THE PEOPLE'S REPUBLIC OF CHINA

THE SIXTH NATIONAL REPORT UNDER THE CONVENTION ON NUCLEAR SAFETY

August 2013

Beijing

Contents

A. INTRODUCTION

The Chinese government has consistently attached high importance to nuclear safety, earnestly performed all obligations committed to international community, undertaken the safety responsibilities for its nationwide nuclear power plants (NPPs),and made unremitting efforts to meet and keep a high-level nuclear safety standard accepted internationally.

A.1 General Situation of the Peaceful Uses of Nuclear Energy in China

Since the development of nuclear power, China has set up a system of applicable nuclear safety regulations and standards, and established a nuclear safety supervision and management mechanism that is geared to China's national conditions. Besides, China has also fully drawn reference other countries' experience in the development of nuclear power, introduced mature technology and advanced reactors, continuously improved and constantly improved the capability and level of preventing nuclear accident by relying on advancement in science and technology. Nuclear power plants have established a relatively complete set of rules and regulations and continually improved quality assurance system for nuclear power safety. Furthermore, effective measures have been taken to ensure safety of nuclear power plants and spread nuclear safety culture. China's practices of developing nuclear energy for years have testified safety for construction and operation of nuclear power plants.

Up to December 31, 2012, three major nuclear power bases have been formed in Chinese mainland, namely, Qinshan of Zhejiang, Daya Bay of Guangdong， Tianwan of and Jiangsu, altogether with 15 units in commercial operation with total installed capacity of 12,538MW and 30 units[1] under construction with total installed capacity of 32,671MW. From 2010 to 2012, the annual accumulative electricity generated by these units and the on-grid power increased steadily. In 2012, the accumulative electricity by nuclear power units in commercial operation reached 98.301 billion KWH, a year-on-year increase of 13.09% and accounted for about 1.99% of total

[1]First fuel loading was carried out for Unit 1 of Ningde NPP on September 28, 2012 and for unit 1 of Hongyanhe NPP on November 22, 2012. The two nuclear power plants have 4 Units under construction respectively.

electricity generated in the country; the annual accumulative on-grid electricity was 92.657 billion KWH, a rise of 13.07% year on year.

So far, China's nuclear power units in operation have boasted good safety performance, without any operating incident at International Nuclear Event Scale (INES) level-2 or above. The units under construction can generally satisfy China's current nuclear safety regulations and meet the requirements of the latest safety standards of International Atomic Energy Agency (IAEA). And effective management is secured in the process of siting, design, manufacture, construction, installation, commissioning and others. The quality assurance system functions well, the construction meets the design requirements and the overall quality is under control.

The construction and operation of nuclear power plants have not only generated sound social and economic benefits, but also enabled China to gain valuable experience in respect of nuclear power design, equipment manufacture, construction, operation management, etc., thus having laid a good foundation for sustainable development of China's nuclear power. Along with the rapid development of China's economy, nuclear power is playing an increasingly important role in meeting China's demand for electricity.

Chinese government has been persisting in the basic policy of "safety first" all the time, effectively coping with all sorts of challenges in the course of nuclear power development, ensuring nuclear safety and having well promoted the sustainable development of China's nuclear power.

After Fukushima Nuclear Accident in 2011, China took active measures, implemented independent, comprehensive, in-depth and systematic inspection and evaluation on the safety conditions of nuclear power plants in operation and those under construction across the country, put forward detailed requirements for safety improvement, and phased rectification and reformation, thus having enhanced the level of nuclear power safety.

By the end of 2012, with removal of suspension of approval for construction of nuclear power units, the four units have commenced successively. The construction for new nuclear power units was resumed in China.

A.2 Policies and Objectives for Nuclear Power Development in China

It is inevitable that rapid increase of energy consumption will go with fast development of China's economic and social undertakings. Although China's total energy resources are comparatively rich, the per capita ownership is low, with uneven distribution, great difficulties in taping and relatively low energy efficiency. The coal-dominated energy consumption imposes much pressure on the environment. For this reason, Chinese government puts forward the strategy of energy resource development featuring "economical, clean and safe development", and adheres to the basic policy of relying on domestic resources and opening up, so as to ensure steady supply of energy resources by steadily increasing domestic energy resources and thus to promote the development of world's energy resources.

Nuclear energy is a safe, clean and reliable and is of significance in improving energy structure in China, ensuring energy security, protecting environment, coping with global climate change and boosting the capacity of electro-mechanical equipment manufacture, and also meets the objective need and strategic requirement for coordinated development of energy resource, environment and economy.

According to "The 12th Five-Year Plan on Energy Development", under the framework of state's overall strategy for energy development and based on the basic energy development principle of "adhering to saving first, relying on domestic resources, developing in a diversified manner, protecting the environment, deepening the reform, promoting scientific and technical innovation, strengthening international cooperation and improving people's livelihood", China will have fulfilled the energy structure optimization goals of improving the proportion of non-fossil energy consumption to 11.4%, the proportion of installed non-fossil energy power generation units to 30% and the proportion of natural gas in primary energy consumption to 7.5% and reducing the proportion of coal consumption to 65% or so

by 2015. In the field of nuclear energy, China adopts the policy of "safe and efficient development of nuclear power", and strictly implements "Nuclear Power Safety Program" as well as "Medium and Long-Term Development Plan on Nuclear Power". The policy of "safety first" will be carried out through the whole process of nuclear power planning, construction, operation and decommissioning as well as all related industries. Based on thorough safety inspection, China continually carries out safety modification for nuclear power units in operation and those under construction, fully enhances nuclear power safety management and improves the capability of response to nuclear accident emergency. In respect of nuclear power development, China sticks to the technical route of "three-step development" of thermal reactor, fast reactor and fusion reactor. Currently, China focuses on the development of million-kilowatt advanced pressurized water reactor, and meanwhile actively develops new technologies like high-temperature gas-cooled reactor, commercial fast reactor and small-scale reactor. Besides, we keep the proper construction pace in order to promote nuclear power construction steadily and orderly, arrange the projects in a scientific manner by conducting comprehensive review on new sites and prioritizing arrangement of coastal sites, and also complete manufacturing equipment independently by use of limited time and existing projects to comprehensively improve the level of equipment manufacturing in China. Furthermore, China accelerates the establishment of modern nuclear power industry system and plans to achieve the development goals of 40 million KW installed capacity for nuclear power units in operation and 18 million KW for those under construction by 2015.

In October 2012, the State Council deliberated and approved "Nuclear Power Safety Program" (2011-2020) as well as the adjusted and improved "Medium and Long-Term Development Plan on Nuclear Power" (2011-2020). It was pointed out in these two plans that China's NPPs would be constructed in accordance with the latest international nuclear safety standards and that no nuclear power projects shall be constructed in inland China during the "12th-Five-Year Plan" period. And as planned for the construction scale of NPPs in two plans, installed capacity of NPPs in

operation would be up to 58 million KW and that of NPPs under construction would be around 30 million KW by 2020.

A.3 Nuclear Safety Policy in China

China insists on developing nuclear power on the premise of ensuring safety and always implements the fundamental principle of "safety first, quality first". While keeping the proper development pace, China insists on synchronous development of nuclear safety supervision and nuclear power industry, sets up the objectives of ensuring nuclear safety, environmental safety and public health, strictly adheres to the basic principles of "preventing first, defending in depth; stressing both the new and old issues, combining prevention with control; relying on science and technology, making continuous improvements; sticking to the rule of law, implementing strict regulation; staying open and transparent and maintaining harmonious development", and completely fulfills the overall requirements of "more strictness, prudence, carefulness and practicality". Besides, China also adheres to independent, open, legal, rational and effective supervision conception and persists in law-based administration, comprehensive integration, invigorating large enterprises while relaxing control over small ones as well as open, transparent and strict supervision.

China attaches importance to strengthening national nuclear safety capacity, continuously increases input for nuclear safety, improves the legal system, improves nuclear safety management mechanism and constantly promotes nuclear safety management level. China also enhances human resource cultivation for nuclear safety by setting up a comprehensive training plan and a diversity training mode. Besides, China strengthens nuclear safety measures, intensifies supervision and inspection to remove potential safety hazards and improve the overall level of nuclear safety. In addition, China is committed to its international obligations for nuclear safety, develops extensively international cooperation in nuclear safety and actively provides nuclear safety assistance for other countries.

In developing nuclear power, China keeps taking regulations as the criterion of nuclear power development, scientific and technological progress as its guide, and

basic capability as its support and will constantly improve the levels of nuclear safety and radioactive contamination prevention and control to ensure nuclear safety, environmental safety and public health and to continually promote safe, sound and sustainable development of nuclear energy utilization on the basis of further clearly defining responsibilities, optimizing mechanisms, implementing strict management and continuously removing potential hazards.

In May 2012, "The 12th Five-Year Plan on Nuclear Safety and Radioactive Contaminant Prevention and Long-range Objectives in 2020" (hereinafter referred to as "Nuclear Safety Program") was approved and released by the State Council. "Nuclear Safety Program" is implemented under organization by Ministry of Environmental Protection (MEP) together with other competent departments.

Based on results of nationwide comprehensive safety inspection on nuclear facilities and those of daily safety assessment conducted continually, "Nuclear Safety Program" gives an in-depth analysis of existing weaknesses in current work relating to nuclear safety. With the goal of ensuring nuclear safety, environmental safety and public health, the plan puts forward the basic principle for nuclear safety and radioactive contaminant prevention as well as planned objectives in the "12th- Five-Year Plan" period and long-term objectives in 2020 and it also presents an overall plan for 9 key tasks, 5 key projects and 8 safeguard measures.

The overall goal specified in "Nuclear Safety Program" is to further improve safety level of nuclear facilities and nuclear technology devices, to substantially reduce safety risks of radiation environment, to basically build the capability of accident defense, contamination control, scientific and technical innovation, emergency response and safety regulation, so as to ensure sound nuclear safety, environment safety, public health and radiation environment quality. Meanwhile, it puts forward detailed goals in eight aspects, including improvement of safety level of nuclear facilities, improvement of safety level of nuclear technology devices, reduction of safety risk of radioactive environment, accident defense, contamination control, scientific and technical innovation, emergency response and safety regulation.

"Nuclear Safety Program" specifies the detailed goals in eight aspects which are described as follows:

As for improving safety level of nuclear facilities, safety performance indicators of operating nuclear power units should be maintained in good condition and reach internationally advanced level, nuclear incident at level-2 must be avoided and no incident or accident at level-3 or above will happen; newly-built nuclear power units shall be equipped with completed measures to prevent and mitigate severe accidents; probability of annually severe core damage of each reactor shall be lower than 1/100,000, and probability of annual release of large quantity of radioactive substances of each reactor shall be lower than 1/1,000,000; significant potential safety hazards in research reactors and nuclear fuel cycle facilities should be eliminated to ensure operation safety.

As for improving safety level of nuclear installations, license management system for radioisotopes and radiation emitting devices shall be fully implemented; annual incidence of radiation accidents caused by radioactive sources should be below 2.0 accidents per 10,000 sources; severe and extremely serious radiation accidents can be effectively prevented.

As for reducing safety risk of radiation environment, the goal is to basically eliminate safety risk posed by legacy medium- and low-radioactivity waste to a minimum level, to finish decommissioning of some old nuclear facilities, and to basically fulfill the comprehensive treatment of uranium mining and metallurgy environments.

With regard to accident defense, it means to complete safety modification of NPPs in operation and those under construction, research reactor as well as nuclear fuel cycle facilities, and to improve capabilities to withstand external events and prevent and mitigate severe accidents.

As for contamination control, it requires to establish an advanced and efficient radioactive contamination control and waste disposal system that suits the level of

nuclear industry and to basically complete the construction of medium- and low-radioactivity waste disposal sites.

As for scientific and technical innovation, it means to perfect scientific and technical innovation platform of nuclear safety and radioactive contamination treatment, to cultivate a batch of leading intellectuals and to achieve major technological breakthroughs.

As for emergency response, it requires to enhance the capacity of government and each organization at various levels on emergency commanding, responses, monitoring and technical support rendering during an emergency case, to create rescue forces that can be dispatched in a centralized manner in case of a nuclear accident emergency and to enrich emergency supplies and equipment.

As for safety regulation, it means to basically complete the construction of the national technological R&D centers for nuclear and radiation safety regulation, set up the platform for regulatory technical supporting and preliminarily acquire the capacity to conduct relatively independent, relatively complete analysis and assessments, performing checks on calculation results, and experimental verification results. It also requires building a nationwide radiation environmental monitoring network and calls for the capacity of environmental monitoring at both national and provincial levels to 100% meet the relevant capacity building standards.

"Nuclear Safety Program" describes long-range objectives by 2020 for nuclear safety and radioactive contamination prevention: continuously improving safety level on nuclear facilities in operation and those under construction, and striving to achieve the goal of actually eliminating the possibility of releasing massive radioactive substances by way of design from new nuclear power units constructed in the "13th Five-Year Plan" period and afterwards; carrying out comprehensive radioactive contamination treatment, achieving remarkable effect in decommissioning of early nuclear facilities, basically eliminating the safety risk posed by legacy radioactive waste, and completing the top layer design for high-radioactivity waste treatment and disposal facilities and constructing

underground laboratories; fully completing R&D base of national nuclear and radiation safety supervision technology and nationwide radiation environment monitoring system as well as forming a nuclear and radiation accident emergency response system featuring complete functions, high sensitivity and efficient operation. By 2020, nuclear power safety will reach the internationally advanced level; nuclear safety and radioactive contamination prevention will be improved comprehensively and sound radiation environment will be maintained.

"Nuclear Safety Program" presents an overall deployment of 9 key tasks: firstly, strengthening defense in-depth to ensure operation safety of NPPs; secondly, strengthening modification and improvement to eliminate potential safety hazards of research reactors and nuclear fuel cycle facilities; thirdly, conducting strict safety management and standardizing utilization of nuclear technology; fourthly, strengthening control of uranium mining and metallurgy to guarantee environmental safety; fifthly, accelerating decommissioning of aged facilities and treatment of wastes to reduce safety risks; sixthly, enhancing quality assurance to improve equipment reliability; seventhly, promoting advance of science and technology to realize continuous safety upgrading; eighthly, perfecting emergency system to effectively respond to emergency; finally, reinforcing fundamental capability and improve regulation level.

To achieve planned objectives, "Nuclear Safety Program" gives deployment of 5 key projects, including safety improvement, contamination control, scientific and technical innovation, emergency support and regulation capability building. To improve the effect of implementation of key projects, MEP established a database of key projects together with departments concerned to conduct dynamic management, which shall be implemented in all regions in the form of annual plan under the guidance of competent departments according to functional division. And according to division of powers, governments at all levels shall focus on giving financial support to nuclear safety improvement of non-profit scientific research and education facilities, building of emergency support and nuclear safety supervision capability,

treatment of radioactive contamination to environment, as well as research and development of nuclear safety technology, etc.

To promote timely commencement of key projects and completion of all tasks as scheduled, the Plan also puts forward 8 measures to guarantee achievement of the objectives, including: establishing sound regulations and standards, consolidating security foundation; optimizing management mechanism, improving management and control efficiency; improving policies and systems, remedying the defects; promoting safety culture, improving responsibility consciousness; accelerating personnel training, promoting balanced flow of human resources; enhancing international cooperation, drawing on the advanced experience; deepening public participation, enhancing social confidence; enlarging financial investment, guaranteeing funds support.

A.4 Preparation and Structural Features of the National Report

The report was compiled according to the "Convention on Nuclear Safety" and the "Guidelines Regarding National Reports under the Convention on Nuclear Safety" (hereinafter called the Guidelines), and comprehensively and systematically expounded the series of measures that Chinese government had adopted to strengthen its nuclear safety during the sixth period of China's implementation of the Convention, during which time Chinese government had performed all obligations stipulated in the "Convention on Nuclear Safety".

In terms of structure, the report consists of three parts: introduction, overview and detailed reports. "Introduction" gives a comprehensive and brief description of current situation of the peaceful uses of nuclear energy in China, describes the development status and objective of nuclear power in China and illustrates China's policies and opinions in respect of nuclear safety. "Overview" expounds implementation and promotion of the fifth review results in China. In light of the review at the Second Extraordinary Meeting on "Convention on Nuclear Safety", this part illustrates hot issues and focused areas in nuclear safety during this Implementation of Convention, as well as the latest development of safety

improvements for nuclear power plants in China after the Fukushima Nuclear Accident, including activities carried out by China in respect of strengthening its responses to extremely external disasters, ensuring safety function of nuclear power plants, improving the capability of accident prevention and mitigation, developing probabilistic safety analysis (PSA) and severe accident management research, improving emergency management system for nuclear accident, cultivating nuclear safety culture, etc., as well as other ten safety improvement measures that have been planned by China.

Please refer to the third part "Detailed Reports" for details of the above contents. At the same time, this part shows the implementation of various improvement measures in nuclear power plants in operation and those under construction by including main problems during comprehensive safety inspection on China's nuclear power plants, including prevention and mitigation of severe accident, design basis flood of Qinshan NPP and the influence of tsunami on China's NPPs. "Detailed Reports" covers from Chapter 6 to Chapter 19 of the report and is prepared according to contents of Article 6 to Article 19. All sections of this part begin with the original text of "Convention on Nuclear Safety" and expound how to fulfill obligations specified in "Convention on Nuclear Safety" by Chinese government through presentation of requirements of laws and regulations, important activities, practices and corresponding progresses.

In the report, data concerning nuclear power plants in Taiwan Province of China are not available.

B. OVERVIEW

B.1 Summary on the Fifth Implementation of Convention

With a view to strictly performing commitments in the "Convention on Nuclear Safety" and obligations of contracting party prescribed in the Convention, Chinese government has set up Chinese Implementing Group of the "Convention on Nuclear Safety", which is in charge of organizing and coordinating China's implementation of the Convention and ensures that the requirements to the contracting parties made by the Convention and that all resolutions made in the previous review meetings related to the national reports under the "Convention on Nuclear Safety" will be fulfilled.

In September 2010 and April 2012, China submitted "The Fifth National Report of the PRC under the 'Convention on Nuclear Safety'" and "National Report of the PRC for Extraordinary Meeting on Fukushima Nuclear Accident under 'Convention on Nuclear Safety' respectively. In the meantime, all written questions raised to China on the fifth national report by other contracting parties were well addressed.

In the fifth review meeting of the Convention, contracting parties seriously reviewed China's implementation of convention by means of report review, site statement and question answering, and spoke highly of the practices and progresses made by China since last review meeting in the development of nuclear safety laws and regulations system, capacity building of nuclear safety supervision and management, establishment of nuclear accident emergency system and capacity, technical improvement of NPPs, application of probabilistic safety analysis technology, aging management, training of human resources, etc.

The peer review meeting of contracting parties considered that they were good practices of China NPPs to actively keep in touch with foreign nuclear power operators and suppliers of their import NPPs, continuously improve technical cooperation with relevant foreign organizations, improve the new NPPs according to actual conditions and apply the experience in existing NPPs. The peer review

meeting showed great attention to the changes of nuclear power regulation system in China during the fifth implementation of convention.

The peer review meeting affirmed the achievements made in China in nuclear safety area, including: MEP (NNSA) accepted the IRRS mission performed by IAEA in 2010; NPPs accepted 5 times of international peer reviews (IAEA OSART and WANO peer reviews) during the three years of the fifth implementation of convention; Large-scale Class III emergency drill of national level was organized and implemented and China participated in international emergency drill; 29 times of refueling overhaul & inspection were completed during the fifth implementation of convention; some NPPs had formulated and implemented aging management program; Qinshan NPP smoothly implemented several technical modifications including "replacing of pressure vessel closure head and relevant component system" and "I&C comprehensive modification" (reactor protection system and relevant equipment); Qinshan NPP and Daya Bay NPP had completed the first PSR with review results applied into safety improvement; China had launched active personnel recruitment and training plans to carefully select talents with related professional experience and arrange trainings at home and abroad.

In the meantime, the peer review meeting also pointed out the challenges China is confronted with and the fields which need to be further improved, including:

(1) Human resources: the development of China's nuclear power requires a large number of professionals to engage in scientific research, design, fuel, manufacturing, operation and maintenance, engineering, nuclear and radiation safety, operation management, etc. In the meanwhile, the development of nuclear energy and technology in China also requires strengthening the development of regulatory team.

(2) R&D and design capabilities: Although China has laid a foundation in R&D of nuclear power technology and engineering design, certain gap still exists in the mastering of key design technologies for million-kilowatt NPPs and independent innovation, which needs further improvement.

(3) Equipment manufacturing capability: China has made great progress in nuclear power equipment manufacturing in recent years, but the manufacturing of main pumps, some key nuclear pumps, some nuclear valves, reactor internals, heavy castings and forgings, heat transfer pipe of steam generator, nuclear instruments and meters, some special materials, etc. still need to be further improved.

(4) Strengthening of nuclear safety regulation capability: The situation of importing from different countries, having various reactor types and coexisting of multi-class standards and technologies has long existed ever since the beginning of nuclear power industry in China, which brings challenges to the nuclear safety regulation. Despite the improvement in recent years, along with the construction of passive advanced PWR (AP1000) and European pressurized water reactor (EPR), further requirements on technical capability are raised for nuclear safety regulation, including reinforcement of the regulation team and increase of financial investment into scientific research and routine work of nuclear safety regulation.

(5) Regulations and standards system: Following the development and changes of international nuclear safety standards and practices, introduction of new technologies and requirements of independent NPP construction in China, the existing articles and safety regulations should be supplemented and modified accordingly, and the supporting guidelines should be updated, revised and supplemented timely. In the process of China's nuclear power autonomous development, standard system of nuclear power design, equipment manufacturing, construction, and operation management should be gradually set up to meet the demand of continuous nuclear power development in China.

The review meeting affirmed the following measures that Chinese government plans to take so as to further improve nuclear safety:

(1) In the area of revision and perfection of nuclear safety-related laws and regulations, China will further strengthen special legislation on nuclear safety, prepare five-year plans according to laws and regulations, and phase system development of nuclear safety regulations and standards with emphases.

(2) In the area of human resources, confronted with the current situation of having various reactor types and multinational technologies, Chinese government plans to reinforce the organization and staffing for the rapid development of nuclear power. By making full use of the experience and technologies of related institutions and personnel at home and abroad, the government will train and strengthen the nuclear safety regulatory capability through bilateral or multilateral cooperation.

(3) With emphases on improvement of nuclear safety review, independent verification and testing, R&D and regulatory capabilities, Chinese government will improve the regulatory capability of NPPs safety, regulatory capability of nuclear safety equipment, monitoring capability of radiation environment, regulatory capability of radioactive materials transportation, regulatory capability of safe disposal of radioactive waste and regulatory capability of nuclear technology utilization. Besides, China will develop new regulation technologies and information system to improve the effectiveness of nuclear safety regulation. Chinese government is continuously improving the technical capability in nuclear safety supervision and management.

(4) In terms of aging management in NPPs, Qinshan NPP and Daya Bay NPP are planning to carry out aging management and assessment on important equipment step by step on the basis that their aging management had undergone the PSR period. Lingao NPP, Qinshan Second NPP, Qinshan Third NPP and Tianwan NPP are preparing for PSR as planned.

Considering that China's new nuclear power projects have adopted various technologies, the peer review suggests that China more actively participate in international cooperation projects, such as multinational design evaluation program.

B.2 Subjects of the Report

B.2.1 Challenges during the Implementation of Convention

According to "Nuclear Safety Program", "Nuclear Power Safety Program" (2011-2020) and "Medium and Long-Term Development Plan on Nuclear Power

(2011-2020)", the challenges China faces in nuclear safety mainly include the following items during the implementation of convention:

- Improving the system of nuclear safety laws and regulations;
- Improving and implementing nuclear safety standard requirements;
- Strengthening the capability building of nuclear safety regulations;
- Implementing safety improvement measures after Fukushima Nuclear Accident;
- Improving R&D of nuclear safety technology and technological innovation;
- Establishing national nuclear emergency response team.

B.2.2 Activities carried out and Planned for Safety Improvement

(1) Revision and Improvement of Nuclear Safety Laws and Regulations

China actively carries out special legislation on nuclear safety, continuously improves standard system framework of nuclear safety regulation, accelerates the formulation and revision of nuclear safety regulation standards and strengthens the cohesion of relevant industrial standards and guidelines for nuclear safety regulations. Besides, China enhances nuclear safety management and policy research.

In May 2010, MEP (NNSA) issued the "Nuclear and Radiation Safety Regulations System (Five-Year Plan)" to instruct the formulation and revision of nuclear and radiation safety regulations. After the Fukushima Nuclear Accident, China actively participated in formulating international nuclear safety standard. Based on in-depth analysis on and experience from Fukushima Nuclear Accident and considering the current situation of China's existing nuclear safety regulations system, China has optimized a series of laws and regulations. According to an in-depth analysis on Fukushima Nuclear Accident, China has summarized 26 aspects for deliberation in the process of revising its nuclear power regulations, mainly involving 5 aspects: nuclear safety management system, plant site safety, design safety, operation management and emergency response. Based on the summary above, China has formulated "Action Plan for Safety Regulations Formulation and Revision of China's NPPs after Fukushima Accident".

(2) Capacity Building and Enhancement of Nuclear Safety Supervision and Management

Chinese government keeps reinforcing the capacity building of nuclear safety supervision and management by increasing input, improving scientific research system, conducting international cooperation, strengthening regulatory team and other means. By constructing the R&D base of national nuclear and radiation safety regulation technology, providing necessary research tools and technical equipment and improving the capabilities of analysis and evaluation on nuclear and radiation safety as well as check calculation and experimental verification, the government keeps strengthening the basic capacity building of nuclear and radiation safety supervision. By strengthening the construction of national radiation monitoring network and improving national radiation environment quality monitoring, monitoring of pollution sources and radiation environment emergency monitoring system, China has continuously improved its emergency monitoring capability on radiation environment of nuclear accidents.

(3) Improvement of NPPs' Safety Level

In accordance with the results and improvement requirements of comprehensive safety checks, China's NPPs in operation and under construction have taken effective measures in terms of technology, management, engineering, etc. to continuously strengthen the safety level of the existing NPPs and improve the capability of preventing and mitigating severe accidents through technology upgrading, engineering reconstruction and optimization of operational experience feedback system.

China's in-service NPPs have carried out safety analysis, technical assessment and engineering reconstruction to cope with possible accidents and severe accidents, formulated corresponding management provisions and response plans, carried out PSR and strengthened equipment maintenance management and safety culture cultivation.

In line with China's current nuclear safety regulations and the latest IAEA standards, the NPPs under construction have reexamined the design safety level, making sure all requirements for license fulfilled prior to the initial charging. The overall and all-dimensional control on the quality and safety of nuclear power project construction is exercised, the independent third-party supervision in place, the access system of nuclear power construction team carried out, professional level and the quality assurance system of nuclear power project construction improved. Meanwhile, we strengthen the commissioning supervision and strictly implement the incident reporting system and the management system of nonconformities.

Those new nuclear power projects applying for construction permits will have to conduct siting and design in line with the latest nuclear safety regulations and standards of China and IAEA, and select advanced reactors with more mature technology so as to improve inherent safety. Until the nuclear power technology has its latest safety indicators fully verified will the scale and speed of nuclear power construction be under proper control.

(4) Enhancement and improvement of nuclear safety technology R&D and scientific innovation capability

China encourages nuclear power-related enterprises to carry out nuclear safety technology innovation and enhance the development and application of new technologies and processes. China supports basic capacity building in nuclear safety technology R&D institutions and sets up R&D platform of nuclear safety-related technologies by fully integrating and utilizing the existing research resources and major special project channels.

China actively promotes safety technology and scientific research and results application of major projects, such as large pressurized water reactor and high temperature gas-cooled reactor, with emphasis on technical research of the fields such as reactor safety, safety of nuclear power plant site, measures of preventing and mitigating flyers crashing nuclear power plants, quality reliability of nuclear safety equipment, radioactive materials transportation and physical protection, radiation

environment impact assessment and radiation exposure control, radioactive waste treatment, NPP decommissioning safety, etc. Meanwhile, China carries out targeted technical R&D through mechanism research, R&D of key equipment, typical site analysis and core safety technology level, etc. so as to transform the experience feedback of Fukushima Nuclear Accident into advanced nuclear power safety technology which can improve the safety of Chinese nuclear power units and resistance against extreme disasters. China has launched R&D of passive emergency power supply (high-capacity energy storage system) and high elevation cooling water source system; research and experimental verification on severe accidents prevention and mitigation of NPPs; analytic research of seismic ability improvement and beyond design basis seismic margin for China's existing upgraded NPPs; research on external flooding of beyond design basis and research on prevention and mitigation measures for spent fuel melting accidents in NPPs; development of emergency rescue robots for severe accidents and other first batch of R&D programs.

(5) Consummation of nuclear accident emergency system

China has established the three-tier organization and management system of nuclear accident emergency. Years of practice has proved the fact that: Chinese existing nuclear accident emergency system is effective. However, Chinese government has also realized that it is necessary to improve nuclear accident emergency response mechanism and enhance the response capability.

In light of the problems related to emergency preparedness and responsiveness disclosed in comprehensive safety check, competent departments are carrying out improvement measures actively (see Chapter 5 in "National Report of the PRC for Extraordinary Meeting on Fukushima Nuclear Accident under 'Convention on Nuclear Safety'"). By the end of 2012, China has completed the revision and evaluation of nuclear accident emergency plans (contingency plans) of various levels and types; improved the contents of recovery action after termination of emergency status; enhanced emergency exercises/drills; carried out researches on emergency supplies and equipment deployment demands for national nuclear and radiation

accidents; reasonably specified the range of nuclear accident emergency planning zones for NPPs. Besides, China has strengthened the capacity building of emergency command, response, monitoring and technological support by local governments, made the emergency responsibilities of nuclear power corporations and improved their internal emergency support system.

In view of long-time blackout for the whole plant and accidents occurring with multi-units in one plant site, China plans to further improve emergency plans, adjust and enrich local emergency response capability of NPP operating units and strengthen the coordination of on-site and off-site emergency plans based on a reevaluation of the on-site emergency capability of various NPPs.

(6) Human resources development

Considering the status quo of Chinese nuclear electricity development and the possible talent shortage as a result of future development of nuclear power, China is constantly modifying and improving the human resource guarantee plan. Through intensifying training efforts and improving the training system, the talent education and training system involving the government, colleges, social training institutions and employing organizations has been set up.

China is now constructing and expanding nuclear power training facilities. New employees are trained through enterprise-university cooperation programs. Simulator training resources of all NPPs are coordinated and improved to ensure sufficient time for the first batch of operators of a new project. Human factor training laboratories are set up to train key personnel and improve their performance. Various NPPs and engineering companies are encouraged to include contractors, suppliers and other entities in their own training programs. Intensified efforts are made to ensure effective work of contractors. China is also bettering the system of registered nuclear safety engineers, strengthening further education and training of personnel in key positions of nuclear safety and optimizing qualification management and training systems of nuclear safety inspection and review personnel.

China plans to achieve intensification and scale effect of personnel training through constructing better infrastructure for training. Through reinforcing nuclear safety-related discipline development in colleges, NPPs have consolidated links with higher institutions and the industry so as to quicken the steps in fostering professionals badly in need.

(7) Public participation and information disclosure

Chinese government constantly engages the public in nuclear power construction projects, strengthen information transparency and better relevant mechanisms.

China has set up systems of information disclosure and public engagement. Competent departments are equipped with corresponding personnel and materials. Ministry of Environmental Protection (MEP) (NNSA) has formulated and released "Working Procedures for Nuclear and Radiation Safety Information Disclosure", "MEP (NNSA) Contingency Plan for Public Opinion Monitoring and Nuclear and Radiation Safety", "Notice on Strengthening Publicity and Information Disclosure of Nuclear and Radiation Safety", "MEP (NNSA) Program of Nuclear and Radiation Safety Control Information Disclosure (Trial)" and "Notice on Strengthening Nuclear and Radiation Safety Information Disclosure of NPPs", "Information Release Working Program for Guangdong and Hong Kong in Case of Incidents under Emergency State Occurring to Daya Bay NPP Base" and "Regulations for Nuclear and Radiation Safety Information Disclosure of NPP Operating Units" and other working documents, to further specify information disclosure and public engagement systems. NPPs operating units have also released corresponding nuclear and radiation safety information reports and disclosure systems, with information disclosure platforms established for the public.

The "Nuclear Safety Program", when completed, was released to the public to solicit opinions of all parties. Opinions of the public were solicited by means of hosting press conferences of related parties, publishing contents and readings of "Nuclear Safety Program" on newspapers, holding forums of public opinions collected on website, professional meetings and forums of academicians, sending letters to

people's governments at the provincial level to gather public opinions, etc. Altogether 621 opinions and suggestions were received, including those in official letters sent by provincial people's governments (autonomous regions and municipalities), nuclear enterprises and groups, nuclear-related research institutes and social organizations, netizens' suggestions from interactive platform of the MEP's website, opinions in emails sent from private mailboxes, written proposals of professionals, etc. On the whole, all walks of life spoke highly of the action of seeking public opinion on the "Nuclear Safety Program" and thought it showed that the Party Central Committee and the State Council attached great importance to nuclear safety, which could effectively enhance public confidence in nuclear safety and improve government credibility. And the "Nuclear Safety Program" was generally accepted by all sectors of society, so no changes in principle had been made and only some details were modified according to feedbacks. Besides, popularization and implementation of "Nuclear Safety Program" were carried out in time to promote the fulfillment of the Program, and the popularization and implementation meeting of "Nuclear Safety Program" was held in Beijing on December 11.

China plans to set up more extensive contact channels for information disclosure and public participation. Briefings of nuclear power safety situations participated by social media will be held regularly to increase the degree of public participation in siting, design, construction, operation and other stages of an NPP; special areas on nuclear power safety in science museums above provincial level will be established to spread the awareness of nuclear power science; publicity of nuclear power safety will be well conducted via mass media such as TV and broadcast; and open day activities of NPPs will be held for the public.

(8) International exchange and cooperation

China attaches great importance to international exchange and cooperation in the field of nuclear safety and proactively develops multilateral, bilateral and regional international cooperation on nuclear safety. During Fukushima Nuclear Accident, departments of Chinese government kept close contact with international

counterparts such as Japan, USA and France, to exchange and share information and experience and report related information to IAEA timely.

Through international cooperation, China has closely followed international experience feedbacks and actions taken after the Fukushima Accident, and actively participated in the research and formulation of international nuclear safety standards; actively participated in Multinational Design Evaluation Program (MDEP); strengthened information exchange and regulatory cooperation with exporting countries in terms of new-type NPPs, including AP1000 of USA, EPR of France, VVER of Russia. By increasing input, China actively develops cooperation research project on nuclear power safety with developed countries. Besides, Chin has taken an active part in peer review, experience exchange and international training concerning nuclear power safety, including exchange and discussion with international organizations of IAEA, WANO and countries (or regions) like USA, France, Japan, Russia, South Korea.

China plans to develop more international exchanges and cooperation in sharing nuclear safety experience and capability, nuclear accident information report, international cooperation systems and mechanisms of nuclear safety, etc., so as to promote the nuclear power safety technology.

B.2.3 International Peer Review Activities, Main Results and Follow-up Action Plans accepted and carried out during this Implementation of Convention

At the request of Chinese government, IAEA dispatched a review team to conduct the Integrated Regulatory Review Service (IRRS) mission on China from July 19 to July 30, 2010. This was the third peer review on effectiveness of China nuclear and radiation safety regulation by IAEA since 1990.

This review team consisted of 22 experts from IAEA and 15 member states. It was carried out mainly based on the latest framework requirements of nuclear and radiation safety regulations issued by IAEA, which represented the latest standard of nuclear and radiation safety regulation system in international society. The review

mainly covered responsibilities and functions of the government, global safety regime as well as responsibilities and functions, management system, activities of regulatory bodies including licensing, review and assessment, inspection, enforcement, laws, regulations and guides, also including emergency preparedness and response. The IRRS review team identified the following good practices:

— The Medium and Long-Term Development Plan of Nuclear Power (2005-2020) issued in October, 2007 and the Plan for Nuclear Safety and Radioactive Pollution Prevention (2006-2020) issued in 2007 include a clear-cut nuclear safety policy statement - adhering to "safety first" principle and committed to strengthening supervision of nuclear safety and its enforcement;

— MEP (NNSA) has made available the basic conditions covering, inter alia, organizational, resource and safety culture factors for companies wishing to acquire a license to have access to Chinese nuclear market;

— MEP (NNSA) recommendations for universities and engineer training in some professional areas are very useful;

— Qualification and registering of nuclear safety engineers in China;

— China has made in recent years the authorization procedures and regulations for Chinese organizations engaged in nuclear safety equipment. The regulatory supervision has been strengthened and better organized;

— MEP (NNSA) training program for inspectors includes simplified reactor behavior simulation training as well as licensee-provided material on site equipment and systems; and

— MEP (NNSA) has initiated periodic meeting mechanism among Chinese nuclear utilities to promote the exchange of important safety-related information.

Meanwhile, the review team also identified some priority issues in need of improvement, mainly touching upon formulation and improvement of nuclear safety laws and regulations, development of finance, human resources and technical capacity for nuclear safety regulation, improvement of effectiveness of nuclear safety

regulation coordination mechanism, strengthening of independent verification of safety assessment and experience feedback, etc.

From 2010 to 2012, Chinese NPPs had altogether accepted six times of WANO peer reviews and two WANO peer review follow-up visits. In light of areas needing improvement (AFIs) revealed in peer reviews, all NPPs timely carried out corrective actions. In addition, WANO carried out pre-startup peer review for Yangjiang NPP in July, 2012. While accepting international peer reviews, Chinese NPPs also conducted national assessments of different levels. Please refer to Chapter 14.2.6 in this report for details.

B.2.4 Safety Improvement of Chinese NPPs after Fukushima Nuclear Accident

After the Fukushima Nuclear Accident took place, Chinese government attached great importance to nuclear power safety and the State Council held an executive meeting to make work arrangements to ensure NPPs' safety. The NNSA and the nuclear power industry took responsive actions immediately:

— Conducting comprehensive safety checks on NPPs;

— Conducting safety margin assessment on external events of NPPs in operation;

— Drafting the "Nuclear Safety Program" and "Nuclear Power Safety Program" and revising the "Medium and Long-Term Development Program on Nuclear Power".

— All NPPs fulfilled requirements of improvement actions after Fukushima Nuclear Accident.

— Studying and drafting safety requirements for newly-built NPPs.

These response actions have been completed in general. The "Nuclear Safety Program" is described in Chapter B.2.2 of the Report and other improvement actions are described in Chapter 20.

6. EXISTING NUCLEAR POWER PLANTS

> Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1 List of Existing Nuclear Power Plants

Up to Dec. 31, 2012, there were 15 units in commercial operation and 30 units under construction in China. Cumulatively, construction permits of 11 units had newly been issued within the three years from 2010 to 2012. The list of existing nuclear power plants is shown in Appendix 1. The distribution of China's NPPs is shown in Figure 1.

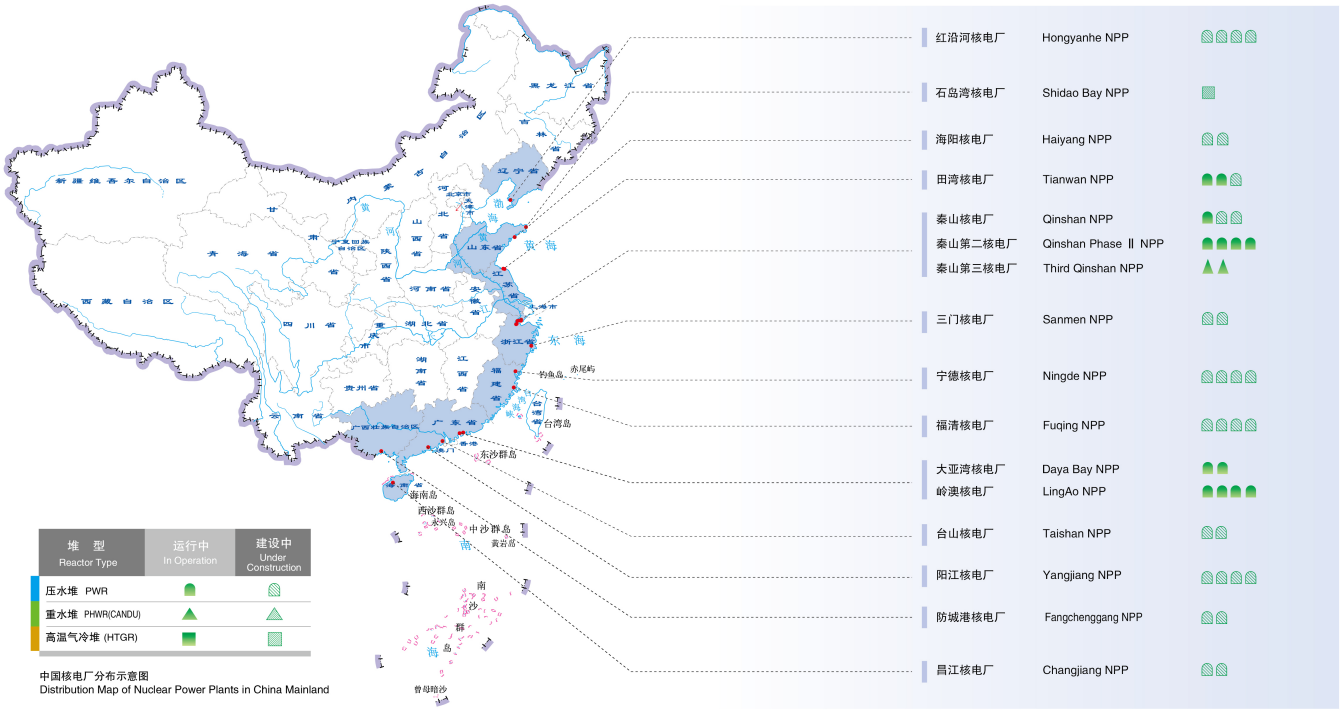

Figure 1 China's NPPs Distribution

6.2 General Situation of Existing NPPs

The light-water Pressurized Water Reactor (PWR) predominated in China's existing NPPs. Third Qinshan NPP is Pressurized Heavy Water Reactor (CANDU-6), and Shidao Bay NPP Demonstration Project is Graphite Pebble Bed High-temperature Gas-cooled Reactor.

China's NPPs in commercial operation maintained in safe and steady operation, including Qinshan NPP, Daya Bay NPP, Qinshan Phase II NPP Unit 1, Unit 2, Unit 3 and Unit 4, LingAo NPP Unit 1, Unit 2, Unit 3 and Unit 4, Third Qinshan NPP and Tianwan NPP Unit 1 and Unit 2, and have created favorable social and economic benefits. Except Qinshan NPP Phase II Unit 3 and Unit 4 and LingAo NPP Unit 3 and Unit 4, the circumstances of the above-mentioned NPPs have been expounded in the 4th and the 5th national reports. This chapter only describes the circumstances of Qinshan Phase II NPP Unit 3 and Unit 4 and LingAo NPP Unit 3 and Unit 4 as well as units under construction.

Several necessary improvements were taken for Qinshan Phase II NPP Unit 3 and Unit 4 and LingAo NPP Unit 3 and Unit 4 to improve safety performance of the units, which were resulted from the operating experience of their reference units of Qinshan Phase II NPP units1&2 and LingAo NPP Unit1&2 respectively, and international similar units. Moreover, several important improvements, including improvement of capability to prevent and mitigate severe accidents were taken during design of Qinshan Phase II NPP Unit 3 and Unit 4. Applicable safety improvements of internationally similar units were adopted for LingAo NPP Unit 3 and Unit 4, such as equipped with passive hydrogen recombiner for hydrogen generated from 100% reactor core zirconium-water reaction and applied function extension of relief valves of pressurizer against high-pressure core melting for further improving capability to prevent and mitigate severe accidents.

Among 30 nuclear power units being under construction at the present in China, 22 units adopted the million-kilowatt improved pressurized water reactor nuclear power unit, one unit adopted VVER technology, four units adopted AP1000 technology, two

units adopted EPR technology and one unit adopted graphite pebble bed high-temperature gas-cooled reactor technology.

Hongyanhe NPP Unit 1, Unit 2, Unit 3 and Unit 4, Ningde NPP Unit 1, Unit 2, Unit 3, and Unit 4, Yangjiang NPP Unit 1, Unit 2, Unit 3 and Unit 4, Fuqing NPP Unit 1, Unit 2, Unit 3 and Unit 4, Extension Project of Qinshan NPP (Fangjiashan nuclear power project) Unit 1 and Unit 2, Changjiang NPP Unit 1 and Unit 2 and Fangchenggang NPP Unit 1 and Unit 2 all adopted million-kilowatt improved pressurized water reactor nuclear power unit, and Tianwan NPP Unit 3 all adopted VVER type nuclear power unit. These units were designed on the basis of reference NPPs which had successful experience and good performance. Furthermore, some necessary improvements have been conducted to further enhance the inherent safety characteristics of the NPPs.

Sanmen NPP Unit 1 and Unit 2 and Haiyang NPP Unit 1 and Unit 2 adopted AP1000 technology. Taishan NPP Unit 1 and Unit 2 took the path of EPR technology. ShidaoBay NPP Demonstration Project adopted graphite pebble bed high-temperature gas-cooled reactor technology.

6.3 Safety Status of NPPs in China

Based on constantly summing up its own experiences, China paid attention to assimilating internationally advanced experiences and established nuclear power safety management system in conformity with circumstances of China. The Chinese government and NPP operating organizations adheres to the principle of "Safety First", strengthens surveillance and management of safety for operation units, attaches high importance to safety management and quality control for units under construction , and gained a series of results.

During the three years, there were 72 operating events at INES level-0 that occurred in Chinese NPPs, two operating events at INES level-1 and no operating events at INES Level-2 or above. See Appendix 7 for events statistics.

In China, all commercial operating NPPs have been established and step by step perfected their respective performance indicator systems. They periodically submit

related data to the MEP (NNSA), the nuclear industry administration departments and international organizations such as the IAEA and the WANO, etc. at their request. According to WANO performance indicators, Chinese nuclear power units in operation are generally at a better international level, and some units have reached international advanced level with some units among the best. The WANO performance indicators of all operating NPPs in China from 2010 to 2012 are listed in Appendix 2, these data presented a good overall trend within three years, and some of the performance indicators in Appendix 2 have ranked best quartile in all WANO nuclear power units.

7. LEGISLATION AND REGULATION

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

2. The legislative and regulatory framework shall provide for:

(i) The establishment of applicable national safety requirements and regulations;

(ii) A system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;

(iii) A system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licence;

(iv) The enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

7.1 Structure of Legislation and Regulation

Since 1982, China has collected extensively and studied carefully the laws and regulations on nuclear safety used in nuclear power developed countries, consulted the nuclear safety codes and guides of the IAEA and established the Chinese nuclear safety regulation system step by step. With continuous increase of operating Chinese NPPs, China has cumulated actual experience on nuclear power siting, design, construction, commissioning, safety operation and other aspects. With combination of the newest requirements of international nuclear industry, China continually improves its system of nuclear safety laws and codes.

7.1.1General Description of Nuclear safety Laws, Codes and Guides

The system of laws, regulations and guides on nuclear safety of China consists of laws, administrative regulations, department rules, guiding documents and reference documents.

(1) Laws

The laws applicable to nuclear safety field in China are enacted by the National People's Congress and its Standing Committee and have legal effects higher than administrative regulations and department rules.

(2) Administrative regulations of the State Council

Regulations on nuclear safety, which have legal binding effects, are administrative regulations of the State Council and are promulgated by the State Council according to the Constitution and laws. The existing administrative regulations applicable to nuclear safety field are regulations to stipulate the scope of nuclear safety management, administrative organization and its rights, principles and procedures of surveillance and other important issues.

(3) Department rules

The nuclear safety codes and the detailed rules are department rules; they are prepared and promulgated by related departments of the State Council within extent of their authority according to the laws and the administrative regulations of the State Council and have legal binding effects. Nuclear Safety Codes are department rules enacting nuclear safety objectives and basic safety requirements, and the detailed rules are departmental rules which stipulate specific implementing measures according to these regulations on nuclear safety management.

(4) Guiding documents

Nuclear safety guides, which are prepared and promulgated by related departments of the State Council, are guiding documents that explain or supplement nuclear safety codes and recommend relevant methods or procedures to implement safety code.

(5) Reference documents

Nuclear safety technical documents are reference documents in the technical fields of nuclear safety, and are promulgated by related departments of the State Council or its entrusting party.

The hierarchy of nuclear safety laws, codes and guides is listed in Figure 2.

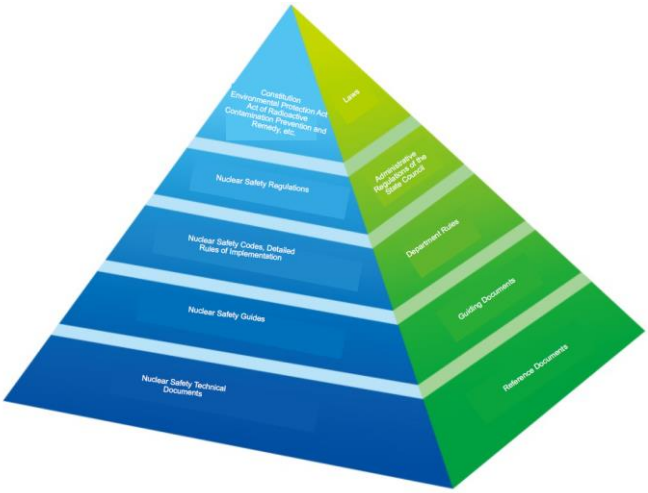

Figure2. The hierarchical structure of laws, regulations and guides on nuclear safety of China

7.1.2Issued Laws, Regulations and Guides on Nuclear and Radiation Safety

The Chinese government always attaches high importance to nuclear safety. Since October 1986 when the State Council promulgated the "Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China", China has already enacted a series of laws, regulations and guides which cover NPPs, other reactors, installations for nuclear fuel production, processing, storage and reprocessing, and facilities for radioactive waste processing and disposal, etc. All these formed an available law system that shall be obeyed by nuclear installations in siting, design, construction, operation and decommissioning.

The "Environmental Protection Act of the People's Republic of China" was approved by the Standing Committee of the National People's Congress in 1989. It is the specific law for protecting and improving the living environment, preventing and remedying contamination, guaranteeing human health and promoting social development. The "Law on Environmental Impact Assessment of the People's Republic of China" was approved by the Standing Committee of the National People's Congress in 2002. The "Act of Prevention and Remedy of Radioactive Contamination of the People's Republic of China" was approved by the Standing Committee of the National People's Congress in 2003. This Act is applied to prevent environment contamination caused by discharges of radioactive gas, liquid, solid waste and penetrating radiation during the nuclear energy development, nuclear

technology application, uranium (thorium) mining and associated mineral resources' exploitation and application. The purpose of the Act is to protect environment and health of the public.

The State Council promulgated the "Regulations on the Safety Regulation for Civilian Nuclear Safety Installations of the People's Republic of China" and the "Regulations on Nuclear Materials Control of the People's Republic of China" in 1986 and 1987 respectively. These regulations systematically stipulated the purpose and the scope of surveillance of NPPs and nuclear materials, established nuclear safety licensing system, specified rules for regulation of nuclear materials, defined the duty of regulatory bodies and the legal responsibility of operating organizations. In 1993, the State Council promulgated the "Emergency Management Regulations of Nuclear Accidents at Nuclear Power Plant", which stipulates principles, countermeasures, and measures adopted for nuclear accident emergency. In 2007, the State Council promulgated "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment", which stipulates standards, licensing system and requirements of quality assurance followed by such activities as design, manufacture, installation and non-destructive testing of civilian nuclear safety equipment and import and export management of civilian nuclear safety equipment. In 2009, the State Council promulgated "Regulations on the Safe Transportation of Radioactive Material". And in 2011, the State Council promulgated "Regulations for the Safety Management of Radioactive Waste".

Since 1986, according to different technical fields, the MEP (NNSA) and the related departments have promulgated in succession a series of nuclear safety codes and detailed rules related to siting, design, operation and quality assurance of NPPs. China Atomic Energy Authority (CAEA) and the Ministry of Health have also promulgated some department rules.

In addition, the related departments correspondingly formulated relevant nuclear safety guides. Based on implementations, supplement and revision have been made

for the issued codes and guides. Therefore, a relatively complete system of regulations and rules on nuclear safety has been formed.

Existing laws, regulations, guides on nuclear safety in China are listed in Appendix 3.

7.1.3Newly Issued Laws, Regulations and Guides on Nuclear Safety during this Implementation Period

During this implementation period, China has promulgated a series of new laws, regulations and guides, the related activities are as follows:

— In May 2010, the MEP (NNSA) promulgated the "Standard Format and Content of Safety Assessment (Analysis) Report of Design for Transport Cask of Radioactive Material" (HAD701/01-2010).

— In August 2010, the MEP (NNSA) promulgated the "Emergency Preparedness and Emergency Response of Operating Organization of Nuclear Power Plant" (HAD002/01-2010) and "Emergency Preparedness and Emergency Response of Operating Organization of Nuclear Fuel Circulating Facilities" (HAD002/02-2010).

— In March 2011, the MEP (NNSA) promulgated the revised "Regulations for Environmental Radiation Protection of Nuclear Power Plant" (GB6249-2011).

— In December, 2011, the State Council promulgated the "Regulations for the Safety Management of Radioactive Waste".

— In May 2012, the MEP (NNSA) promulgated the "Nuclear Power Aging Management" (HAD103/12). According to the status and demand of nuclear power development, China has been making further formulation, revision and perfection of nuclear safety regulations: One department rule, four guides and one technical document, such as "Rules on Management of Storage and Disposal of Radioactive Solid Waste", etc. have been submitted for approval; revision and perfecting also have been started for code on the "Safety of Nuclear Power Plant Quality Assurance", supporting documents of "Regulations on the Safe Transportation of Radioactive

Material", code on the "Safety of Civilian Nuclear Fuel Circulating Facilities", code on the "Safety Regulation for Radioactive Waste", code on the "Safety of Decommissioning of Nuclear and Radioactive Facilities and Environment Improvement" and other regulations.

7.1.4 Participation relating to International Convention on Nuclear Safety

China has acceded into "Convention on Early Notification of a Nuclear Accident", "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", "Convention on the Physical Protection of Nuclear Materials" and its amendments, "Convention on Nuclear Safety", "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" and other international conventions, and strictly implements the duties under these conventions.

The "Convention on Early Notification of a Nuclear Accident" was put into force in China on October 11, 1987. The Chinese government declared at the same time to be not under constraint of the two kinds of dispute settlement procedures specified in Clause II, Article XI of the convention.

The "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency" was put into force in China on October 14, 1987. The Chinese government declared at the same time to be not under constraint of the two kinds of dispute settlement procedures specified in Clause II, Article XI of the convention. For the "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", the Chinese government declared that: (1) in case of death, injury, loss or damage due to individual gross negligence, Clause II, Article X of the convention is not applicable to China; (2) the People's Republic of China is not under constraint of the two kinds of dispute settlement procedures specified in Clause II, Article XIII of the convention.

The "Convention on the Physical Protection of Nuclear Materials" was put into force in China on January 2, 1989. The Chinese government declared at the same time to

be not under constraint of the two kinds of dispute settlement procedures specified in Clause II, Article XVII of the convention.

On October 28, 2008, China approved amendment of the "Convention on the Physical Protection of Nuclear Materials" which was approved in Vienna on July 8, 2008.

The "Convention on Nuclear Safety" was put into force in China on March 1, 1996.

The "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" was put into force in China on April 29, 2006. The Chinese government declared at the same time that: (1) Government of the PRC understands Item (u) of Article 2 and "cross-border transport" mentioned in Article 27 as: before any contracting party of the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" as the destination country agrees another contracting party to perform cross-border transport of domestic object, it shall confirm that the cross-border transport has been approved by the country of departure. (2) Before further notice of government of the PRC, the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" is not applicable to the Macao Special Administrative Region of the PRC at present.

7.2 Licensing System

China adopts licensing system for nuclear safety.

Nuclear safety license is a law document that is approved by national regulatory body and authorizes applicant to deal with the specific activities related to nuclear safety (such as siting, constructing, commissioning, operation and decommissioning of NPPs, etc.). Only after obtaining relevant license or approval document, the operating organization of NPP is allowed to carry out relevant construction, fuel loading, operation, decommissioning and other activities. By means of license examination and approval, surveillance, enforcement of laws, rewards, sanction and implementation of nuclear safety surveillance relevant to licensee's activities, the

MEP (NNSA) ensures that licensee can bear the responsibilities for nuclear safety and carry out nuclear activities in conformity with legal provisions.

7.2.1Types of Licenses for NPP

Types of licenses for Chinese NPPs include:

(1) Review comments on NPPs siting.

(2) Construction permit of NPPs.

(3) Instrument of ratification for the first fuel loading of NPPs.

(4) Operation license of NPP.

(5) License for operators of NPP.

(6) Instrument of ratification for the environmental impact reports at siting, construction and operation phases of NPPs and the evaluation of harm and effect from occupational diseases.

(7) Other permits subject to be approved which include the instrument of ratification for decommissioning of NPPs, etc.

7.2.2 Issuance of NPP Licenses

The procedures of application and issuance of licenses are shown in Figure 3.

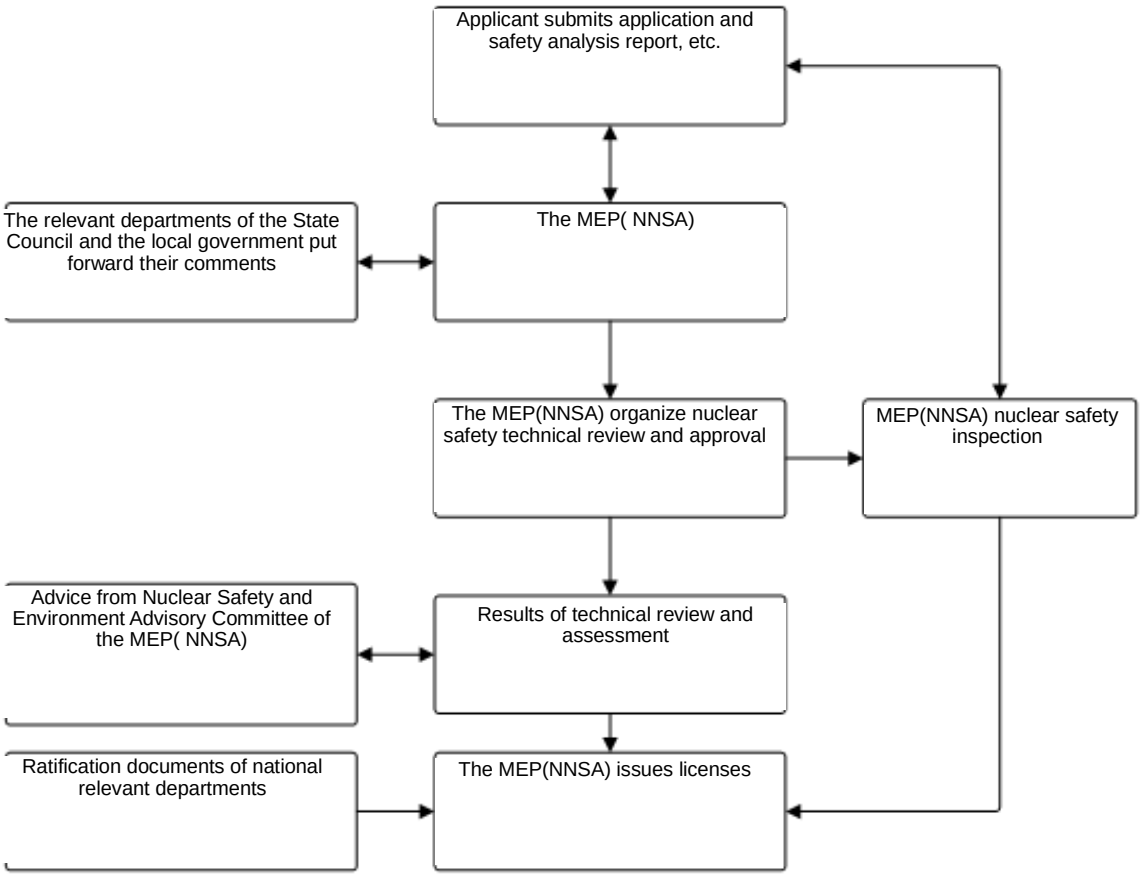

Figure 3 The procedures of application and issuance of licenses

The applicant should submit the application, safety analysis report and other related documents required by the regulations to the MEP (NNSA). Only after appraisal and approval, the applicant is allowed to carry out relevant nuclear activities.

During the process of appraisal, the MEP (NNSA) should ask for opinions of the related departments of the State Council as well as the governments of province, autonomous region or municipality directly under the central government where NPPs are located.

After getting the results of technical appraisal, asking for comments of the related departments of the State Council and local governments, and also seeking advice from the Nuclear Safety and Environment Advisory Committee, the MEP (NNSA) decides independently whether the licenses are to be issued or not, meanwhile the MEP (NNSA) stipulates the essential license conditions.

7.2.3 Nuclear Safety Review and Surveillance System

Nuclear safety review is the technical basis of nuclear safety license system.

In accordance with Chinese laws and regulations for nuclear and radiation safety, operator of NPP shall submit information, the MEP (NNSA) shall organize technical support units to conduct comprehensive review and assessment on the application information submitted by operating organization of NPP, so as to confirm whether the facilities or activities are in conformity with safety goal, principle and guides.

The MEP (NNSA) confirms upon review and assessment:

(1) The existing information proves that the activities proposed by the NPP are safe;

(2) Information submitted by the operator is accurate enough to confirm it is in conformity with surveillance requirement;

(3) Technical solutions, especially new solutions, can reach required safety level upon inspection / test or certification / examination of both.

Issuance of nuclear safety licenses depends on result of nuclear safety review.

Review and assessment of the MEP (NNSA) cover the whole activities in the life-time of the NPP, such as NPP siting, construction, non-conformance item control during construction, commissioning program, plan, setting of control points for commissioning, first fuel loading, operation, modification during operation, refueling safety analysis report, PSR, decommissioning etc. In order to normalize nuclear safety surveillance and inspection activities during operation stage of NPP, the MEP (NNSA) developed the safety surveillance and inspection program of nuclear power plant, which is applicable to the whole operation stage of the NPP from first fuel loading to decommissioning.

Nuclear safety regulations require operating organization of NPP must review operation status of the NPP periodically and submit specified documents and information for review by the MEP (NNSA) to ensure reference for issuance of license is still invalid.

By means of license examination and approval, surveillance, enforcement of laws, rewards, sanction and implementation of nuclear safety surveillance relevant to licensee's nuclear safety activities, the MEP (NNSA) ensures that licensee can bear

the responsibilities for nuclear safety and carry out nuclear activities in conformity with legal provisions.

The MEP (NNSA) and its accredited regional offices send regional inspection groups (inspectors) to the site of plant siting, construction and operation of NPPs to exercise the following duties:

(1) Examine whether the information submitted conforms to actual situation;

(2) Inspect whether the construction is carried out in accordance with the approved design;

(3) Inspect whether the management is performed in accordance with the approved quality assurance program;

(4) Inspect whether t the construction and operation of the NPPs in accordance with the nuclear safety regulations and the conditions specified in the licenses;

(5) Investigate whether the operating organization has an adequate capability for safety operation and carrying out emergency response plan;

(6) Perform other necessary supervision.

When performing a mission, the nuclear safety inspectors have the right to access the sites of equipment manufacturing, construction and operation of NPPs to make investigations and collect information related to nuclear safety.

When necessary, the MEP (NNSA) has the right to take compulsory actions, including charging NPPs to stop operation.

7.2.4 Newly Issued Licenses during this Implementation Period

The MEP (NNSA) has newly issued the following licenses to NPPs between 2010 and 2012:

(1) Siting review comments

－ On May 4, 2010, siting review comments for Tianwan NPP Unit 5 and Unit 6issued.

－ On September 19, 2010, siting review comments for Hongyanhe NPP Unit 5 and Unit 6issued.

— On December 3, 2012 siting review comments for Tianwan NPP Unit 3 and Unit 4issued.

(2) Construction permits

— On April 20, 2010, construction permit of Hainan Changjiang NPP Unit 1 and Unit 2 issued.

— On July 18, 2010, construction permit of Guangxi Fangchenggang NPP Unit 1 and Unit 2issued.

— On November 12, 2010, construction permit of Yangjiang NPP Unit 3 and Unit 4 issued.

— On December 30, 2010, construction permit of Fujian Fuqing NPP Unit 3 and Unit 4 issued.

— On December 4, 2012, construction permit of Demonstration Project of High-temperature Gas-cooled Reactor Nuclear Power Station of Huaneng Shandong Shidao Bay NPP issued.

— On December 26, 2012, construction permit of Tianwan NPP Unit 3 and Unit 4 issued.

(3) **The instrument of ratification for the first fuel loading**

— On April 20, 2010, the Instrument of Ratification for the First Fuel Loading of LingAo NPP Unit 3issued.

— On May 28, 2010, the Instrument of Ratification for the First Fuel Loading of Qinshan Phase II NPP Unit 3issued.

— On December 30, 2010, the Instrument of Ratification for the First Fuel Loading of LingAo NPP Unit 4issued.

— On October 20, 2011, the Instrument of Ratification for the First Fuel Loading of Qinshan Phase II NPP Unit 4issued.

— On September 27, 2012, the instrument of ratification for the first fuel

loading of Ningde NPP Unit 1issued.

－On November 15, 2012, the instrument of ratification for the first fuel loading of Hongyanhe NPP Unit 1issued.

(4) Operation licenses

On May 28, 2010, operation license of Tianwan NPP Unit 1 and Unit 2 was issued by MEP (NNSA).

On November 23, 2011, due to change of management mode and improvement of operation mode of the existing nuclear power plant, the MEP (NNSA) changed operation licenses of Qinshan NPP, Qinshan Phase II NPP Unit 1 and Unit 2 as well as Third Qinshan NPP Unit 1 and Unit 2, the owner and operating organization of NPP jointly hold the changed operation licenses and jointly bear safety responsibilities. The organizations holding changed operation licenses are Qinshan Nuclear Power Co., Ltd. and China Nuclear Power Operation Management Co., Ltd., Nuclear Power Qinshan Joint Venture Co., Ltd. and China Nuclear Power Operation Management Co., Ltd., Third Qinshan Nuclear Power Co., Ltd. and China Nuclear Power Operation Management Co., Ltd.

8. REGULATION

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfill its assigned responsibilities.

2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.

8.1 Nuclear Safety Regulation System

The MEP (NNSA) is Chinese regulatory body for nuclear safety. It is in charge of unified and independent regulation of the nuclear safety of NPPs throughout the country. The licensing system is one of main measures of the MEP (NNSA) in regulation. By means of the management of licenses, the MEP (NNSA) regulates NPPs, nuclear materials and nuclear activities.

The MEP (NNSA) is in charge of the regulation of environmental protection of NPPs throughout the country.

The Ministry of Health is in charge of the prevention and treatment for occupational diseases of the NPPs and the medical emergency rescue of nuclear accidents.

China Atomic Energy Authority (CAEA) is the nuclear industry administration of Chinese government, which is responsible for researching, drafting out, and implementing policies, regulations, programs, plans and nuclear industry standards for Peaceful Uses of atomic energy in China, and is in charge of communication and cooperation in nuclear energy field among governments and also among international organizations, and it is also in charge of emergency management of state nuclear events as leader.

The National Energy Administration is the administrative department of energy resource industry of China. It is responsible for drafting out and implementing developing program, conditions for access and technical standards of nuclear power;

for putting forward the opinions about review of significant nuclear power project; for organizing coordination and guidance of scientific research of nuclear power; and for organizing the emergency management of the NPPs.

According to nuclear safety regulations in China, the licensees (or applicant) of nuclear safety licenses bear all responsibilities for the safety of NPPs, nuclear materials and nuclear activities.

8.2 Regulatory Body

8.2.1Organization Structure of MEP (NNSA)

The MEP (NNSA) is headquartered in Beijing and established six regional offices as East China Regional Office of Nuclear & Radiation Safety Supervision (located at Shanghai), South China Regional Office of Nuclear & Radiation Safety Supervision (located at Shenzhen), Southwest China Regional Office of Nuclear & Radiation Safety Supervision (located at Chengdu), North China Regional Office of Nuclear & Radiation Safety Supervision (located at Beijing), Northwest Regional Office of Nuclear & Radiation Safety Supervision(located at Lanzhou) and Northeast Regional Office of Nuclear & Radiation Safety Supervision (located at Dalian) respectively, and these regional offices are responsible for the routine supervision of nuclear and radiation safety in corresponding regions.

In order to perform the regulation better, the MEP (NNSA) has established the Nuclear and Radiation Safety Center as its technical support center, and has set Zhejiang Regional Office of Radiation Environment Monitoring as the Radiation Environment Monitoring Technical Center of the MEP to provide technical support in terms of nationwide radiation environment monitoring and management.

The MEP (NNSA) has established a Nuclear Safety and Environment Advisory Committee. The Advisory Committee is to provide technical advices for formulation of regulations, technology development, review and inspection of nuclear safety.

The organization structure of the MEP (NNSA) is shown in Figure 4.

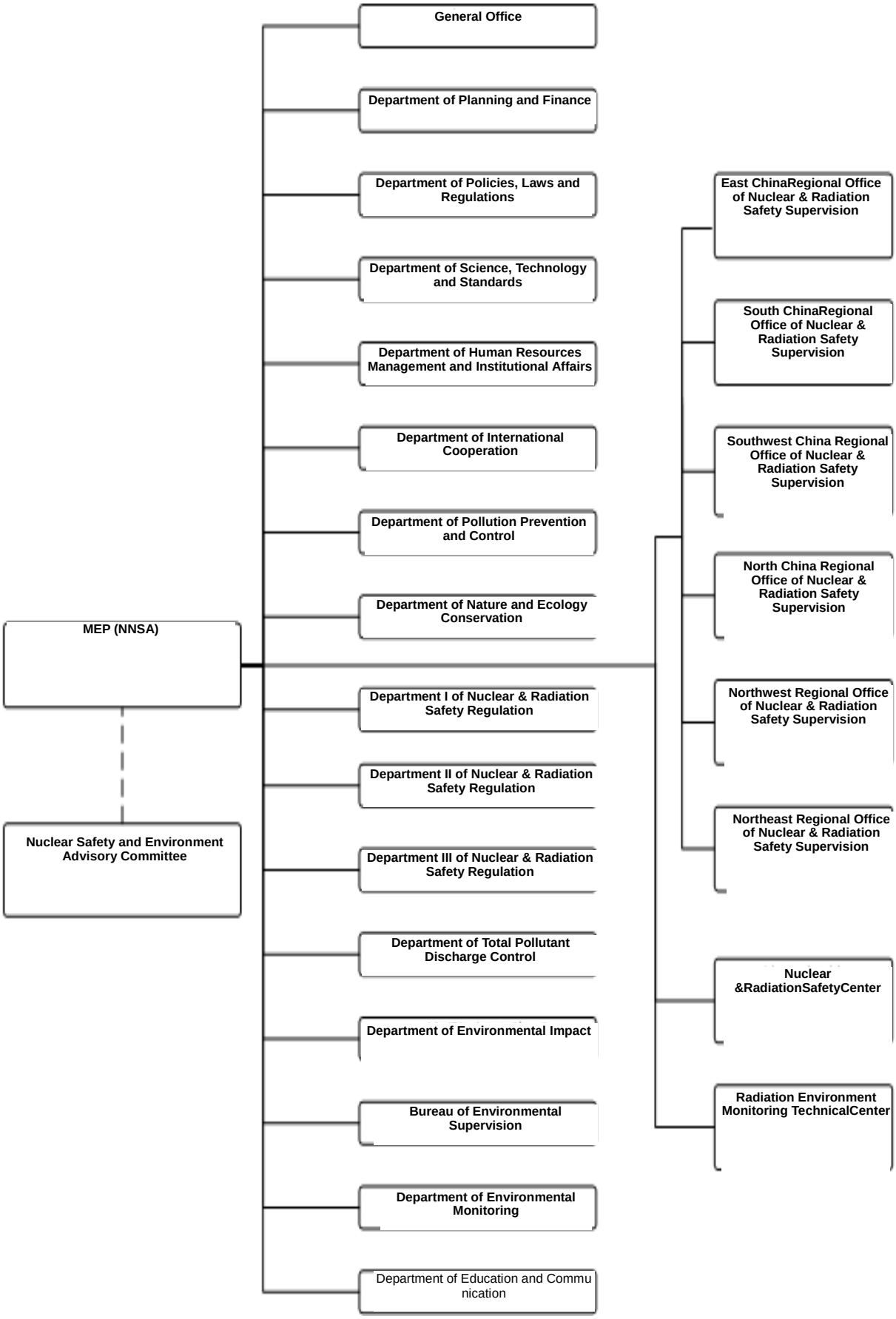

Figure 4 The organization structure of the MEP (NNSA)

8.2.2 Main Duties and Responsibilities of the MEP (NNSA)

(1) To be responsible for regulation of nuclear safety and radiation safety, and for drafting out, organizing and implementing policies, programs, laws, administrative regulations, department rules, systems, standards and specifications relating to nuclear safety, radiation safety, electromagnetic radiation, radiation environment protection as well as nuclear and radiation accident emergency.

(2) To be responsible for unified regulation of nuclear facility safety, radiation safety and radiation environment protection.

(3) To be responsible for regulation of nuclear safety equipment in permission, design, manufacture, installation and non-destructive testing activities and the safety inspection of imported nuclear safety equipment.

(4) To be responsible for control of nuclear materials and regulation of physical protection.

(5) To be responsible for regulation of radiation safety and radiation environment protection of nuclear technology application projects, uranium (thorium) mines and associated radioactive mines, and to be in charge of radiation protection.

(6) To be responsible for regulation of safety and radiation environment protection of management and disposal of radioactive waste, and for surveillance and inspection of radioactive contamination protection.

(7) To be responsible for regulation of safety transport of radioactive material.

(8) To be responsible for nuclear and radiation emergency response, investigation and treatment of the MEP (NNSA) and participation in prevention and management of nuclear and radiation terrorist event.

(9) To be responsible for qualification management of reactor operator, special process personnel of nuclear equipment, etc.

(10) To be responsible for organizing and developing radiation environment monitoring and supervision monitoring of nuclear equipment and key radiation sources.

(11) To be responsible for domestic implementation of international conventions relating to nuclear and radiation safety.

(12) To guide operation service relating to regional office of nuclear & radiation safety supervision.

After restructuring of the government organization, specific operation service of the MEP (NNSA) in nuclear and radiation safety field was undertaken by Department I of Nuclear & Radiation Safety Supervision, Department II of Nuclear & Radiation Safety Supervision and Department III of Nuclear & Radiation Safety Supervision. In 2011, the regulation budget of the MEP (NNSA) was RMB 180 million, and this number rose to RMB 350 million in 2012.

8.3 Ministry of Health

Main duties and responsibilities of the Ministry of Health in nuclear power safety management include:

(1) To be responsible for formulating hygienic codes and standards related to the health of personnel working in NPPs and general public;

(2) To be responsible for monitoring exposure dose of personnel working in NPPs and general public;

(3) To be responsible for the health management of personnel working in NPPs and the evaluation of adverse impacts on human body due to nuclear contamination;

(4) To be responsible for the prevention and cure of radiation injury.

(5) To be responsible for sanitation censoring, and final acceptance of construction for siting and design of newly constructed, expanded and transformed nuclear power projects.

(6) To be responsible for organization and coordination of medical preparation and rescue for national nuclear emergency, and for guiding local departments of health to conduct proper medical preparation and management for nuclear emergency.

8.4 China Atomic Energy Authority

The CAEA includes Administration Department, System Engineering Department, International Cooperation Department, Comprehensive Planning Department, Science and Technology Quality Control Department as well as National Nuclear Accident Emergency Office, Nuclear Material Control Office and Isotope Management Office..

Duties and responsibilities of the CAEA include:

(1) To research and draft out policies and regulations for Peaceful Uses of atomic energy in China;

(2) To research and establish developing program, planning and nuclear industry standard for Peaceful Uses of atomic energy in China;

(3) To organize demonstration, review and approval of relevant science and technology research project on Peaceful Uses of nuclear energy; and be in charge of surveillance and coordination of the implementation of science and technology projects;

(4) To be in charge of control of nuclear material and physical protection of nuclear facilities;

(5) To be in charge of review and management of nuclear export;

(6) To be in charge of communication and cooperation in nuclear energy field among governments and also among international organizations; take part in the IAEA and its activities on behalf of the Chinese government;

(7) To undertake emergency management of state nuclear accidents, lead on organizing the National Coordinating Committee for Nuclear Accident and be in charge of developing, preparing and implementing national nuclear emergency plan;

(8) To be in charge of the decommissioning of nuclear installations and the treatment of radioactive waste.

8.5 National Energy Administration

The National Energy Administration includes nine departments. In June 2013, departments of the National Energy Administration are increased to twelve after

institutional restructuring, including General Affairs Department, Legal and Institutional Reform Department, Development and Planning Department, Energy Conservation and Scientific Technology Department, Electric Power Department, Nuclear Power Department, Coal Department, Oil and Gas Department (National Oil Reserve Office), New Energy and Renewable Resources Department, Market Supervision Department, Electric Power Security Regulation Department and International Cooperation Department..

Duties and responsibilities of the National Energy Administration in nuclear energy field include:

(1) To be in charge of nuclear power management and lead on drafting out laws and regulations related to nuclear power;

(2) To draft out and implement developing program, conditions for access and technical standards of nuclear power;

(3) To put forward the layout of nuclear power and opinions about review of significant project;

(4) To organize coordination and guidance of scientific research of nuclear power;

(5) To organize the emergency management of the NPPs;

(6) To be in charge of international cooperation and communication among governments in the field of nuclear power and be in charge of external negotiations and contracting for agreement on peaceful utilization of nuclear energy among governments.

9. RESPONSIBILITIES OF THE LICENSEES

> Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.

As the licensee, the operating organization is comprehensively responsible for safe operation of the NPPs, and this responsibility will not be mitigated or transferred due to design, manufacture, construction and supervisors' activities and responsibility. The units in charge of design, manufacture and construction also undertake corresponding responsibilities of nuclear and radiation safety within their respective working scopes.

It is specified in Article VII of the "Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China" (HAF001) that:

The operating organization of the NPP is directly responsible for the safety of the NPP in operation. Its main responsibilities are as follows:

(1) To comply with the relevant laws, administrative regulations and technical standards of the country to ensure the safety of NPPs;

(2) To accept the safety inspection from the MEP (NNSA) and the Ministry of Health, etc.; to report the safety situation timely and faithfully and to provide relevant information;

(3) To take overall responsibility for the safety of its NPPs, the safety of nuclear materials, and the safety of the site personnel, the public and the environment.

The policy of "Safety First" and nuclear safety objectives are principal requirements for all organizations engaged in nuclear power activities. The operating organization shall give its commitment to NPP safety. All other organizations such as design and construction organizations, suppliers should give their corresponding safety commitments. The commitment to safety is to be written in the policy

statement of quality assurance program and be inspected by operating organization and supervised by the nuclear safety regulatory bodies. All organizations shall fulfill the task of commitment in their own target of management.

Commitments to safety: All activities related to the NPP safety shall accord with the standards in safety codes. Nuclear safety is placed on the position of top priority. The position shall not be restricted and affected by production schedule and economic benefit. NPP shall establish and maintain effectively "defense-in-depth" system to protect the NPP staff, the public, and the environment from radioactive hazards. Safety review and assessment system shall be established to monitor and assess relevant activities, to find out and correct the faults and deficiencies created from work as well as to pursue high quality work target so that safety performance could be continuously improved.

The MEP (NNSA) and other regional offices shall implement nuclear safety inspection task continuously throughout the whole process of NPP siting, design, construction, commissioning, operation and decommissioning as well as all important activities. Nuclear safety inspection is divided into daily, routine and non-routine (special) types with major methods of document inspection, site observation, informal discussion, interview, measurement or test.

The MEP (NNSA) shall perform legal surveillance for activities of the licensees in accordance with the "Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China", "Regulations on Nuclear Materials Control of the People's Republic of China", "Emergency Management Regulations of Nuclear Accidents at Nuclear Power Plant of the People's Republic of China", "Regulations for Civilian Equipment of the People's Republic of China", "Regulations on the Safe Transportation of Radioactive Material of the People's Republic of China", "Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China - Part Two: Safety Surveillance of Nuclear Installations" as well as their supporting regulations and relevant administrative provisions.

10. PRIORITY TO SAFETY

> Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

10.1 The Policy of "Safety First" and Nuclear Safety Objectives

NPPs in China always insist on the policy "Safety First", carry through the safety concept of defense-in-depth, and take effective measures to ensure nuclear safety.

In all activities of siting, design, construction, operation and decommissioning of the NPPs, the policy of "Safety First" has the utmost priority. Organizations and individuals engaged in nuclear power activities shall follow through this policy.

In 2012, the Chinese government issued the "Nuclear Safety Program", and pointed out overall goal of nuclear safety and radioactive contamination treatment in China as: "to further improve safety level of nuclear facilities, to greatly reduce safety risk of radiation environment, to basically form accident defense, contamination control, scientific and technical innovation, emergency response and safety regulation capability, so as to ensure sound nuclear safety, environment safety, public health and radiation environment quality." The detailed goals in accordance with this document are as follows:

— As for improving safety level of NPP, safety performance indicators of operating nuclear power units shall be maintained under sound status; newly built nuclear power units shall have perfect measures to prevent and mitigate severe accidents; probability of annually severe core damage of each reactor shall be lower than 1/100,000, and probability of annual release of large quantity of radioactive substance of each reactor shall be lower than 1/1,000,000.

— As for accident defense, complete safety modification of NPPs in operation and under construction, improve capabilities of NPPs to resist external events and prevent and mitigate severe accidents.

— As for scientific and technical innovation, perfect scientific and technical

innovation platform of nuclear safety and radioactive contamination treatment, develop a number of leading personnel and break through a batch of key technology.

— As for emergency response, strengthen capability of emergency command, emergency response, emergency monitoring and emergency technical support, establish the force under unified scheduling to deal with nuclear accident emergency, and enrich emergency supplies and equipment.

— As for safety regulation, basically complete national technical research and development base of nuclear and radiation safety, build regulation technical support platform, preliminarily possess capability of relatively independent and complete safety analysis and evaluation, verification, calculation, testing and validation; establish nationwide radiation environment monitoring network.

10.2 Nuclear Safety Culture

In order to achieve excellent safety performance and enhance the safety culture level, in the recent three years, the regulatory body and Chinese NPPs made the following improvements in cultivation of nuclear safety culture: establishing evaluation system of nuclear safety culture, performing nuclear safety culture evaluation activities, making efforts to cultivate nuclear safety culture and improving responsibility consciousness of all the staff, so as to make decision-making level, management level and execution level of all units can ensure nuclear safety consciously.

To be specific, the following improvements are made:

(1) Systematically promoting the cultivation of nuclear safety culture: Plant managers lay stress on support and participation of the cultivation of nuclear safety culture and regard their leading model role as the key factor of improving safety culture. Moreover, they emphasize on the resource investment concerning safety issues, make efforts to establish non-censure safety culture environment and encourage plant staff to report any mistake which occurred or was found in a conscious, timely, complete and precise manner. They advocate and promote concept of study-oriented enterprises in a systematic and progressive manner to constantly

improve nuclear safety culture through perfecting all kinds of procedures and regulation, adopting the methodology of quality management "Plan-Do-Check-Action", setting up the target of safety culture cultivation, tracking fulfillment of targets at all levels and carrying out further assessment and improvement.

(2) Establishing safety management system: Establishing "defense-in-depth" safety management system. Following the policy of "Safety First", NPP organizations at all levels attach importance to active prevention and conservative decision-making. Establishing safety management system including technical management safety system and safety surveillance system through application of advanced safety management concept and method. Building up multilevel and in-depth safety mechanism in combination with safety management like organization, rules, control, surveillance, feedback, emergency preparedness, improvement, etc., organically integrating nuclear safety culture into all kinds of rules and regulations through advocating enterprise's safety culture and improving their staff 's fundamental qualification.

(3) Keeping on open attitude: Regulatory bodies and the NPPs attach importance to international communication and cooperation. On the one hand, Regulatory bodies and the NPPs voluntarily apply for IAEA's Operational Safety Review Team (OSART) and Integrated Regulatory Review Service (IRRS)and WANO peer review activities , and actively participate in the platform of international organizations like IAEA and WANO for sharing operating experience feedback information and meanwhile, contributing to operating experiences information. On the other hand, they find gaps for further improvements through international benchmarking and communication.

(4) Enhancing cultivation of nuclear safety culture: The NPPs promote and popularize safety culture concept to NPP personnel at all levels through organizing nuclear safety culture training, holding nuclear safety culture lecture and developing

various activities with characteristics of nuclear safety culture, so as to improve the personnel nuclear safety culture.

(5) Emphasizing on the collective development with contractors: The NPPs attach importance to cooperative relationship with contractors, constantly push development of contractors' nuclear safety culture and form unified cultural language of nuclear safety culture. The contractors have enterprise safety culture with their own characteristics as well as all kinds of safety culture education and practices carried out simultaneously with the NPPs.

(6) Perfecting the system for domestic peer review and operating experience feedback. For the NPPs in operation or under construction, comprehensive review, focus review and periodical self-assessment were conducted actively. China strengthens building and perfection of operating experience feedback system of the NPPs in operation or under construction, adopts activities for operating experience exchange of different themes in different levels and effectively improves management of the NPPs with constant study and feedback. Since 2010, many domestic NPPs have completed nuclear safety culture review and gained good effect.

(7) Establishing good relationship for communication. Through periodically convening annual coordination meeting, nonscheduled dialogues, symposiums, exchange visits, communication, etc., regulatory bodies have established good interactive relationship with the NPPs and enhanced transparency and credibility of safety review and safety supervision. In the meantime, through comprehensively assessing nuclear safety management and assisting the NPPs to identify areas for improvement, regulatory bodies constantly improved and strengthened the establishment of nuclear safety culture.

11. FINANCIAL AND HUMAN RESOURCES

> 1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.
>
> 2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

11.1 Financial Resources

Chinese government allocates certain amount of funds for technical research and development of nuclear power and its safety. In order to adapt to the demands on development of NPPs in China, Chinese government has increased financial budget and capacity-building to ensure implementation of the functions in nuclear safety regulation. In 2011, the regulation budget of the MEP (NNSA) was RMB 180 million, and this number rose to RMB 350 million in 2012. The nuclear safety review charging system, which was put into force in 2001, works as a financial resource supplement of the MEP (NNSA).

The Chinese government gives full play to guiding role of government, establishes effective fund guarantee mechanism, increases financial input to nuclear safety and radioactive contamination treatment, and promotes implementation of programmed projects; perfects fund management and control mode of nuclear safety management; clearly defines fund source, method of capital contribution, approval process and application of funds for expenses to be jointly undertaken by the government and enterprises and involving nuclear emergency, nuclear insurance, nuclear compensation, radioactive contamination treatment of civilian nuclear installations and construction of public-good nuclear safety infrastructure; and strictly investigates fund flow to ensure appropriate fund raising and use.

All expenses for safety operation and improvement of NPPs are borne by NPPs. After an NPP has been put into operation, a defined percentage of the revenue from generating electricity is preserved for safety improvement, radioactive waste

management and final decommissioning of the plant. Items for improving the safety and their expenses have a priority in the annual plan and financial budget.

The "Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China" specifies:

— The operating organization of nuclear power plant shall prepare the decommissioning plan for nuclear power plant. The expenses of decommissioning and radioactive waste treatment shall be accrued and included in the budgetary estimate of investment or production cost.

— The environmental protection administration of the State Council is responsible for the regulatory surveillance on nuclear facilities. The expenses of construction, operation and maintenance of regulatory surveillance shall be included in budget.

The "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant" specifies: in-plant emergency preparedness fund for nuclear accident shall be borne by the nuclear power plant and listed into project investment budget of the NPP and operating cost. Off-site emergency preparedness fund for nuclear accident shall be jointly borne by the NPP and the local people's government, and amount of the fund shall be examined and approved by the department assigned by the State Council with relevant departments. The fund borne by the NPP is handed in at a certain proportion determined according to capacity of the NPP before operation and actual generating capacity after operation; it is used for emergency preparedness of regional off-site nuclear accidents after aggregate balancing by planning department of the State Council; the rest part is disposed by the local people's government.

In order to further regulate collecting and using of emergency preparedness fund for nuclear accident and intensify management of special revenue for emergency preparedness of nuclear accident, the "Rules on Management of Special Revenue for Emergency Preparedness of Nuclear Accident" was promulgated in 2007, which definitely stipulates where to collect special revenue for emergency preparedness of

nuclear accident, standard, proportion, time and mode, applied scope, budget and final accounting mechanism, regulatory mechanism, etc.

China has established nuclear accident liability insurance system and required the NPPs to take out the insurance of third party liability. In 2007, the Chinese government required operators of the NPPs to adjust maximum limit of liability for third-party liability insurance due to a nuclear accident from the original RMB 18,000,000 to RMB 300,000,000. In case the amount of payable compensation for damage due to nuclear accident exceeds specified maximum limit of liability, the state will provide financial compensation with upper limit of RMB 800,000,000. As for the compensation for damage due to unusual nuclear accident, its financial compensation to be provided by the state will be determined after assessment by the State Council.

11.2 Human Resources

11.2.1 Human Resource Assurance Measures

In 2009, the central government has approved that up to 2012, its staff can increase to 1,000 persons, including70 people in the headquarters, 330 people in its six regional offices and 600 people in the Nuclear and Radiation Safety Center. Presently, the MEP is gradually doing the work about personnel recruitment. The increase of nuclear safety supervisors ensures human resource of nuclear safety regulation to adapt to the current nuclear power development.

The Chinese government is actively preparing talents education and cultivation plan to meet the increasing demand for human resources of nuclear power in China. The state, enterprises and academies of science of colleges and universities vigorously strengthen talents cultivation and increase input for talent reserve in terms of science research, design, fuel, manufacture, operation, maintenance, etc. as well as nuclear power design, nuclear engineering technology, nuclear reactor project, nuclear and radiation safety, operation management and other professional fields.

(1) Perfecting talents cultivating system: through governmental support and close cooperation between college and enterprise, NPPs and universities could

combine college fundamental education and specialty education with pre-job training and on-job training of enterprise to innovate talents training system; through applying systematized training method, NPPs could copy standardized procedure and expedite talents cultivation; through setting up majors related to nuclear power, and enlarging the amount of students enrolled in colleges and universities, optimize structure of majors in colleges and universities could be optimized as well as talents training.

(2) Increasing resources for training: the nuclear power plants increase investment for training resources continuously, equipped with full scope simulator, principle simulators and training simulator/mockups and established the center for skills training, the training center for prevention of human errors, etc.; aiming at different posts, nuclear power plants develop corresponding training program and training materials, constantly expand the team of full-time and part-time teachers, and improve their training skills and level; within the entire enterprise group, through integration of resources and unified application, set up the talents training base to meet the demand of large-scale personnel training.

(3) Broadening the way to talent cultivation and recruitment: according to the demand of talents for surveillance, design, engineering and operating in the development of nuclear power, government builds up different patterns for cultivation; through enlarging the amount of students enrolled in colleges and universities, social recruitment, introducing experts from home and abroad, to meet the demand of human resource.

(4) Attaching importance to demand of top talents: before starting up new project, all kinds of high-level core talents shall be selected and trained; through expanding exchange and cooperation of education in nuclear power field, key talents with international vision in management and technology would be trained; Introduction of requested high-end talents into nuclear power industry shall be carried out by active utilization of social resources.

(5) Actively building up the nuclear power specialists support system: by setting up nuclear power specialists committee at different levels and specialized technology working group, talent information could be broadly collected from home and abroad or inside and outside the nuclear power industry as well as enter into talent pool and establish shared platform for nuclear power talents; by utilizing resource of talents and technologies from nuclear power technology support organizations, government would develop personnel training examination of qualification and authorization for key positions, and provide advisory expertise for important activities and decision-makings of regulatory bodies, the industry administration and the nuclear power operating organizations.

(6) Enhancing international cooperation and exchange of talents cultivation: in order to enhance sharing and exchanging nuclear power construction experience with other countries, in 2011, the International Training Center for Nuclear Power Construction was formally put into operation in China and held the first training for international nuclear power construction management.

11.2.2 Application of Systematized Training Method

In recent years, Systematic Approach to Training (SAT) was further popularized and applied to nuclear power industry in China. A) Presently, post task analysis, training demand analysis, formulation of training target and training outline, implementation and assessment of training/assessment are extended to all production related posts from key operating posts. B) According to the status quo of nuclear power plants and operating experience feedback, training materials have been constantly improved and perfected as well as popularizing experiences and training materials to under construction project for nuclear power. C) Targeting specialties and posts of nuclear power industry, corresponding skill training and authorization shall be developed. D) Attach more importance to systematized training of management skills and capability development, skill training and assessment of important maintenance posts, skill training and capability development for preventing human errors in the work, and skill training and development in the important technology support field. E) Apply

the method of SAT to plan and arrange the whole training management system of the NPPs in the beginning of nuclear power projects under construction.

Many NPPs in China have started to study and put training by SAT method into application. With more extensive and in-depth application of SAT method, its training field has covered power station operation, maintenance, technical support and other key posts, and its content covers design of training system, construction of training facilities, training implementation, etc. In recent years, with emerging new management ideas and training methods, effect of the SAT method used in NPPs is continuously improved.

11.2.3Qualification, Training and Examination of Nuclear Safety Regulatory Personnel

In order to ensure the quality of nuclear safety regulation, the main requirements for nuclear safety regulatory personnel are specified in The "Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China", including education background, working experience, ability, basic professional ethics, etc.

The MEP (NNSA), according to mandatory requirement of relevant regulations and laws and demand of the work, carries out selecting, training and examination of the personnel. After training and passing examinations (including written and oral test), these personnel will be licensed with "Qualification Certificate of Nuclear Safety Supervisor" by the MEP (NNSA).

The MEP (NNSA) attaches high importance to the training of nuclear safety supervisors and utilizes many channels and various modes to intensify training of nuclear safety regulatory personnel. For example, specially train new staffers in NPP training center for half a year; conduct training for nuclear safety regulatory posts; exchange on-the-job trainings with personnel of nuclear power enterprises; arrange trainings and discussions about nuclear safety regulation by inviting international experts; dispatch personnel to participate in short-term training and discussion held

by foreign regulatory departments and international organizations; moreover, annually, provide training and education of various academic degrees for 30 persons.

11.2.4Examination and License management of the Licensed Operators

The "Application and Issuance of Safety License for Nuclear Power Plant", the detailed "Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations" prescribed that those who hold the "Reactor Operator License" or the "Senior Reactor Operator License" of the People's Republic of China can operate the reactor control system of NPP, the validity period of the license is two years; if the operator leaves this post for more than six months, his license will be expired automatically. In addition, the detailed rules for implementation of "Issuance and Management Procedures for Operator License of Nuclear Power Plants" have made definite requirements to the issuance and management of operator's license.

According to the requirement of the regulations, the nuclear departments in charge issued the "Management Methods for License Examination of Operators of NPP", "License Examination Rules for Nuclear Power Plant Operators" and the "Standards for License Examination of Nuclear Power Plant Operators", which specified the activities of assessment and license management of NPP operators. Ministry of Health of the People's Republic of China issued the "Specification of Health Standards and Medical Surveillance for Nuclear Power Plant Operators", which definitely specified the health requirements for operators and specific requirements for medical surveillance to operators.

The operators of nuclear power plants shall receive strict training, and shall pass the license examination and the qualification review organized by the Review Committee on Qualification for Operators of Nuclear Power Plants of the National Energy Administration. After the review and approval of the Authorization Committee on Qualification for Operators of Nuclear Power Plants of the MEP (NNSA), the "Operator License" or the "Senior-Operator License" will be issued by the MEP (NNSA).

The examinations for applying operator license include paper examination, simulator test and oral test. The overall examination process is under the surveillance and inspection of the MEP (NNSA).

The license conditions of operators of Chinese NPPs by the end of 2012 are listed in Appendix 4.

11.2.5Training and Assessment of Personnel in NPPs

The "Code on the Safety of Nuclear Power Plant Operation" promulgated and implemented by the MEP (NNSA) in April 2004 put forward specific requirements for personnel qualification and training of operating organization of NPP. Recruitment, training, retraining and authorization of operating personnel are conducted according to the nuclear safety guide entitled "Staffing, Recruitment, Training and Authorization for Personnel of Nuclear Power Plants".

Training/Retraining programs and procedures are prepared and implemented in NPPs according to the work post qualification derived from task analysis, in accordance with the requirement of relevant regulations, guides and standards. Only those who are qualified or authorized after experiencing appropriate training and examination could implement relevant work.

The management of period of validity for personnel qualification and authorization is conducted in NPPs. In case the period of validity is exceeded, the certificate shall be renewed or changed according to the requirements of a specific post; personnel shall be re-training and re-authorized to ensure that they meet the requirements of specific posts.

Training organization in Chinese nuclear power plant is responsible for planning, implementation, assessment and improvement of training. Training center is equipped with training facilities, including a full-scope training simulator, for training, retraining and examination for NPPs operators and management personnel.

Requirement on the management of training, authorization and qualification for domestic and foreign contractors is the same as for NPPs. Moreover, management policies of contractors are prepared to control and regulate training management.

In order to ensure the quality of nuclear safety regulation, the main requirements for nuclear safety regulatory personnel are specified in The "Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China", including education background, working experience, ability, basic professional ethics, etc.

The MEP (NNSA), according to mandatory requirement of relevant regulations and laws and demand of the work, carries out selecting, training and examination of the personnel. After training and passing examinations (including written and oral test), these personnel will be licensed with "Qualification Certificate of Nuclear Safety Supervisor" by the MEP (NNSA).

The MEP (NNSA) attaches high importance to the training of nuclear safety supervisors and utilizes many channels and various modes to intensify training of nuclear safety regulatory personnel. For example, specially train new staffers in NPP training center for half a year; conduct training for nuclear safety regulatory posts; exchange on-the-job trainings with personnel of nuclear power enterprises; arrange trainings and discussions about nuclear safety regulation by inviting international experts; dispatch personnel to participate in short-term training and discussion held by foreign regulatory departments and international organizations; moreover, annually, provide training and education of various academic degrees for 30 persons.

During this implementation period, China is building and extending training facilities of NPPs; has optimized simulator training resources of the NPPs through coordination and strengthened targeted training, field simulation drilling and simulator drilling for accident regulation operating and supporting personnel to ensure sufficient training time for first batch of operators for newly built nuclear power project; has set up human-factor training laboratory to train key staff of the NPPs and improve personnel performance; and promotes the NPPs and engineering companies to bring the contractors, suppliers, etc. into their own training plans and intensifies the training to ensure effective implementation of works of the contractors.

Operating organization of NPP regulated training and drilling plan on beyond design basis accident for licensees, strengthened training for personnel of the NPP in terms of severe accident management, especially the beyond design basis accident, and re-prepared training plan and re-training period of Severe Accident Management Guideline (SAMG). Reactor licensees restudied the accident regulations relating to power loss.

11.2.6Registered Nuclear Safety Engineer System

The Chinese government enacted the "Temporary Regulations on the Professional Qualification of Registered Nuclear Safety Engineer" in2002, which regulates the professional qualification of personnel in key posts related to nuclear safety who engaged in application of nuclear energy and nuclear technology or are in the organizations of providing technical services on nuclear safety; and which is brought into the system for professional certificates of Chinese professionals and technicians for unified planning and management. The Ministry of Human Resources and Social Security and the State Environmental Protection Administration (SEPA) jointly promulgated "Implementing Regulation for Professional Qualification Examination of Registered Nuclear Safety Engineer" and "Assessment Regulations for the Determination of Professional Qualification of Registered Nuclear Safety Engineer" in 2003. And the Chinese government enacted the "Registration Management Rules for Professional Qualification of Registered Nuclear Safety Engineers (on trial)" in 2004 and the "Regulations on Continuing Education of Registered Nuclear Safety Engineers (on trial)" in 2005. Furthermore, serial books about posts training of registered nuclear safety engineers were compiled and published, which refer to laws and regulations relevant to nuclear safety, comprehensive knowledge of nuclear safety, professional practice of nuclear safety and cases analyzing of nuclear safety.

After going through corresponding systematic training and qualifying examinees, the country organizes uniform national examination each year. The "Professional Certificate for Registered Nuclear Safety Engineer in People's Republic of China" is issued after passing the examination. The validity date of registered nuclear safety

engineer is two years. Continuing educational system shall be performed for registered nuclear safety engineers.

Professional scopes of registered nuclear safety engineer are: review of nuclear safety, surveillance of nuclear safety, operation of NPP, nuclear quality assurance, radiation protection, radiological environmental monitoring and other fields closely related to nuclear safety which is specified by the MEP (NNSA).

Since examination of professional qualification of the first batch of registered nuclear safety engineers was held in 2004, as of the end of 2012, eight national examinations of professional qualification of registered nuclear safety engineers have been completed.

In 2012, the MEP (NNSA) reviewed the applications of nuclear safety-related personnel for unit recording and registered nuclear safety engineers for registration who work in related units, and released the list of related units which the third batch of safety-related personnel works for and the list of the second batch of registered nuclear safety engineers in 2012.The total number of the third batch of units which nuclear safety-related personnel work for is 48, while that of registered nuclear safety engineers was 486 in 2012, including 210 persons who applied for the registration, 212 persons who continued the registration and 64 persons who changed the registration. By the end of 2012, validly registered personnel amounted to 1,477.

12. HUMAN FACTORS

> Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1 Actions Taken to Prevent and Correct Human Errors

China attaches importance to the research on human factors to find out management measures and effective methods to prevent and correct human errors so as to maintain and improve the safety level of the NPPs. These measures were definitely specified in laws, regulations and guides on nuclear safety and applied to the whole life-time of the NPPs, mainly including:

(1) In the course of management of design, construction and operation, the concept of "defense-in-depth" should be implemented to ensure that all activities related to safety (include those related to actions of organization, design or personnel) are under the defense of overlapping measures; even if one measure is ineffective, errors can still be compensated or corrected.

(2) At early stage of NPP design, human factors and human-machine interfaces shall be considered between people and machines throughout the whole process of design, and the human factors would be validated and confirmed at due time.

(3) According to the principle of ergonomics, the working area and working environment for the workers in the plant shall be designed with optimization of layout and procedure of the NPP, including operation, maintenance and inspection.

(4) In the course of designing control room of the NPP, the working load, possibility of human error, reaction time of operator, reduction of physical strength of the operators and intensity of brainwork shall be taken into account to ensure that safety operation could be effectively fulfilled under normal condition or event state.

(5) For important posts in operation of the NPP, enough qualified personnel should be staffed, and their duties, purview and contact channel should be definitely stipulated. Sufficient and effective training, assessment and test shall be provided,

and the personnel who undertake important safety responsibility should possess formal certificates issued or recognized by the country or safety and security departments. Duties should be strictly performed according to procedures and operation flow of the NPP, and also strict examination and approval shall be implemented as well as periodic review and timely update of the operating flow and procedures.

(6) By utilizing independent evaluation from inside and outside and self-evaluation, the operation status of the NPP shall be periodically reviewed. NPPs should strengthen the safety awareness and prevent overconfidence in themselves and self-complacence; and NPPs should also systematically assess and apply internal and external experiences about human factors, timely take technological or administrative measures for prevention or correction to attain persistent improvements.

(7) Human factors shall be reviewed during PSR of the NPP as they affect all aspects of the safety of NPPs. In review, the status of human factors shall be checked to determine that they comply with the good practice which has been recognized and will not contribute to an unacceptable risk.

12.2 Measures Taken by the Licensees and Operating Organization

According to requirements of regulations and guides on nuclear safety in China and actual status of the NPP, the operating organization of the NPP adopts the following measures to strengthen human factors management:

(1) Defining duties of organizations and posts explicitly. Through constantly strengthening posts responsibility system and surveillance system, utilities build up and execute response and decision-making mechanism for unexpected events and put various interfaces and working process in order, decrease human errors in the process of coordinating management and decision-making.

(2) Constantly perfecting all sorts of management system. By establishing routine inspection and topic inspection system, utilities introduce special operation sheet, adopt various methods including STAR self-inspection, pre-job briefing,

post-job briefing, and the method of calling out the names of those voted for while counting ballots, etc. to improve the management of NPPs.

(3) Strengthening work permit system. For operation, maintenance, periodic testing of NPPs as well as other safety- related activities, the operating organization requests certificated personnel to do relevant work according to operating tickets and procedures.

(4) Enhancing the system for root cause analysis of events related to human factors. Aiming at typical or recurring events related to human factors, utilities carry out specific analysis thoroughly, strive to identify defects and deficiencies in the aspect of management policies and organization structure, and make efforts to adopt more effective and preventive measures; regularly check the implementing conditions of human error prevention measures, and perform self-assessment for the implementing conditions of human error control measures.

(5) Strengthening internal and external experience feedback systems. On the basis of making operating experience feedback work being procedural, organized, standardized and systematized as well as making experience feedback and education over events become daily work, utilities analyze, compare and seek for managerial deficiencies and potential weakness in the aspect of human factors from internal, absorb and adopt advanced experience of success and lessons of failure from the international peers in order to avoid similar human errors and possibility of recurring.

(6) Popularizing the application of human error prevention tools to remind and prevent human errors; developing the manuals and related training materials for human error prevention in related fields (such as operation, maintenance and chemistry), and compiling the multimedia training courseware for human error management to strength the education on human error prevention with vivid teaching methods; based on the manuals for human error prevention, assessing the application and effects of the human error prevention tools, performing specific assessments of performance of the tools, and preparing and releasing an assessment report.

(7) Further strengthening the exchange of experience among NPPs by organizing training courses, field study and discussion, and experience exchange meetings on human factor management in NPPs. Moreover, all NPPs shall continue to strengthen the construction and perfection of human error prevention laboratories in NPPs, make a human performance management program, actively organize the trainings for junior staffs, cultivate and improve the staffs' skill to prevent human errors.

(8) Developing a human factor management program in combination with the actual situation of NPPs, and enabling some NPPs to bring human error prevention trainings into the basic safety authorization trainings.

(9) Actively developing the competitions against human errors. In August, 2012, the China National Nuclear Corporation (CNNC) held a human error prevention competition among the employees. The competition was the first one held in the nuclear power industry to improve the employees' safety awareness and skilled use of the human error prevention tools, and to ensure the safety of nuclear power.

(10) At the industry level, actively carrying out the in-depth human factor research from the perspectives of individual, system, organization and management, culture, etc. to seek for the methods and ways to reduce human errors. The China Nuclear Energy Association is carrying out the project of the study on improving the events related to human factors and human performance in NPPs to identify the differences and focus and to explore the methods and strategies to improve human performance by classification statistics, correlation analysis and typical case analysis on the events related to human factor in China as well as comparative analysis on the events related to human factors in foreign countries.

12.3 Supervision and Control

China's nuclear safety regulatory body has definitely accounted for technical and management requirement related to human factors in relevant regulations and guides, and ensure that all requirements related to human factors could be effectively implemented in the course of design, construction and operation through nuclear

safety surveillance and review. Main contents inspected include: technical and administrative measures related to human factors in the application documents for license; configuration of organization of the NPP; staffing, training, assessment and authorization of personnel related to quality and safety; report, analysis and feedback on defects/events related to human factors in the NPP.

Furthermore, through constant strengthening of communication and cooperation at home and abroad, the regulatory body promotes development of research and exploration and experience feedback in the area of human factors of the industry, intensifies training and qualification management of personnel on important posts of nuclear safety, and constantly boosts human performance and human factors management in the industry.

13. QUALITY ASSURANCE

> Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1Quality Assurance Policies

NPPs in China always insist the policy 'Safety First'. The Quality Assurance Program (QAP) at each phase of NPP is established and implemented in accordance with the requirements of Code on the Safety of Nuclear Power Plant Quality Assurance (HAF003). The controls on the activities related to the quality in NPP are specified, and the appropriate control conditions are provided for accomplishing all activities affecting the quality.

The top management of NPP takes overall responsibilities for effectively implementing the QAP. All personnel taking part in the activities related to safety and quality should comply with the requirements of QAP and be responsible and accountable for reporting quality problems discovered. An independent quality assurance department is set up to be responsible for the establishment and management of QAP. The effectiveness on the implementation of QAP is verified by performing inspection, surveillance and audit. The quality assurance department has the authority and sufficient independence from cost and schedule when disposing the quality problem until the quality problem has been disposed and resolved effectively.

13.2 Basic Elements on Quality Assurance

The respective basic quality assurance requirements are clearly defined in the Code on the Safety of Nuclear Power Plant Quality Assurance (HAF003), which mainly include:

(1) Establishing and effectively implementing the overall Quality Assurance Program (QAP) in NPP and the separate QAP for each activity; establishing the procedures, detailed rules and drawings in written form, and periodically reviewing

and revising them; performing periodically management review to identify the status and adequacy of QAP, and taking corrective action if necessary.

(2) Establishing a documented organizational structure, clearly defining functional responsibilities, levels of authority and channels of internal and external communication; controlling and coordinating the working interfaces between organizations; controlling the selection, staffing, training and qualification examination of personnel to ensure that sufficient proficiency of work is achieved and maintained by working personnel.

(3) Controlling the preparation, review, approval, distribution and change of the documents necessary for the execution and verification of the work to preclude the use of outdated or inappropriate documents.

(4) Controlling design process, design interface and design change, and performing design verification to ensure that specified design requirements are correctly translated into specifications, drawings , procedures or detailed rules.

(5) Controlling the preparation of procurement documents, evaluating and selecting the suppliers, and controlling the procured items and services to ensure that the requirements of procurement documents are satisfied.

(6) Identifying and controlling materials, parts and components, controlling the handling, storage and shipping of items, and appropriately maintaining important items related to safety so as to ensure that the quality is not degraded.

(7) Controlling the processes affecting quality used in the course of design, fabrication, construction, testing, commissioning and operation of NPP to ensure that the processes are performed by qualified personnel, using qualified equipment in accordance with approved procedures.

(8) Establishing and effectively implementing Inspection and Test Program, verifying that item and activity meet specified requirements, and demonstrating that the SSCs can work satisfactorily. Controlling selection, calibration and usage of measuring and test equipment, and performing identification and control on inspection, test and operating status.

(9) Controlling identification, review and disposition of non-conformance items, defining the responsibilities and authority for review and disposition, and re-inspecting the repaired and reworked items.

(10) Identifying and correcting conditions adverse to quality. For significant conditions adverse to quality, determining the cause of such conditions, and taking corrective actions to prevent repetition.

(11) Establishing and executing quality assurance recording system, controlling coding, collection, indexing, filing, storage, maintenance and disposal of records to ensure that records are legible, complete and correct to provide the evidence on quality of item and/or activity.

(12) Establishing and executing internal and external auditing system to verify the implementation and effectiveness of QAP. Taking corrective actions for the deficiencies discovered during audit and taking follow-up actions for tracking and verification.

In addition, a series of complementary requirements and implementing recommendations against the above-mentioned basic requirements are provided in ten safety guides of quality assurance.

13.3 Establishment, Implementation, Assessment and Improvement on QAPs of NPPs

Chinese NPPs attach importance to the establishment of quality assurance system. A lot of manpower resources and financial resources are utilized per year to ensure the effective operation of the system and the realization of the safety objectives. A specific quality assurance department which is granted adequate authorities is established to effectively prevent and control the activities endangering safety and quality until the problems are effectively resolved.

13.3.1Establishment of QAP

The QAP of a NPP is normally formulated by four stages including design and construction, commissioning, operation and decommissioning, prepared by the operating organization of the NPP according to requirements of safety regulations

and relevant guides, and submitted to the MEP (NNSA) for review and approval as one of materials for application for corresponding licenses. Important contractors of the NPP, according to requirements of nuclear safety regulations and relevant contracts, establish and implement separate QAP applicable to the undertaken work. The separate QAP of contract or should be submitted to the operating organization for review and approval. For organizations related to the design, manufacture, installation and non-destructive test of civilian nuclear safety equipment, their separate QAP also should be submitted to the MEP (NNSA) for review.

13.3.2Execution, Evaluation and Improvement of QAP

Quality assurance is an essential aspect of good management in NPP of China. The QAP is implemented effectively through thorough analysis of the tasks to be performed, identification of the skills required, selection and training of appropriate personnel, use of appropriate equipment and procedures, creation of a satisfactory environment, recognition of the responsibility of the individual who is to perform the task, verification that each task has been satisfactorily performed and the production of documentary evidence to demonstrate that the required quality has been achieved.

Quality assurance department of the NPP is in charge of formulation, management, supervision, evaluation and update of the QAP. Quality assurance department is independent of other departments and directly reports its work to top management. The quality assurance department can discover deficiency existing in quality assurance system by carrying out planned internal and external quality assurance surveillance, audit, review and evaluation, and take corrective action timely. Furthermore, non-conformance items and corrective actions are controlled rigorously. Various quality information and trends are collected, analyzed and reported to high level management periodically. Relevant corrective action is taken promptly as necessary.

13.3.3Management Review

The management departments periodically review suitability and effectiveness of the QAP, and emphatically reviewed the results of inspection and supervision of internal and external quality assurance within the period of evaluation and other related information, including quality problems, status of corrective measures, quality trend, accidents and failures, qualification and training of personnel, etc. According to defects relating to the QAP, management and quality discovered in the review, management departments analyze their causes, carefully work out and implement corresponding corrective measures, and timely inform relevant organizations and departments in written form.

Over the past three years, the NPPs completed the following work and improvements in the field of quality assurance while implementing China's nuclear safety regulations:

(1) The NPPs have made work programs and plans for Quality Month and undertaken Quality Month activities to continue the good quality management, to promote the continuous and steady improvement of the work related to quality, and to enhance all employees' quality awareness and sense of responsibility.

(2) According to the requirements of QAP, the NPPs under construction have built up a quality management verification system with such many levels as owner, supervising organization, general contractor, contractor/supplier, etc. to make design, procurement, construction and commissioning activities under control and ensure quality of relevant activities to satisfy the requirement of applicable regulations and standard, and meanwhile, accept management and supervision from the group, the industry and government.

(3) To enhance the effectiveness of the quality assurance system, the NPPs under construction prepared a plan for human resources demands according to the project progress to allocate the staffs necessary for corresponding posts, and launched the overall quality assurance trainings to meet the needs of construction projects. Furthermore, they organized the experts to review major construction schemes and strengthened the process inspection; managed non-conformance items

by classification and grading and made corresponding review, approval, tracking and handling procedures; recorded, tracked and handled the related quality issues according to their severity and urgency by means of informing in the oral form or via E-mail, Quality Observation Report (QOR), Corrective Action Request (CAR), Stop-Work Order (SWO), etc.

(4) The NPPs in operation constantly improve the existing quality assurance system, and gradually advanced the establishment of comprehensive management system, which based on existing quality assurance system and integrated ISO9001 for quality, ISO14001 for environment and OHSAS18001for occupational health safety standard system. In the meantime, the NPPs in operation timely revised and updated the "Quality Assurance Program During Operating Stage" according to organizational changes and program implementation, conducted audits and surveillance of quality assurance in key fields, evaluated the auditors' skill and performance to improve the effectiveness of audit activities, boosted the work of cultivating quality culture, optimizing management procedures and developing study of cases, constantly improved and optimized the operation of quality assurance system, and guaranteed continuous suitability of quality assurance system and effectiveness of implementation of QAP.

(5) To review the applicability, adequacy and effectiveness of implementation of quality, EHS management system and QAP, the NPPs in operation conducted management review activities every year according to the requirements of associated nuclear safety regulations and guidelines, so as to identify weaknesses, opportunities for improvement and change requirements, and determine corrective actions.

(6) The NPPs in operation effectively carried out internal and external quality assurance audit. According to quality assurance audit procedures, and in combination with unit characteristics and work practices, QA department planned and prepared an overall annual plan for internal and external quality assurance audit, performed audit internally on each department, and evaluated the effectiveness of program implementation within the scope of liability of each department, with audit range

covering all production related departments in the NPP and all elements for QAP in operation. Meanwhile, they conducted audit on contractor basis according to the contracting projects to verify the implementation of contracts and the quality assurance system by contractors.

(7) The NPPs in operation focused on activities related to plant operation to carry out quality assurance supervision especially on outage activities and to strengthen the awareness of obeying the rules and regulations and strictly implementing the procedures; established an outage quality assurance organization for each outage, made the plans for outage quality assurance supervision and carried out the supervision at the stages of outage preparation and implementation.

(8) The nuclear power group corporation and optimized the resources of qualified suppliers, performed unified, classified and hierarchical management on suppliers of equipment, materials, spare parts, services, etc., evaluated the qualification of existing qualified suppliers periodically, supervised, evaluated and shared the information of the suppliers' quality assurance system, working process and actual performance, supervised the manufacturing of the key nuclear safety equipment in the factory, and strengthened quality supervision, validation and acceptance in key processes.

(9) Aiming at significant quality events in the construction and operation of the NPPs, utilities organize symposium, prepare specific study report, carry out trend analysis and typical case analysis about important non-conformance items, identify significant events and problems and timely consolidate forces to resolve the problems, and spread and share experiences acquired from success, lessons from failures and good practices among the industry, the group corporation and the NPPs.

13.4 Supervision and Control

The MEP (NNSA)'s control of the quality assurance activities of NPP is embodied in the following:

(1) Reviewing and approving NPP quality assurance program and other safety important documents, including the modifications on the documents in line with nuclear safety regulations and relevant safety guides on the quality assurance.

(2) Performing nuclear safety surveillance on the implementation of QAP of the NPPs, selecting control points on related quality plans and conducting supervision on site with regard to significant safety and quality activities; organizing technical review and verification on the result of significant safety and quality activities.

(3) Strengthening the investigation and treatment of non-conformance items during NPP construction, organizing technical review on significant non-conformance items, and performing effective surveillance on the disposing process to properly handle the non-conformance items, to avoid potential safety hazards and promote the improvement of the related technical level.

The MEP (NNSA) actively summarizes the experience in the supervision of NPP construction, further strengthens the surveillance and management of units under construction, and strengthens NPP safety review by centralizing the sources and mobilizing industry experts to promote the standard and unified surveillance of NPPS under construction in China. Meanwhile, the MEP (NNSA)carries out in-depth inspection on engineering companies and construction companies, strengthens process surveillance on construction, installation, commissioning, etc., strictly conducts important focus inspection of prestress construction, key equipment installation, main circuit welding, safety system commissioning, etc. and inspection on the permit of such control points as dome lifting, cold commissioning, initial loading and first criticality, and strengthens the efforts to investigate and handle construction events and significant non-conformance items to properly resolve engineering problems including numerous design errors, non-conformance items of civil engineering and equipment, abnormal system commissioning, digital control structure, etc.

The MEP (NNSA) and regional offices perform a series of surveillance and inspection on significant activities relating to safety and quality for each NPP by strictly following the requirements of the regulations and relevant policies or documents, and conscientiously fulfilling the surveillance functions on nuclear safety. The specific activities are described in relevant chapter of this report.

14. ASSESSMENT AND VERIFICATION OF SAFETY

Each Contracting Party shall take the appropriate steps to ensure that:

(i) Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented and filed, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

(ii) Verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

14.1 Licensing Process for Different Stages of an NPP

In comparison with mandatory requirements of existing safety regulations/standards and practices of the industry, by means of review, supervision, inspection, test, analysis and review, assessment and validation on safety of the NPPs is conducted to assess safety conditions of SSCs in the NPPs, and ensure a high level of safety in the life-time of the NPP.

For NPPs, the Chinese government implements licensing system. Operating organization of the NPPs is required to systematically conduct safety assessment and validating activities at different stages in line with requirements of regulations and standards, form corresponding analysis report and submits to nuclear safety regulatory body for review. After passing the review and obtaining relevant licenses or documents of ratification, such follow-up activities as design, construction, first fuel loading, operation and decommissioning, etc. can be carried out. During the review of nuclear safety licenses, the MEP (NNSA) will keep a close watch on safety assessment and validating activities from siting, design, construction, the first fuel loading, operation and decommissioning through the whole life of the NPP.

At the phase of siting for the NPP, applicant must submit materials of applying for review, including "Safety Analysis Report of Plant Site", to the MEP (NNSA).

Starting from project technology scheme and selection of equipment, the "Safety Analysis Report of Plant Site" must demonstrate the feasibility of the plant site in terms of safety, technology, economy, etc.

At the phase of construction of the NPP, applicant must submit "Application for the Construction of Nuclear Power Plant", "Preliminary Safety Analysis Report of NPP (PSAR)" and other relevant materials to the MEP (NNSA) before initiation of construction. The "Preliminary Safety Analysis Report (PSAR)" must definitely describe characteristics of the plant site in detail and preliminarily describe systems, facilities and other things. After obtaining Construction Permit of Nuclear Power Plant through examination and approval, the construction can be started.

At the phase of commissioning of the NPP, before the NPP's first nuclear fuel loading in reactor core, applicant must submit "Application for First Fuel Loading of Nuclear Power Plant", "Final Safety Analysis Report of Nuclear Power Plant" and other relevant materials to the MEP (NNSA). In the "Final Safety Analysis Report of Nuclear Power Plant", applicant must describe systems and facilities in detail and comprehensively demonstrate the commitments to the MEP (NNSA) in the course of reviewing the "Preliminary Safety Analysis Report (PSAR)". After obtaining "Instrument of Ratification for First Fuel Loading of Nuclear Power Plant" through examination and approval, the NPP can load nuclear fuel and carry out commissioning.

At the phase of operation the NPP, after 12 months of trial operation beginning from the date when the NPP reaches its full power at the first time, applicant must submit the "Revised Final Safety Analysis Report of Nuclear Power Plant" and other relevant materials to the MEP (NNSA). In the "Revised Final Safety Analysis Report of Nuclear Power Plant", applicant must comprehensively reflect the experience and feedback at the phases of commissioning and trial operation in this analysis report as well as the commitments to the MEP (NNSA) in the course of reviewing the "Final Safety Analysis Report of Nuclear Power Plant". After obtaining "Operation License

of the Nuclear Power Plant" through examination and approval, the NPP can initiate its commercial operation.

At the phase of decommissioning of the NPP, applicant must submit the "Report on Decommissioning the Nuclear Power Plant" and other relevant files to the MEP (NNSA), which should be reviewed and qualified by MEP (NNSA), and then, the "Instrument of Ratification for Decommissioning of the Nuclear Power Plant" will be issued.

14.2 Safety Assessment and Verification Practices in NPPs

14.2.1 Probabilistic Safety Analysis

According to stipulations of relevant nuclear safety regulations, the design of NPPs must adopt the analyzing method of deterministic methodology and probabilistic methodology to carry out safety analysis. In the meantime, in the periodic safety review of NPP, in order to complement evaluation of deterministic methodology, Probabilistic Safety Analysis (PSA) methodology must be implemented as input of periodic safety review so as to understand the relative contribution to safety in all different aspects of NPP.

"Policy of Technology: Application of Probabilistic Safety Analysis Technology in Nuclear Safety Field" promulgated by the MEP (NNSA) in 2009 clearly pointed out that the use of probabilistic safety analysis method should be actively promoted in the activities of nuclear safety, which should be suitable to the extent of support given by the present technology and data of probabilistic safety analysis, encourage continuous improvement of probabilistic safety analysis method and collection of data, encourage information sharing, technological exchange and peer review, jointly advance development and application of probabilistic safety analysis technology. HAD102/17 "Safety Assessment and Verification of Nuclear Power Plant" also provided definite guidance about the probabilistic safety analysis method, scope and target to be met.

The MEP (NNSA) vigorously promotes the application of PSA (Probabilistic Safety Assessment) technology, begins to build the basic work for regulatory authorities to

apply PSA and promotes the creation of reliability databases. NPP operators are required to carry out pilot work for PSA application according to their own actual conditions, thus laying the foundation and gaining experience in the preparation of the PSA-based regulatory mode, standards and regulations. NPPs in operation select their own PSA application pilot project in combination with the actual situation, and determine the projects, time node arrangement, summary of experience, etc. At present, the MEP (NNSA) is carrying out the related work according to the application pilot plan of each NPP to gradually enhance the application of PSA in NPPs in operation.

In 2006, Qinshan NPP finished the development work of Probabilistic Safety Analysis (PSA) for grade I full power internal events incurred initially, which passed the review of the MEP (NNSA) at the end of 2007. After development, Qinshan NPP begins to apply the management philosophy of PSA in production activities, finds out the weaknesses in some designs/operations of NPPs by PSA analysis and improves them. In daily planning and management, Qinshan NPP strictly implement "Regulations of Risk Management for Production Planning Items" to select daily planning items, review and approve risk analysis and PSA analysis for single equipment, and makes corresponding risk management measures according to analysis results. Meanwhile, Qinshan NPP assesses the benefits and risks based on detailed analysis to determine whether a project can be implemented according to a temporary reactor shutdown/trip plan or an outage plan. Moreover, Qinshan NPP adds risk analysis of PSA to the planned risk analysis to provide reference for maintenance decisions, improves and supplements some operating procedures/test details aiming at the results of human factor analysis for PSA, and optimizes the initial training and retraining of the operators according to the PSA results.

Daya Bay NPP, finished its research work of probabilistic safety assessment for trip of the reactor in 2007, and has finished the building of fire and flooding PSA models. Meanwhile, Daya Bay NPP analyzed overall fire risks, found out the dominated accident sequence and failure mode which mainly lead to the fire risks of Daya Bay

NPP, and established a basic database of fire and flooding PSA. Furthermore, Daya Bay NPP and LingAo NPP revised the equipment reliability database, finished application data acquisition and computing system development for the risk-directed PSA, and completed the acquisition of some reliability data.

Qinshan Phase II NPP began to develop the PSA for unit operation at the beginning of 2010, such as developing the grade I operating PSA model for internal events incurred initially (including loss of external power supply but not including internal fire and flooding) under power operating conditions, low power conditions and reactor shut-down conditions of the units in operation, finished the report and relevant supportive materials to evaluate the level of nuclear safety of units. Up to now, Qinshan Phase II NPP has finished the grade I PSA model and total report for the Unit 1 and Unit 2under power operating conditions, low power conditions and reactor stopping conditions as well as phase I development of the online risk assessment and management system.

Based on the PSA report and analytical model at NPP design stage provided by AECL (Atomic Energy of Canada Limited), Third Qinshan NPP improved and perfected the model to develop the PSA model at NPP operating stage. Based on the model, the NPP developed the Third Qinshan Nuclear Power Plant Risk Monitor (TQRM) system to perform daily operation risk management in the NPP and to apply the model in analysis support of outage period optimization and other applications in the NPP.

Tianwan NPP gradually applies PSA technology in supporting the optimization of start-up process after outage of the NPP.

The corresponding probabilistic safety analysis for new nuclear power plant has been finished according to regulatory requirements, and the probabilistic safety analysis report has been submitted to regulatory authorities for review. As the supplementary and auxiliary to determination safety analysis, PSA is used to verify whether the design complies with the overall safety objectives, to identify the weaknesses of

NPPs, to balance the design of NPPs and to evaluate the design improvement scheme.

After the accident in Fukushima Nuclear Power Plant, NPPs under construction actively promoted and improved PSA for external events of NPPs according to the requirements of improvement actions. Hongyanhe NPP and Yangjiang NPP are carrying out the research for PSA of grade II and of spent fuel tanks. Fangchenggang NPP is conducting long-term research for PSA of grade II and of external disasters.

14.2.2 Surveillance for Items Important to Safety

As required by nuclear safety regulations, the NPPs developed monitoring program on the basis of experience of foreign NPPs and monitoring requirements of components provided by the manufacturers. The monitoring program includes monitoring plant parameters and system status, monitoring chemistry and radiological chemistry sampling, tests and calibrations of the instrumentation, tests and inspections of the safety-related systems.

Periodical tests are the main measures for implementing plant monitoring program, which are used for determining whether or not the safety-related systems and components continuously carry out their functions as required by design. The procedures of periodical tests are required to be implemented and verified in the phase of commissioning, and fully implemented after commercial operation. These periodical tests are used by NPPs to confirm whether safety-related systems and equipment have integral functions.

Since commercial operation, NPPs have had carried out surveillance, inspection and testing on safety-related systems in strict accordance with items, frequency and other requirements specified in "Technical Specifications", promptly repaired and eliminated defects and abnormalities discovered during tests, retested for verification until functions and parameters met acceptance criteria, and recovered the systems in strict accordance with time limit in "Technical Specifications". Nuclear safety engineers independently review and witness the implementation of nuclear safety-related regular test items to make sure that the regular test items are

controllable. The results of surveillance, inspection and testing of the safety system show that at the stages of NPP startup and normal operation, safety system have stable and reliable functions which meet design and technical requirements, thus ensuring the safe operation of NPPs.

China's NPPs constantly improved technical means and managing procedures of nuclear power plant surveillance, developed and applied online performance monitoring system based on computer and internet technology, took this system as data platform, combined management system of specific fields like production management and chemical management, etc., implemented analyses and feedbacks on all sorts of collected monitoring data, timely identified unfavorable trend and took corresponding measure for correction and improvement.

To further implement management requirements of "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment" and supportive regulations and to strengthen the surveillance and management of civilian nuclear safety equipment, the MEP (NNSA) specified relevant requirements in the Regulations and supportive regulations, including:

1) Permission scope of "Directory of Civilian Nuclear Safety Equipment (first batch)".

2) Performance requirements for license application of civilian nuclear safety equipment company.

3) Requirements on making imitation items for license application of civilian nuclear safety equipment company.

4) Requirements on qualification and performance of overseas registration and application company.

14.2.3 In-Service Inspection

According to the requirements of in-service inspection programs, corresponding in-service inspection plan was formulated for important safety systems and equipment of reactor building, such as unit pressure-retaining components, containment components, pressure pipes, thermal transmission branch pipes, heat

transfer tube of steam generator and other equipment/components, submitted to the MEP (NNSA) for review and implemented during outage of units.

During the past three years, Chinese NPPs have completed 33in-service inspections during the outages of reactor. Any deficiency of equipment or component discovered in the inspection should be input into the in-service inspection database and compared with the previous results to forecast the trend. When necessary, the scope and frequency of inspection should be increased, and the component with deficiencies should be repaired or changed. Qualified inspectors implement in-service inspection in accordance with approved inspection procedures, make use of qualified inspection equipment, and strict quality assurance and quality surveillance in the process of inspection are performed so as to assure the effectiveness of the inspection results. Through previous in-service inspections, some deficiencies in NPPs have been discovered and corrected, which have guaranteed the integrity of three safety barriers and safety operation of NPPs. The results of in-service inspections are also reviewed by MEP (NNSA).

In recent years, in order to decrease the risk of operation safety of NPPs and the possibility of lacking or omitting non-destructive testing or mistaken judgment in the course of in-service inspection, China is gradually building up capacity verification system for in-service inspection according to the latest industry standards and practices. Beginning from 2008, according to the requirement of "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment", only after passing the censoring of capability and qualification conducted by safety regulatory body and obtaining corresponding licenses, the organizations engaging in non-destructive testing of civilian nuclear safety equipment will be able to undertake pre-service and in-service inspection of nuclear power plant and continuously accept the surveillance of the safety regulatory body.

14.2.4 Aging Management

To further improve the nuclear and radiation safety regulation system and to enhance the level of nuclear safety surveillance, the MEP (NNSA) organized to formulate and

release "Aging Management of Nuclear Power Plants". The "Code on the Safety of Nuclear Power Plant Design" and the "Code on the Safety of Nuclear Power Plant Operation" determine the principles and objectives for carrying out aging management in NPPs, while "Aging Management of Nuclear Power Plants" explains and supplements relevant items in the two codes, and provides guidance and advices for aging management of key NPP safety-related structures, systems and components and how to carry out aging management effectively, thus facilitating operators to make, implement and improve the program of aging management in NPPs.

According to requirement of relevant codes, the NPPs formulated and implemented aging management program and took such measures as monitoring, testing, sampling and inspection to assess the expected aging mechanisms in the design of NPPs and identify the unexpected possible conditions or performance degradation during operation.

When implementing PSR, aging management was reviewed as a specific area to confirm that aging has been effectively managed by the plants, all required safety functions has been maintained, and an effective control of aging and degradation was realized.

According to the overall objectives of aging management, Qinshan NPP prepared an aging management program, selected the objects of aging management, and carried out aging management activities on some key structures, systems and components (reactor pressure vessels, pressurizer, steam generators, reactor containments, grade 1E cables, etc.). Meanwhile, the NPP actively conducted feasibility study on service life extension of 300,000kW unit.

During aging management, Daya Bay NPP and LingAo NPP made progresses in technical research and application in several professional fields. Meanwhile, the NPPs finished a number of researches in life assessment methods of main transformers, fault analysis of inverters, etc., completed the construction of eight major laboratories for the control equipment aging and reliability research center in the NPPs which had been put into operation, and prepared series of aging

management programs of nuclear grade passive mechanical equipment including reactor pressure vessels, reactor internals, control rod drive mechanism, control rod components, etc., and studied the anticorrosion technology of concrete silence to lay a foundation for the application of the technology in reactor containments.

Qinshan Phase II NPP gradually carried out aging management, prepared corresponding aging management programs, procedures and specifications, and performed aging mechanism analysis and database development on key equipment. The NPP has finished developing the program for corrosion and aging management of secondary-loop pipe flow acceleration, the aging management program of reactor containments and coatings, and unit anticorrosion program. Meanwhile, the NPP is developing the aging management program of the entire NPP.

Third Qinshan NPP has built systematical working methods and procedures for aging management, finished selecting the objects of aging management, analyzing the aging mechanism of related equipment and preparing aging management procedures, made and constantly perfected the aging management program, and continued to promote aging management according to the requirements in the program.

Nuclear power projects under construction are gradually carrying out or planning aging management work according to their own conditions, such as studying the laws and regulations related to aging management in NPPs at home and abroad, collecting, recording and sorting out relevant fundamental data, selecting the objects of aging management, preparing corresponding aging management programs, procedures and specifications, establishing aging management organizations, etc.. Ningde NPP and Hongyanhe NPP have finished setting up the aging management system, and established an Aging Management Project group to take full charge of coordinating and managing the aging management-related work in NPPs. Haiyang NPP gradually ascertains its own aging management technology routes by studying the requirements of China's nuclear safety regulatory bodies on aging management and surveillance. Ningde NPP, Haiyang NPP and Hongyanhe NPP are carrying out cable aging sampling and reservation work.

14.2.5 Periodical Safety Review

The operational NPPs, according to requirement of relevant regulations, will implement periodical safety review once in every ten years after beginning of commercial operation. According to operating experience, relevant important safety information, and existing safety standard and practice, the NPP systematically conducts re-assessment of safety. The scope of review covers all aspects of nuclear safety, including 14 safety elements in five categories.

Duration of periodical safety review shouldn't exceed three years. In the process of periodical safety review, according to result of review, NPPs identify reasonable and achievable corrective action/safety improvement and the execution plan, fully take interaction and mutual cover of all safety elements into consideration, and pay attention to corrective action/safety improvement's influence on all safety elements. NPPs comprehensively assess the weakness which weren't reasonably resolved, identify related risks and provide corresponding certificates for sustainable operation. During the periodical safety review, repeated work should be minimized by fully utilizing relevant research results and comments from regular safety review, special safety review, probabilistic safety analysis, etc.

Qinshan NPP and Daya Bay NPP have finished the first periodical safety review; and the result shows that the two NPPs are able to continue steady safety operation. The two NPPs have taken actively corrective action for the weakness discovered in the review and are carrying out the second PSR. According to requirement of codes, 1# and 2# units of LingAo NPP and Qinshan Phase Ⅱ NPP, Third Qinshan NPP and Tianwan NPP will perform periodical safety review in succession.

Qinshan NPP started the preparation of the second PSR since 2010. In August 2012, PSR program was accepted by MEP (NNSA); the overall PSR is expected to be completed in 2015. At present, the first-phase review preparations have been completed, and the review procedure and standard list have been released; the PSR is in progress.

Daya Bay NPP started the second PSR since the beginning of 2012. The PSR totally involves 14 factors and four new subjects (including reactor core and nuclear fuel, security of electrical power system, security of instrument control system and security of ventilation system); which is planned to be completed at the end of 2014.

Qinshan Phase Ⅱ NPP considers implementing the primary PSR of 1# and 2# units. In August 2012, the program of the primary PSR was accepted by MEP (NNSA); the overall primary PSR is expected to be completed in 2014. At present, the first-phase review preparations have been completed, and the review procedure and standard list have been released; the PSR is in progress.

As for 1# and 2# units of LingAo NPP, report on all 14 factors of the primary PSR has been completed and has been submitted to MEP (NNSA) in five batches; totally more than 400 problems in four batches of MEP (NNSA) have been answered, and the overall review report and correction action plan have been submitted.

PSR in Third Qinshan NPP started in 2012 and expects to be completed in 2014. Based on the comprehensive evaluation, the specific degree of Qinshan Phase III NPP meeting current safety standard and practice, the validity of the license issuing basis as well as the safety improvement to be implemented with the purpose of solving the determined safety problem will be determined.

Tianwan NPP has launched the PSR, and PSR program has been submitted to MEP (NNSA). At present, the program is being revised according to the review comments of MEP (NNSA); it is expected to completely conduct PSR in 2013.

Some prophase preparations are performed for all nuclear power projects under construction, including studying requirement of "Code on the Safety of Nuclear Power Plant Operation" and "Periodic Safety Review of Nuclear Power Plants", collecting and studying relevant PSR achievement of other NPPs completed in China.

14.2.6 Internal and External Assessment in NPPs

To ensure safe and reliable operation, Chinese NPPs have established a comprehensive system for internal and external assessments by continuously learning the advanced management experience from foreign NPPs in combination with the development practices of Chinese NPPs, see Figure 5.

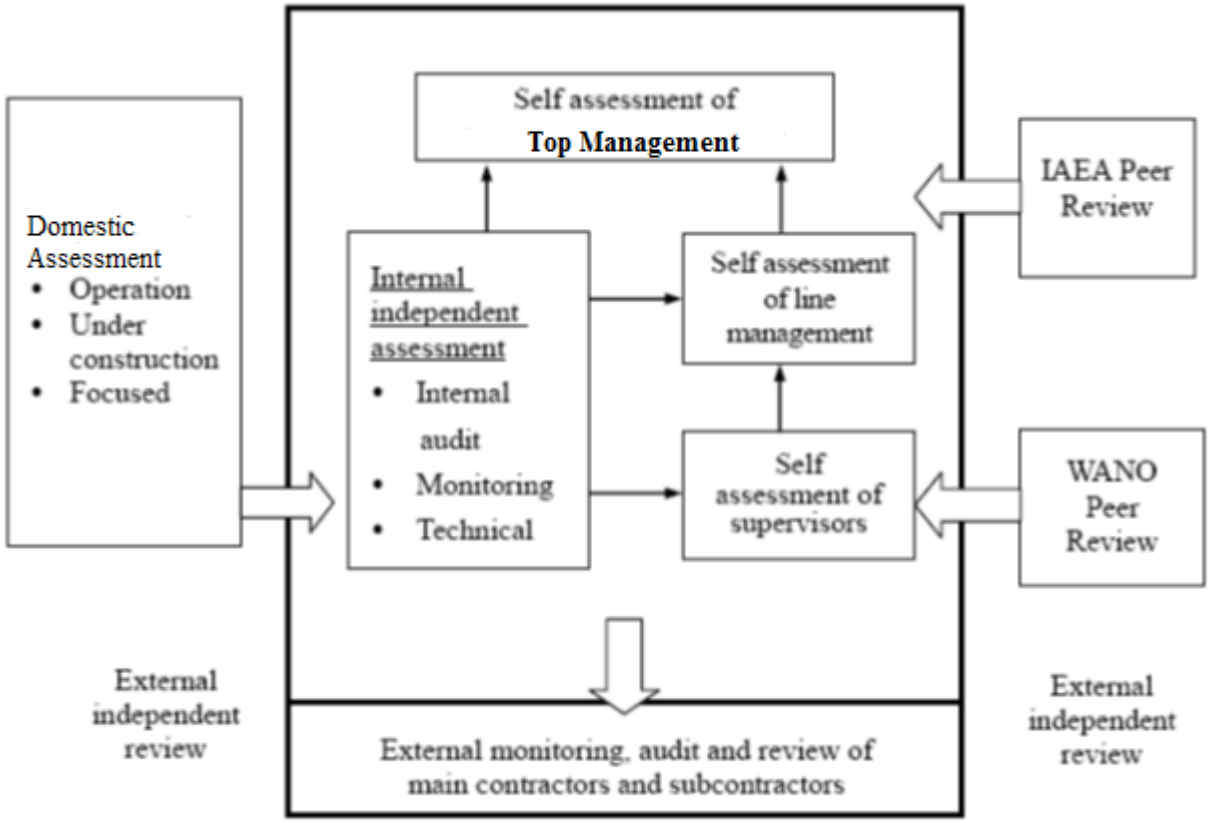

Figure 5 Assessment System of NPPs

Internal assessment of NPP includes independent assessment in NPPs and self-assessment at different management levels. Independent assessment is conducted by authorized departments or organizations, through auditing, monitoring and technical review to check and verify each job done by plant personnel or contractor. The results of independent assessment are an important input for self assessment.

Self-assessment at different management levels existed in routine jobs. Its purpose is to determine the effectiveness on establishing, promoting and achieving the goals of nuclear safety, and identify and correct managing weaknesses and obstacles to achieving nuclear safety goals. Self-assessment of top management departments focuses on strategic goals suitable for organization, including safety goals. The line

management pays more attention to monitoring and review of working process, including the monitoring of item, service and process, review and confirmation of design documents, review of procedures and records, observation of independent assessment, and periodical walk-down of facilities.

CNNC organizes peer review observation for NPP during outage; performance objectives and criteria for outage in NPP were prepared with guidance of "Guideline for Outage Management of WANO Plan" in combination with outage observation practice and with reference to related document. Meanwhile, CNNC actively promote nuclear safety culture assessment. In 2011 and 2012, Qinshan NPP and Tianwan NPP respectively accepted the first nuclear safety culture assessment organized by CNNC, which actively makes explorations in the realization of transmitting, assessing and exploring nuclear safety culture and provides workable means for continuously improving nuclear safety culture. Based on the assessment, the field to be improved was found, cause analysis was performed, improvement measures was executed and management level was improved.

At the industry level, technical support and service on NPP peer review and experience exchange by relying on Peer Review and Experience Exchange Committee of NPP was actively developed. Subsequent works in aspects of nuclear safety culture assessment standard and method study, assessment leader/assessor training program development and performance evaluation method, study of advanced information package for NPP peer review preparation guidance, study of NPP emergency preparation and response assessment guidance, study of NPP assessment and experience exchange system management document and technical document, etc. were completed.

In the past three years, China continuously implemented comprehensive assessment and follow-up for domestic NPPs in operation, and meanwhile, according to actual demand of NPP, focused assessment of operation in specific fields and on the industry and the group corporation level was conducted to enable assessment of domestic operation for constant in-depth development.

Following large-scale construction of NPPs in China, in the meantime, China applied innovatively the idea and method of peer review of operational NPPs to nuclear power projects under construction. From different level like the industry, the Group Corporation, etc., China organized related technical support organizations to develop performance objective and criteria of assessment on NPP in construction, successively implemented construction project peer assessment on project owners, general contractor, etc., and on the basis of construction assessment practices, standard and method for assessment have been constantly improved and perfected.

Furthermore, China's NPPs also actively accepted reviews of IAEA-OSART and peer review of WANO. From 2010 to 2012, China's NPPs totally accepted one review of IAEA-OSART, six peer reviews of WANO and two follow-up for peer reviews of WANO.

The results of all above assessments and reviews have shown that the evaluated NPPs on the whole were in good safety condition and the quality of project construction was under control. At the same time, assessment activities helped the evaluated NPPs or projects identify the difference with other NPPs at home and abroad and determine the improving objective and standards to be achieved, and promoted further improvement of safety and quality management.

14.3 Supervision and Control

It is specified in Chinese law that the operating organization of NPP undertakes the overall safety responsibility. The MEP (NNSA) implements independent nuclear safety monitoring for nuclear power plant in siting, design, construction, operation and decommissioning phases, which includes technical review, administrative licensing, supervision and inspection. Moreover, the MEP (NNSA) dispatches field supervisor to all nuclear power plants to perform supervision on activities of the nuclear power plant field.

The MEP (NNSA), by way of formulating codes, guides, policies and standards of nuclear safety, put forward requirements for safety assessment and verification of NPPs, and by way of nuclear safety review, nuclear safety inspection, periodical

safety review, etc., perform supervision on related activities within the lifetime of the NPP to confirm the NPP and its activities in conformity with goal, principle and criteria.

At different phases of NPPs, emphases for review of regulatory body are different. At the phase of siting, the MEP (NNSA) performs technical review on "Safety Analysis Report of Siting" and "Environmental Impact Report (Siting Phase)" submitted by the operating organization of NPP to review and determine that the chosen plant site complies with related codes and standards from safety and environmental aspects; the emphasis is laid on the suitability of the chosen plant site and the feasibility of design basis relating to surroundings of the plant site and implementation of plan for emergencies; At the phase of construction, before main building of NPP is constructed, viz. placing foundation concrete for nuclear island, the MEP (NNSA) reviews the design of structure, system and equipment of NPP important to safety to confirm the design of the NPP meets nuclear safety and environmental protection requirements; During construction, the field supervisor of the MEP (NNSA) supervises the whole process (civil construction, system and equipment installation, cold and hot state debugging, preparations before fuel loading and other activities) and conducts technical review on various safety and quality problems of NPP and raises the requirement. At the phase of commissioning, MEP (NNSA) review and identify whether the NPP construction is completed according to the recognized design, whether the NPP conforms to requirements of nuclear safety codes, whether the NPP reaches requirement for quality and whether it has completed with eligible records of quality assurance; At the phase of operation, MEP (NNSA) review and identify whether the result of trial operation is in line with design or not, and review and confirm operation limits and conditions revised. During the life of NPP operation, the MEP (NNSA) dispatches supervisor to work on site of the NPP permanently to implement on site supervision on operation status and operation activity of the NPP rises nuclear safety requirement for the abnormal condition and violation on operation regulation of the NPP found in supervision to further guarantee the

operation safety of the NPP. At the phase of decommissioning, MEP (NNSA) review and identify whether the steps of decommissioning and status of all phases of decommissioning of the NPP are in line with requirements of safety.

At the same time, the MEP (NNSA) inspected the implementations of nuclear safety management requirement and conditions stipulated in the licenses by way of nuclear safety surveillance, and urged the NPP to correct those items which are not complying with nuclear safety management requirement and conditions stipulated in the licenses. Through the whole life of the NPP, in consideration of operating experience and new important information acquired from relevant resources, the MEP (NNSA) requires the operating organization of the NPP to systematically assess safety of the NPP by taking the method of periodical safety review. The reviewing strategy and safety elements to be assessed must obtain approval and agreement from the MEP (NNSA) so as to identify the extent of validity of existing safety analysis report.

In the past three years, the MEP (NNSA) further strengthened nuclear safety surveillance, safety review and experience feedback of the operating NPPs, continuously improved the supervision mode and means, timely found and handled the nuclear safety problem and guaranteed the operation safety of NPP; conducted technical review and approval on applications relating to nuclear safety for operating NPP; organized inspection before reactor critical status after refuel outage, put forth relevant nuclear safety management requirements; convoked several review dialogue sessions and expert reasoning conferences to review the flood control and flooding prevention scheme as well as other important problems of Qinshan NPP.

In the past three years, the MEP (NNSA) further strengthened nuclear safety inspection of NPP under construction to ensure the construction quality of the NPP. At present, nuclear power units under construction in China have stepped into installation and commissioning peak comprehensively; the supervision task is arduous; AP1000, EPR and other new nuclear power units bring technical challenges on the supervision due to design change and equipment problem. The MEP (NNSA)

implemented special inspection on important equipment installation, safety system commissioning and other important activities and enhanced the investigation and treatment of construction event and significant non-conformance items by strengthening the process supervision in construction, commissioning and other links to timely find and handle the problems during construction of NPPs; completed reviewing work of safety analysis report on plant siting of intended construction and environmental impact report, and issued corresponding Position Paper on Review of Plant Siting and Instrument of Ratification on Environmental Impact Report; according to the requirements of nuclear safety codes and relevant safety regulations and guides, by way of nuclear safety review and on-site supervision, construction permits of accumulatively 11 units was issued; along with the issuance and implementation of "Regulations on the Safety Regulations for Civilian Nuclear Equipment" with its supporting regulations, the MEP (NNSA) defines relevant requirement of "Regulations on the Safety Regulations for Civilian Nuclear Equipment" and its supporting regulations, further regulated the examination and approval of nuclear safety equipment, intensified surveillance and management of imported civilian nuclear safety equipment; promulgated technical policy on application of probabilistic safety analysis technology to the field of nuclear safety; focusing on the impact possibly resulted from significant design improvements influencing safety of the NPP, gave the instruction of conducting independent verification for safety assessment.

15. RADIATION PROTECTION

> Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1 Basic Requirements of Radiation Protection

Chinese government promulgated a series of laws, regulations and national standards to ensure the implementation and achievement of radiation protection objectives.

(1) The "Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China" was promulgated by the Standing Committee of the National People's Congress on June 28, 2003, requires that:

— The operating organizations of the NPPs are in charge of protection and remedy of radioactive contamination within their own responsibilities and receives monitoring and management of administrative competent department and other related departments, and are responsible for all consequences caused by radioactive contaminations required by the law;

— The operating organizations should survey the categories, concentration and amount of radionuclide in the effluents to the surrounding, and periodically report the survey results to administrative environmental protection department of the State Council and local governments.

— The operating organizations should minimize the effluent of radioactive waste. The airborne and liquid effluents shall be below the national standard of protection and remedy of radioactive contamination, and the operating organization shall periodically report the effluents survey result to administrative environmental protection department.

(2) The National People's Congress reviewed and approved the "Act of Prevention and Treatment on Occupational Diseases of the People's Republic of China" on Oct. 27, 2001, and approved the revision of the act on December 31, 2011,

which specifies prevention and treatment of occupational diseases in enterprises like nuclear power plants, etc. as follows:

— The organizations must deploy their protective equipment and alarming devices and ensure the working personnel of approaching radiation by carrying their individual dosimeters.

— The organizations should implement routine monitoring of pernicious factors leading to occupational diseases, undertaken by the persons specially arranged, and ensure that the monitoring system is in normal operation.

(3) The new national standard GB18871-2002, The "Basic Standard on the Ionization Radiation Protection and Radioactive Source Safety" was issued on October 8, 2002. The standard requires that the release of radioactive substance should be controlled, all the critical channels which lead to public exposure should be determined, and the influence on human being and environment should be evaluated. The new standard meets the international standards, and involved the recommendations from ICRP (International Committee of Radiation Protection). The limits of personal dose in "The Basic Standard on the Ionization Radiation Protection and Radioactive Source Safety" are required as follows:

- Occupational exposure

- An effective dose of 20 mSv per year on average over five consecutive years, which defined by regulatory body (not for retroactive average).
- An effective dose of 50 mSv in any single year.
- An equivalent dose to the lens of the eye of 150 mSv in a year.
- An equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.
- In special circumstances, the period of averaging 20mSv of annual dose may exceptionally be up to 10 consecutive years, and the effective dose for any worker shall not exceed 20 mSv per year on average over this period and

shall not exceed 50 mSv in any single year, and the circumstances shall be reviewed when the dose accumulated by any worker since the start of the extended period reaches 100 mSv; the temporary change in the dose limitation shall not exceed 50 mSv in any single year and the period of the temporary change shall not exceed 5 years.

- The exposure to general public

- An effective dose of 1 mSv in a year.
- In special circumstances, an effective dose of up to 5 mSv in a single year provided that the average dose over five consecutive years does not exceed 1 mSv per year.
- An equivalent dose to the lens of the eye of 15 mSv in a year.
- An equivalent dose to the skin of 50 mSv in a year.

(4) In each stage of nuclear power plant, the radiation protection principled requirements are defined in series regulations on siting, design, operation and the others by the regulatory body. The requirements are as follows:

— During siting of NPP, the protection to general public and environment from over exposure due to release caused by radiation accident should be assured. Meanwhile, the normal radioactive substance release should be considered.

— During design of NPP, the radiation protection requirements should be considered, such as optimization of layout, setting the barriers, reducing the number and duration of personnel working in radiation area, and treatment of radioactive substance to proper shape.

— Measurement should be carried out to reduce the amount and density of radioactive substance in plant or released to environment.

— The potential radiation accumulation in the personnel working area should be considered, and the products of radioactive waste should be minimized.

— The operating NPP should evaluate and analyze the radiation protection requirements and plant actual condition, establish and implement the radiation protection program, ensure correctly implementing each program by monitoring, checking and auditing, verify the achievement of the goals, and take necessary corrective actions.

— The radiation protection responsible department establishes and implements the radioactive waste management program and environment survey program, and evaluates radiation affection of radioactive release to environment.

(5) In 2004, the MEP (NNSA) promulgated the "Code on the Safety of Nuclear Power Plant Design". It is mandatory that nuclear safety analysis should be completed in the design of NPP to evaluate the acceptable dose of staff in NPP and general public, and potential consequence to environment. It is also required that the NPP should take measures to control exposure of radiation and decrease the possibility of accidents. The safety design of NPP shall follow the principle of low probability of incident with high radiation dosage or high radioactive substance release, and no or little radiation consequence of high probability incidents.

(6) On September 1, 2011, the MEP (NNSA) revised GB6249-2011 "Rules on the Environmental Radiation Protection of Nuclear Power Plant"; the effective dose equivalent limits and the annual discharge limits of airborne and liquid radioactive effluents to any individual (adults) of the general public caused by the release of the radioactive substance of each NPP to the environment are clearly stipulated by the national standard.

- The effective dose of radioactive substance released by all nuclear power reactors to any individual of the general public shall be less than the dose limit 0.25mSv every year. The operating organization of NPP shall respectively prepare dose management target value of airborne and liquid radioactive effluents according to the dose limit approved by Review and Management Department.

- NPP shall control the annual total discharge of radioactive effluents for

every reactor. The control value of the reactors with thermal power of 3,000 MW is shown in Table I and Table II. For the reactor with the thermal power greater than or less than 3,000 MW, the control value shall be adjusted appropriately according to the power.

Table I Control of Radioactive Airborne Effluents (Unit: Bq)

	Light water reactor	Heavy water reactor
Noble gas	6×10^{14}	
Iodine	2×10^{10}	
Particles (Half life≥8d)	5×10^{10}	
^{14}C	7×10^{11}	1.6×10^{12}
Tritium	1.5×10^{13}	4.5×10^{14}

Table II Control of Radioactive Liquid Effluents (Unit: Bq)

	Light water reactor	Heavy water reactor
Tritium	7.5×10^{13}	3.5×10^{14}
^{14}C	1.5×10^{11}	2×10^{11} (except tritium)
Other nuclides	5.0×10^{10}	

– For the plant site with multiple reactors of the same type, the annual total discharge of all units shall be controlled within 4 times the value specified in Table I and Table II. For the plant site with multiple reactors of different types, the annual total discharge of all units shall be approved by the regulation body.

15.2 Application of ALARA Principle in NPPs

15.2.1 Application of ALARA Principle in NPP Design

(1) General design considerations

— Proper layout and shielding are adopted for the SSCs which contain radioactive substance.

— Times and duration of personnel working in radiation area in the design are minimized.

— The radioactive substance is processed into proper shape for easy transportation, storage and treatment.

— The amount and density of radioactive substance which disperses in plant and releases to environment are reduced.

(2) Design consideration for equipment

— Reliable and durable equipment, components, and materials are selected to reduce or eliminate the need for maintenance.

— The selected coating materials for equipment and components are easily flushed and decontaminated.

— Modularized designs of equipment and components are adopted for easy disassembly and replacement or moving to a lower radioactive area for repair.

— Redundant equipment or components are prepared to reduce the demands for instant repair when radiation levels may be too high or feasible approaches are unavailable.

— Equipment and components can be remotely operated, maintained, repaired, monitored, and inspected.

(3) Design consideration for equipment layout

— Improve accessibility of equipment;

— Provide radioactive equipment with shielding;

— Provide proper and sufficient ventilation;

— Control contamination, conduct obvious isolation between contaminated

area and non-contaminated area, and decontaminate the contaminated area;

— The processing technology and detection of radioactive substance;

— Arrange equipment, instrumentation and sampling spots in low radiation area.

15.2.2 Application of ALARA Principle in NPP Operation

The operating NPPs achieve the radiation protection goals by taking all possible and reasonable measures as below:

(1) Perfecting radiation protection management system. While maintaining effective operation of original management system, according to the previous experience and practice, NPPs constantly amended and perfected radiation protection program and relevant procedures, and by way of management of radiating control areas, training of radiation protection for all of its working personnel (including contractors), special operation management of the work with high radiation risk, working process management of operation in controlled areas, etc., guaranteed that all the radiation related activities are conducted and normalized with plan as well as monitored independently.

(2) Dosage objective Management. NPPs periodically monitor and assess the objective management value of radiation protection and according to previous experience and practice, constantly optimize dose limits by way of management improvement and technical transformation.

(3) Improving source control technology. For example, using the primary circuit water strainer with smaller aperture; replacing silver gasket of nuclear power plant; developing and researching the equipment for eliminating a part of hot radiation spots, etc.

(4) Strengthening such contamination protection measures as strengthening surveillance for the starting work conditions of radioactive system and equipment; setting witness point of radiation protection for open ended work.

Because most of radiation exposure of NPP staff mainly occurs in the period of outage, NPPs have attached high importance to radiation protection activities during outage. The above-mentioned measures have been applied and strengthened effectively during the refueling outage, such as following up major projects by special person, enhancing contamination control on site, preparing and implementing ALARA plan as well as strengthening boundary management of radiation protection, item transfer control, contamination control, site shielding, regional isolation and simulation exercise, etc. By strictly performing these measures, NPPs have guaranteed the boundary integrity of radiation control zone during the refueling outage, effectively controlled radioactive substance in the course of transfer and reduced exposure dose of workers.

15.3 Personnel Exposure Control

The survey of the occupational exposure shows that the annual average effective dose equivalent for the site personnel in the operating NPPs of China is far below the dose equivalent limit set by the national standards. The survey results are listed in Appendix 5.

The radiation environment monitoring stations of the province in which Chinese NPPs are located have performed the monitoring of the environment around NPPs. The results indicate that the maximum individual dose equivalent of the general public due to the discharge of the radioactive effluents during the operation of NPP is far below the dose equivalent limit set by the national standards.

15.4 Environment Radioactivity Monitoring

Chinese Government attaches great importance to strengthening construction of radiation environment monitoring network. At present, the national radiation environment monitoring network, nuclear and radiation emergency response technical center and radiation environment monitoring technical center have been built to monitor routine radiation environment in all key cities in China.

According to critical nuclides, critical exposure and transfer paths and critical public groups defined in the environmental impact report (EIR), operating organization of NPPs has established environment monitoring programs for monitoring the radioactivity in environment, to ensure that the requirements in related national laws and regulations are met, the discharges of radioactive substance are kept within discharge limits, and the public are protected from injury due to radioactivity during nuclear plant operation. The survey data of nuclear plant environment radioactivity are evaluated and analyzed in the aspects as follows:

- The effectiveness of controlling the release of radioactive substance to the environment;

- The radiation exposure to the public by the radioactive effluents of NPPs;

- The long-term tendency of environment radioactivity;

- The transfer and diffusion of radioactive substance in the environment;

- The validation of environment model used in EIR.

(1) The environment background investigation of pre-operation

The NPPs fulfill a two-year investigation of the ambient radioactivity background and the ocean ecosystem to obtain the information of critical nuclides, critical exposure (and transfer) paths and critical public groups. The media of the environment to be investigated include the air, surface water, ground water, land-living organisms, water-living organisms, food, soil, etc. The investigation range of γ radiation in the environment is 50km and the investigation range of the other items is 20km. The analyzing and measuring contents include the radiation level in the environment and the radioactive nuclides related to NPPs.

Before operation, the Chinese NPPs have monitored and recorded the level of the ambient background, to ensure the scope and frequency of environment monitoring are representative and meet the requirement of related regulations.

(2) The environmental radiation monitoring

In order to satisfy the environmental evaluation needs, the NPPs fully use the investigation data obtained before the operation to achieve the optimization of environmental monitoring. The emphases of environmental monitoring are put on those items that bring the most hazards to the critical public groups. According to requirements of the "Code on the Safety of Nuclear Power Plant Design", NPPs must make arrangement for identifying NPPs' any possible radioactive influence on surrounding areas besides monitoring in NPPs. Particularly, the following must be noted: all sorts of approaches including food chain, which influence dwellers; radioactive impact on local ecological system (if it's true); possible accumulation of radioactive substance in physical environments; any possible channels which are not approved.

Conforming to state environmental protection regulations and environmental radiation monitoring standards, the NPPs effectively monitor and evaluate the environment according to their environmental monitoring programs.

The monitoring and analysis result of living organisms, air, soil and sea and others in the ambient background indicated that in the past three years, operating NPPs in China did not cause bad influence to the surrounding environment.

(3) The radioactive effluent monitoring

All kinds of airborne and liquid radioactive effluents are monitored after NPP's operating. The measuring contents include the total discharge amount, the discharge concentration and the main nuclides to be analyzed. The monitoring results indicate that the radioactive effluents of each plant are below the limits of national standards during operation.

(4) The meteorological monitoring

The plants have developed the meteorological monitoring program to monitor the conditions of air diffusion. The wind direction, wind speed and air temperature at different elevations, as well as precipitation and air pressure are continuously monitored in selected monitoring points which are representative. Moreover, the communication between the operating organization and the local provincial meteorological department has been kept to exchange the related meteorological data.

(5) The environmental emergency monitoring under accident

The NPPs have established a monitoring plan for environmental emergency

before the trial operation of NPPs. The monitoring plan for environmental emergency formulates some deduced action levels for the purpose of evaluating the monitoring results and determining as soon as possible whether it is necessary to take relevant actions

The NPPs have installed such instruments as the radiation monitors, the radiation detectors, the contamination monitors, the air samplers and the environmental media samplers, etc., which are periodically checked, calibrated and tested, if necessary, these instruments need to be tested to ensure that these emergency response facilities are available when they are used.

Under nuclear accident emergency condition, the operating organization of NPP and local nuclear and radiation environment monitoring department undertake mainly the radiation environment monitoring responsibilities in China; the Emergency Reponses Committee out of the site (the local provincial government usually) shall take charge of the leading and coordination to sufficiently coordinate the resources and activities of all related parties and unify the action.

At early phase of nuclear accident, nuclear and radiation surrounding the site is monitored mainly relying on the emergency nuclear and radiation monitoring source and power on the site of the operating organization of NPP. At later phase of accident, nuclear and radiation are monitored relying on monitoring source and power out of the site since recovery in large scope area is involved. At middle phase of accident, environmental monitoring is completed by both parties inside and outside of the site.

(6) The evaluation of the public doses and environment impacts in normal operation and in the accident

The NPPs evaluate the dose equivalent imposed upon the general public and the impact on the environment in the normal operation and in the accident of NPPs by using the data obtained from the monitoring of the accumulative γ-radiation dose around the site boundary and the sampling analyses of the environment media such as the atmosphere dust, the land-living organisms, the soil, the water, etc.

15.5 Control Activities and Capacity Establishment of the Regulatory Body

Supervision on radioactive effluents of NPP by Regulatory Body covers:

— To formulate codes and guiding documents related to the radioactive waste management.

— To formulate codes, guiding documents and standards related to the radiation protection and the discharge limits of radioactive effluents.

— To evaluate whether the NPPs conform to the related regulations and standards by reviewing design, construction and operation of the radioactive waste management installations, as well as the personnel qualifications and records.

— To demand the operating organizations to take remedial and corrective measures for the items discordant with the requirements of the related regulations and standards;

— To review the Environmental Impact Report submitted by the operating organization of the NPP.

— To review and approve the control limits of the annual discharge of airborne and liquid radioactive effluents.

— To review the environment monitoring report submitted by the operating organization, and to organize the provincial environmental monitoring center to perform environment monitoring of radioactivity.

Environmental protection departments of each province where the NPP is located have built up peripheral regulatory monitoring system to monitor and assess surrounding NPP, then compare check the monitored data with those from the NPPs, also compare with the date of international NPPs. The MEP (NNSA) and the provincial environmental protection bureau are responsible for reviewing the monitoring reports submitted by the operating organization of the NPP and local radioactive environment monitoring stations so as to ensure accuracy and authenticity of monitoring results.

In 2010, the MEP (NNSA) issued and implemented "Rules on Management of Safe Transportation of Radioactive Material" which sets the management rule on design,

manufacturing and use of radioactive substances container and transportation of radioactive substances as well as other links. In 2011, Radiation Environment Monitoring Technical Center of MEP was established in Zhejiang, which further strengthened the radiation monitoring capacity of China.

16. EMERGENCY PREPAREDNESS

1.Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.

For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

3.Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency

16.1 Basic Requirements for Emergency Preparedness

China released "Act of Protection and remedy of Radioactive Contamination of the People's Republic of China", "Act of Emergency Response for Unexpected Events of the People's Republic of China", "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant" and a series regulations and guides, which specify the national emergency management system and emergency preparedness of NPP operating organization.

Wherein, the "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant" specifies that the principles of emergency management of nuclear accidents should be unremitting preparedness, positive compatibility, unified command, energetic coordination, protection of the public, and protection of the environment. According to the "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant" and the "National General Plan of Emergency Preparedness on Unexpected Public Events", the State Council issued the "National Nuclear Accidents Emergency Plan".

In 2010, the MEP (NNSA) organized and revised the "Emergency Preparedness for Operating Organization of Nuclear Power Plant" and "Emergency Plan for Operating Organization of Civilian Nuclear Fuel Circulating Facilities" which specify the detailed emergency preparedness requirement of operating organization of NPP and civil nuclear fuel circulation facility.

All the above mentioned laws, regulations, department rules, nuclear safety guides and all sorts of technical documents constitute relatively complete laws and regulations system for Chinese nuclear emergency response. Hence, the necessary and effective emergency response actions can be activated in case of severe accident of NPP.

China's nuclear accident emergency preparedness includes: establishing emergency organizations, preparing emergency response plan and emergency response implementing procedures, preparing emergency response facilities and conducting periodic emergency response training and exercises. Specific requirements for NPP emergency preparedness are stated in the nuclear safety regulations.

Chinese government has issued nuclear emergency codes or standards which involve the report system for nuclear accident emergency, medical treatment, emergency management of severe accident, emergency management for radioactive material transportation, management of nuclear accident trans-boundary, etc., thus promoted the normalized management of nuclear accident emergency.

After the Fukushima nuclear accident, Chinese Government organized relevant department to actively follow and study the international trends of nuclear safety regulations and standards, revise relevant nuclear safety regulations and standards in China timely, promote the synchronization of nuclear safety regulations and standards in China with the international level and continuous improvement of safety level of NPP. Chinese Government arranged scientific research institutions and NPP to set about studying the countermeasures of NPP when multiple units of nuclear power base under emergency conditions simultaneously and reviewing emergency

command capacity and the preparation and coordination plan of emergency rescue personnel and material.

All NPPs are preparing the emergency response plan when multiple units under emergency condition simultaneously and optimizing the emergency resource distribution. New nuclear accident emergency response system of Qinshan Base has been put into formal operation; emergency response plan and resource distribution are under optimization.

16.2 Emergency Organizational System and Duties

According to the "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant", a three-level emergency preparedness system is carried out in China, which consists of Nuclear Accidents Emergency Organizations of State, Provincial (autonomous regions and municipalities) and NPP operating organizations. See Figure 6.

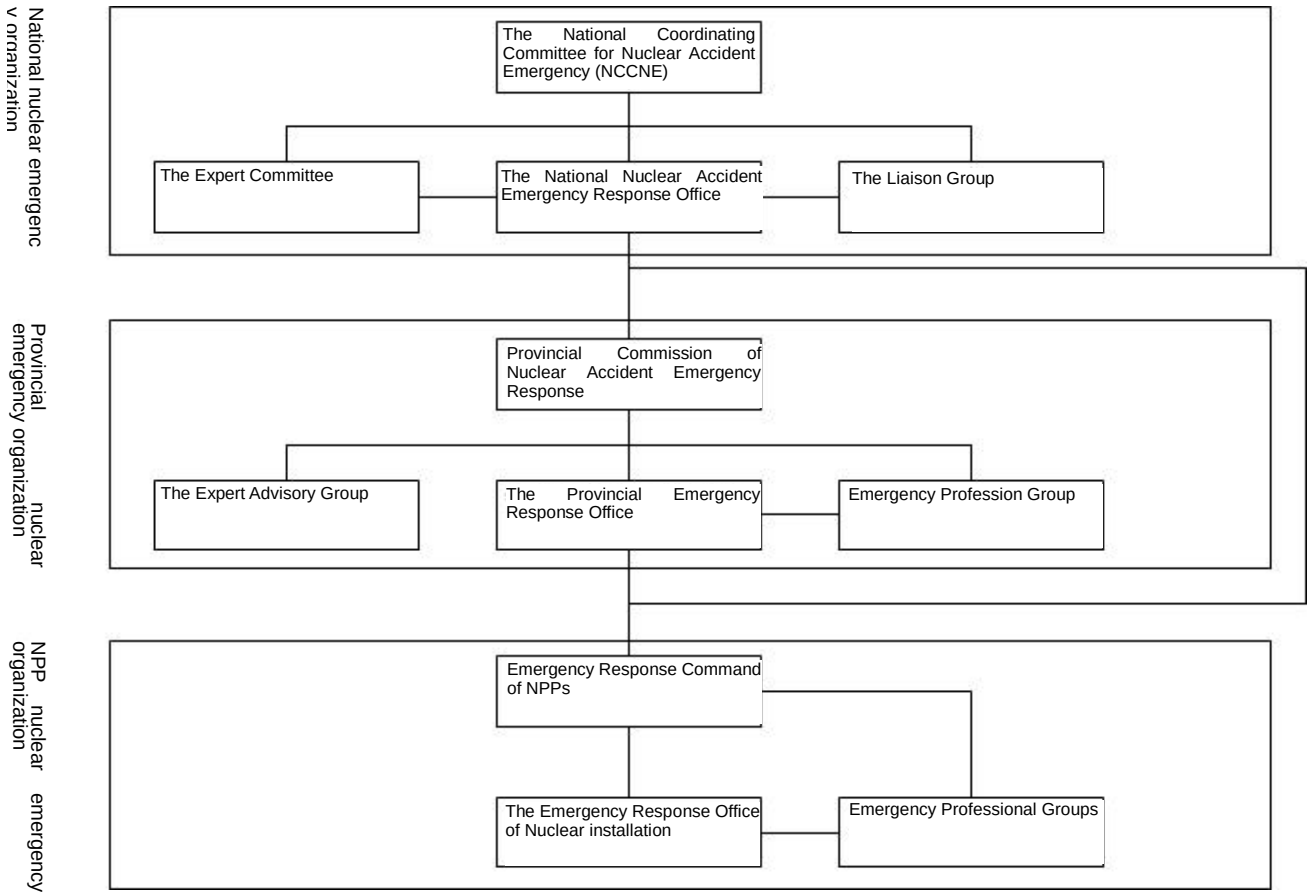

Figure 6 Organizational Structure of National Nuclear Emergency Response System

Within the three-level emergency response system, the main duties of the organizations concerned are as follows:

(1) The National Coordinating Committee for Nuclear Accidents Emergency is responsible for organizing and coordinating the national emergency management of nuclear accidents;

— Carrying out the policies on national emergency management of nuclear accidents, drawing up national policy for nuclear emergency activities;

— Organizing and coordinating emergency response activities of the related departments subordinate to the State Council, the nuclear industry administration, local government, NPPs and other nuclear installations as well as the Army;

— Reviewing national work programming for nuclear accidents emergency and annual work plan;

— Organizing the preparation and implementation of the national emergency response plan of nuclear accidents, reviewing and approving off-site emergency response plan;

— Approving the declaration and termination of the off-site emergency status at appropriate time, when responding to emergency;

— Unifying the activities for decision-making, organizing and commanding of emergency response supports, reporting to the State Council at any moment;

— Putting forward suggestions to the State Council on implementing special emergency response actions at appropriate time;

— Fulfilling relevant international conventions on nuclear emergency and bilateral or multilateral cooperation agreements. Reviewing and approving bulletin and international notification for nuclear accident; working out the scheme for requesting international aids;

— Conducting other affairs assigned by the State Council;

— If necessary, the State Council leads, organizes, and coordinates national nuclear accidents emergency management.

(2) The National Nuclear Accident Emergency Response Office is an administrative organization for national nuclear emergency. It is a subordinate department of CAEA. Its main responsibilities are as follows:

— Carrying out nuclear accidents emergency policies of the State Council and the National Coordinating Committee for Nuclear Accidents Emergency;

— Taking charge of routine activities of the National Coordinating Committee for Nuclear Accidents Emergency;

— Implementing national nuclear accident emergency plan, inquiring; coordinating and supervising emergency preparedness activities of member organizations of the National Coordinating Committee for Nuclear Accidents Emergency; inspecting, guiding, and coordinating related emergency preparedness of local governments, NPPs and its superior organizations;

— Taking charge of receiving, verification, handling, transmitting, notifying, and reporting the information on nuclear and radiation emergency; Undertaking the relevant affairs for implementing relevant international convention and bilateral or multilateral cooperation agreements, and requesting international aids as a national emergency liaison point to the external,

— Preparing national nuclear accidents emergency work programming and annual work plan; Working out scientific research plan and scheme of technical support system for emergency;

— Organizing the reviews of the off-site emergency plan, the off-site integrated exercise plan, and the joint exercise plan of on-site and off-site; making the review comments.

— Organizing activities of liaison persons and experts advisory group.

— Organizing relevant training and exercise on nuclear accidents emergency.

— Collecting information, putting forward report and proposal, timely communicating and executing decisions and orders from the State Council and the National Coordinating Committee for Nuclear Accidents Emergency, checking and reporting the evolution of implementation when responding to emergency,

— Undertaking related affairs decided by the National Coordinating Committee for Nuclear Accidents Emergency after termination of emergency situation.

(3) The Commission of Nuclear Accidents Emergency Response of the province at which the NPP located is responsible for emergency management for nuclear accident in its district, its main duties are:

— Implementing national regulations and policies of emergency response for nuclear accidents;

— Preparing the off-site emergency response plans and making the emergency preparedness of nuclear accidents;

— Conducting unified command of the off-site nuclear accidents emergency response actions in the province;

— Organizing the supports to on-site nuclear accidents emergency response actions;

— Notifying timely the nuclear accident situations to the neighboring provinces, autonomous regions, municipalities directly under the Central Government or special administrative regions;

— If necessary, the provincial government leads, organizes and coordinates emergency response management of nuclear accidents within its administrative area.

(4) The organization for nuclear accident emergency of NPP is responsible for:

— Implementing national regulations and policies of nuclear emergency for nuclear accidents;

— Preparing on-site emergency response plans and emergency preparedness of nuclear accidents;

— Determining the grade of emergency conditions of nuclear accidents and implementing the unified command of emergency response actions of the plant;

— Reporting timely the accident situation to the state and provincial nuclear emergency organizations and the organizations designated and putting forward recommendations on declaration of entering off-site emergency condition and implementation of emergency protective measures;

— Assisting and coordinating the provincial nuclear emergency response commission to conduct the emergency response management of nuclear accidents.

(5) MEP (NNSA), the Ministry of Health, the Army and member unit of other national nuclear emergency response coordination committee as well as other related departments conduct relevant emergency activities for nuclear accident according to respective responsibilities.

16.3 Classifying and Reporting of Emergency Conditions

The emergency situations of nuclear accidents are classified into the following four scales:

(1) Emergency on Standby: In case of some specific situations or external events which may lead to endangering the safety of NPP, relevant plant personnel will be on standby. Some off-site emergency organizations may be notified.

(2) Plant Emergency: The radiation consequences of the accident are confined within a partial area of the plant, on-site personnel are activated and off-site emergency response organizations concerned are notified.

(3) On-site Emergency: The radiation consequences of the accident are confined within the site, on-site personnel are activated and off-site emergency response organizations are notified while some off-site emergency organizations may be activated.

(4) Off-site Emergency: The radiation consequences of the accident go beyond the site boundary, both on-site and off-site personnel are activated and the plans for on-site and off-site emergency response are needed to be implemented.

In the case of emergency on standby, the emergency response organization for nuclear accident of NPP shall report timely to its competent authorities and the MEP (NNSA), if necessary, report to the provincial commission of nuclear accidents emergency response. In case radioactive substance may release or have released, the emergency response organization for nuclear accident of NPP shall timely declare the start of plant buildings emergency condition or plant site emergency condition and promptly report to competent authorities at a higher level, the MEP (NNSA) and the provincial commission of nuclear accidents emergency response.

In case radioactive material may spread or have spread beyond the site boundary, suggestion on entering the off-site emergency condition and taking corresponding emergency prevention measures shall be promptly put forward to the provincial commission of nuclear accidents emergency response. Upon receiving emergency report from nuclear accidents emergency response organization of NPP, the provincial commission of nuclear emergency response shall promptly take corresponding countermeasures and preventive measures and report timely to National Nuclear Accident Emergency Response Office. Off-site emergency condition will be declared after approval by the National Coordinating Committee for Nuclear Accidents Emergency. But in some special cases, the provincial commission of nuclear accidents emergency response can declare the off-site emergency in advance and then report to the National Coordinating Committee for Nuclear Accidents Emergency promptly.

Under the off-site emergency condition, relevant departments such as the National Nuclear Accident Emergency Response Office and the MEP (NNSA) shall send staff to the site and direct the nuclear emergency response actions.

16.4 On-site and Off-site Emergency Plans of NPP

Focusing on the nuclear accidents that probably occur, on-site emergency response plan is prepared by operating organization of the NPP, and off-site emergency response plan is prepared by local government and the national emergency response plan for nuclear accident is prepared by the National Coordinating Committee for Nuclear Accidents Emergency. The contents of the three levels of emergency response plans are mutually linked and harmonized. Each plan has its implementing procedures as a detailed supplement. Besides, emergency schemes are prepared respectively by the main member organizations of the National Coordinating Committee for Nuclear Accidents Emergency, emergency support organizations and the Army. The emergency response plans and the schemes are prepared, reviewed and approved, and revised periodically according to regulations.

The contents of emergency response plans include the emergency response organizations and their responsibilities, the detailed schemes of emergency preparedness and response, facilities and equipment, coordination and supports from the organizations concerned, and other technical aspects. According to the principle for being positively compatible with nuclear accident emergency, a national technical support system for nuclear emergency is established to guarantee the capability on nuclear emergency response by fully utilizing the existing conditions, establishing and maintaining necessary technical supporting centers or technical aid organizations such as ones for emergency decision support, radiation monitoring, medical treatment, meteorological service, NPP operation technical supports, etc.

The emergency plan of the operating organization of NPP is reviewed by National Energy Administration, submitted to the MEP (NNSA) for approval and reported to the National Nuclear Accident Emergency Response Office for filing up; the nuclear accident emergency response plan of the provincial government at where the NPPs are located is reviewed and approved by the National Coordinating Committee for Nuclear Accidents Emergency; the national nuclear accident emergency plan is reviewed and approved by the State Council.

16.5 Training and Exercises for Emergency Preparedness

In order to enhance the professional level of the personnel and provide enough manpower for nuclear emergency preparedness and response, the national and local emergency organizations conduct training activities by means of workshop, technical training and emergency knowledge exam to strengthen training and discipline of human resource on nuclear emergency.

All emergency response personnel, including emergency commanders, of Chinese NPPs are trained and examined systematically before the first fuel loading. The training and the examination compatible to their expected emergency response activities should be performed at least once a year in the NPP operation lifetime.

Emergency training in NPP includes basic training, special training and on-job training with the content of emergency preparedness and response, which are applied to general staff of NPP (including contractors), personnel engaged in emergency organization and personnel on posts requiring higher techniques and skills.

Emergency response united exercise is implemented before the first fuel loading to verify the effectiveness of nuclear emergency preparedness of new NPPs in recent years, according to the requirements of nuclear safety regulations. Various types of emergency drill are carried out periodically for operating NPPs to verify, improve and strengthen the abilities of emergency preparedness and emergency response. China regularly organizes national joint drill of three-level nuclear emergency organizations.

In recent years, China's NPPs have carried out single drills, comprehensive drill and joint drill for many times in accordance with the requirement of nuclear emergency regulations. Please refer to Appendix 6 for details.

16.6 The Public's Acquaintance with Emergency Preparedness

With the rapid development of China's nuclear power industry, the attention and participation awareness of the public to nuclear safety is continuously improved. Each nuclear-power enterprise and government relevant departments concerned at different levels increase the publicity of nuclear power to the public through different

channels, with information disclosure system established, and corresponding organization, facilities and resources configured.

China has formulated and established nuclear and radiation safety supervision information disclosure system and public sentiment monitoring system. And all departments concerned are allocated with corresponding personnel and supplies to adapt to the situation of nuclear power development, impel and normalize nuclear and radiation safety information disclosure of NPPs and realize the right to know of the public.

The National Nuclear Accidents Emergency Response Office has established information communication network to enhance communication with relevant departments, local governments, the NPPs and the public.

Local governments are responsible for the popularized education of the public around the NPPs on the basic knowledge of nuclear safety and radiation protection, and propagating knowledge on emergency protection, such as alarm, shielding, evacuation and taking preventive anti-radiation medicine in case of an emergency, and giving directions on how to take these actions.

The operating organization of NPP takes various measures such as utilizing local broadcast and TV, publicizing propaganda material and inviting local public to visit plant and to take part in or to watch emergency exercises, to make the public to eliminate nuclear panic, and to effectively participate in emergency response activities in case of an emergency.

The NPPs and their provincial environmental protection departments publish the annual environmental surveillance results to the public via proper news media.

Emergency organizations at different levels have established relatively broad social basis for nuclear emergency to promote the harmonic coexistence among NPPs and their neighboring communities and environment through various kinds of communication activities on nuclear energy.

In case of severe nuclear accidents and off-site emergency status, China performs centralized and unified standardized management on the information of nuclear

accident and emergency response, with corresponding regulations and requirements for information channel, information classification, information disclosure, etc., so as to ensure the information of nuclear and radiation accident is released and reported to the public timely, uniformly, transparently and accurately.

During the emergency period of Fukushima Accident in 2011, MEP set up special column named "Related Issues on Nuclear Safety in Japanese Earthquake" on its website to explain the problems of the public's concern in various forms such as press conference and organizing experts interviews, etc. Since March 12, domestic relevant monitoring data of radiation environment had been disclosed on the website every day and the related media of the government had also released main monitoring results regularly. The National Nuclear Accidents Emergency Response Office organized to conduct relevant public propaganda and released authoritative information of China's National Nuclear Emergency Coordination Committee every day.

Since Fukushima Accident, Chinese government has perfected the information release system for occurrence of nuclear and radiation accidents, and information communication mechanism and channel, enhanced the effort of science popularization education of nuclear and radiation safety knowledge to the social public, conducted public psychology social effect research of nuclear and radiation accidents. Aiming at the characteristics of the nuclear accident, it has also formulated and perfected the management procedure of public information standard release to timely eliminate the worries of the public to nuclear power safety. Chinese government is continuing the perfection of information release system for occurrence of nuclear and radiation accident, public information communication mechanism and effective communication channel, and enhancing the science popularization education effort of nuclear and radiation safety knowledge.

16.7 Regulatory and Control

According to China's nuclear safety regulation "Regulations on Emergency Measures for Nuclear Accidents at Nuclear Power Plants", in case of off-site emergency,

relevant departments of army, public security, fire-fighting, sanitation and civil administration, etc. should carry out corresponding rescue work jointly.

Ministry of Health of the PRC (MOH) has set up medical emergency center for nuclear accidents, which is divided into three clinical medicine departments; and constructed 17 radiation injury rescue bases across the country, including two national rescue bases, 15 provincial rescue bases. Meanwhile, it has set up two national nuclear and radiation emergency medical rescue teams, who have configured equipment conducted trainings and drills so as to carry out national and international rescue rapidly in case of the sudden nuclear and radiation accidents.

Medical emergency center for nuclear accidents of MOH has established contact system of medical emergency communication and technical support system of nuclear accidents medical emergency, opened the communication contact with departments such as the National Nuclear Accidents Emergency Office, etc., so as to guarantee effective medical emergency handling of nuclear accidents.

In case of severe accidents in NPPs, under the leadership of local nuclear accident emergency committee, competent communication and transportation departments of province, autonomous region and directly-controlled municipality shall organize transportation leader group and combine the supports of other areas and departments to conduct uniform organization and leadership on transportation.

The preparation and organization of transportation resource and power is multilevel and multipath. The transportation departments of province, autonomous region and directly-controlled municipality shall transfer and organize emergency response transportation force jointly with other departments concerned. Local transportation force shall be the main component of emergency transportation force. When it is insufficient, the government of province, autonomous region and directly-controlled municipality shall command to transfer the force of transportation department in other neighbor areas to support. Request nearby army to dispatch transportation force for supporting when necessary. Water transportation and air transportation force can be dispatched by local authority or the army.

In case of nuclear accident emergency response, the army shall act in accordance with "Regulations on the Chinese People's Liberation Army Participating in Nuclear Accident Emergency Rescue of NPPs", with possible tasks of: participating in radiation monitoring, decontamination, medical emergency rescue and engineering rescue, providing support for transportation, sanitation, weather, communication, guard, protection, etc., and assisting local authority in guiding public protection.

National nuclear emergency management department, nuclear safety regulation department, competent department of nuclear energy industry, maritime department and earthquake department shall strength information exchange and real-time contact; establish early warning mechanism and emergency plan of preventing earthquake and tsunami.

In April, 2012, China's National Nuclear Emergency Coordination Committee reviewed and approved "The 12th Five-year Plan of National Nuclear Accident Emergency", and revised the "National Emergency Plan for Nuclear Accidents". In the meantime, it increased its member unit from the original 18 to 24, and increased the number of provincial nuclear emergency organization from 12 to 16.

Based on the experience feedback of Fukushima Accident, Chinese government is considering further establishing and perfecting emergency support system for nuclear accidents at the level of corporation (group) and regarding this system as the important supplement for the governed NPPs to carry out nuclear accident emergency preparedness and response.

MEP (NNSA) organizes all nuclear power group companies to prepare emergency support plan to provide support for nuclear accident emergency response of the governed NPP. Meanwhile, MEP (NNSA) is organizing China National Nuclear Corporation and China Guangdong Nuclear Power Corporation to establish emergency support base for nuclear accident respectively, so as to strengthen the support capability of off-site emergency for the governed NPPs and mutual support capability of groups.

16.8 International Arrangements for Nuclear Accidents Emergency

As one of the Contracting Parties of "Convention on Early Notification of a Nuclear Accident" and "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", China implements its obligations required by these two conventions.

The "Management Rules of Emergency Crossing the Boundary for Radioactive influence due to Nuclear Accidents", which was issued by the CAEA in April, 2002, emphasizes that China will carry out obligations in accordance with relevant international conventions and take corresponding emergency response actions in case of radiological impact of nuclear accidents trans-boundary.

In case that nuclear accidents result in impact trans-boundary, the National Nuclear Accident Emergency Response Office collects related accidental information and notifies accidental information directly to or via IAEA to those countries or regions which are or may be involved in according to the requirements of "Convention on Early Notification of a Nuclear Accident".

Meanwhile, the multilateral and the bilateral international cooperation can be used to promote the personnel and information exchange and learn the experience and lessons, hence, the management level of nuclear emergency in China can be enhanced. In the past few years, China has participated in the following international cooperation activities:

(1) On May 22, 2011, China, Japan and South Korea held the fourth conference of leader and published "Declaration of the Fourth Conference of Leaders from China, Japan and South Korea". Cooperation Secretariat of the three countries is set up in South Korea in 2011.

(2) In June 2011, China participated in Nuclear Safety Assembly of Member Countries at Minister Level held by IAEA in Vienna, which advocated carefully drawing lessons learnt from experiences; further perfecting nuclear safety standard, strengthening nuclear safety information sharing, and giving full play to the leading role of IAEA.

(3) In August 2011, China-Japan Nuclear Safety Seminar was held in China, which is the first conference to draw lessons learnt from Fukushima accident between China and Japan.

(4) In October 2011, the 11th Biennial Conference of WANO was held in Shenzhen, which was the first biennial conference of WANO after Fukushima Accident. On the conference, five Crisis Management Measures Coping with Fukushima Accident were voted through. Meanwhile, it was decided to set up pre-startup peer review office in Shenzhen to conduct the first precritical safety construction and review report of units in NPPs. This is also the first administrative body established in China by WANO.

(5) In October, 2011, relevant departments of China, Japan and South Korea held Fukushima Nuclear Leak Health Response Seminar in Beijing. The three countries discussed and exchanged various health response measures taken for Fukushima nuclear leak, risk assessment, risk communication, nuclear hygiene emergency and other contents.

(6) In November, 2011, China, Japan and South Korea cosigned "Cooperation Proposal on Nuclear Safety" at the Fourth Senior Officials Meeting of Nuclear Safety Supervision, which would play an important role in promoting regional nuclear safety.

(7) In February, 2012, China and Pakistan held the 6th China-Pakistan Nuclear Safety Cooperation Supervisor Conference in Fuzhou. On the conference, they summarized the cooperation progress on training, information sharing, operating experience, etc., and confirmed the cooperation contents of the next stage. Both parties indicated to deepen nuclear safety cooperation between China and Pakistan and improve the nuclear safety level of both countries.

(8) In November 2012, China, Japan and South Korea cosigned the revised "Memorandum of Cooperation of Senior Officials Meeting of Nuclear Safety of National Nuclear Safety Administration of the People's Republic of China, Nuclear Regulation Authority of Japan and Nuclear Safety and Security Committee of South

Korea" at the Fifth Senior Officials Meeting of Nuclear Safety Supervision for the purpose of further promoting information exchanging and experience sharing among them.

17. SITING

Each Contracting Party shall take appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

(ii) for evaluating the possible safety impact of a proposed nuclear installation on individuals, society and the environment;

(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the possible safety impact on their own territory of the nuclear installation.

17.1 Evaluation on site-related factors

There are altogether 13 NPP sites in operation and under construction in Chinese mainland, all of which are coastal NPPs. Siting of most of these NPPs dates from the end of last century, so the siting procedure and external event evaluation shall be conducted according to nuclear safety regulations, which is reviewed and confirmed by MEP (NNSA).

17.1.1 Regulations and Requirements on Nuclear Power Plant Siting

China always insists on regarding relevant regulations and standards of IAEA as the basic criteria for siting evaluation. For nuclear power construction begins late in China, it can better learn from international experiences in terms of siting regulations and standards as well as siting evaluation, with corresponding siting regulations and standards relatively perfected and strictly carried out. At present, regulations and requirements applicable to siting of NPPs mainly involve: "Application and Issuance of Safety License for Nuclear Power Plant", the "Code on the Safety of Nuclear Power Plant Siting", the "Earthquakes and Associated Topics in Relation to Nuclear

Power Plant Siting", the "Atmospheric Dispersion in Relation to Nuclear Power Plant Siting", the "Siting Selection and Evaluation for Nuclear Power Plant with Respect to Population Distribution", the "External Man-induced Events in Relation to Nuclear Power Plant Siting", and the "Hydrological Dispersion of Radioactive Material in Relation to Nuclear Power Plant Siting", etc. (see Appendix 3).

17.1.2 Criteria for NPP Siting

The siting for Chinese nuclear power plants should comply with the "Code on Safety of Nuclear Power Plant Siting". The following aspects have been taken into considerations.

(1) Effects of external events occurring in the region of the particular site (these events could be natural or man-induced origin).

(2) Characteristics of the site and its environment which could influence the transfer of released radioactive substance to human body.

(3) Density and distribution of the population and other characteristics in the zone around the site needed for evaluating the possibility of implementing emergency response measures and the risks to individuals and the population.

17.1.2.1 Criteria of Defining Design Basis for External Natural Events

(1) Proposed sites are adequately investigated with respect to all site characteristics that could affect safety in relation to design basis natural events.

(2) Natural phenomena that may exist or can occur in the region of a proposed site should be identified and classified according to the potential effects on the safety operation of the nuclear power plant. This classification is used to identify the important natural phenomena from which design bases are derived.

(3) Historical records of the occurrences and severity of the above mentioned important natural phenomena in the region are collected and carefully analyzed for the reliability, accuracy and completeness.

(4) Appropriate methods are adopted to establish the design basis for natural events for some important natural phenomena. The methods should be proved to be compatible with the characteristics of the region and the current state-of-the-art.

(5) The size of the region that should be studied in determining design basis natural events by certain method shall be large enough to cover all the features and areas which could contribute to the determination of the design basis natural events and their characteristics.

(6) Important natural phenomena are expressed as input in inferring the design bases in relation to natural events for NPPs.

(7) In the derivation of design basis events, specific data of the site are used unless such data are unavailable. In this case, the data from other regions that are similar to the region of interest may be used.

17.1.2.2 Criteria for Defining Design Basis for External Man-induced Events

(1) Proposed sites are adequately investigated with respect to all the characteristics that could affect safety in relation to the design basis man-induced events.

(2) The region at which the NPP site is located should be investigated to find out those facilities and human activities that might endanger the proposed nuclear power plant under some conditions. These conditions are classified according to the severity of the effects they may have on safety. This classification is used to identify important man-induced events for which design basis are derived. The foreseeable significant changes in land use, such as expansion of existing facilities and human activities or the construction of high-risk installations should be considered.

(3) Information concerning the frequency and severity of those important man-induced events is collected and analyzed for reliability, accuracy and completeness.

(4) Appropriate method is adopted for defining the design basis for man-induced events. The method should be compatible with the characteristics of the region and the current state-of-the-art.

(5) Each important man-induced event is expressed as input in deriving the design bases of man-induced events for NPPs.

17.1.2.3 Criteria for Defining Potential Impact of the Nuclear Power Plant on the Region

(1) In evaluating the radiation impact on the site region under NPP's operating condition and accident condition that may need emergency measures, appropriate estimates have to be made for expected or potential releases of radioactive substances after taking into account the design of the plant and its safety features. In the review of siting, these radioactive releases are often treated as radiation source terms.

(2) The direct and indirect approaches by which radioactive substances released from the NPP could reach and affect the people should be evaluated. In this evaluation, abnormal characteristics of region and site should be taken into account and the special attention should be paid to the role of the biosphere in accumulation and transport of radioactive nuclides.

(3) The relationship between the site and the design of the NPP should be examined to ensure that the radiation risk to the public and the environment arising from the releases defined by the source terms is acceptably low.

(4) The design of the nuclear power plant should compensate for any unacceptable effects on the region where the NPP is located, otherwise the site should be deemed unsuitable.

17.1.2.4 Criteria for Considering Population Factor and Emergency Response Plan

(1) The region at which the proposed site is located is studied to evaluate the present and foreseeable future characteristics and distribution of the population of the region. Such a study includes evaluation of present and future uses of land and water within the region and takes into account any special characteristics which may

influence the potential consequences of radioactive releases to the individuals and the population.

(2) With respect to characteristics and distribution of the population, the site and plant combination should satisfy that

- Under operating conditions the radioactive exposure of the residents remains as low as reasonably achievable and accords with national regulations in any case;

- Under event conditions, including those which may lead to taking measures for emergency response, the radiation risk to the residents is acceptably low in accordance with national regulations.

After thorough evaluation, if it is shown that there will be no appropriate measures to meet the above requirements, the site is then deemed unsuitable for the construction of the proposed NPP.

(3) A peripheral zone around a proposed site should be established in view of the potential radiation consequences to the public and the capability of implementing emergency response plans as well as any effect of external events which may hinder implementation of emergency response plan. Before starting construction of the NPP, it shall be affirmed that no basic problems exist in the peripheral zone for establishing an emergency response plan before the NPP operation. In order to meet this requirement appropriately.

- A reasonable evaluation of the radioactive releases under events including severe accidents is performed by using appropriate specific site parameters.

- The feasibility of the emergency response plans is evaluated.

17.1.2.5 Planned Restricted Area

A planned restricted area refers to a buffer zone delimited around a nuclear power plant and other important nuclear installations. The restricted area is not the land possessed by nuclear installations but the development and construction activities within this area should be restricted to a certain extent.

According to the provisions of the "Act of Protection and Remedy of Radioactive Contamination", the surrounding areas of NPPs and important nuclear installations

should be delimited as restricted areas. The delimitation and management measures of the planned restricted areas are regulated by the State Council. Planned restricted areas are delimited in all Chinese NPPs.

17.2 Implementation of Codes on the Safety of Nuclear Power Plant Siting

In the phase of siting, according to the requirements in the "Code on the Safety of Nuclear Power Plant Siting", all site-related factors affecting the safety and the impacts of the NPP on the individuals, the society and the surrounding environment during its expected lifetime have been evaluated by the applicant.

17.2.1 Natural Events Affecting the NPPs Safety

During the siting, the natural factors affecting the safety are investigated and evaluated in detail, and the engineering design bases are determined according to the investigation results and the related safety requirements. The natural factors affecting the safety of the NPP are as follows.

- Floods due to precipitation and other causes,
- Waves caused by earthquake,
- Floods and waves caused by burst of dam and dyke, etc.
- Surface faulting,
- Slope instability,
- Site surface collapse, subsidence or uplift,
- Earthquakes,
- Soil liquefaction,
- Tornadoes,
- Tropical cyclones (typhoon), and
- Other important natural phenomena and extreme conditions.

17.2.2 Man-induced Events Affecting the NPPs Safety

The factors affecting the nuclear power plant such as aircraft crashes, chemical explosions, the site parameters affecting the long-term residual-heat removal from the reactor core and other important man-induced events, etc., have been investigated. As the results of the investigation, the impact of these low-probability events on the safety of nuclear power plant is very small, and is within the acceptable level by proper design.

During nuclear power plant siting, the activities that may cause external man-induced events and the controls of their future development in the site region have been adequately taken into consideration by the relevant government departments according to the protection level demanded by the NPP.

17.2.3 Nuclear-Safety Impact of Nuclear Power Plant on Surrounding Environment and Inhabitants

During NPP siting, the risks imposed by the potential releases of radioactive substances to the surrounding environment and the inhabitants have been adequately considered, and the pathways leading to the risks have been studied and controlled.

Factors such as the dispersion of radioactive substances in the atmosphere, in the surface water and the ground water, the population distribution, the utilization of the land and the water, etc. have been extensively investigated, periodically observed, studied and analyzed by using the computerized models so as to effectively control the radiation risks caused by the potential radioactive releases to the surrounding environment and inhabitants.

17.2.4 Public Participation during the Siting Stage

From siting to decommissioning, relevant Environmental Impact Report is required to submit at every stage. The public can take different forms to participate in construction projects according to specific requirements of Environmental Impact Assessment of every stage and the work progress. According to provisions of the "Law on Environmental Impact Assessment of the People's Republic of China" and the "Interim Measures on Public Participation in Environmental Impact Assessment", projects which may cause adverse environmental impacts and directly get involved in

public's environmental interests should ask for opinions on Environmental Impact Report from units concerned, experts and the public by holding discussions, public hearings or other forms before the draft was submitted for approval.

The public participation chapter should be compiled in the Environmental Impact Report of NPP siting stage. The constructing and operating organizations shall seriously consider the opinions on environmental impact from units concerned, experts and the public, and then make statements of opinions adopted or not adopted which should be attached to the Environmental Impact Report submitted for approval. The competent department of environment protection administration under the State Council will not accept the Environmental Impact Report without the public participation chapter.

During the review and approval stage of NPP sites, the construction organization shall widely spread relevant knowledge of nuclear power to the public dwelling in the project location in a direct and effective way before public opinions collection, e.g. giving out brochures of nuclear power knowledge, organizing special lectures of nuclear power knowledge, holding exhibitions of nuclear power knowledge and site visits of NPPs.

The implementation of public participation work in environmental impact assessment at the siting phase of NPP sites mainly includes following steps:

(1) The constructing organization of the NPP shall bulletin the relevant information of the construction project to the public within seven days after confirming the organization in charge of environmental impact assessment work.

(2) After obtained preliminary conclusions on environmental impact assessment from the commissioned organization in charge of environmental impact assessment, the construction organization of the NPP shall announce the main content and the relevant information of environmental impact assessment of the NPP in a way that is accessible to the public (e.g. news media as local newspapers, magazines, Internet, TV, broadcast etc.) and issue the simplified edition of the Environmental Impact Report to the public.

(3) After the information bulletins of the environmental impact assessment and the simplified edition of the Environmental Impact Report were made public by the local media, meanwhile ways of Internet, public reception, giving out questionnaires and holding public discussions (or public hearings) should be adopted to openly ask for opinions of the public.

(4) The construction organization or its commissioned organization in charge of environmental impact assessment should timely and effectively handle all public opinions and suggestions proposed in public participation activities and give feedback on the specific website or the Environmental Impact Report.

17.3 Re-check and Evaluation of Site-related Factors

After Fukushima Accident, MEP (NNSA) conducted comprehensive safety inspection on NPPs in operation and under construction in China jointly with relevant ministries and commissions. During comprehensive safety inspection on external event of NPPs in operation and under construction according to the determined "Implementation Plan for Comprehensive Safety Inspection of Civil Nuclear Facilities", they emphasized on rechecking and evaluating the appropriateness of evaluated external event during siting, as well as the prevention and mitigation measures for flood prevention ability and plans of NPPs, seismic capacity and plans of NPPs.

It can be known from the inspection conclusion that as nuclear power construction in Chinese mainland begins late, NPPs adopt the regulations and standards of IAEA as the evaluation basis for siting, widely absorb international practical experiences and implemented them carefully in siting of NPPs. Therefore, evaluation on extreme external event during siting is appropriate and can meet relevant requirements of current nuclear safety regulations and latest international criteria. Refer to Chapter 1 and Chapter 2 in "National Report of the PRC on Second Special Session under 'Convention on Nuclear Safety'" for details.

17.4 Supervision and Control

17.4.1 Enhancement of Surveillance and Management for Site Protection and Preliminary Work

The Chinese government has paid much attention to the protection of site resources of NPPs and carried out comprehensive evaluation of NPP sites. The MEP (NNSA) classified the factors affecting NPP sites into four levels and carried out the comprehensive evaluation of selected sites from four aspects: nuclear safety, environment protection, regional planning and environmental regionalization. On the basis of comprehensive evaluation results with taking every factor into consideration, the NPP sites were classified into four categories for sort management.

China's consistent stand towards NPPs: Unauthorized construction is prohibited with projects not included in the national plan. As for projects included in the plan, the work should be carried out orderly in accordance with scheduling and effective measures should be taken for plant site protection.

17.4.2 Continuous Monitoring Activities Related to the Siting

The system of radioactive contamination monitoring has been established in China according to the requirements in "law on Environment Protection of the People's Republic of China", the "Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China", and the regulations and rules of siting, design, and safety operation of NPP. The MEP (NNSA) is responsible for performing continuous supervisory monitoring of nuclear power plants, and for managing the radioactive contamination monitoring. Meanwhile, the operating organizations are required to monitor the types and the concentration of the radioactive nuclides in the surrounding environment of nuclear power plants, and the amount of radioactive nuclides in the effluents of NPPs.

According to the requirements of the safety guides related to NPP siting, factors affecting the site safety of a NPP such as meteorological, hydrological and geological phenomena have been monitored and evaluated continuously by the operating organizations to ensure the safety of NPPs.

17.4.3 Implementation of Corrective Actions for Fukushima Accident

Main problems of siting discovered in comprehensive safety inspection of Chinese NPPs are:

(1) Problems concerning design basis flood level of Qinshan NPP

Constructed in 1983, with the standardized elevation of siting of 5 meters, Qinshan NPP adopts flood bank to cope with possible flooding issues under extreme case (the largest storm surge superimposed the largest astronomic tide). After tracing safety review launched by MEP (NNSA), the plant heightened the flood bank based on the design basis flood level of 9.51m, and set wave wall on the top of levee crown, with total elevation of 9.7-9.9m. According to the latest hydrologic data of Hangzhou Bay and evaluation on the factors such as bank shape and depth change possibly caused by reclamation plan in the following 20 years, the design basis flood level shall be 10.01m after the completion of the reclamation pan. Based on this new conclusion, the existing flood control measures for the plant will hardly cope with this extreme case.

(2) Effect of Tsunami on Chinese NPPs

Tsunami has always been one of the evaluation factors for siting of Chinese NPPs. Prior to Fukushima Accident, the mainstream common view of the academic circles was that the threat of seismic sea wave in coastal areas of China was small and the flood threat to costal NPPs of China mainly came from storm tide based on the conditions such as possible earthquake parameter of surrounding waters of China and submarine structure, etc. In order to fully draw lessons from Fukushima Accident, it was re-evaluated in comprehensive safety inspection, so as to reassess the Manila trench and Loochoo trench possible of creating seismic sea wave threat to Chinese NPPs in a more conservative way. Preliminary evaluation result indicates that the main source of possible seismic sea wave threat is Manila trench. Conservatively supposing the possible biggest earthquake magnitude taking place in Manila trench is 8.8, the object influenced by tsunami is the NPPs at seacoast of Guangdong, and the maximum tsunami offshore height of surrounding water of Daya Bay NPP is about 2.7m. Specific to the evaluation result of tsunami, units concerned preliminarily

re-checked the anti-tsunami capability of each NPP at seacoast of Guangdong and accomplished tsunami analysis and demonstration. The conclusion is the surging height is low and the effect is controllable.

In order to further improve the safety level of Chinese NPPs, MEP (NNSA) confirms the following improvement requirements specific to the problems discovered in inspection:

(1) Check the anti-flooding capability of relevant doors and windows, ventilation openings, cable penetration, process pipe penetration, etc. item by item under the condition of beyond design basis flood level, and conduct necessary plugging.

(2) Qinshan NPP implements flood control reconstruction by heightening the sea wall, setting up wave wall, increasing anti-flooding and drainage measures of safety plant and other means. Before completion of flood control reconstruction, the unit will be in cold shutdown condition in case of both astronomical tide and front typhoon landing.

(3) Each NPP shall conduct external event PSA, including earthquake PSA or anti-seismic margin evaluation; Daya Bay NPP makes in-depth evaluation on seismic sea wave risk and completes necessary improvements.

(4) Strengthen seismic monitoring, as well as maintenance and management of recording instruments and meters for NPPs, to ensure effectiveness of monitoring and recording system; improve post-earthquake action of operator and enhance anti-seismic response capability of NPPs.

Up to December 31, 2012, implementation of all improvements is as follows:

(1) NPPs in operation had completed all short term (by the end of 2011) safety improvement projects, including the implementation of waterproof plugging, setup of mobile emergency power supply and mobile pump, improvement of anti-seismic response capability of NPPs. Implementation of medium-term (by the end of 2013) and long-term (by the end of 2015) safety improvement projects generally meets the requirements of time node, including flood control reconstruction of NPPs, in-depth

evaluation on earthquake and tsunami risk of site, perfection of prevention and mitigation measures for severe accidents, improvement of emergency capability, strengthening information disclosure, carrying out external event PSA, etc. Wherein, the scheme of heightening sea wall and setting up wave wall of Qinshan NPP was reviewed and approved by MEP (NNSA) in December 2012 and the construction was already in progress. Regarding the influence of seismic sea wave on Daya Bay NPP Base, the research conclusion obtained by accurate calculation based on numerical simulation calculation and physical model test is: the maritime work structures of each NPP in Daya Bay Nuclear Power Base can resist potential impact of seismic sea wave, without influence on safe and stable operation of NPP.

(2) 26 nuclear power units under construction which receive comprehensive safety inspection are implementing relevant safety improvement projects to be accomplished before initial loading as planned. Those fail to complete are forbidden to conduct initial loading. Improvement projects to be accomplished during the 12th Five-Year Plan are also promoted actively.

17.5 Negotiation with Other Contracting Parties Possibly Affected by NPPs

NPPs in China are mainly distributed in eastern coastal areas. For the plants near the border, China will negotiate to solve the influence of potential nuclear accidents on overseas and issues of nuclear emergency field possibly involved via bilateral or multilateral cooperation in accordance with relevant requirements of signed "Convention on Early Notification of Nuclear Accident", "Convention on Assistance in the case of Nuclear Accident or Radiological Emergency" and "Convention on Nuclear Safety". National Nuclear Accidents Emergency Response Office attaches great importance to it and are conducting research and communication actively on the relevant issues.

18. DESIGN AND CONSTRUCTION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) The design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) The technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) The design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the human-machine interface.

18.1 Regulations and Requirements of the Design and Construction of NPPs

18.1.1Regulations and Requirements of the Design of NPPs

By reference to relevant nuclear safety standards of IAEA and other related national standards, the "Code on the Safety of Nuclear Power Plant Design", and a series of guides on nuclear power plant design have been established by the MEP (NNSA), see Appendix 3.

During reviewing the design of the imported NPPs, the MEP (NNSA) requires the applicant of the "Nuclear Power Plant Construction Permit" to illustrate that the standards and specifications to be used comply with the requirements of regulations on nuclear safety of China. If there are no such standards and specifications in China, the standards and specifications adopted should be approved by the MEP (NNSA).

The safety of NPPs relies on the guarantee of three basic safety functions (reactivity control, residual heat removal, and the confinement of radioactivity). The defense-in-depth concept is helpful to maintain these three basic safety functions, and is conducible to preventing the general public and the environment from radioactive hazard.

The MEP (NNSA) revised the "Code on the Safety of the Nuclear Power Plant Design" and implemented it in April of 2004. The new regulation clearly specified the safety objectives, safety management requirements, technical requirements and design requirements.

The nuclear safety objectives in the "Code on the Safety of the Nuclear Power Plant Design" are as follows:

Establish and keep effective defense to radioactive harm in NPP, so as to prevent personnel, society and environment from being harmed. The general nuclear safety objective is supported by radiation protection objective and technical safety objective, and these two objectives are supplement to each other. The technical measures and administrative and procedural measures work together to guarantee the defense of ionization radioactive harm.

The safety management requirements in the "Code on the Safety of Nuclear Power Plant Design" are as follows:

(1) Management responsibility

All responsibilities for safety are undertaken by the operating organization. Safety affairs shall be put at the top priority by all units engaged in safety important activities.

(2) Design management

The necessary reliability of safety important SSCs shall be ensured to guarantee that the safety function of NPP is performed and NPP operates safely during its designed lifetime, and to prevent the occurrence of accidents to protect the site personnel, the general public and the environment.

(3) Verified engineering practice

If possible, the SSCs shall be designed based on the latest authorized or currently applicable standards and specifications; its design shall be verified before under the equivalent use condition, and the selection of these items shall accord with the reliability objective of NPP required by safety.

When unverified design or installations are introduced, or the design or installations deviate the existing engineering practice, their safety shall be proved reasonable by right appropriate backup research plan or by checking operating experience obtained from other relevant applications.

(4) Operating experience and safety research

The results of relevant operating experience and research obtained from the operating NPP shall be given fully consideration.

(5) Safety assessment

The safety assessment shall be made comprehensively on design, so as to prove the design of manufacture, construction and completion delivered satisfies the safety requirements purposed at the beginning of the design.

(6) Independent verification of safety assessment

Before submitted to the National Nuclear Safety Supervision Department, the design shall be guaranteed by the operating organization to be verified independently by individuals or groups that have not participated in the relevant design.

(7) Quality assurance

The quality assurance program, which specifies general arrangement of management, implementation and assessment of NPP design, shall be worked out and implemented. This program shall be supported by more detailed plans of every SSC, so as to ensure the quality of design all the time.

The main technical requirements determined in the "Code on the Safety of Nuclear Power Plant Design" are as follows:

(1) Defense-in-depth

The concept of defense-in-depth is implemented in all safety-related activities, including related aspects with organization, personnel behavior and design, so as to provide a series of multi-level preventive measures, such as the inherent safety characteristic, equipment and procedures and so on, to prevent event occurrence or provide appropriate protection when failing to prevent the event occurrence.

(2) Safety function

The following basic safety functions shall be implemented under any operating status and during and after the design basis accidents, or under the accident situation of selected beyond design basis accident:

- Reactivity control.

- Heat removal from the reactor core.

- Radioactive substance containment, operation discharges control and, accident release limiting.

(3) Accident prevention and safety characteristic of NPP

The design of NPP shall minimize the sensitivity of anticipated operational occurrence. Expected response to any anticipated operational occurrence shall be the following reasonably achieved situations (in order of importance):

- Rely on the inherent characteristic of NPP to enable the anticipated operational occurrence not to cause safety-related impacts or only enable NPP to change towards safety status;

- Rely on the function of passive safety facilities or safety system operating continuously under this status in order to control this occurrence and enable NPP tends to safety when the anticipated operational occurrence happens;

- Rely on functions of safety system which shall be put into operation for the sake of response to this occurrence to make NPP tend to safety, when the anticipated operational occurrence happens;

- Rely on special procedures to make NPP tend to safety when the anticipated operational occurrence happens.

(4) Radiation protection

The design shall take the prevention or mitigation (when out of control) of radioactive exposure caused by design basis accident and selected severe accident as its objective. Measures shall be adopted to guarantee radioactive dose which may be received by the public and site personnel do not exceed the acceptable limits and reduce it as low as reasonably achieved. Probability of the NPP status, which may cause high radioactive dose or radioactive release, shall be controlled low, and NPP

status with high occurring probability should be guaranteed to cause tiny potential radioactive result.

The main design requirements determined in the "Code on the Safety of Nuclear Power Plant Design" are as follows:

(1) Safety classification

All safety important SSCs shall be confirmed, including meter and control software, then classified according to the safe function and safe importance. Its design, construction and maintenance shall enable its quality and reliability consistent with such classification.

(2) General design basis

The necessary capability of NPP shall be specified in the design basis, so as to adapt the confirmed operation status and design basis accident within the prescribed radiation protection requirement. The design basis shall contain the technical specification of normal operation, NPP status, safety classification and important assumption caused by anticipated operational occurrences together with special analysis methods at certain situations. Besides design basis, the design shall take into account the specific accidents beyond the design basis, including behaviors in the selected severe accidents.

(3) Reliability design of SSCs

Consider the malfunction of common factor, apply single malfunction standards, and adopt methods such as malfunction safety design to guarantee important safety items such as SSCs can endure all confirmed anticipated operational occurrences with sufficient reliability.

(4) Measures for in-service test, maintenance, repair, inspection and monitoring

In order to maintain the ability of implementing function of safety important SSCs, its design shall satisfy calibration, test, maintenance, repair or replacement, inspection and examination within the lifetime of NPP, to prove the satisfaction of reliability objective.

(5) Equipment qualification

The procedure of equipment qualification shall be adopted to affirm the safety important items can satisfy the requirement of implementation of safety function under the condition (such as vibration, temperature, pressure, impact of jet stream, electromagnetic interfering, radiation exposure, humidity and any possible combination of these factors) needed in the design and operation lifetime.

(6) Aging

As required by nuclear safety regulations, there shall be adequate safety margins for SSCs in the design of NPP to consider the related mechanisms of aging and wearing, and potential performance degradation, so as to ensure that the SSCs should keep their capability of carrying out their functions in the lifetime.

(7) Design for optimizing operator performance

The working place and environment for site personnel shall be designed according to principles of human-machine engineering.

The human factor and human-machine interface shall be considered systematically at the beginning of the design, and carried through the entire process of design.

The design of human-machine interface shall be "friendly" to operators, and takes the limitation of man-made error as the objective. The human-machine interface shall be designed to not only provide complete and tractable information, but also comply with the time needed in making decision and adopting action.

(8) Safety analysis

The safety analysis shall be carried out to NPP and the analysis method of deterministic theory and probability theory shall be used. The nuclear power plant designed through safety analysis and argumentation shall meet all regulatory limits of various NPP status under radioactive release and the potential acceptable limits of radioactive dose, and demonstrate that the defense-in-depth makes sense.

(9) Other design considerations

The design code also specified many requirements on aspects such as SSCs, nuclear fuel and radioactive waste transport, package, evacuation route and

communication manner as well as entrance and exit control of NPP and its decommissioning for the multi-reactor.

In addition, the "Code on the Safety of Nuclear Power Plant Design" also specified design of important NPP systems such as reactor core, reactor coolant system and containment system, I&C system, emergency control, emergency diesel generator and radiation protection.

18.1.2 Basic Requirements of Nuclear Power Plant Construction

Basic requirements of nuclear power plant construction are mainly embodied in the nuclear regulation, the "Code on the Safety of Nuclear Power Plant Quality Assurance", and its guides. Focused on the concrete features of the construction activities, the requirements provided by nuclear safety guide, "Quality Assurance during the Construction of Nuclear Power Plants", are as follows.

(1) General requirements include:

- Make plans for onsite construction (including the verification) and form written documents.

- Stipulate and finish the required activities according to the written procedures, the working instructions, the specifications and the drawings.

- Perform on-site management to assure the necessary quality of the items to be built and assembled.

- Control the receiving, storage, load and unload of the materials and the equipment to prevent them from abusing, misuse, damage, degradation or missing tags.

- Specify and implement requirements of flushing fluid systems and relevant components and the management requirements of the cleanness.

- Finish the quality/safety-related items and surface painting or coating according to the approved procedures.

- Manage the measuring and testing equipment, and control the selection,

labeling, calibration and utilization of the equipment.

- The workers shall receive necessary trainings and have necessary working skills to finish the jobs.

(2) Installation, inspection and test of the items

During the construction of the NPP, there are three types of activities: installation, inspection and test which are all conducted for soil, foundation, concrete and structural steel; mechanical equipment and systems; monitoring instruments and electrical equipment.

The main links of the above activities are strictly controlled.

- The verification of the prerequisites before construction and installation.

- The management and control during construction and installation.

- The inspection and test of the built structures and the installed equipment and systems after construction and installation.

(3) Analysis and evaluation of the results of inspection and test.

The results of the inspection and test are collected, rearranged, analyzed and assessed to judge whether the required operational level of the structures, equipment and systems is achieved, and to determine the subsequent actions.

18.1.3 Event Reporting System of NPPs under Construction

According to the requirements of the "Reporting System of Operating Organizations of NPPs", during construction stage, the operating organizations of Chinese nuclear power plants shall report the following events to the MEP (NNSA), the competent department of nuclear industry administration and other related departments.

(1) In violation of the requirements of accepted Quality Assurance Program (QAP);

(2) The final design in violation of the agreement in accepted Preliminary Safety Analysis Report (PSAR) or the conditions of the Construction Permit;

(3) Construction activities or items not in accordance with laws and regulations, standards, technical specifications or other design requirements;

(4) Significant deviation, defects and faults in construction items which may cause non-compliance to anticipated requirements and safety functions or items or activities needing re-assessment and verification;

(5) Significant events commonly concerned by the public;

(6) Other events needing to be reported in the opinion of NNSA or the operating organization.

18.2 Implementation of Defense-in-Depth

18.2.1 Defense-in-Depth Conception

Chinese NPPs have carried through the concept of defense-in-depth in the entire design, and have taken all reasonable and feasible technologies and management means to guarantee the effectiveness of every defensive measure of NPP and the integrality of multiple barriers so as to prevent nuclear accidents and mitigate the consequences in case of accidents. It embodies in the following aspects:

- Provide multiple physical barriers to prevent the radioactive substance from releasing to the environment without control.

- Conservatively design NPP and construct and operate it with high quality, so as to guarantee a minimal probability of malfunction and abnormal operation in NPP.

- Control the behavior of NPP during and after the anticipated operational occurrence by using inherent characteristic and specific safety facilities, try to minimize transient process without control, or even exclude it.

- Provide extra controls to NPP, these controls adopt automatic spring of safety system, so as to reduce the operator‘s interference at the early stage of anticipated operational occurrence.

- Provide equipment and procedures to control the development of accident and limits its result.

- Provide multi-means to guarantee each basic safety function to be fulfilled, that is, reactivity control, heat discharge and radioactive substances containing, so as to guarantee the effectiveness of every barrier and mitigate the result of anticipated operational occurrence.

In order to carry through the concept of defense-in-depth, Chinese NPPs try to prevent the following situations as reasonably as possible in design:

- The occurrence of affecting the integrality of barrier.

- The barrier loses its function when it is needed.

- Function failure of one barrier is caused by that of another barrier.

It is a basic requirement that every defense layer is prepared one by one according to different operation manners at any time. Continuous operation is no longer appropriate if one layer is lack.

Refer to the China's fifth national report under the "Convention on Nuclear Safety" for the related description of the application of the defense-in-depth in the design process of Chinese NPPs.

After Fukushima accident, MEP (NNSA) proposed a series of new requirements on NPP, including: conduct in-depth evaluation of earthquake and tsunami risk; carry out analysis and assessment on safety margin for the resistance to external events; launch external event PSA, etc. These requirements are proposed and implemented to further consolidate and improve NPP's capacity in defense-in-depth.

18.2.2 Five Layers of the Defense-in-Depth

The first application of the defense-in-depth concept to the design process of Chinese NPPs is that a series of echelons of inherent features, equipment and procedures defenses are provided in order to prevent accidents or to ensure appropriate protection in the event when the prevention of accidents fails.

(1) The purpose of the first layer defense is to prevent offsetting from normal operation and prevent function failure of the system.

(2) The aim of the second echelon is to detect and intercept deviations from normal operation conditions in order to prevent anticipated operating occurrences from escalating into accident conditions. To meet this objective, in the design process of NPPs, special systems are provided and the operating procedures are established.

(3) For the third echelon, it is assumed that, although very unlikely, the escalation of certain anticipated operational occurrences or postulated initiating events may not be arrested by a preceding echelon; more severe events may happen and develop.

(4) The aim of the fourth echelon is to cope with the severe accidents which may be beyond the design basis, and to ensure the consequences of radioactivity as low as reasonably achieved (ALARA).

(5) The aim of the fifth echelon is to relieve the radioactive consequences imposed by the probable release of radioactive materials in the accident conditions.

18.2.3 Three Physical Barriers of the Defense-in-Depth

During the design process of Chinese NPPs, three physical barriers are provided to prevent the escape of radioactive substance to outside. These barriers include the fuel matrix and the fuel cladding, the reactor coolant system pressure boundary as well as the containment.

18.3 Measures against Event Prevention and Mitigation

18.3.1 Measures against Event Prevention

Chinese NPPs mainly rely on conservative design, improving the reliability of system and equipment together with reasonable operating practice to prevent the occurrence of malfunction, rely on the quality assurance to check up whether the design purpose was achieved, and rely on monitoring to discover performance degradation or early malfunction and rely on certain measures to guarantee tiny disturbance or that early malfunction will not become much more serious. Therefore, the following factors should be considered:

- The adequate use of inherent safety features.

- The adequate margins for material properties and technical parameters during the design and operation of the nuclear power plant.

- The adoption of effective technologies proven by the engineering practices.

- Systems and components which monitor and control the nuclear power plant operation being designed as far as possible to be of fail-safe, redundancy, diversity and physical segregation of the same type components if necessary.

- The strict and overall quality assurance of the equipment and the material significant to safety.

- The periodic monitoring, inspection and testing of components related to safety.

- The timely detection of abnormal conditions which may affect nuclear safety using monitoring systems with alarm and automatic initiation of corrective actions in many cases.

- The probability risk assessment (PRA) of nuclear power plant for seeking weak points in design, and

- The operating experience feedback for improving the design and operational procedures of nuclear power plant.

In the design stage of Chinese nuclear power plants, human errors which may occur during operation are considered. In order to minimize human errors, the transient actions of the nuclear power plant operation are designed to be automatic as far as possible to provide operators more time to make diagnoses and decisions, and relieve their psychological pressure.

18.3.2 Event Management Measures

Measures of event mitigation of nuclear power plants are categorized into three types, i.e. safety and protection systems including the engineering safety features, the accident management and the emergency response measures.

All Chinese NPPs are provided with engineering safety features as safety injection system, containment spray system, containment hydrogen concentration control and air monitoring system, auxiliary feedwater system of the steam generator, containment isolation system etc. Engineering safety features are used to limit the consequences caused by damaged radioactive product shielding of hypothetical events. The performance of engineering safety features is verified by periodic testing.

In Chinese nuclear power plants, there are containments to enclose radioactive material releasing from the core, and to reduce to minimum the discharge of radioactive material to the environment so as to protect the public and the environment.

In order to realize the status control of post-accident units, Chinese NPPs establish the post-accident monitoring system. The instrument and equipment of the post-accident monitoring system can work under severe environment and provide correct information of post-accident unit status.

Chinese NPPs are provided with the accident management procedure which covers from anticipated transient events to design basis accidents of the unit. The accident management procedure of some NPPs even extends to beyond-design basis accidents (e.g. plant blackout, steam generator deprived of all feedwater) to take precautions against and mitigate accidents with lower probability of occurrence. In order to strengthen the implementation effectiveness of the accident management procedure, Chinese NPPs carry out the retraining of the accident management procedure to operating personnel of the NPP regularly.

18.3.3 Countermeasures against Severe Accidents

Chinese NPPs take the following measures to prevent against and mitigate severe accidents:

-Operating organizations conducts self-assessment of severe accident weakness in the operating NPPs by using a systematic approach and proposes feasible improvement measures.

-Use PSA method to select representative and predominant severe accident sequences, to analyze accident sequence process, and to select appropriate severe accident management strategies specific to accident sequence.

-Establish severe accident management program, implement severe accident management procedures and guidelines, and conduct personnel training and exercises of severe accidents.

-Assess the availability and ability of system, equipment and instrumentation required for the prevention and mitigation of severe accidents and make design improvements.

-Establish severe accident management organization system and interface management.

In the nuclear power units those have been put into commercial operation in China, Daya Bay NPP, Third Qinshan NPP, Qinshan Phase II NPP, LingAo NPP and Tianwan NPP have completed and implemented severe accident management guidelines (SAMG).

For the under construction nuclear power units, the regulatory authority requests that SAMG must be prepared before the initial loading.

At present, Chinese NPPs can withstand various risks within the scope of design basis accidents and have certain control and mitigation capabilities to cope with beyond-design basis severe accidents.

(1) Requirements to the newly-built NPP

In April of 2004, the MEP (NNSA) promulgated the amended "Code on the Safety of Nuclear Power Plant Design", which stipulated that countermeasures against severe accidents shall be considered in the design of newly-built NPPs.

Although high-reliability design is provided for current nuclear power plants to cope with the design-basis accidents (DBAs) so as to prevent the core from severe damage and to inhibit the releases of radioactive substances, it is still possible to cause severe damage of the core by certain extremely low probability events. Hence,

the newly built nuclear power plants are required to take following measures into considerations for severe accidents based on the existing operating experience and combined with the results of safety analyses and safety studies:

- Identify the important events sequences which can lead to severe accidents by combining the probabilistic and deterministic methods with rational engineering judgments.

- Determine which severe accidents shall be considered in the design according to a set of review criteria.

- For the selected event sequences, evaluate the modifications of design and the changes of procedures which may decrease the events' probabilities or mitigate their consequences if occurred. These measures shall be taken if they are reasonable and feasible.

- Consider the whole designed capabilities which include using certain systems and components (for example, safety-class and non-safety-class systems and components) under the conditions beyond their predefined functions and anticipated operational conditions, and using additional temporary systems and equipment to make the severe accidents return back to the controlled status and/or to mitigate their consequences. These systems and equipment shall fulfill their functions in the anticipated situation.

- For the multiple-unit NPPs, applications of available means and/or supports from other units should be considered provided that the safety operation of other units is not jeopardized.

- Accident-management procedures shall be formulated for the representative and predominant severe accidents.

(2) Countermeasures taken by operating NPPs

All operating NPPs, reference to above requirements and international experience combined with their own actual conditions, have performed the studies of severe accidents. Some reasonable and feasible prevention and mitigation measures will be phased in:

- Actively investigate and study up-to-date development of severe-accident research of foreign organizations and nuclear power plants.

Initiate the research plans and formulate the SAMG so as to protect the pressure vessel boundary containing fission-product and the containment, to mitigate the consequences of severe accidents, to decrease the releases of radioactive substances to the environment, and to finally recover nuclear power plant to a controlled and steady state.

- Perform engineering evaluations and modifications for the systems and facilities for mitigation of severe accidents, thus enhance the capability in mitigating the severe accidents.

(3) Actively promote the management of severe accidents

The Daya Bay NPP, Third Qinshan NPP and Tianwan NPP have compiled the severe accident management program suitable for its own plant on the basis of referring the practices of similar foreign plants and in full combination with the actual situation of the plant.

After Fukushima accident, ongoing work carried out in China includes: establishment of response plan of NPP after multiple -units at nuclear power bases under emergency condition simultaneously; assessment of emergency command ability, allocation and coordination programs of emergency rescue personnel and materials; improvement and perfection of environment monitoring capabilities and emergency control center function of NPPs in case of severe accidents.

18.4 Adoption of the Proven and Up-to-Standard Process and Technology

In order to promote the advancement of nuclear power technology to continuously improve the safety and economy, China has made continual design improvements to the nuclear power units in operation or under construction on the basis of domestic and international experience feedback and related technological advancements. The improvement allows the nuclear power technology to be further mastered and nuclear power independent design capacity to be enhanced, thus improving the safety and operation performance of NPPs.

18.4.1 NPP in Operation

Since the unit has been put into operation, Qinshan NPP has carried out dozens of major technological modification projects, such as the modification on auxiliary power relay protection system, emergency diesel generator electrical system and generator excitation system, the replacement of pressure vessel head and related component systems, as well as the transformation on reactor protection and related equipment I&C system.

Daya Bay NPP has completed the improvement on inadvertent dilution prevention, improvement on core uncovering prevention, modification on refueling machine, modification on inlet dead pipe of residual heat removal system, the improvement on boiler effect prevention, modification on the rack and support of nuclear island relay, modification on emergency diesel jet pipe and other major technological improvement projects.

Unit 1 and Unit 2 of Qinshan Phase II NPP have carried out a series of design improvements according to construction and operating experience of similar plants during the design. A further improvement has been made to Unit 3 and Unit 4 on the basis of fully absorbing the experience of Unit 1 and Unit 2, such as the use of new AFA3G type fuel assembly, the adoption of digital I&C systems, the addition of hydrogen mitigation measures under beyond-design basis accident, the addition of inadvertent boron dilution prevention, etc.

LingAo NPP has implemented dozens of major design improvement projects on the basis of Daya Bay NPP and its own operating practice, such as coolant pump fire detection, multi-point hydrogen measurements in containment, K1 level AIR-LB connection improvement for penetration pieces, test pipeline modification of containment spray system, etc.

Third Qinshan NPP has made necessary design improvements based on the operating experience of CANDU-6 type heavy water reactor and the actual situation in China, such as the improvement of low-level radioactive liquid waste discharge standards and technology thereof, feeder pipe material of thermal transport system, steam

generator, main control room design, sea water pumping house, the modification of recycling cooling water system and the fast switching modification of electrical system, etc.

Unit 1 and Unit 2 of Tianwan NPP have made some improvements in the design based on VVER-1000 type pressurized water reactor and their own operating experience, such as the use of double containment and four series of safety system, anticipated transient in case of severe accidents and without shutdown , the addition of emergency boron injection system, fuel pool being located inside the containment and capable of storing spent fuel for ten years, modification on ventilation units of negative pressure system in containment building, overall modification of rotary filter screen, etc.

Unit 3 and Unit 4 of LingAo NPP have made a number of technical improvements reference to Unit 1 and Unit 2, in which 13 safety design improvements are included, such as the adoption of advanced AFA 3G fuel assemblies, the use of solid forging for core activity segment of reactor vessel, the extension of pressure relief function of pressurizer to prevent high pressure core melt condition, the modification of containment sand filter pressure relief discharge system, etc.

The safe and stable operation has been effectively guaranteed through continuous technological improvements of operating NPPs in China. After Fukushima accident, every operating NPP actively carried out appropriate improvements combined with the results of national comprehensive safety inspection and self-inspection thereof and based on the plans formulated by MEP (NNSA). At present, every safety improvement measure has been carried forward in order as scheduled and has got stage effect. The short-term safety improvements which have been completed include the implementation of waterproof plugging, the addition of mobile emergency power and portable pump, the enhancement of seismic response capability of NPPs, etc. Medium and long-term safety improvement projects include flood control modification of NPP, in-depth assessment of earthquake and tsunami risk of site, completion of severe accident prevention and mitigation measures, enhancement of

emergency capability, strengthening of information disclosure and development of external events PSA, etc. Current progress can also meet the node requirements.

18.4.2 NPP under Construction

A series of design improvements are made to the independently designed pressurized water reactor units in Chinese NPP under construction based on the introduction, digestion and absorption of foreign mature technology and combined with years of operating experience of similar units at home and abroad and the results of safety research and continuous improvement. Compared with similar international units, a higher safety level is achieved.

Hongyanhe NPP, Ningde NPP and Yangjiang NPP and other subsequent nuclear power construction projects all have adopted the improvements of reference power plants.

Fuqing NPP and Fangjiashan Nuclear Power Project also made a number of important technical improvements as per respective characteristics on the basis of referencing Unit 1 and Unit 2 of LingAo NPP.

Sanmen NPP and Haiyang NPP adopted AP1000 nuclear power technology. China has established corresponding technology absorption and acquisition organizations and founded major scientific and technological project to support it.

Taishan NPP adopted EPR technical route, took the similar unit being constructed in France as the reference plant and referred to the similar unit being constructed in Finland on partial system and equipment.

Hainan Changjiang Nuclear Power Project planned to construct four sets of 650,000KW PWR. Project Phase I took Qinshan Phase II as the reference plant and was constructed in accordance with the principle of duplication with improvement.

Unit 3 and Unit 4 of Tianwan NPP took Unit 1 and Unit 2 as the reference plant, continued to use VVER-1000/428 type reactor device which was designed and constructed in Russia for nuclear island and made necessary design improvements.

Chinese NPPs under construction basically meet the requirements of current national nuclear safety regulations and latest IAEA standards and have implemented effective

management in all links like siting, design, manufacturing, construction, installation , commissioning and quality assurance system and quality monitoring system are in normal operation. The engineering construction meets the design requirements.

18.5 Optimized Design for Operating Personnel

The design organizations in China pay great attention to the control room since it is the area with most centralized man-machine interface and the direct working place of operating personnel. The design of newly-built NPPs in recent years successfully employed following practices according to the experience feedback and the reference of design ideas of other advanced NPPs.

(1) Fully adopted the design ideas of digital I&C system and the advanced control room. The master control room adopted digital man-machine interface, the logical relation of man-machine interface, operating display frame and rules and the alarm system were designed with digital principles.

(2) In designing the backup panel, operating practices of the operating personnel on aspects as function zoning, function grouping and equipment standardization were fully taken into consideration to reduce human errors.

(3) The man-machine interface equipment was accordant with the master control room for remote shutdown stations etc., which guaranteed the operating personnel did not need to be accustomed to another interface and enables their quick access.

(4) Carried out the environmental design of the master control room by applying basic research findings of ergonomics, physiology and psychology.

(5) Carried out the physical design verification and guaranteed the independence of the verification team; formulated design rules relevant to human factors and integrated the design team.

18.6 Regulatory and Control Activities

During the past three years, the MEP (NNSA) mainly regulated the following activities on the construction permit of NPPs, letter of ratification for the first fuel

loading of NPPs, design, manufacture and installation and Non-destructive testing service of the civilian nuclear safety equipment:

(1) Organized and completed the review of conditions of the first fuel loading to 6 Units, and issued the letter of ratification of the first fuel loading.

(2) Organized and completed the nuclear safety review of construction permit documents of 11 Units and issued the corresponding construction permit.

(3) Organized and completed the review and approval work of receiving application, project establishment review, license application, changing license and expanding license of some domestic nuclear safety equipment license applicants according to "the Regulations on the Safety Regulation for Civilian Nuclear Equipment" and the supported nuclear safety regulations. Carried out nuclear safety surveillance and management to domestic units engaged in design, manufacture and installation and non-destructive testing of the civilian nuclear safety equipment; carried out registration system to overseas enterprises engaged in design, manufacture and installation and non-destructive testing activities of the civilian nuclear safety equipment.

(4) From March to December 2011, MEP (NNSA), SDRC (National Energy Administration) and China Earthquake Administration performed comprehensive safety inspection on nuclear power units in operation and under construction throughout the China as well as civilian research reactors and nuclear fuel cycle facility. A number of potential design improvements were identified, mainly including: improvement on residual heat removal and cooling of spent fuel pool, improvement of fire control system, improvement of containment filtered discharge system, improvement in station blackout accidents mitigation measures, etc. The MEP (NNSA) and National Energy Administration specified the short, medium, and long-term safety improvement requirements, requested and urged every civilian NPP to complete the corresponding improvements on schedule.

19. OPERATION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) procedures are established for responding to anticipated operational occurrences and to accidents;

(v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19.1 Initial Authorization

19.1.1Basic Requirements of Nuclear Power Plant Operation

"Code on the Safety of Nuclear Power Plant Operation" issued in 2004 has established requirements to operating organization of the NPP, training and qualification of personnel, commissioning of NPP, operational limits and conditions, operating instructions and procedures, reactor core management and fuel handling,

maintenance, test, surveillance and inspection, modification, radiation protection, radioactive waste management and PSR. In addition, the "Code on the Safety of Nuclear Power Plant Operation" has also made relevant regulations on records, reports and decommissioning of a NPP and so on.

19.1.2 Operation Licensing Process

The licensing process for operation license of Chinese NPP is divided into two phases: Phase 1, before operation, the operating organization applies for the "Instrument of Ratification for the First Fuel Loading of Nuclear Power Plant" at first. Phase 2, after the first fuel loading, the operating organization applies for the "Operation License of Nuclear Power Plant" 12 months after the trial operation on full power.

19.1.2.1 Licensing Process of "Instrument of Ratification for the First Fuel Loading of Nuclear Power Plant"

The operating organization shall submit the Application for the First Fuel Loading of the Nuclear Power Plant to the MEP (NNSA) prior to the first fuel loading of the nuclear power plant together with the prescribed documents:

The MEP (NNSA) organizes relevant experts to review and assess the documents submitted by operating organization and confirms that these documents comply with the requirements of national nuclear-safety regulations, on-site and off-site nuclear accident emergency plan of the newly-built NPP is reviewed and approved, meanwhile emergency maneuver of on-site and off-site nuclear accident is organized by the emergency response agency of the NPP and the section appointed by people's government at the provincial level, then the "Instrument of Ratification for the First Fuel Loading of Nuclear Power Plant" can be issued to the applicant.

19.1.2.2 Licensing Process of "Operation License of Nuclear Power Plant"

The operating organization shall timely submit following documents to the MEP (NNSA) after 12-month trial operation from the date when the first full power of the nuclear power plant is realized:

- "Revised Final Safety Analysis Report of Nuclear Power Plant";

- "Instrument of Ratification of the Environmental Impact Report of Nuclear Power Plant";

- "Reports of Commissioning and Trial Operation of Nuclear Power Plant after the Fuel Loading";

- "Quality Assurance Program of Nuclear Power Plant (operation stage)".

The MEP (NNSA) organizes relevant experts to review and assess above mentioned documents. The "Operation License of Nuclear Power Plant" can be issued to the applicant after confirming these documents in accordance with the requirements of national nuclear-safety regulations.

19.1.3Safety Analysis and Commissioning

The trial operation of current nuclear power plants in China is based upon the proven fact that the constructed nuclear power plant is consistent with requirements of design, related safety analysis, and commissioning program.

Commissioning program and quality assurance program are drawn up by operating organizations in order to ensure that the commissioning activities are safely and effectively implemented according to the written procedures. The commissioning program and quality assurance program should get approval from the MEP (NNSA). All necessary tests and relevant activities are listed in the commissioning program to verify that the design and the construction of nuclear power plant are appropriate to ensure the safety operation of nuclear power plant. In the meantime, the opportunities are provided for the operating personnel to acquaint the operation of nuclear power plant.

The commissioning program of the operating organization is divided into several stages in order to indicate the tests required to be finished in the expected period of each stage and define the control points of reviewing the testing results before entering the next stage. The necessary tasks prepared for the next stage, especially

the requirements of the availability of the systems used in the next stage, are included in each stage.

The next stage cannot be started until the evaluation and the examination of the obtained results in current commissioning stage are finished and confirmed that all objectives have been achieved and all regulatory requirements of nuclear safety have been met.

All commissioning tests are implemented according to the approved written procedures. The important commissioning procedures and their modifications on safety shall be reported to the MEP (NNSA).

In order to achieve the target of safe commissioning, the whole commissioning work is completely managed, controlled and coordinated by the operating organizations. Practical working plans are stipulated to optimistically utilize the personnel, equipment, methods and time, etc.

19.2 Operation Limits and Conditions

"Code on the Safety of Nuclear Power Plant Operation" makes provisions for the operation limits, conditions and procedures of nuclear power plant. "Operation Limits, Conditions and Procedures of Nuclear Power Plant" is a further supplement and explanation to the relevant provisions of "Code on the Safety of Nuclear Power Plant Operation" in order to provide guidance for NPPs to establish and carry through the operation limits, conditions and procedures.

The technical and managerial operation limits and conditions are prepared by all operating organizations and approved by the MEP (NNSA). The operation limits and conditions which include requirements for all operational conditions (including the shutdown) form an important basis on which the operating organization is authorized to operate the nuclear power plant. These operational conditions include startup, power operation, shutdown, maintenance, testing and refueling. Operational requirements should be determined in operation limits and conditions to ensure that safety systems including engineering safety features can perform necessary functions in all operating states and design basis accidents. The operational personnel who are

directly responsible for operation are familiar with and strictly comply with the operation limits and conditions.

The operation limits and conditions include the limits and operational requirements to be followed for SSCs significant to the safety of NPP to implement intended functions those are assumed in safety analysis report on the technical aspects, and further include the actions to be taken and the limits to be followed by operating personnel. For operating personnel, the operation limits and conditions include the principles and requirements on necessary supervision, correction or supplement activities to the function implementation of the equipment related to the maintenance thereof. Some operation limits and conditions may include the combination of automatic function and manual operation.

Operation conditions and limits of NPP include:

— safety limits;

— setting of safety system;

— normal operation limits and conditions;

— surveillance requirements;

— Actions to be taken in case of deviation from operation limits and conditions.

The operation limits and conditions are based on the analyses of specific nuclear power plant and its environment and are in accordance with the provisions in the final design. Some necessary amendments are made according to the results of tests in the commissioning phase, and the reasons and the necessities to adopt each operation limits and conditions are illustrated in the written form.

Operating organization shall carry out periodical review to the operation limits and conditions throughout the operating life of the nuclear power plant in order to ensure that they continue to apply to the intended purpose and make periodical modifications in the light of accumulated experience and technological developments. Even if no modification is made to NPP, this periodic review shall also be carried out.

The operating organization is responsible for preparing the working procedures to revise operation limits and conditions and performs the revision of the operation limits and conditions according to the procedures.

The application of probabilistic safety analysis on the aspects of operation limits and conditions optimization should be considered by the operating organization. Probability safety assessment method and operational experience can be used together in the illustration and revision of operation limits and conditions.

Assessments and reports of anticipated operational incidents are important bases for determining whether or not the operation limits and conditions need to be revised. Any modification to operation limits or conditions should be reviewed and approved by the MEP (NNSA).

19.3 Program of Operation, Maintenance, Inspection and Test of NPP

Before the operation of nuclear power plant, the written operational procedures are worked out by the operating organizations in cooperation with the design institutes and the vendors. The compilation, review and revision of the operational procedures accord with the approved operation limits and conditions with adaptable safety margins. The necessary actions that should be taken in normal operation, anticipant operational incidents and accidents condition are included in the formulated operational procedures. The operational procedures facilitate the operational personnel to perform the manipulations according to the correct sequence, and define the responsibilities and the communication means of the operational personnel in case of being forced to deviate from the written procedures. All the operational procedures shall be reviewed regularly and any modification shall be noticed to operational personnel and other holders of these documents. The modification shall be carried out according to the procedures in written form

Prior to the operation of nuclear power plant, the necessary programs for periodic maintenance, testing, inspection and verification of the structure, systems and components are prepared by the operating organization. The programs are re-evaluated according to the operating experience. The programs of the maintenance,

test, verification and inspection satisfy the operation limits and conditions, as well as the available regulatory requirements of nuclear safety.

Prior to the maintenance, test verification and inspection of the SSCs, the written procedures and programs which clearly define the standards and the periods of the maintenance, test verification and inspection of the safety important SSCs, are compiled by the operating organization of nuclear power plant in cooperation with the vendors of nuclear power plant and the equipment. After the maintenance, the inspections for the SSCs are performed by the authorized personnel, and relevant verification experiments are performed if necessary.

For the in-service inspection (ISI) of nuclear power plant, some measures have already been taken in the design stage, and reviews have also been performed for the design of systems, components and their configuration for considering that the inspecting personnel can reach the components to be inspected so as to perform smoothly the required inspections and tests and to make the personnel exposure be as low as reasonably achievable (ALARA). The ISI program in which the systems and components need to be inspected and the frequency for the inspections are determined according to the safety importance and the rate of the equipment degradation, etc. has been worked out by the operating organization before the operation of nuclear power plant. In addition, the integrity of the pressure-retaining components has to be verified through the in-service inspections.

All inspection results are evaluated by the operating organization of nuclear power plant to determine whether or not the requirements of the standards are met. The components not suitable for further service through the assessment will be repaired or replaced.

In three years (2007-2009), more efforts on following aspects besides safe operation, maintenance and periodic test were also made by the operating NPPs in China:

(1) Maintenance based on Reliability-Centered Maintenance (RCM) is carried out, i.e. RCM are applied to the plant maintenance based on RCM analysis. Meanwhile the RCM analysis database and the equipment maintenance status

witness database of key sensitive equipment and components have been developed by information technology and the equipment and components management process has been regulated. RCM project work plan has been developed in Qinshan NPP and criticality analysis of some systems has been completed.

(2) Equipment aging and lifetime management related work has been in progress based on equipment reliability management information by means of operating experience. The IPM (Integrated Program Management) database has been developed and the preventive maintenance system has been established. Management on key and sensitive equipment and components are carried out to analyze the key equipment and components which directly impact on the safe and stable operation of NPP and monitor their performance correspondingly. These efforts are long-term basic managements of NPP equipment, which will further optimize preventive maintenance and improve the safety and stability of units.

(3) Aiming at the outage work, NPPs established preventive measures in advance by applying three-level risk analysis method; the outage risk was well controlled in general. NPPs continued to promote outage optimization management, seriously accumulated the best outage practices, actively adopted new technology to improve outage management, and launched standard time for outage and maintenance, and promoted standardization plan and optimal plan for annual outage in some NPPs to improve work efficiency. In addition, means such as maintenance organization optimization, progress of both main and auxiliary key paths in parallel, optimization of procedures and test methods are consistently used to optimize maintenance duration.

(4) Specific outage observation activities are organized, by which the communication among outage management personnel of each NPP was enhanced and the widespread use of outage management experience was promoted.

19.4 Accident Response Procedures

The NPP has worked out relevant response procedures on anticipated operation events and accidents, tried to verify accident procedure at full scope simulator and/or on site, and performed training to operators.

At present, the accident response procedures chiefly include two kinds of methods: event-oriented method and symptom-oriented method.

According to the principles for managing the design-basis accidents and the functions of engineering safety features, the accident response procedures of Chinese NPPs are classified into two categories on the basis of design methods:

- Single-event deterministic procedures are based upon the accident evolution premeditatedly studied in order to maintain the reactor in safe condition or lead it to safe condition. These procedures include Abnormal-Condition Handling Procedures (I), Design-Basis Accident Handling Procedures (A), and Beyond Design-Basis Accident Handling Procedures (H).
- Multi-failures of the equipment and/or human factors are possible. In order to deal with the difficulties caused by the combination of several events, the core-condition approaching method is selected to compile the accident response procedures including Severe Accident Handling Procedures (U), Continuous-Monitoring Procedures (SPI) of Abnormal Conditions, and Continuous-Monitoring Procedure of Severe Accidents (SPU).

According to the up gradation of NPP system, research results of PSR and PSA, operating experience of accident procedures and research on accident evolvement, Chinese NPPs actively followed the international development to assess and modify accident procedures. After Fukushima accident, MEP (NNSA) took the lead in organizing safety inspection and proposing rectification requirements for the management of severe accidents, requiring all NPPs to develop or optimize SAMG. In accordance with the requirements, a series of work was carried out by NPPs. Detailed completion status is described in 18.3.3.

19.5 Engineering and Technical Support

After many years' development and practice, China has established the engineering and technical support system of NPPs.

Through the practices of independent construction and operation, NPPs gradually establish technical support department directly under NPPs, which provide comprehensive technical support for operational safety.

Chinese government and every nuclear power corporation appropriately readjust and recombine the existing design and research organizations of nuclear power engineering to establish NPP–oriented technical support system including the areas of operation research, safety analysis, radiation protection, in-service inspection, plant modification, special tests, equipment maintenance and safety reviews.

Through cooperation and information exchange channels with international organizations as IAEA and WANO, Chinese NPPs can get technical supports from the international peers if necessary.

19.6 Event Reporting System of Operating NPP

According to the requirements of the "Reporting System of Operating Organizations of NPPs", during commissioning and operation, in case of specified events, the operating organizations of Chinese nuclear power plants shall report to the MEP (NNSA), the competent department of nuclear industry and other related organizations.

The ways of reporting the events are:

- Oral notification which shall be sent out in 24 hours after the occurrence of the event;

- Written notification which shall be submitted in three days after the occurrence of the event and in a given format;

- Event report which shall be submitted in 30 days after the occurrence of the event and in a given format;

- Accident report in the emergency condition (see 16.3).

Except the accidents which need to be reported to nuclear safety supervision departments and nuclear departments in charge, Chinese NPPs should submit relevant accident reports to IAEA and WANO according to the requirements and guideline of accident report of IAEA and WANO.

19.7 Operating Experience Feedback

The operating experience collection, analysis and feedback system has been established and constantly improved and the implementation plan has been stipulated in China. The experience feedback of China is consistent to the main objectives described in the fifth national report.

Exchanging and sharing operating experience are achieved by Chinese nuclear power plants mainly through event report, activities of competent department of the government, experience feedback activities of NPPs, operating experience exchanges among nuclear plants, positive participation in activities of international nuclear industry, and other ways.

In the past three years, China continuously improved and perfected the existing operating experience feedback system and initially established a set of event sharing mechanism to ensure the event information of every NPP can be shared within the industry. Relied on the information platform set up by technical support organizations, every NPP achieved information exchange and sharing within the industry and promoted mutual learning, mutual comparing and mutual reference through operating seasonal report, annual report, weekly report of domestic and foreign events, annual experience feedback report, key performance indicator report and other relevant information.

Statistical analysis on reporting criteria of lisenced operating events and internal events, level of INES , attributes of events, direct and root causes, involved systems and components, consequences and NPP activities when the event occurs are made and major problems which are common and worth of paying attention to are proposed in annual operating experience report. The problems mainly involve the loss of offsite power, failure of I&C component, work practice, equipment aging and

corrosion and so on. Meanwhile, in-depth feedback analysis is performed to the event of an important reference.

The key performance indicator report provides the basis for management improvements by acquiring the overall operational performance and trends of NPP through the comparison of performance indicators among operating NPPs and trend analysis.

In the recent three years, major activities in the area of operating experience of NPPs in China include the follows:

(1) MEP (NNSA) formulated and promulgated "Approach of Managing Operating Experience of NPPs (Trail)" which specified the responsibilities, processes and methods of operating experience feedback work in NPPs. Experience exchange meeting for operating NPPs, and experience exchange meeting for NPPs and research reactor regulators for Fukushima accident experience feedback were organized to strengthen the experience exchange and sharing among nuclear industry and within supervisory system.

(2) MEP (NNSA) organized the compilation of "Operating NPPs Experience Feedback System Construction Plan (Draft)"in which the entire system was planned, including file system, information platform construction and experience feedback expert database system. NPP operating event database was established, in which all operating events in Chinese NPPs, internal events, international event and correlation analysis modules under development were included.

（3）China Nuclear Energy Association (CNEA) set up topic working groups. CNEA created the industry model of topic working groups by widely listening to advices from its member units and using domestic and overseas successful experience and established 14 topic working groups including large transformer, quality assurance, commissioning starting, aging management and PSA, etc. In the recent three years, a series of technical analysis reports, application standards and regulations for equipment were prepared by every working group as per the work plans, such as "Special Report on Analysis of Nuclear Emergency Diesel Generator

Set Event in China", "Technical Analysis Report on Operating Conditions of Large Power Transformers in NPPs", "Refueling and Outage Performance Objectives and Criteria for NPPs", "RCM Technical Specifications for Nuclear Industry", "Peer Assessment Performance Objectives and Criteria for Commissioning and Operations Preparation of NPPs", etc. A total of 32 workshops and technical training activities were organized with 2,700 professionals participating in.

(4) Chinese NPPs actively took the initiative to undertake major conferences of WANO. After Fukushima accident, China Guangdong Nuclear Power corporation hosted the 11th WANO Biennial Meeting in October 2011, with the theme of "WANO at post-Fukushima era, continue to strengthen global nuclear safety", which is the highest-level technical meeting ever held in China by WANO.

（5）Chinese NPPs carried out a series of topic experience exchange activities aiming at common issues, covering PSA, human error prevention, aging and lifetime management, severe accident management, welding and non-destructive test and oil immersed power transformer, etc.

(6) In order to promote the outage optimization management, the operating NPPs constantly collected good practice of the outage of plants, actively used new technologies to improve the outage management and released notice about outage during the outage of each unit. The notice mainly covers the milestones completion of outage plan, schedule control, major abnormal conditions during the outage, etc.

(7) Technical support mechanisms developed performance indicators of operating NPPs and prepared various special reports related to operating experience, including annual operating experience report for Chinese operating NPPs, operating experience report on Chinese operating NPPs events and topic operating experience report on the vibration of turbine-generator in NPPs, etc.

19.8 Management of Spent Fuel and Radioactive Wastes

The operating organizations of Chinese nuclear power plants have prepared and carried out the waste management program and a variety of measures for processing,

storing and disposing the wastes and effectively controlling the release of the effluents. The program shall be submitted to the MEP (NNSA) for approval before the operation of the nuclear power plant, and the approved discharge limits shall be included in the operational limits and condition.

The operating organizations of nuclear power plants conduct the operation of waste management systems by stipulating the detailed procedures and in terms of design intentions and assumptions. Through adequate supervision and measures for training and quality assurance, all activities related to the operation and maintenance of waste management systems are effectively controlled, hence the occurrence probabilities of concerned abnormal events are decreased and the amount of produced radioactive wastes is kept as low as reasonably achieved (ALARA).

To effectively control and decrease the production amount of radioactive wastes, Chinese nuclear power plants have taken a series of measures. The technological course producing wastes is monitored to provide the information about the sources and characteristics of radioactive wastes and to prove that it is consistent with the operational procedures. Results of the supervision show that the discharge amount of the radioactive effluents during operation of NPP is far lower than the discharge limit stipulated by the national standards.

Facilities to store radioactive wastes produced during the normal operation and the anticipated operational occurrences are enough. Excess accumulation of the untreated wastes is avoided during waste disposal. Records and documents of the amount of stored wastes are well kept in terms of the requirements of relevant regulations and quality assurance.

In order to ensure the integrity and subcriticality of the spent fuel, according to written procedures, the operating organizations of Chinese NPPs handle and store the spent fuel by using approved equipment inside the approved facilities. The underwater storage conditions of the spent fuel and the water quality are kept in accordance with the chemical and physical characteristics specified. With the accumulation of NPPs operating time, preparation for subsequent storage from the

reactor of spent fuel has been done well accordingly. Each operating NPP signs service agreement for outward transport and disposal of spent fuel with related technical service units in succession, and defines the corresponding responsibilities for disposal mode, off-site transportation and storage of spent fuel. Each NPP under construction also signs long-term service agreement for spent fuel transportation, namely, service agreement for spent fuel receiving and storage with technical service units successively. This marks that preparation for disposal and treatment from the reactor of spent fuel has been done well by Chinese NPPs.

Chinese government promulgated the "Act of Prevention and Remedy of Radioactive Contamination of the People's Republic of China", in which all requirements for managing the radioactive waste are further provided on the law bases, and the Act further promoted the realization of the management objects of the radioactive waste. In order to prevent and remedy the radioactive contaminations, China has implemented the policy of "Crucial Prevention, Prevention Combined with Remedy, Strict Management, Safety-First" and established a monitoring system of the radioactive pollution. The administrative competent department of environment protection of the State Council conducts the unified surveillance and management for the prevention and remedy of the national radioactive pollution. According to the provided discharge modes, the operating organizations discharge the radioactive waste gas and waste liquid in terms of the requirements in the national standards on prevention and remedy of radioactive contamination. The operating organizations should submit their application for the discharge amount of radioactive nuclides to the department which is responsible for reviewing and approving the reports of the environmental impacts, and periodically report the results for discharges. The radioactive waste liquid which cannot be discharged into the environment is processed and stored. A near-surface disposal is conducted for the low and medium-level radioactive solid wastes in the regions provided by China. A concentrated deep-ground disposal is performed for the high-level radioactive solid wastes.

The newly promulgated "Regulations on the Safety Management of Radioactive Waste" specifies the treatment, storage, disposal, and supervision and management activities, etc. for radioactive wastes. Safe management of radioactive wastes shall stick to the principles of reduction, harmlessness, proper disposal and permanent safety. Classification management is carried out to radioactive wastes by the state. The Ministry of Environmental Protection is in charge of the safety supervision and management of radioactive wastes throughout the country and establishes management information system of radioactive wastes across the country together with relevant administrative departments of nuclear industry under the State Council and other relevant departments to realize information sharing.

20. Improvement for Safety of Chinese NPPs (Nuclear Power Plant) after Fukushima Nuclear Accident

20.1 Comprehensive Safety Inspection on NPPs

20.1.1 Comprehensive Safety Inspection on NPPs

Under the uniform deployment of the State Council, comprehensive safety inspection on NPPs both in operation and under construction in China was conducted by NNSA, jointly with departments concerned, from March 2011 to December 2011. The inspection was conducted mainly on the basis of China's existing and valid nuclear safety laws, regulations and technical standards, by reference to the latest nuclear safety standards released by IAEA and by drawing the lessons and experiences from Fukushima nuclear accident. The inspection covers 11 fields, including appropriateness of evaluated external event during siting, capability to prevent and mitigate extreme external event, measures to prevent and mitigate severe accidents, effectiveness of environment monitoring and emergency system, etc. and it was carried out mainly by means of scheme evaluation, document review, self-inspection of NPPs, site survey, record checking, technical assessment, etc.

Overall conclusion of comprehensive safety inspection is as follows: NPPs in operation and under construction in Chinese mainland generally meet requirements of China's nuclear safety regulations and the latest safety standards of IAEA, they had certain capability to prevent and mitigate severe accidents and safety risk was under control, thus safety was guaranteed.

Upon comprehensive safety inspection, some problems that may influence safety of NPPs were also found and mainly included: flood prevention ability of Qinshan NPP did not meet the new requirements; some NPPs have not formulated or implemented severe accident management guidelines (SAMG), further assessment on influence of earthquake-induced tsunami to some coastal NPPs.

20.1.2 Proposal of Improvements after Fukushima Nuclear Accident that should be taken by all NPPs

NNSA put forward requirements, including general requirements and detailed requirements, on NPPs for management of improvements after Fukushima nuclear accident based on problems found during comprehensive safety inspection, in combination with experience feedback of Fukushima nuclear accident and improvement works that could further improve safety level of NPPs and by fully considering importance of safety improvement and feasibility of implementation progress.

The general requirements are applicable to all NPPs and mainly involve continuous improvement that is required to be conducted for a long period in respect of management, including: 1. attaching great importance to continuous improvement for safety of NPP's operation and nuclear and constantly improving safety level of NPPs, 2. following research progress of Fukushima nuclear accident at home and abroad and performing sound experience feedback and assessment improvement, 3. strengthening information communication with meteorological, marine and earthquake departments improving early warning and response capability in case of external disaster, 4. perfecting and improving monitoring emergency capability and cooperating in sharing of emergency resources and capabilities at a national or regional scale, 5 perfecting information disclosure of NPPs and strengthening popularization of nuclear knowledge, etc.

The detailed requirements refer to technical improvement measures put forward for specific NPPs and mainly cover three aspects: the first one is improving capability to resist external events, the second one is improving capability to prevent and mitigate severe accidents, and the third one is improving nuclear accident emergency and monitoring capability. To be specific, they include eight technical improvement measures as below:

－Improvement on anti-flooding capability of NPPs;

－Selection of emergency water supplement equipment and layout of pipelines;

－Selection of portable power supply and interface setting;

－Monitoring on spent fuel pool;

－Improvement of hydrogen monitoring and control system;

－Habitability and functions of emergency control center;

－Radiation environment monitoring and emergency improvement;

－Response to external disaster.

All improvements were implemented respectively in three kinds of duration, namely, short term, medium term and long term. Short-term improvements were required to be completed before the end of 2011 and medium-term improvements were required to be completed before the end of 2013.

20.1.3 Issuance of General Technical Requirements for Improvements after Fukushima Nuclear Accident

In order to normalize improvements of the NPPs in Chinese mainland, the NNSA developed the "General Technical Requirements for Improvements of NPPs after Fukushima Nuclear Accident".

The General Technical Requirements provided technical guide for improvements and include the main contents as follows:

1. When implementing waterproof plugging, estimate level of accumulated water according to design basis flood level superposed by thousand-year rainfall, and ensure an available residual heat removal security series before connection of a portable water supplement device.

2. Design capacity of the portable water supplement device in accordance with connection of it 6 hours after shutdown and equip two sets of such device in each plant site.

3. Equip two sets of portable power supply, with one set having the capacity to drive low head safety injection pump or auxiliary feedwater pump.

4. Store portable water supplement devices and portable power supply in the places that can prevent flood 5m higher than design basis flood and are more than 100m

away from safety system, add one degree for structures based on that of civil building, and check according to SL2.

5. Install necessary level and temperature monitoring facilities for spent fuel pool.

6. Assess containment hydrogen in accordance with cladding zirconium-water reaction of 100% active region.

7. Add one degree for structures of emergency control center based on that of civil buildings and check according to SL2. Estimate habitability as 100mSv in case of severe accidents.

"General Technical Requirements" was prepared in combination with actual conditions of China's NPPs and based on overall consideration to preliminary experience feedback after Fukushima nuclear accident, and it integrated and coordinated depth and breadth of safety improvement strategies taken by all NPPs as much as possible and basically eliminated possible discrepancy in understanding of regulatory authorities and operating organizations on safety improvement strategies, thus providing technical guidance for improvements of China's NPPs after Fukushima nuclear accident essentially. With progressing of international nuclear power industry's research about Fukushima nuclear accident and deepening of the understanding, the NNSA will further amend or improve the "General Technical Requirements" in future.

20.1.4 Implementation of Requirements for Improvements after Fukushima Nuclear Accident

Upon presentation of requirements for improvements after Fukushima nuclear accident, the NNSA discussed improvement implementation plan and technical details with operating or construction organization of NPP many times and constantly organized on-site verification on implementation of improvements in NPPs in operation and under construction.

On the whole, NPPs in Chinese mainland have completed short-term safety improvements, basically completed medium-term safety improvements and are implementing long-term safety improvements according to requirements of time

limit. The implementation schedule meets the requirements of time node in general. The detailed implementation is shown in Annex 2.

20.2 Conduction of Safety Margin Assessment on External Events of NPPs in Operation

20.2.1 Assessment Coverage and Method

The NNSA promulgated "Notice on Carrying out Margin Assessment on External Events of NPPs in Operation" in March 2012, which requires China's NPPs in operation to further assess safety margin in response to beyond design basis external events so as to optimize and fulfill improvement measures proposed in comprehensive safety inspection. External events selected for assessment include earthquake (initiating event), flood (initiating event) and station blackout (safety system fails afterward), and the assessment covers accident response, defense and consequence of NPPs in case of extreme external events, effectiveness of mitigation measures and possible weakness and steep-sided effect of NPPs.

As for the assessment method, with deterministic view as the benchmark, supposing defense lines of NPPs lose effectiveness successively during development of extreme natural disasters but failure probability is not investigated, improvements for organization system or technical aspects are put forward through assessment on solidity and safety margin of defense-in-depth of NPPs as well as appropriateness of current accident management measures.

In this assessment, in terms of seismic margin, EPRI SMA method was adopted to find out all systems and equipment for accident mitigation, and on this basis, the path to successively make NPPs realize safe and stable shutdown was chosen; in terms of flood safety margin, the most likely flooding path was found out according to data of equipment, system and powerhouse, and it was assumed that all systems failed gradually due to rising flood level till reactor core meltdown; in terms of station blackout (SBO), considering only battery power supply was used for monitoring main unit parameters and controlling unit status under the accident condition that

off-site and emergency diesel power was not restored, the duration of units being kept under controllable state was assessed.

20.2.2 Assessment Conclusion

According to results of NPP assessment and conclusion of peer review, all NPPs in operation in Chinese mainland can meet requirements of resistance to earthquake 1.5 times or above design basis earthquake; they have the safety margin in response to beyond design basis flood. However, 300MW unit of Qinshan NPP is at a wet site and does not meet requirements of beyond design basis flood level, now some improvements are being implemented, so it also will have the safety margin in response to beyond design basis flood after completion of such improvements; all NPPs have taken sound countermeasures for station blackout accident, and the batteries have the capacity of supplying power for more than 8 hours after blackout.

20.3 Preparing safety requirements for newly-built NPPs

In order to implement Nuclear Safety Program and the policies & guidelines determined on executive meeting of the State Council, NNSA launches the formulation of safety requirements for NPP. Currently, NNSA has finished preparing Safety Requirements for Newly-built NPPs during the "Twelfth Five-year Plan" (hereinafter referred to as Safety Requirements), and is seeking for opinions from relevant units in China. The preparation of safety requirements for newly-built nuclear power units during the "Thirteenth Five-year Plan" and in future is also included in work plan.

20.3.1 Promotion of Safety Requirements in terms of nuclear safety

Relative to the current regulations and requirements on NPP in China, Safety Requirements is promoted in the following aspects:

- **Probability safety goal**

It is clearly required that the probability of serious core damage frequency (CDF) event occurring to newly-built NPP per reactor each year shall be lower than

1/100,000 and that of large release frequency (LRF) event per reactor each year shall be lower than 1/1,000,000.

– **Safety analysis**

The role of probability theory in safety analysis is promoted, that is, adjusting the principle of "Determination theory safety analysis leading and probability theory supplementing" in HAF102 into "Taking the results of determination theory safety analysis and probability theory safety analysis into consideration", which provides powerful support for newly-built NPP to promote safety level and verify conformance to probability safety goal.

– **Safety function and safety classification**

It adopts the latest Specific Safety Requirements for NPP Design (SSR-2/1) of IAEA to cope with safety consideration of design expansion working conditions, HAF102 requirements and the measures for severe accidents through years of experiences. Moreover, it proposes that the equipment and components for preventing and relieving severe accidents shall meet the requirements of availability and accessibility under corresponding accident conditions, and demonstrates by means of analysis, test or inspection, etc.

In order to avoid possible mixing of systems in actual process, Safety Requirements still follows the condition classification and corresponding safety classification system in HAF102.

– **Defense in depth**

Further put forward the requirements of strengthening multilevel defense in depth measures of NPP, to guarantee the validity of defense in depth measures at all levels and the independence among all levels.

Defense in depth measures shall also be adopted for fortification of extreme external event so that severe accidents caused by reliable extreme external event can be prevented and relieved through multi-level defense.

– **Plant site safety**

It is required to select NPP site cautiously after sufficient safety evaluation. In addition, it is specially stressed to learn from the experiences of Fukushima Nuclear Accident. Not only NPP siting shall be avoided from regions with high risk of extreme natural disaster, but the influence of low probability extreme event shall be fully considered in siting safety evaluation so that the design basis of NPP defending external event can be determined appropriately and conservatively.

– **Fortification of external event**

It proposes that for external event beyond the design basis, proper safety margin shall be taken into consideration in fortification (e.g. earthquake, flood, etc.); with stricter fortification measures adopted, so as to improve the capability of NPP resisting extreme external event, esp. extreme natural disaster.

It proposes that aseismic design of NPP shall have safety analysis of earthquake allowance or seismic probability conducted based on specific conditions. Seismic oscillation level of safe shutdown determined by design basis of newly-built NPPs shall be no lower than 0.3 g.

Based on the experiences of Fukushima Nuclear Accident, it proposes that the influences of extreme flood event and flood factors combination shall be fully considered for flood control design of NPP, and "Dry siting" shall be considered in flood control design as far as possible (field elevation higher than the design basis flood level with wave influence considered).

– **Prevention and mitigation of severe accident**

It puts forward to adopt adequate prevention and mitigation measures for severe accident and keep balance between them. It also clarifies to adopt specific measures to cope with plant blackout (emergency power supply), high-pressure core melting, large-volume hydrogen explosion, molten core-concrete interactions (MCCI), containment bypass, etc. in terms of design,

– **Application of mature technology**

It proposes to apply the most advanced mature nuclear power technology in the world, and perform sufficient experimental verification on new technology to reach the specified safety index before applying in NPP design.

- **Core safety design**

It proposes the requirements of further improving core safety characteristics, mainly involving: diversified safe shutdown means, negative power reactivity coefficient; appropriate consideration of design safety margin for fuel assembly and fuel element; and preference to mature or validated fuel element. Newly developed fuel element shall pass sufficient experiments before formal adoption in NPP.

In order to guarantee appropriate safety margin of core and fuel assembly of NPP, it specifies that over 15% margin above limiting power parameters shall be reserved for newly designed core and fuel assembly.

- **Containment**

It proposes that containment design must guarantee its integrity under design basis conditions, improve the containment capability under severe accident, strengthen the ability of collecting radioactive substance leaking from containment, or make the radioactive substance leaking from containment be detained and decayed. Conditional failure rate of containment shall be no greater than 0.1.

- **Station blackout**

It states that "The possibility and troubleshooting measures of plant blackout must be considered in terms of design". Major countermeasures and technical means required: (1) at least configure two sets of portable power source and portable pump unit for each multi-reactor plant site based on stationary additional power source of original plant site; (2) in terms of off-site power source, the principle of "Strengthening the reliability of off-site power source, or considering appropriate compensation measures, and managing to improve the reliability of supply line from external power grid to NPP and giving priority to measures of recovering off-site power source" is clarified; (3) it specifies that "Real model analysis method shall be adopted to ensure

NPP can maintain continuous cooling of core without serious damage on core within 8 h after loss of off-site and on-site emergency AC power supply. NPP shall be equipped with corresponding power supply support system to ensure that no unacceptable large release accident occurs to NPP within 72 h after loss of off-site and on-site emergency AC power supply."

– **Large commercial aircraft crash**

In consideration of resisting large commercial aircraft impact, Safety Requirement puts forward that the effect of large commercial aircraft impact shall be considered in design of NPP with risks of large commercial aircraft impact.

– **Reliability requirement on system and equipment**

It proposes that probability safety analysis shall be adopted to evaluate the reliability of safety-important structures, systems and components (SSC) as well as its contribution to and influence on reactor safety and CDF/LRF index, and identify the weak links of design to optimize design and improve SSC reliability, thus ensuring sufficient reliability of SSC in design stage.

– **Radiation protection management**

It further emphasizes to optimize the management control and acceptance criteria of radiation protection in operating condition within the whole service period of NPP (considering the influence of severe accident), raises requirements on environmental radiation monitoring, radioactive waste processing and minimal design, and absorbs the advanced indexes in GB6249 and GB18871. And these indexes shall be at internationally advanced level.

– **Others**

It fully considers and absorbs the improvement requirements proposed in General Technical Requirements on Improvement Actions of NPP after Fukushima Nuclear Accident, and lists the completion of General Technical Requirements on Improvement Actions of NPP after Fukushima Nuclear Accident as a must for newly-built nuclear power units.

20.3.2 Principle for preparing Safety Requirements

– Absorb the latest *Specific Safety Requirements for NPP Design* (SSR-2/1) of IAEA and the latest safety requirements of other countries based on format contents of HAF102;

– Cover the requirements concerning nuclear safety and characteristics of advanced technology in User Requirements Document (URD) and European Utility Requirements (EUR), and consider the requirements in *Safety of new NPP designs* (DRAFT 9) published by Western European Nuclear Regulators Association in October 2012, NRC Standard Review Plan (SRP), etc., thus in more compliance with the development of nuclear power technology in China.

– Fully consider the practical conditions of newly-built NPPs during the "Twelfth Five-year Plan" in China and allow the realization of safety requirements through various technical approaches and measures.

– Reflect the practical experience of long-term safety review and embody the solutions to common safety problems of NPPs in operation and under construction, and general technical requirements on safety improvement actions after Fukushima Nuclear Accident.

Safety Requirements shall be implemented by obedience for it supplements and extends relevant safety-important matters of newly-built NPPs during the "Twelfth Five-year Plan". As for those contents not involved in the Safety Requirements, provisions in current nuclear safety regulations shall be carried out as usual.

Appendix 1: The List of Nuclear Power Plants in China (by December 31, 2012)

NPP Name		Unit No.	Reactor Type	MW(e) Nominal Power MW (e)	Date of the Construction	Date of the First Connection to Grid	Date of Commercial Operation
Qinshan NPP		CN-01	PWR	310	1985-03-20	1991-12-15	1994-04-01
Daya Bay NPP	Unit 1	CN-02	PWR	2×983.8	1987-08-07	1993-08-31	1994-02-01
	Unit 2	CN-03			1988-04-07	1994-02-07	1994-05-06
Qinshan Phase II NPP	Unit 1	CN-04	PWR	4×650	1996-06-02	2002-02-06	2002-04-15
	Unit 2	CN-05			1997-04-01	2004-03-11	2004-05-03
	Unit 3	CN-14			2006-04-28	2010-08-01	2010-10-05
	Unit 4	CN-15			2007-01-28	2011-11-25	2011-12-30
LingAo NPP	Unit 1	CN-06	PWR	2×990.3 2×1080	1997-05-15	2002-02-26	2002-05-28
	Unit 2	CN-07			1997-11-28	2002-09-14	2003-01-08
	Unit 3	CN-12			2005-12-15	2010-07-15	2010-09-20
	Unit 4	CN-13			2006-06-15	2011-05-03	2011-08-07
Third Qinshan NPP	Unit 1	CN-08	HWR	2×700	1998-06-08	2002-11-19	2002-12-31
	Unit 2	CN-09			1998-09-25	2003-06-12	2003-07-24
Tianwan NPP	Unit 1	CN-10	PWR	3×1060	1999-10-20	2006-05-12	2007-05-17
	Unit 2	CN-11			2000-09-20	2007-05-14	2007-08-16
	Unit 3	CN-45			2012-12-27		
Hongyanhe NPP	Unit 1	CN-16	PWR	4×1080	2007-08-18		
	Unit 2	CN-17			2008-03-28		
	Unit 3	CN-26			2009-03-07		
	Unit 4	CN-27			2009-08-15		
Ningde NPP	Unit 1	CN-18	PWR	4×1080	2008-02-18	2012-12-28	
	Unit 2	CN-19			2008-11-12		
	Unit 3	CN-34			2010-01-08		
	Unit 4	CN-35			2010-09-29		

Fuqing NPP	Unit 1 Unit 2 Unit 3 Unit 4	CN-20 CN-21 CN-42 CN-43	PWR	4×1080	2008-11-21 2009-06-17 2010-12-31 2012-11-17		
Yangjiang NPP	Unit 1 Unit 2 Unit 3 Unit 4	CN-22 CN-23 CN-40 CN-41	PWR	4×1080	2008-12-16 2009-06-04 2010-11-15 2012-11-17		
Extension Project of Qinshan NPP(Fangjiashan Nuclear Power Project)	Unit 1 Unit 2	CN-24 CN-25	PWR	2×1080	2008-12-26 2009-07-17		
Sanmen NPP	Unit 1 Unit 2	CN-28 CN-29	PWR	2×1250	2009-03-29 2009-12-17		
Haiyang NPP	Unit 1 Unit 2	CN-30 CN-31	PWR	2×1250	2009-09-24 2010-06-20		
Taishan NPP	Unit 1 Unit 2	CN-32 CN-33	PWR	2×1750	2009-11-18 2010-04-15		
Changjiang NPP	Unit 1 Unit 2	CN-36 CN-37	PWR	2×650	2010-04-25 2010-11-21		
Fangchenggang NPP	Unit 1 Unit 2	CN-38 CN-39	PWR	2×1080	2010-07-30 2010-12-23		
Shidao Bay NPP	Demonstration Project	CN-44	Graphite pebble bed High-temperature gas-cooled reactor	211	2012-12-09		

Appendix 2: WANO Performance Indicators of Operational Units in China (from 2010 to 2012)

*Table 1 **WANO** Performance Indicators of Operational Units (2010)*

No.	Item (unit) \ Year / Unit		2010									
			Qinshan NPP CN1	Daya Bay NPP		Qinshan Phase II NPP		LingAo NPP		Third Qinshan NPP		Tianwan NPP	
				CN2	CN3	CN4	CN5	CN6	CN7	CN8	CN9	CN10	CN11
1	Unit Capability Factor (%)		83.35	89.08	92.80	91.70	86.64	93.71	91.12	89.73	92.07	87.02	82.28
2	Unplanned Capability Loss Factor (%)		6.02	1.61	0.01	0.19	0.37	0.16	0.35	0.02	1.81	0.00	0.08
3	Automatic Scrams per 7,000 Hours Critical (Times)		0.94	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00
4	Collective Radiation Exposure (man•Sv)		0.401	0.556	0.391	0.220	0.220	0.519	0.407	0.363	0.363	0.213	0.213
5	Safety System performance	High-Pressure Safety Injection System	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0293	0.0000	0.0000
		Auxiliary Feed-Water System	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Emergency AC Supply System	0.0000	0.0000		0.0001		0.0000		0.0018		0.0000	
6	Fuel Reliability (Bq/g)		0.037	0.037	11.923	0.037	0.037	0.037	8.570	0.037	0.037	0.037	0.037
7	Chemistry Performance		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	Industrial Safety Accident Rate		0.00	0.099		0.00		0.00		0.00		0.00	
9	Forced Loss Rate (%)		0.45	0.00	0.01	0.21	0.43	0.17	0.38	0.03	1.93	0.00	0.09

10	Grid Related Loss Factor (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Contractor Industrial Safety Accident Rate	0.00	0.00		0.00		0.00		0.07		0.00	

Table 2 WANO Performance Indicators of Operational Units (2011)

No.	Item (unit) \ Year / Unit	2011													
		Qinshan NPP CN1	Daya Bay NPP		Qinshan Phase II NPP			LingAo NPP				Third Qinshan NPP		Tianwan NPP	
			CN2	CN3	CN4	CN5	CN14	CN6	CN7	CN12	CN13	CN8	CN9	CN10	CN11
1	Unit Capability Factor (%)	88.04	99.98	86.56	73.71	90.95	81.60	91.39	94.05	72.06	99.58	92.53	91.02	86.55	87.05
2	Unplanned Capability Loss Factor (%)	1.20	0.00	2.55	3.97	0.00	0.16	0.00	0.02	6.97	0.34	1.85	0.00	0.06	0.00
3	Automatic Scrams per 7,000 Hours Critical (Times)	0.00	0.00	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Collective Radiation Exposure (man•Sv)	0.421	0.060	0.933	0.389	0.389	0.439	0.859	0.534	0.740	0.007	0.411	0.421	0.302	0.302
5	Safety System performance: High-Pressure Safety Injection System	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0006	0.0000	0.0000
	Safety System performance: Auxiliary Feed-Water System	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Safety System performance: Emergency AC Supply System	0.0000	0.0000		0.0005		0.0443	0.0000		0.0002		0.0021		0.0000	
6	Fuel Reliability (Bq/g)	0.037	0.037	40.677	0.037	0.037	0.037	10.791	1.683	0.037	27.101	0.037	0.037	0.728	0.037
7	Chemistry Performance	1.00	1.00	1.00	1.01	1.00	1.05	1.00	1.00	1.31	1.92	1.00	1.00	1.00	1.00
8	Industrial Safety Accident Rate	0.00	0.00		0.00		0.00	0.12		0.00		0.00		0.00	
9	Forced Loss Rate (%)	0.41	0.00	0.00	2.88	0.00	0.20	0.00	0.02	6.88	0.34	1.96	0.00	0.07	0.00
10	Grid Related Loss Factor	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	(%)														
11	Contractor Industrial Safety Accident Rate	0.17	0.00		0.00		0.00	0.00		0.21		0.00		0.00	

Table 3 WANO Performance Indicators of Operational Units (2012)

No.	Item (unit) \ Year / Unit		2012															
			Qinshan NPP CN1	Daya Bay NPP		Qinshan Phase II NPP				LingAo NPP				Third Qinshan NPP		Tianwan NPP	
				CN2	CN3	CN4	CN5	CN14	CN15	CN6	CN7	CN12	CN13	CN8	CN9	CN10	CN11
1	Unit Capability Factor (%)		99.94	83.94	99.97	85.24	79.68	90.10	95.81	93.59	91.25	88.45	80.60	96.26	90.46	86.78	87.78
2	Unplanned Capability Loss Factor (%)		0.02	1.35	0.00	0.00	8.96	0.44	0.04	0.01	0.00	0.98	0.01	0.33	0.02	0.00	0.00
3	Automatic Scrams per 7,000 Hours Critical (Times)		0.00	0.00	0.00	0.00	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Collective Radiation Exposure (man•Sv)		0.038	1.161	0.074	0.531	0.531	0.084	0.084	0.468	0.479	0.284	0.645	0.233	0.456	0.507	0.507
5	Safety System performance	High-Pressure Safety Injection System	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Auxiliary Feed-Water System	0.0000	0.0000	0.0000	0.0000	0.0003	0.0004	0.0001	0.0004	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000
		Emergency AC Supply System	0.0002	0.0002		0.0003		0.0047		0.0000		0.0000		0.0005		0.0000	
6	Fuel Reliability (Bq/g)		0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.238	0.037	0.037	0.037	0.037
7	Chemistry Performance		1.00	1.00	1.00	1.00	1.00	1.00	1.26	1.00	1.00	1.01	1.21	1.00	1.00	1.00	1.00
8	Industrial Safety Accident Rate		0.00	0.119		0.00		0.00		0.000		0.000		0.90		0.00	

9	Forced Loss Rate (%)	0.02	0.14	0.00	0.00	10.10	0.49	0.04	0.01	0.00	1.10	0.02	0.34	0.03	0.00	0.00
10	Grid Related Loss Factor (%)	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.01	0.00	0.00	0.00	0.00
11	Contractor Industrial Safety Accident Rate	0.00	0.00		0.00		0.00		0.117		0.00		0.00		0.00	

Appendix 3: Laws, Regulations and Rules of China on Nuclear Safety

(By the end of December 31, 2012)

I. National Laws

1. Constitution of the People's Republic of China

(Promulgated in the Fifth Meeting of the Fifth National People's Congress, December 4, 1982, and amended in accordance with the amendments to the Constitution of the People's Republic of China adopted at the Second Session of the 10th National People's Congress on March 14, 2004)

2. Laws on the Environment Protection of the People's Republic of China

(Issued by the Standing Committee of the National People's Congress, on December 26, 1989)

3. Act of Prevention and Treatment on Occupational Diseases of the People's Republic of China

(Promulgated in the Twenty-fourth Meeting of the Standing Committee, the Ninth National People's Congress of the People's Republic of China, on October 27, 2001; and amended in the Twenty-fourth Meeting of the Standing Committee, the Eleventh National People's Congress of the People's Republic of China, on December 31, 2011)

4. Law on Environmental Impact Assessment of the People's Republic of China

(Promulgated in the Thirtieth Meeting of the Standing Committee, the Ninth National People's Congress of the People's Republic of China, on October 28, 2002)

5. Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China

(Promulgated in the Third Meeting of the Standing Committee of the Tenth National People's Congress of the People's Republic of China, on June 28, 2003)

II. Decrees of the State Council

1. Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China (HAF001)

(Promulgated by the State Council on October 29, 1986)

2. Regulations on Nuclear Materials Control of the People's Republic of China (HAF501)

(Promulgated by the State Council on June15, 1987)

3. Regulations on the Emergency Management for Nuclear Accidents of Nuclear Power Plan (HAF002)

(Promulgated by the State Council on August 4, 1993)

4. Regulations on the safety Regulation for Civilian Nuclear Safety Equipment

(Promulgated by the State Council on July 11, 2007)

5. Regulations on the Safe Transportation of Radioactive Material

(Promulgated by the State Council on September 14, 2009)

6. Regulations for the Safety Management of Radioactive Waste (Promulgated by the State Council on December 20, 2011)

7. Regulations on the Safety and Protection of Radioisotopes and Radiation Devices (Promulgated by the State Council on September 14, 2005)

8. Regulations of the People's Republic of China on Nuclear Export Control (Promulgated by the State Council on September 10, 1997)

9. Regulations of the People's Republic of China for Export Control on Nuclear Dual-purpose Goods and Related Technologies (Promulgated by the State Council on June 10, 1998)

III. Department Rules

1. Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China.

— Part One: Application and Issuance of Safety License for Nuclear Power Plant (HAF001/01)

(Issued by NNSA on December 31, 1993)

2. Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China — Part One

Appendix one: Issuance and Management Procedures for Operator License of NPP (HAF001/01/01)

(Issued by NNSA on December 31, 1993)

3. Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China.

— Part Two: Safety Surveillance of Nuclear Installations (HAF001/02)

(Issued by NNSA on June 14, 1995)

4. Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China—Part Two

Appendix One: The Reporting System for Operating Organization of

Nuclear Power Plant (HAF001/02/01)

(Issued by NNSA on June 14, 1995)

5. Rules for the Implementation of Regulations on Emergency Management of Nuclear Accident for Nuclear Power Plant

— Part One: Emergency Preparedness and Response for Operating Organization of Nuclear Power Plant (HAF002/01)

(Issued by NNSA on May 12, 1998)

6. Code on the Safety of Nuclear Power Plant Quality Assurance (HAF003)

(No. 1 Decree, Promulgated by NNSA on July 27, 1991)

7. Code on the Safety of Nuclear Power Plant Sitting (HAF101)

(No. 1 Decree, Promulgated by the NNSA on July 27, 1991)

8. Code on the Safety of Nuclear Power Plant Design (HAF102)

(Promulgated by NNSA on April 18, 2004)

9. Code on the Safety of Nuclear Power Plant Operation (HAF103)

(Promulgated by NNSA on April 18, 2004)

10. Code on the Safety of Nuclear Power Plant Operation

Appendix One: Management of Refueling, Modifications and Accidental Shutdown of Nuclear Power Plant (HAF103/01)

(Issued by NNSA on March 2, 1994)

11. Code on the Safety of Civilian Nuclear Fuel Cycle Installations (HAF301)

(No.3 Decree, promulgated by NNSA on June 17, 1993)

12. Code on the Safety Regulation for Radioactive Waste (HAF401)

(Promulgated by NNSA on November 5, 1997)

13. Rules for the Implementation on Regulations on Nuclear Materials Control of the People's Republic of China (HAF501/01)

(Promulgated by NNSA, the Ministry of Energy and Commission of Science, Technology and Industry for National Defence on September 25, 1990)

14. Rules on Civilian Nuclear Safety Equipment in Design, Manufacture, Installation and Non-destructive Testing (HAF601)

(Promulgated by the State Environmental Protection Administration (NNSA) on December 28, 2007)

15. Rules for Qualification Management on Non-destructive Testing Personnel of Civilian Nuclear Safety Equipment (HAF602)

(Promulgated by the State Environmental Protection Administration (NNSA) on December 28, 2007)

16. Rules for Management of Qualification Management on Welder and Welding Operator of Civilian Nuclear Safety Equipment

(Promulgated by the State Environmental Protection Administration (NNSA) on December 28, 2007)

17. Rules on the Safety Regulation for Imported Civilian Nuclear Safety Equipment (HAF604)

(Promulgated by the State Environmental Protection Administration (NNSA) on December 28, 2007)

18. Rules for the Implementation of Regulations on the Safety Regulation for Civilian Nuclear Installations—Part Two

Appendix Three: Reporting System of Fuel Cycle Facilities (HAF001/02/03-1995)

(Issued by NNSA on June14, 1995)

19. List of Classification Management for Environmental Impact Assessment on Construction (the Ministry of Environmental Protection Act 2)

(Issued on September 2, 2008)

20. The Measures for the Administration of Security License for Transportation of Radioactive Substances (HAF701-2010)

(Issued by NNSA on September 25, 2010)

21. The Measures for the Administration of Security License for Radioisotopes and Radiation Devices (HAF801-2008)

(Issued by NNSA on December 6, 2008)

22. The Measures for the Administration of Safety and Protection of Radioisotopes and Radiation Devices (HAF802-2011)

(Issued by NNSA on April 18, 2011)

23. The Measures for the Administration of Electromagnetic Radiation Environmental Protection

(Issued by NNSA in 1997)

Appendix 4: Licensed Reactor Operators and Senior Reactor Operators of Chinese NPPs in Commercial Operation (By Dec. 31, 2012)

Items \ Plant		Qinshan NPP (one unit)	Daya Bay Unit (two units)	Qinshan Phase II NPP (four units)	Ling Ao NPP (four units)	Third Qinshan NPP (two units)	Tian wan NPP (two units)	Ning de NPP	Hong yanhe NPP
Reactor Operators (RO)	Number of RO	15	52	73	97	61	45	113	130
Senior Reactor Operators (SRO)	Number of SRO	25	63	69	152	40	64	43	73

Appendix 5: Occupational Exposure of NPPs in China

NPP (Project) \ Item			Annual Man Average Effective Dose (mSv)	Annual Maximum Individual Effective Dose (mSv)	Annual Collective Effective Dose (man.Sv)	Normalized Collective Effective Dose (man.mSv/GWh)
Qinshan NPP	2010		0.265	4.814	0.401	0.172
	2011		0.282	5.106	0.421	0.169
	2012		0.041	3.681	0.038	0.013
Daya Bay NPP	2010		0.343	10.843	0.946	0.060
	2011		0.327	8.434	0.993	0.062
	2012		0.413	8.116	1.235	0.078
Qinshan Phase II NPP	2010		0.218	4.941	0.440	0.042
	2011	(Unit 1 and Unit 2)	0.328	7.998	0.777	0.081
		(Unit 3 and Unit 4)	0.146	5.549	0.439	0.093
	2012	(Unit 1 and Unit 2)	0.449	9.325	1.061	0.112
		(Unit 3 and Unit 4)	0.074	2.118	0.168	0.016
LingAo NPP	2010		0.334	9.905	0.925	0.058
	2011	(Unit 1 and Unit 2)	0.419	8.326	1.392	0.087
		(Unit 3 and Unit 4)	0.208	5.665	0.747	0.071
	2012	(Unit 1 and Unit 2)	0.297	6.059	0.947	0.060
		(Unit 3 and Unit 4)	0.286	6.644	0.929	0.059
Third QinshanNP	2010		0.329	5.430	0.727	0.064
	2011		0.361	14.637	0.832	0.072

P	2012	0.316	8.661	0.689	0.059
Tianwan NPP	2010	0.174	2.156	0.426	0.027
	2011	0.224	3.788	0.604	0.038
	2012	0.345	4.232	1.014	0.062

Appendix 6: List of Emergency Drill of Chinese NPPs (From 2010 to 2012)

Year	Plant	Type of Drill	Time(s)
2010	Qinshan Phase I NPP	Comprehensive drill	1
2010	Qinshan Phase II NPP	Comprehensive drill	1
2010	Qinshan Phase II NPP	Joint drill	1
2010	Third Qinshan NPP	Comprehensive drill	1
2010	Daya Bay NPP	Comprehensive drill	1
2010	Tianwan NPP	Comprehensive drill	1
2010	LingAo NPP	Comprehensive drill	1
2010	LingAo NPP	Joint drill	1
2011	Daya Bay NPP	Comprehensive drill	2
2012	Qinshan Phase I NPP	Comprehensive drill	1
2012	Tianwan NPP	Comprehensive drill	1
2012	Daya Bay NPP	Comprehensive drill	2
2012	Hongyanhe NPP	Comprehensive drill	1
2012	Hongyanhe NPP	Joint drill	1
2012	Ningde NPP	Comprehensive drill	1
2012	Ningde NPP	Joint drill	2

Note: According to the definitions in 9.2.2 of the "Emergency Preparedness and Emergency Response of Operating Organization of NPP" (HAD 002/01-2010) issued by NNSA on August 20, 2010, emergency drill includes single drill (exercise) and comprehensive drill of in-plant emergency organization as well as joint drill of off-site emergency organization, and the drill can be a part of the drill. Appendix 6 only records comprehensive drill and joint drills.

Appendix 7: Statistics of NPP Operational Events (From 2010 to 2012)

Plant \ INES Level		INES0			INES1			≥INES2		
		2010	2011	2012	2010	2011	2012	2010	2011	2012
Qinshan NPP	Unit 1	3	0	0	0	0	0	0	0	0
Guangdong Daya Bay NPP	Unit 1	1	0	1	1	0	0	0	0	0
	Unit 2	1	0	0	0	0	0	0	0	0
Qinshan Phase II NPP	Unit 1	0	1	0	0	0	0	0	0	0
	Unit 2	1	0	0	0	0	0	0	0	0
	Unit 3	7	2	3	0	0	0	0	0	0
	Unit 4	/	3	0	/	0	0	/	0	0
LingAo NPP	Unit 1	0	1	0	0	0	0	0	0	0
	Unit 2	1	0	1	0	0	0	0	0	0
	Unit 3	15	2	2	0	0	0	0	0	0
	Unit 4	/	7	2	/	0	0	/	0	0
Third Qinshan NPP	Unit 1	1	2	1	0	0	0	0	0	0
	Unit 2	0	2	1	1	0	0	0	0	0
Tianwan NPP	Unit 1	1	1	1	0	0	0	0	0	0
	Unit 2	1	0	1	0	0	0	0	0	0
Hongyanhe NPP	Unit 1			3			0			0
Ningde NPP	Unit 1			3			0			0
Total		32	21	19	2	0	0	0	0	0

Appendix 8: List of Domestic and Overseas Review Activities Received by Chinese NPPs (From 2010 to 2012)

No.	Time	Host Plant	Review Content	Review Organization
1.	2010.03.29-04.02	Third Qinshan NPP	WANO peer review follow-up	WANO
2.	2010.05.25-05.27	Qinshan Phase II NPP	Outage observation	China National Nuclear Corporation
3.	2010.06.19-06.25	Daya Bay Nuclear Power Base	Focus review on emergency preparedness	China Nuclear Energy Association
4.	2010.07.14-07.16	Qinshan NPP	R12 outage observation	China National Nuclear Corporation
5.	2010.07.31-08.05	Fuqing NPP	Focus review on safety management	China National Nuclear Corporation
6.	2010.08.07-08.13	Tianwan NPP	Operation review follow-up	China Nuclear Energy Association
7.	2010.09.07-09.24	Qinshan Phase II NPP	WANO Peer review and pre- start-up of Unit 1, Unit 2 and Unit 3	WANO
8.	2010.09.06-09.17	Tianwan NPP	WANO peer review	WANO
9.	2010.10.18-10.25	Tianwan NPP	Peer review on Unit 5 and Unit 6 of Extension Project before FCD	China Nuclear Energy Association
10.	2010.11.06-11.12	Qinshan NPP	Operation peer review follow-up	China Nuclear Energy Association
11.	2010.11.22-11.24	Third Qinshan NPP	Focus review of operating experience feedback	China National Nuclear Corporation
12.	2011.01.23-01.28	Ningde NPP	Comprehensive review	China Guangdong Nuclear Power Group
13.	2011.03.14-03.17	Tianwan NPP	T104 outage observation	China National Nuclear Corporation
14.	2011.03.17-03.18	Fuqing NPP	Focusreview on safety management follow-up	China National Nuclear Corporation
15.	2011.04.10-04.15	Hongyanhe NPP	Comprehensive review	China Guangdong Nuclear Power Group
16.	2011.05.15-05.20	Tianwan NPP	Peer review follow-up on Extension Project of Unit 5 and Unit 6 FCD	China Nuclear Energy Association
17.	2011.08.28-09.02	Qinshan NPP	Nuclear safety culture review	China National Nuclear Corporation
18.	2011.09.14-09.16	Hongyanhe NPP	Review of Unit 1 before cold test	China Guangdong Nuclear Power Group
19.	2011.11.07-11.10	Ningde NPP	Review of Unit 1 before	China Guangdong

			cold test	Nuclear Power Group
20.	2011.12.26-12.28	Hongyanhe NPP	Review of Unit 1 before hot test	China Guangdong Nuclear Power Group
21.	2011.12.05-12.16	Ningde NPP	Pre-startup peer review	WANO
22.	2012.02.06-02.23	Hongyanhe NPP Unit 1	Pre-OSART	IAEA
23.	2012.03.05-03.23	Six operating units of Daya Bay Nuclear Power Base	Joint peer review	WANO and China Nuclear Energy Association
24.	2012.03.19-03.23	Yangjiang NPP	Comprehensive review	China Guangdong Nuclear Power Group
25.	2012.03.25-03.29	Ningde NPP	Review of Unit 1 before hot test	China Guangdong Nuclear Power Group
26.	2012.05.28	Ningde NPP	Pre-startup peer review	WANO
27.	2012.05.29-06.08	Daya Bay NPP	Reviewof nuclear safety management, operation and radiation protection	China Guangdong Nuclear Power Group
28.	2012.07.01-07.06	Ningde NPP	Review of Unit 1 before fuel loading	China Guangdong Nuclear Power Group
29.	2012.07	Yangjiang Power Plant	Pre-startup Peer review and pre-visit	WANO
30.	2012.07.21-07.27	Tianwan NPP	Review of nuclear safety culture	China National Nuclear Corporation
31.	2012.07.23	Hongyanhe NPP	Review of Unit 1 before fuel loading	China Guangdong Nuclear Power Group
32.	2012.08.12-08.17	Fujian Fuqing NPP	Focus review on commissioning readiness	China National Nuclear Corporation
33.	2012.08.19-08.24	Fangjiashan Nuclear Power Project	Focus review on commissioning readiness	China National Nuclear Corporation
34.	2012.09.04-09.20	Qinshan NPP	WANO peer review	WANO
35.	2012.11.19-11.23	Tianwan NPP	WANO peer review follow-up	WANO

Annex 1: Implementation of "Plans of Nuclear Safety Action of IAEA"

Content	Implementation
Safety assessment upon accident of Fukushima I NPP of Tokyo Electric Power Company Making assessment for safety weakness of NPP according to lessons learned from the Fukushima accident up to now	− After the Fukushima accident, China responded actively to perform independent, comprehensive, in-depth and systematic inspection and evaluation on safety of Chinese NPPs in operation and under construction, put forward detailed requirements for improvement of safety and reformed and improved them by stages, thus improving safety level of nuclear power. − Comprehensive safety inspection on the Chinese NPPs took nuclear safety regulations during approval period of NPP, existing nuclear safety regulations and the latest international safety standards as well as lessons learned from the Fukushima accident as reference benchmark, and analyzed and assessed safety of the NPPs. Attention is mainly paid to 11 factors on three aspects, such as capability to resist extremely external events, prevention and mitigation against severe accidents, radiation monitoring and emergency preparedness and response, to be specific, including adequacy of the external event assessed, flood control plan and flood control capability, seismic plan and seismic capacity, effectiveness of quality assurance system, firefighting system, prevention and mitigation of various natural event superposed accidents, analysis and assessment of plant blackout accident, measures to prevent and mitigate severe accidents as well as reliability assessment, public propaganda and information disclosure, effectiveness of environment monitoring system and emergency system as well as other possible existing weaknesses.

	− In order to further improve nuclear safety level of Chinese NPPs, the MEP (NNSA) put forward improvement requirements to the NPPs in accordance with result of the comprehensive safety inspection. In order to normalize improvements of the NPPs, the NNSA developed the "General Technical Requirements for Improvements of NPPs after Fukushima Nuclear Accident" which served as a guiding document for follow-up improvements of the NPPs.
IAEA OSART Intensifying IAEA OSART to enable member countries to gain maximum benefit	− From July 19, 2010 to July 30, 2010, IAEA sent an assessment mission to conduct IRRS to China, which is the third assessment activity by IAEA aiming at effectiveness of nuclear and radiation safety surveillance in China. Assessment report was developed, suggestions and hopes for nuclear and radiation safety surveillance in China were put forward and gained good practice was concluded. − From 2010 to 2012, Chinese NPPs had undergone 7 times WANO peer review activities and once WANO peer review follow-up activity. The NPPs actively implemented improvement measures for the areas for improvement (AFI) found out during the peer review. WANO has planned to conduct a pre-startup peer review on Yangjiang NPP Unit 1 from April 14, 2013 to April 27, 2013, and had conducted training and pre-visit activities for on Yangjiang NPP pre-start-up peer review in April 2012 and July 2012; and WANO has planned to conduct WANO pre-start up peer review on Fangchenggang NPP Unit 1 in May 2014. When undergoing international peer review, Chinese NPPs developed domestic review activities at

	different fields actively at the same time.
Emergency preparedness and response Strengthening emergency preparedness and response	— Comprehensive safety inspection of Chinese NPPs has included the inspection on effectiveness of environment monitoring system and that of emergency system. — China is the contracting party of the "Convention on Early Notification of a Nuclear Accident" and "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", and the Chinese government implements obligations in accordance with the conventions. — China is planning to establish a national nuclear emergency response team and to establish rapid rescue force against nuclear accident in China National Nuclear Corporation and China Guangdong Nuclear Power Group respectively.
National regulatory body Strengthening effectiveness of the national regulatory body	— From July 19, 2010 to July 30, 2010, IAEA has sent review team to conduct IRRS to China, which is the third review by the IAEA aiming at effectiveness of nuclear and radiation safety surveillance in China. — The Chinese government is continually accelerating building nuclear safety surveillance and management capability through increasing fund investment, optimizing science & research system, developing international cooperation, intensifying regulatory team building and other measures. — In November 2011, the Department of Nuclear and Radiation Safety Supervision of the MEP is expanded from one to three with staff increased correspondingly, thus improving surveillance capability.

Operating organization Strengthening effectiveness of the operating organization in terms of nuclear safety	— From 2010 to 2012, Chinese NPPs had accepted WANO peer reviews for 7 times and one WANO peer review follow-up. The NPPs actively implemented improvement measures for the areas for improvement (AFI) found out during the peer assessment. WANO has planned to conduct peer review on Yangjiang NPP Unit 1 before start-up from April 14, 2013 to April 27, 2013, and had conducted training and advance visit activities for peer assessment on Yangjiang NPP before start-up in April 2012 and July 2012; and WANO has planned to conduct WANO peer assessment on Fangchenggang NPP Unit 1 before start-up in May 2014. When undergoing international peer assessment, the Chinese NPPs developed domestic assessment activities at different levels actively at the same time.
IAEA Safety Standard Reviewing and strengthening IAEA Safety Standard and intensifying implementation of the safety standard	— Since 1982, China has collected extensively and studied carefully the laws and regulations on nuclear safety used developed in nuclear power countries, consulted the nuclear safety codes and guides of the IAEA and established the Chinese nuclear safety regulation system step by step. — After the Fukushima accident, China actively participated in preparation of international nuclear safety standard, and developed a series of regulation optimization and perfecting works on the basis on in-depth analysis and experience Fukushima accident and in combination with the current situation of existing nuclear safety regulation system in China; and concluded 26 aspects of content to be considered during revision of China's nuclear regulations upon the in-depth analysis of Fukushima accident, mainly involving nuclear safety

	management system, safety of plant site, design safety, operation management and accident emergency. — In order to complete nuclear and radiation safety regulation system of China, the MEP (NNSA) organized systematic and in-depth analysis of 77 special topics of IAEA on the Fukushima accident, and performed gap analysis on requirements put forward by China for improvement of NPPs in operation and under construction as well as the existing domestic regulations. In addition, the MEP also put forward suggestions for relevant safety requirements of the IAEA as guidance for future nuclear safety legislation in China.
International legal framework Improving effectiveness of international legal framework	— China has acceded into "Convention on Early Notification of a Nuclear Accident", "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", "Convention on the Physical Protection of Nuclear Materials" and its amendments, "Convention on Nuclear Safety", "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" and other international conventions, and strictly implements the duties under these conventions.
Capability building Strengthening and maintaining capability building	– China is gradually revising and perfecting human resource guarantee program to create a talents education and training system with joint participation of the government, colleges, social training organizations and employers through intensifying training and perfecting training system. – China has planned to realize intensified and large-scale talents training through basic training conditions strengthening building.

	− The MEP (NNSA) developed Training Program for Nuclear Safety Regulatory Personnel, the National "12th Five-Year" and Medium-and-Long-Term Training Outline of Radiation Environment Monitoring, Emergency Training Program for Nuclear Safety Regulatory Personnel, etc. and determined basic requirements for training on the nuclear safety regulatory personnel as well as contents of training on nuclear safety regulatory personnel, thus gradually forming a multi-level and multi-mode nuclear and radiation safety training system.
Protecting human beings and the environment from ionizing radiation Protecting human beings and the environment from ionizing radiation after nuclear emergency	− China has issued and implemented the "Regulations on the Safe Transportation of Radioactive Material" and set management system from design, manufacture and use of radioactive substance container, transportation of radioactive substances and other links. − Further intensified building of national and provincial radiation environment monitoring capability. − Revised and implemented the new "Regulations for Environmental Radiation Protection of Nuclear Power Plant".
Communication and information spreading Improving transparency and effectiveness of communication and enhancing information spreading	− China is the contracting party of the "Convention on Early Notification of a Nuclear Accident" and "Convention on Assistance in the case of Nuclear Accident or Radiation Emergency", and the Chinese government implements obligations in accordance with the conventions. − During the Fukushima accident, the Chinese government department kept close contact with Japan, the United States, France and other international peers to communicate to share information and experience, and reported relevant information to IAEA.

Research and development Effectively utilizing research and development	− China encourages nuclear power-related enterprises to develop nuclear safety technical innovation and intensify development and utilization of new technology and new process. China supports basic capability building of scientific research unit of nuclear safety technology to create nuclear safety-related technical research and development platform through sufficient integration and utilization of the existing scientific research resources and major special channels. − Research on severe accident mechanism phenomenon and management guide was developed upon the national major special projects, some thermal and hydraulic test platforms used for safety verification will be established in the future for research on passive residual heat removal, gas actions inside containment, molten material actions under severe accident, retention of molten material, etc.; analysis on safety probability of NPP severe accidents was developed, safety goals of NPP were determined and model building and basic analysis and evaluation technology were grasped; researches on probability safety analysis method of external events (earthquake, flood, fire accident, strong wind, etc.) and relevant review methods were performed, and research on application of probability safety analysis in severe accidents was developed; methods and contents of level-II and level-II probability safety analyses were researched and studied to explore method, process and key technologies for probability safety analysis of spent fuel pool and post-treatment facilities; the nuclear safety management system mainly composed of operating organization, group company, competent

	departments of industry and nuclear safety as well as three-level emergency management system for NPP nuclear accidents composed of the national government, the provincial government and operating organization were initially formed through implementation of environment emergency capability building and other projects; research on minimization of radioactive waste was developed to prepare guide for radioactive waste minimization management, decommissioning of many miniature reactors and radiochemical laboratories has been completed, and a batch of medium and low radiation disposal facilities have been built, two medium and low radiation disposal sites have been put into operation, and construction of another medium and low radiation disposal site has been started. A series of uranium mine geological prospecting, decommissioning of mining and milling facilities as well as environmental improvement projects have been completed.Through international cooperation, China closely tracked and researched international experience and correct actions after the Fukushima accident and actively participated in research and preparation of international nuclear safety standard; China actively participated in the multi-national design evaluation plan (OECD); intensified information exchange and surveillance cooperation in terms of American AP1000, French EPR, Russian Pressurized Water Reactor VVER and other new types of NPPs among exporting countries. Through increasing fund investment, China actively developed cooperation with nuclear power developed countries on scientific research projects of nuclear power safety, and actively participated in peer review, experience exchange and international training in terms of nuclear power safety, including communication and

	discussion with IAEA, WANO and other international organizations as well as with the United States, France, Japan, Russia, South Korea and other countries (or regions). – China has planned to develop more international communication and cooperation with respect to international sharing of nuclear safety experience and capability, notification of nuclear accident information, system and mechanism of international cooperation on nuclear safety, etc. to promote continuous improvement of nuclear safety level.

Annex 2: Safety Improvement Actions of NPPs in China

Activity		Completion
Warning and response to external disaster		— Daya Bay NPP and LingAo NPP have signed meteorological disaster forecasting and early warning support agreement with meteorological bureau, have established earthquake information offer mechanism with Guangdong Seismological Bureau, have established technology service for tsunami warning information with the State Oceanic Administration, and will set up warning classification and in-plant early warning release mechanism in succession. — CNNO has established a mechanism for regular communication and exchange of information with units and departments like the East China Sea Forecast Center of the State Oceanic Administration, Jiaxing Weather Bureau, etc.
Assessment and improvement of anti-flooding capacity of important plants	Waterproof plugging for nuclear island facilities and plants, and provisional waterproof measures for important plants	— Each NPP has checked the waterproof plugging condition of doors, windows, vents, cable penetration and process pipe penetration one by one and has measured and reviewed the height difference between threshold of the plant and catchment point. Anti-flooding census for plant cold source, emergency power supply and water system has been completed, and provisional anti-flooding measures for the plant have been carried out onsite. Anti-flooding plugging for important plants has been completed.
	Improvement for flood control facilities of each NPP at Qinshan Nuclear Power Base	— Calculation of probably maximum typhoon waves on seawall frontier of each unit at Qinshan Nuclear Power Base and thematic analysis report on section model test have been completed based on the flood with design basis of 10.01 m. Calculation analysis and results of model test show that except Qinshan NPP, existing flood control (wave wall for

		seawall) facilities of Qinshan Phase II NPP and Third Qinshan NPP are stable, hence, there is no need to carry out improvement. Scheme for seawall heightening and external water retaining wall erection for Qinshan NPP has been reviewed and approved by the MEP (NNSA). On-site inspection before commencement has been completed and on-site construction has been begun.
	Erecting water retaining wall for Tianwan NPP	— Project approval has been completed, and project bidding is underway, of which construction is expected to be completed in 2013.
Earthquake response and assessment on earthquake resistance	Improving earthquake monitoring capacity and earthquake resistance response capacity	— Daya Bay NPP has completed the improvement for earthquake monitoring system of each NPP: adding OBE/SSE alarm for the main control room, which can make the operator in main control room respond quickly under earthquake condition. Simultaneously, in view of avoiding shutdown of reactor caused by false alarm, peak value of acceleration per second shall be delivered to the operator in main control room for reference. — Qinshan NPP has completed the preventative maintenance outline and maintenance procedure for the earthquake monitoring and recording system as well as assessment and upgrading of regular test procedure; upon the review, the reserve quota of spare parts for this system was improved and meets the requirements of safe operation. — Qinshan Phase II NPP has completed the optimization of preventative maintenance outline for earthquake monitoring instrument and revision of maintenance procedure, regular test procedure, alarm response procedure and emergency response regulation. — Third Qinshan NPP has passed the on-site verification and assessment, and the current configuration of power plant meets the needs. Simultaneously, emergency operation procedure (EOP) for common-mode earthquake event has been assessed and upgraded,

		and regular maintenance procedure "Seismic Monitoring System" for earthquake monitoring instrument has been upgraded. — Tianwan NPP is set with earthquake monitoring system and earthquake protection function, and has compiled accident regulations "Shutdown of Reactor Incurred by Earthquake".
	Developing seismic margin analysis and earthquake probability safety analysis	— Daya Bay Nuclear Power Base has investigated and surveyed the safety analysis on earthquake probability and seismic margin analysis and assessment for each NPP. Seismic margin assessment shows that NPP has a certain safety margin in respect of dealing with external event beyond design basis. On-site survey is planned to be performed next when overhaul of the unit is carried out. — Each NPP at Qinshan Nuclear Power Base has completed the report on seismic margin analysis and assessment. The report has passed the assessment and has been submitted to the MEP (NNSA) on time for examination. — Tianwan NPP has signed contract with Russia, and Russia is in charge of analysis for seismic margin of Tianwan NPP. Relevant professionals of Russia are carrying out on-site survey at Tianwan NPP.
Assessment on impact of earthquake and tsunami on NPP	Detailed assessment on impact of earthquake and tsunami on each NPP at Daya Bay Nuclear Power Base	— Detailed assessment on impact of earthquake and tsunami on each NPP at Daya Bay Nuclear Power Base has been completed.

	Multi-departmental joint analysis on impact of earthquake of distant origin (plate margin) on Chinese coastal NPP	— Accurate calculation results of Tianjin Port Engineering Institute Ltd. of CCCC First Harbor Engineering Company Ltd. show that: marine structures of each NPP at Daya Bay Nuclear Power Base are capable of withstanding impact of potential earthquake tsunami which will not affect the safe and stable operation of NPPs.
Monitoring and water supplement for spent fuel pool		— Each NPP at Daya Bay Nuclear Power Base has completed the formulation of water supplement scheme for spent fuel pool and the improvement of on-site water level monitoring under the working condition of outage of the whole plant. It is planned to further improve the monitoring on level of spent fuel pool, which involves setting an alarm in main control room, setting display in main control room or other locations, etc. — Each NPP at Qinshan Nuclear Power Base has confirmed or reviewed and upgraded the operation manual and emergency procedure for spent fuel pool, and has further defined the requirements for monitoring and control of temperature and liquid level of spent fuel in relevant regulations. — Tianwan NPP was originally designed with monitoring and water supplement functions for spent fuel pool. At present, water supplement system of spent fuel pool is being improved, and water supplement interface device for mobile pump is added. — Monitoring scheme for liquid level of spent fuel pool of phase I of Shandong Haiyang NPP has taken diversity and safe reliability into full account, thus liquid level information of spent fuel pool can be monitored normally without further protection after accidents.
Adding facilities like mobile power supply, mobile pump, etc.		— Mobile power supply device and mobile diesel pump have been added for each NPP at Daya Bay Nuclear Power Base. Another set of mobile power generation equipment will be

	added next, with load capacity ensuring monitoring and control of safety parameters, necessary communication, ventilation and lighting, and sealing of main pump and other temporary facilities. — Configuration scheme of mobile device in Qinshan Nuclear Base includes: 2 sets of 400 V mobile diesel power generation car (650 KW), 1 set of intermediate-pressure mobile diesel power generation car (about 1.800 KW) and 2 sets of mobile diesel pump ($65m^3$/hr,220m.H_2O), and also includes cables and pipes. — Purchase bidding for mobile diesel generator of Tianwan NPP has been completed, and the generator is being manufactured. Bidding for mobile diesel pump has been completed and the pump is also being manufactured. — 2 sets of mobile power supply and 2 sets of mobile pump will be added to Haiyang NPP, and detail design is underway.
Adding or improving hydrogen elimination system	— Improvement of hydrogen elimination system for Unit 1 of LingAo NPP has been completed; and passive hydrogen recombiner will be added in the following overhaul for Daya Bay NPP and Unit 2 of LingAo NPP. — Passive hydrogen elimination device has been added during construction and installation of Unit 3 and Unit 4 of Qinshan Phase II NPP. Passive hydrogen recombiner will be added during subsequent overhaul for Qinshan NPP, Unit 1 and Unit 2 of Qinshan Phase II NPP and Third Qinshan NPP. — Through assessment, AP1000 hydrogen monitoring system can monitor hydrogen concentration in containment reliably, and hydrogen control system can reduce the hydrogen concentration in containment effectively to prevent integrity of containment

	being threatened by hydrogen explosion, etc. Simultaneously, severe accident management guideline (SAMG) also covers monitoring and control measures for hydrogen, which meets the technical requirements for improvement of hydrogen monitoring and control system. Therefore, it is unnecessary to carry out improvement for hydrogen monitoring and control system.
Development or optimization of SAMG	— SAMG for the 6 units at Daya Bay NPP has been enabled. Availability demonstration for severe accidents management equipment of LingAo NPP Unit 3 and Unit 4 has been completed, and subsequently Daya Bay NPP and Unit 1 and Unit 2 of LingAo NPP will be demonstrated. — Compilation of SAMG for Qinshan NPP and Qinshan Phase II NPP has been finished. — Development of SAMG for power condition of Unit 1 and Unit 2 of Tianwan NPP has been completed, and corresponding modifications to original accident procedure and beyond design accident management guideline of the NPP are underway. — Guidance for severe accidents management has been developed by NPP under construction. SAMG will be perfected before loading, and each accident condition shall be taken into consideration, such as reactor shutdown condition.