, ensure the safe, sound and sustainable development of its nuclear industry with a people-centered approach, and promote economic prosperity to benefit the country and the people.

China will continue to enforce rigorous safety regulation over nuclear facilities, materials, and activities and radioactive substances. It will continue to modernize its nuclear safety regulatory system and capacity to effectively safeguard the country's nuclear safety and provide a strong guarantee for building a modern socialist country in all respects and realizing national rejuvenation.

China will continue to promote international cooperation in nuclear safety, assume the responsibility required of a major country, and fulfill its international obligations. It will strive for the establishment of an international nuclear safety system characterized by fairness, cooperation, and mutual benefit, raise global standards of nuclear safety, and promote the sharing of global achievements in the peaceful use of nuclear energy among the international community. It will safeguard regional and world peace and stability, and make positive contribution to building a community of shared future for humanity and a clean and beautiful world of lasting peace, universal security, common prosperity, openness, and inclusiveness.