THE PEOPLE'S REPUBLIC OF CHINA

THE FIFTH NATIONAL REPORT UNDER THE CONVENTION ON NUCLEAR SAFETY

May, 2010

Beijing

Contents

1. INTRODUCTION

The Chinese government has consistently attached high importance to nuclear safety, earnestly performed all obligations committed to international community, has 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.

The report compiled according to the "Convention on Nuclear Safety" and the "Guidelines Regarding National Reports under the Convention on Nuclear Safety", comprehensively and systematically expounded that during the fifth period of China's implementation of the "Convention on Nuclear Safety", Chinese government intensified its own nuclear safety and performed all obligations stipulated in the "Convention on Nuclear Safety" by adopting a series of measures. The report reflected major progress and changes in its relevant chapters based on changes and newly increased contents since the fourth implementation of the "Convention on Nuclear Safety". The first chapter of the report comprehensively set forth the status quo of China's peaceful utilization of nuclear energy, present-day policies and objectives of China's nuclear power development and nuclear safety policy. The chapters 2, 3, 4 and 5 are compiled according to the contents in articles 6-19 of the "Convention on Nuclear Safety". Chapter 6, combined with the problems universally concerned by the world during the fourth implementation of the "Convention on Nuclear Safety" and the status quo of China's nuclear power development, discoursed upon China's progress and planning on improvement of nuclear safety. Each chapter, beginning with original text of the "Convention on Nuclear Safety" and through reporting requirements of laws and regulations, important activities, specific practices and developments, expounded how Chinese government performed all obligations stipulated in the "Convention on Nuclear safety".

In the report, the data of nuclear power plants in Taiwan Province of China is left open for the time being.

1.1 General Situation of the Peaceful Utilization of Nuclear Energy in China

Through nearly 30 years' development, new progress of peacefully utilizing nuclear energy has been made in recent years. Presently, Chinese mainland has formed three major nuclear power bases, namely, Zhejiang Qinshan, Guangdong Daya Bay and Jiangsu Tianwan. In 2009, there were 11 units in commercial operation with installed capacity of 9.08GW, representing about 1.04% of total installed capacity in the country; annual nuclear electricity generated was 70.1 billion kwh, accounting for 1.89% of total electrical energy generated by the country. Up to Dec. 31, 2009, 20 units were under construction, among which from 2007 to 2009, construction permits for 18 units were newly issued. The construction and operation of nuclear power plants not only generated good social and

economic interests, but also made China accumulate valuable experiences on the aspects of nuclear power plant designing, equipment production, construction and operation management and laid a solid foundation for China's nuclear power's sustainable development.

Nowadays, China's peaceful utilization of nuclear power has entered the phase of fast development, a batch of new nuclear power projects have been under construction in succession in coastal areas; the layout of nuclear power construction is extending toward inlands from coastal areas. The conditions for serialized construction of the second generation improved pressurized water reactor has been mature. Meanwhile, China is also carrying on the introduction, absorption, assimilation and innovation of the third generation pressurized water reactor technology. Accompanying nuclear power development, research and development, engineering design and technology and capability of equipment manufacture have been greatly improved. In the aspects of siting, construction, commissioning and operation of nuclear power, China has accumulated a whole set of experience.

Chinese government has all the time persisted in the basic policy of "safety first", effectively coped with all sorts of challenges in the course of accelerating nuclear power development, ensured nuclear safety and actively pushed for sustainable development of China's nuclear power.

1.2 Policies and Objectives for Nuclear Power Development in China

In December 2007, Chinese government issued the white paper "China's Energy Resources Status and Policies", pointing out that China is the biggest developing country in today's world, and also is the developing country with speediest development. Fast development of Chinese economy and society not only enable more than one billion Chinese people to get rid of poverty, but also make important contribution to development and prosperity of the world.

It is inevitable that long-term fast development of Chinese economy and society will go with fast increase of energy resource consumption. Although the aggregate of Chinese energy resources is comparatively rich, the possession quantity per capita is low with uneven distribution, more taping difficulties and relatively low energy utilizing efficiency, and the energy resource consumption of taking coal as its main part puts more pressure on the country's environment. For this reason, Chinese government puts forward the strategy of energy resource development of "economical development, clean development and safe development", and adheres to the basic policy of strengthening foothold in the country and the national strategy of opening up to the outside world, ensures steady supply of energy resources by the way of steadily increasing energy resources at home, and promoted common development of energy resource in the world.

Nuclear energy is a kind of safe, clean and reliable energy resource. Actively developing

nuclear power and expediting development process of nuclear power are of significance on optimizing structure of energy resources in China, ensuring energy resource safety, protecting environment, coping with global climate change and boosting the capability of electro-mechanical equipment manufacture, and it is also the objective need and strategic requirement for coordinated development of energy resource, environment and economy. In September 2009, China pointed out at the summit meeting on climate change in the United Nations that one of measures taken by China in coping with climate change was vigorous development of renewable energy resources and nuclear energy, and China was striving for making the proportion of non-fossil energy resource in energy resource consumption reach 15% or so in 2020. In accordance with "Medium-term and Long-term Development Plan on Nuclear Power (2005-2020)", up to 2020, China's installed capacity of operating nuclear power plants will reach 40 million kilowatt.

In order to implement the basic policy of "actively advancing nuclear power construction" and the plan of developing nuclear power, China has quickened its nuclear power construction, and taken a series of measures from different aspects to ensure the realization of strategic objective on developing nuclear power. Its working emphases include:

(1) Perfecting nuclear power safety and security system and expediting the building up of laws, regulations and standards.

China adheres to the principle of "safety first", builds up and perfects the system of laws, regulations and standards about nuclear and radiation safety, expedites the building process of nuclear power legal system and standardization.

(2) Intensifying surveillance of nuclear power safety and improving regulation efficiency.

China strengthens enforcement of laws and regulation of nuclear safety, intensifies capability building of regulatory team, does well events analysis and experience feedback, builds up performance indicators of operating safety to comprehensively assess safety status of operating nuclear power plants, and actively advances the building up of nuclear safety culture and studies of nuclear safety.

(3) Strengthening nuclear power construction of and operating management , and ensuring effective operation of management system

China Strengthens the building of nuclear power's standard system and emergency preparedness system, develops the study of momentous technology projects, intensifies research and development of equipment, advances the process of nuclear power self-reliance and equipment localization, builds up and perfects the system of nuclear power construction and operating management, strictly carries out management and regulation, and ensures effective operating of management system.

(4) Strengthening the building up of nuclear power technical support and service system, and quickening the cultivation of talents related to nuclear power.

China strives for building up and perfecting nuclear power specialized technical support and service system, setting up steady and effective mechanism of research and development for science and technology, strengthening cooperation, highlighting its working emphases, comprehensively boosting capability and level of technical support and service, and intensifying multi-channel and multi-level cultivation of all sorts of talents related to nuclear power to provide important support for safe, steady, reliable and economical NPPs construction and operation.

(5) Intensifying international exchange and cooperation in the field of nuclear power.

China supports and strictly performs the existing international convention on nuclear safety and relevant resolutions made by the Security Council of the United Nations. China attaches importance to and actively participates in international cooperation of nuclear safety, actively provides assistance of nuclear safety for developing countries, and internationally strengthens bilateral and multilateral exchange and cooperation of nuclear safety. Thus, China is playing an increasingly important role in global and regional nuclear safety cooperation.

1.3 Nuclear Safety Policy in China

The Chinese government consistently attaches high importance to nuclear safety. The Chinese government promulgated the "Regulations on the Safety Regulation for Civilian Nuclear Installations of the People's Republic of China" in 1986. The regulations prescribe that the policy of "Safety First" should be followed in the phases of siting, design, construction, operation and decommissioning of civilian nuclear power plants. It also indicated that sufficient measures should be taken to ensure quality and safety operation, prevent nuclear events and minimize potential adverse impacts, and protect the staff, the public and the environment from excessive exposure and contamination beyond the national limits, that is, exposure and contamination should be reduced to a level of as low as reasonably achievable(ALARA).

In October 2003, the Chinese government enacted and implemented the "Act of Prevention and Remedy of Radioactive Contamination of the People's Republic of China" to bring radioactive contamination prevention and control into a law-based regulation. Meanwhile, the Chinese government promulgated additional nuclear safety regulations in succession to clearly define the responsibilities of governmental departments and operating organizations, made duly revisions and improvements of regulation and standard system of NPP safety to keep consistent with the international nuclear safety standard.

According to the laws and regulations, the Ministry of Environmental Protection (the National Nuclear Safety Administration (MEP/NNSA)) is in charge of independent regulation on nuclear safety of civilian nuclear installations, and the operating organizations as licensee is comprehensively responsible for safe operation of the NPPs. The responsibility of nuclear and radiation safety is ultimately undertaken by the principal

unit engaging in nuclear activities and this responsibility will not be mitigated and transferred due to design, manufacture, construction and supervisors' activity and responsibility. The units in charge of design, manufacture and construction also undertakes corresponding responsibilities of nuclear and radiation safety within their respective working scopes.

The Chinese government always sticks to basic policy of "safety first", implements the system of veto by a dissenting vote in the work such as siting, choosing of technical paths, market access, nuclear power construction, operating management, etc., sticks to strict management according to laws and regulations, strictly implements the principle of defense-in-depth and the nuclear activity licensing system, pays attention to all particulars and conservatively makes decisions. Under new situation of quickly developing nuclear power, we will further carry forward culture of nuclear safety.

Since developing nuclear power, China has established an applicable code and standard system of nuclear power safety and the management and regulation mechanism of nuclear power safety basically suitable to the country's situation; fully absorbed and learnt experiences of nuclear power developing from the outside world, introduced mature technologies and advanced reactor type, made further optimization and improvement, and constantly improved capability and level of preventing nuclear event by relying on advancement of science and technology. China has established relatively complete rules and regulations for nuclear power enterprises, and constantly perfected the quality assurance system of nuclear power safety; adopted effective measures to ensure the safety of nuclear materials and facilities and broadly advanced popularization of nuclear safety culture in the whole industry.

Since put into commercial operation, China's nuclear power units has always maintained favorable record of safe operation, made contribution to social development and also laid solid foundation for fast development of nuclear power. The Chinese government attaches high importance to China's nuclear safety and always made surveillance of nuclear safety synchronous to development of nuclear power.

1.4 Summary on the fourth Implementation of Convention

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

In August 2007, China has submitted the 4th national report of the PRC under the "Convention on Nuclear Safety" to the review meeting, and in the meantime, seriously

answered all written questions raised to China by other contracting parties

The comments on China's National Report reviewed in the fourth review meeting of the "Convention on Nuclear Safety" held in Vienna in April 2008 are made as follows:

China's National Report, the presentation on the spot and Chinese afore-hand written responses to 188 questions raised by other contracting parties have been fully reviewed. Representatives of contracting parties present in the conference discussed the practices related to China's nuclear safety surveillance and management. All contracting parties thought that China has the following good practices:

(1) Using of trend analysis of safety performance indicators including WANO indicators and site specific indicators to assess safety culture, annual seminars were held to compare safety culture indicators and experiences and to indentify relative weaknesses among the NPP organizations for the improvement.

(2) Using of International Atomic Energy Agency(IAEA) Safety Standard for provision of safety level that takes into account the best internationally agreed development in the field of nuclear safety.

(3) Standardization of construction practices in large nuclear plan I is conducive to further improving quality and efficiency of construction.

(4) NPP's imported from foreign countries should satisfy the requirements of nuclear safety regulation of China and Vendor's country.

The review meeting pointed out the challenges China was facing and the fields China needed to improve, and paid attention to activities planned by the Chinese government in the side of improving safety, including:

(1) Further development of nuclear safety regulations and guides;

(2) Further enhancement of regulatory capabilities and practices;

(3) Further enhancement in emergency response;

(4) Further enhancement of development of methods and utilization of Probabilistic Safety Assessment (PSA);

(5) Further enhancement of training practices;

(6) Further enhancement of technical improvements in NPP's;

(7) Development of ageing management methods and practices.

The Chinese government attaches high importance to the commitments on the obligations in the "Convention on Nuclear Safety" In review meeting, China learned the advanced experience on nuclear safety surveillance and management from other contracting parties and found our deficiencies to be improved. China actively takes measures to resolve the issues mentioned on the review meeting, so as to make all Chinese

NPPs achieve and keep high-level nuclear safety, and in this national report, expounds its attitudes and views about relevant questions.

1.5 Themes of the Report

This report is prepared according to the requirements specified in the "Convention on Nuclear Safety" and the "Guidelines Regarding National Report under the Convention on Nuclear Safety". It described synthetically and systematically the situation on performing obligations in the "Convention on Nuclear Safety" before December 2009. The report also outlined Chinese important activities in the domain of nuclear safety and the progress on the side of nuclear safety's surveillance and management since the fourth review meeting of the "Convention on Nuclear Safety".

2. 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.

2.1 List of Existing Nuclear Power Plants

Up to Dec. 31, 2009, there were 11 units in commercial operation and 20 units under construction in China. Cumulatively, construction permits of 18 units had newly been issued within the three years from 2007 to 2009. The list of existing nuclear power plants is shown in Annex 1. The distribution of China's NPPs is shown in Figure 1.

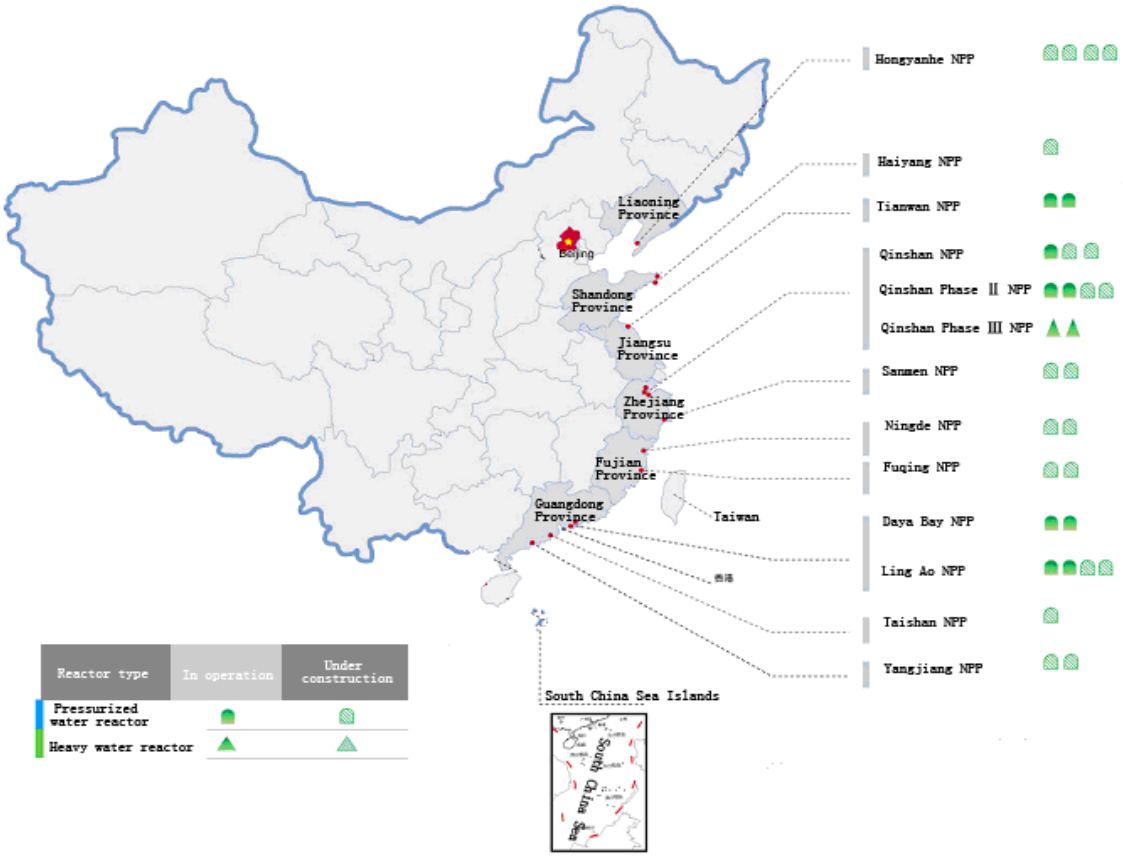

Figure 1. China's NPPs distribution

2.2 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).

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

Among 20 units being under construction at the present time in China, 16 units adopted the second generation improved standardized nuclear power unit, 3 units adopted AP1000 technology and 1 unit adopted EPR technology. Qinshan Phase Ⅱ NPP Unit 3 and Unit 4, LingAo NPP Unit 3 and Unit 4, Hongyanhe NPP Unit 1, Unit 2, Unit 3 and Unit 4, Ningde NPP Unit 1 and Unit 2, Yangjiang NPP Unit 1 and Unit 2, Fuqing NPP Unit 1 and Unit 2 and Extension Project of Qinshan NPP (Fangjiashan nuclear power project) Unit 1 and Unit 2 all adopted the second generation improved standardized nuclear power unit. These units were designed on the basis of some 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 adopted AP1000 technology. Taishan NPP Unit 1 took the path of EPR technology.

2.3 Performance Indicators and Trend

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 World Association of Nuclear Operators (WANO), etc. at their request. The WANO performance indicators of all operating NPPs in China from 2007 to 2009 are listed in Annex 2, these data presented a good macro trend within three years, some of performance indicators in Annex 2 have ranked best quartile in all WANO nuclear power units.

2.4 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.

Effective guarantee for safety of operating NPPs in China is mainly reflected in the following aspects:

(1) Licensed operating incidents or accidents at INES level-2 or above didn't occur in China's NPPs;

(2) The barriers of safety and security for Defense-in-Depth meets requirement of integrity.

(3) Occupational exposure dose of NPPs is far below the national regulatory limits;

(4) Annual discharge volume of radioactive effluents of the NPPs is far lower than the state regulatory limits. No discharges beyond the set standard for radioactive effluents happened in China.

(5) Adverse impacts on the environment due to the NPPs' commercial operations are not discovered.

China effectively controlled safety and quality of units under construction. In the process of siting, design, construction and commissioning for the units under construction, all activities related to nuclear safety are all under control. Effective surveillance and reviews are performed by the MEP (NNSA) according to the requirements in the related nuclear safety laws and regulations in China, and played an important role in ensuring construction quality and nuclear safety.

3. LEGISLATION AND REGULATION

3.1 Structure of 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.

3.1.1 General Description of Nuclear safety Laws, Codes and Guides

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.

Many units have been put into operation in China. The corresponding experience on safety operation of NPPs has been accumulated. According to the experience combined with the newest requirements of international nuclear industry, China continually improves its nuclear safety laws and codes.

The system of laws, regulations and guides on nuclear safety of china consists of laws, administrative regulations, department rules, guiding documents and reference documents. The state laws, which have higher legal effects than administrative regulations and department rules, are enacted by the National People's Congress and its Standing Committee. Administrative regulations, which have legal binding effects, are promulgated by the State Council according to the Constitution and laws. Department rules are promulgated by the related governmental departments within their purview according to the laws and the administrative regulations of the State Council and have legal binding effects.

(1) Laws

The existing state laws applicable to nuclear safety field are "Constitution of the People's Republic of China", "Environmental Protection Act of the People's Republic of China", "Act of Prevention and Remedy of Radioactive Contamination of the People's Republic of China", "Law on Environmental Impact Assessment of the People's Republic

of China" and "Act of Prevention and Treatment on Occupational Diseases of the People's Republic of China".

(2) Administrative regulations of the State Council

The existing administrative regulations applicable to nuclear safety field are "Regulations on the Safety Regulation for Civilian Nuclear Safety Installations of the People's Republic of China", "Regulations on Nuclear Materials Control of the People's Republic of China", "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant", "Regulations for the Safe Transport of Radioactive Material" and "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment". They 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 detailed rules are departmental rules which stipulate specific implementing measures according to these regulations on nuclear safety Management.

Nuclear Safety Codes are department rules enacting nuclear safety objectives and basic safety requirements.

(4) Guiding documents

Nuclear safety guides 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 power plant.

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

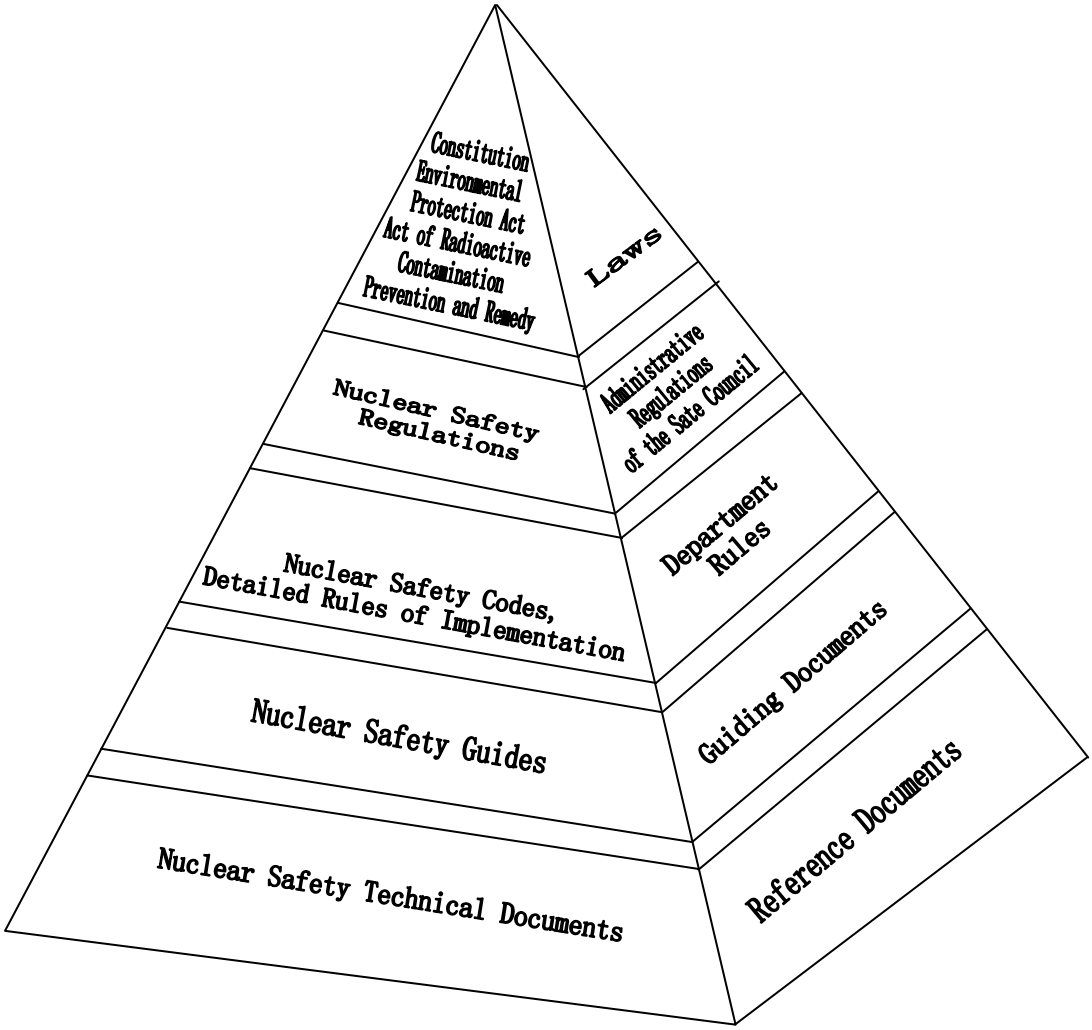

Figure2. The hierarchical structure of laws, regulations and guides on nuclear safety of China

3.1.2 Issued Laws, Regulations and Guides

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 enacts 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 "Act of Prevention and Treatment on Occupational Diseases of the People's Republic of China" was approved by the Standing Committee of the National People's Congress in 2001. 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. The 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 NNPs 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 for the Safe Transport of Radioactive Material".

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 Annex 3.

3.1.3 Newly Issued Laws, Regulations and Guides on Nuclear Safety

Since the Fourth Review Meeting of "The Convention on Nuclear Safety", China has promulgated a series of new laws, regulations and guides, the related activities are as

follows:

In July 2007, the State Council promulgated the "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment" In September, 2009, the State Council promulgated the "Regulations for the Safe Transport of Radioactive Material". As supporting legal documents of the "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment", such codes as the "Rules on Civilian Nuclear Safety Equipment in Design, Manufacture, Installation and Non-destructive Testing" and "Rules for Qualification Management on Non-destructive Testing Personnel of Civilian Nuclear Safety Equipment", "Rules for Qualification Management on Welder and Welding Operator of Civilian Nuclear Safety Equipment" and "Rules on the Safety Regulation for Imported Civilian Nuclear Safety Equipment" were promulgated in the form of department rules in December, 2007 and put in force from January 1, 2008. The nuclear safety guides like "Access Control of Nuclear Installations" and "Nuclear Material Accounting of Nuclear Power Plants" also were promulgated in succession.

Furthermore, some departments also enacted in succession such as the "Management Methods for Occupational Health of Radioactive Workers", etc.

According to the status quo and demand of nuclear power development, China has been making further formulation, revision and perfection of nuclear safety regulations. The MEP (NNSA) formulated "Five-year Plan of Laws and Regulations on Nuclear and Radiating Safety (From 2010 to 2015)".

3.2 Regulatory Body

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.**

3.2.1 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.

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 carries out nuclear activities in conformity with legal provisions.

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.

3.2.2 Duties and Organization Structure of Nuclear Safety Regulatory Bodies and Ministry of Health

The MEP (NNSA) and the Ministry of Health are responsible for surveillance on the nuclear safety of NPPs, environmental protection, the radiation dose of the site personnel and the general public, and hygienic and health conditions, respectively.

3.2.2.1 Duties and Responsibilities of the MEP (NNSA)

(1) To organize drafting and formulating regulations related to the safety of NPPs and to review technical standards of nuclear safety;

(2) To organize review and assessment of both the safety performances of NPPs and the capability of the operating organizations to ensure safety, and to issue or revoke nuclear safety licenses;

(3) To be responsible for performing nuclear safety regulation;

(4) To be responsible for investigation and treatment of nuclear events;

(5) To provide guidance and regulation in drawing up and implementing emergency preparedness plan in cooperation with the relevant departments;

(6) To organize the relevant departments to conduct scientific researches related to safety and management of NPPs, propagation and education as well as relevant international professional contacts;

(7) To be responsible for safety inspection of civilian nuclear materials;

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

(9) To conduct mediation and arbitration of disputes related to nuclear safety jointly with related departments;

(10) To be responsible for formulation, surveillance and enforcement of regulations and standards on environmental management of NPP;

(11) To be responsible for reviewing instrument of ratification of the environmental impact reports of NPP;

(12) To be responsible for the monitoring of radiological environment;

(13) To be responsible for the management of radioactive waste;

(14) To be responsible for the organizing and implementing the system of professional qualification of registered nuclear safety engineers;

(15) To participate in emergency response activities.

3.2.2.2 Duties and Responsibilities of the Ministry of Health

(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.

3.2.2.3 Organization Structure of MEP (NNSA)

The MEP (NNSA) is headquartered in Beijing and established six regional offices, 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.

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 3.

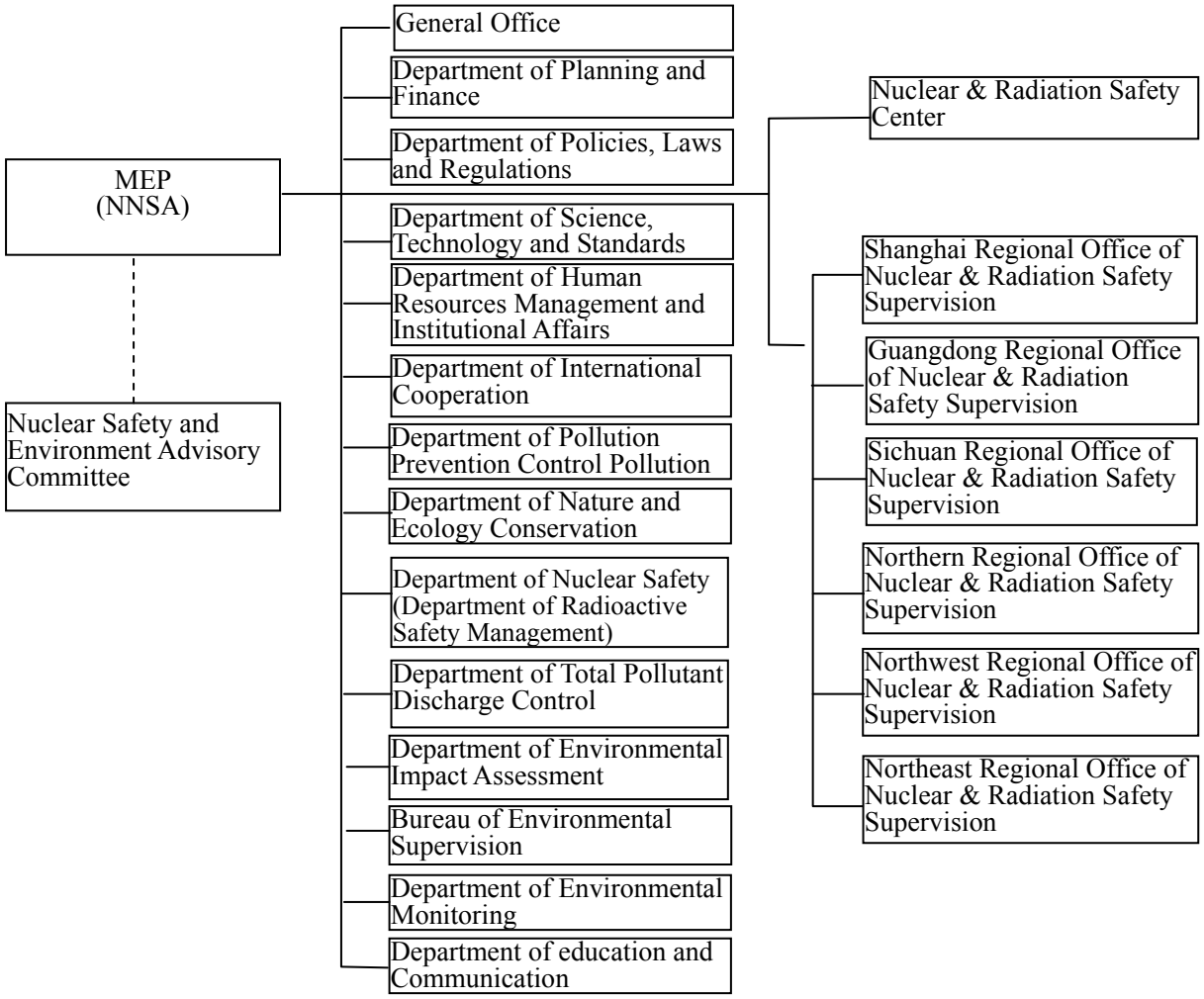

Figure 3. The organization structure of the MEP (NNSA)

The MEP (the NNSA) has about 300 staff members now. In 2009, the central government has approved that up to 2012, its staff can increase to 1,000 persons, including 70 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.

In 2009, the routine regulation budget of the MEP (NNSA) was RMB 110 million, and special outlay like capability building, etc. was about RMB 300 million.

3.2.3 Nuclear Safety Inspection

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) To examine whether or not the information submitted conforms to actual situation;

(2) To inspect whether or not the construction is carried out in accordance with the approved design;

(3) To inspect whether or not the management is performed in accordance with the approved quality assurance program;

(4) To inspect whether or not the construction and operation of the NPPs accords with the nuclear safety regulations and the conditions specified in the licenses;

(5) To investigate whether or not the operating organization has an adequate capability for safety operation and carrying out emergency response plan;

(6) Other functions necessary to be supervised.

When performing a mission, the nuclear safety inspectors have the right to access the sites of equipment manufacturing, construction and operation of NPPs to do 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.

3.3 Management of License

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

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.).

3.3.1 Types of Licenses for NPP

(1) Construction permit of NPP;

(2) Operation license of NPP;

(3) License for operators of NPP;

(4) Other permits subject to be approved which include the review comments on NPPs siting and instrument of ratification for the first fuel loading of NPPs, instrument of ratification for decommissioning of NPPs, etc. .

(5) Instrument of ratification for the environmental impact reports at different phases of NPPs and the evaluation of harm and effect from occupational diseases.

3.3.2 Issuance of NPP Licenses

The procedures of application and issuance of licenses are shown in Figure 4.

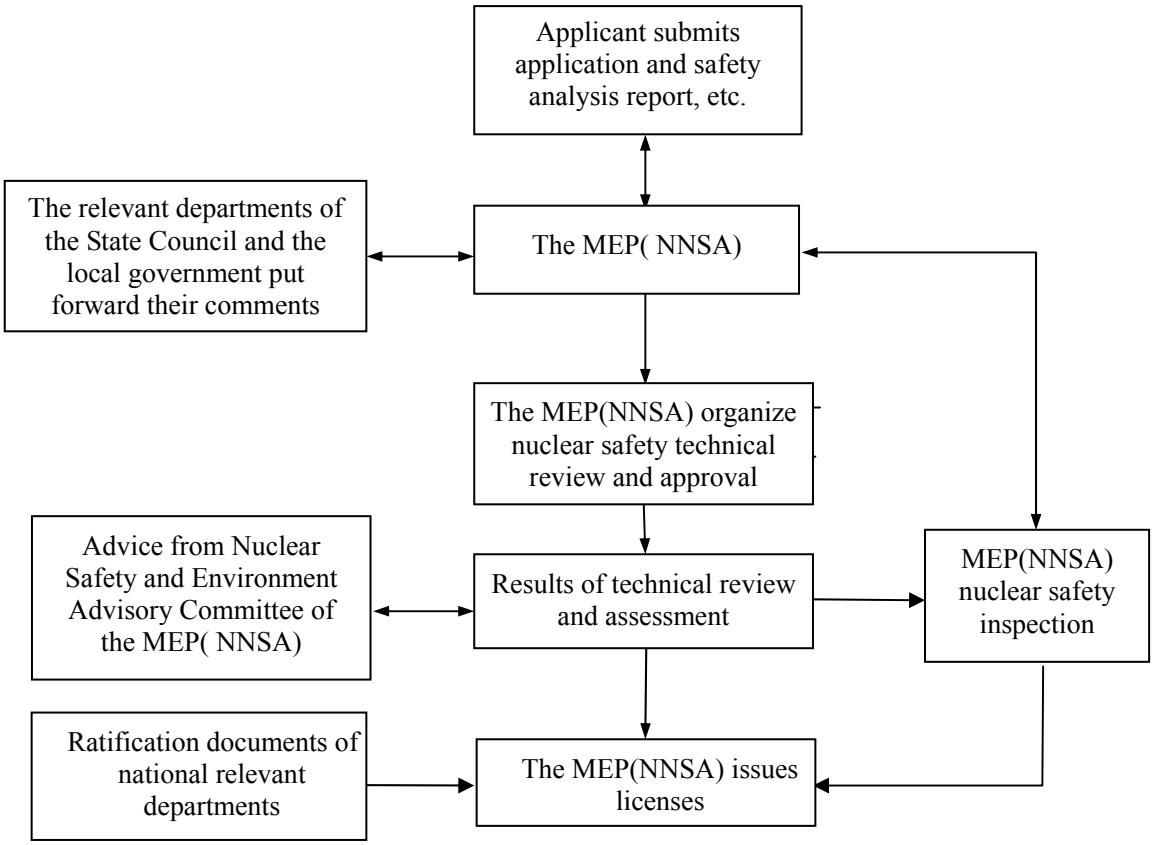

Figure 4 The procedures of application and issuance of licenses

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.

3.3.3 Newly Issued Licenses

Since the fourth National Report Review Meeting of "Convention on Nuclear Safety" was convened, the MEP (NNSA) has newly issued the following licenses to NPPs:

(1) The instrument of ratification for the first fuel loading of Jiangsu Tianwan NPP Unit 2;

(2) Operation licenses of LingAo NPP Unit 1 and Unit 2 and Third Qinshan NPP Unit 1 and Unit 2;

(3) Construction permits of Hongyanhe Phase Ⅰ NPP Unit 1 and Unit 2, Ningde NPP Unit 1 and Unit 2, Fuqing Phase Ⅰ NPP Unit 1 and Unit 2, Yangjiang NPP Unit 1 and Unit 2; Extension Project of Qinshan NPP (Fangjiashan Nuclear Power Project) Unit 1 and Unit 2; Hongyanhe Phase Ⅰ NPP Unit 3 and Unit 4, Sanmen Phase Ⅰ NPP Unit 1 and Unit 2, Haiyang Phase Ⅰ NPP Unit 1 and Unit 2, and Taishan NPP Unit 1 and Unit 2;

(4) Siting review comments for Hongyanhe Phase Ⅰ NPP Unit 3 and Unit 4, Ningde NPP Unit 3 and Unit 4, Yangjiang NPP Unit 3, Unit 4, unit 5 and unit 6, Taishan NPP Phase Ⅰ Project, Changjiang NPP Unit 1 and Unit 2, Fangchenggang NPP Unit 1 and Unit 2, and Fuqing NPP Unit 3, Unit 4, unit 5 and unit 6;

In addition, the MEP (NNSA) has also reviewed and approved Environmental Impact Reports of the NPPs at corresponding phases.

3.3.4 Responsibilities of the Licensees

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.

3.4 Duties and Organization Structure of China Atomic Energy Authority

China Atomic Energy Authority (CAEA) is the nuclear industry administration in China. It is in charge of the development of peaceful utilization of atomic energy in China, establishment of relevant regulations, control of nuclear material, safety management of nuclear industry, and it is also in charge of emergency management of state nuclear events as leader. It takes part in IAEA and conducts its activities on behalf of the Chinese government.

3.4.1 Duties and Responsibilities of the CAEA

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

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

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

(4) To be in charge of control of nuclear materials and physical protection of nuclear installations.

(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 related activities on behalf of the Chinese government;

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

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

3.4.2 Organization Structure of the CAEA

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

3.5 Duties and organization structure of the National Energy Administration

The National Energy Administration is the administrative department of energy resource industry of China. It is in charge of developing plan, and policy of nuclear power and relevant implementations, organizing the emergency management of the NPPs, and undertaking international cooperation among governments in related fields.

3.5.1 Duties and Responsibilities of the National Energy Administration

(1) To 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.

3.5.2 Organization Structure of the National Energy Administration

The National Energy Administration includes nine departments. They are general affairs department, policies and regulations department, development and planning department, energy conservation and scientific technology department, electric power department, coal department, oil and gas department (national oil reserve office), new energy and renewable resources department and international cooperation department.

4. GENERAL SAFETY CONSIDERATIONS

4.1 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.

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

"Safety First" is regarded as the nuclear safety policy of all the NPPs in China.

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 the case of contradiction of safety with other aspects, such as economical or rate of progress, etc., any resolutions should be subordinated to the requirements of nuclear safety.

The general nuclear safety objectives are defined as establishing and keeping an effective defense against radiation jeopardy to protect the site personal, the public and the environment.

The general objectives are supported by two interrelated and complementary safety objectives which are objective for radiation protection and objective for technical safety. Technical measures, together with management and procedure measures, guarantee an effective defense against radiation jeopardy.

(1) Objective for radiation protection is to ensure that radioactive exposure within NPPs and radioactive exposure due to scheduled effluent of radioactive waste under all operation conditions are within the stipulated limits and in accordance with ALARA, and to mitigate the radioactive effects of all events.

(2) Objectives for technical safety are to take all reasonable actions to prevent events in NPP and mitigate their consequences, to minimize the radioactive consequences of all possible events including events with very low probability considered in design of NPP and be within the specified limits, to ensure that probability for event with severe radioactive consequences is very low.

4.1.2 Licensee's Commitment to Safety

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.

4.1.3 Cultivation of 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:

(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 "defense-in-depth" safety management system. Following the policy of "Safety First", organizations at all levels pay attention to active prevention and conservative decision-making, 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 pay attention 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 peer review activities organized by the WANO, and actively participate in the platform of international organizations like IAEA and WANO for sharing experience and feedback information

and meanwhile, contributing to experiences and information. On the other hand, they find difference and deficiencies for further improvements through international benchmarking and communication..

(4) Developing diversified activities for boosting safety culture. Through holding symposiums for nuclear safety culture and debate contest of safety culture, NNPs develop and use tools for preventing human factor errors, conduct safety culture education in various themes and forms in order to promote nuclear safety culture in depth.

(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 review and experience feedback. For the NPPs in operation or under construction, comprehensive review, special review and periodical self-assessment were conducted actively. We strengthen building and perfection of experience feedback system of the NPPs in operation or under construction, adopt activities for experience exchange of different themes in different levels and effectively improve management of the NPPs with constant study and feedback.

(7) Enhancing the public's participation and information exchange. In the phases of siting, construction and operating of the NPPs, related departments collect public opinions by sending out questionnaires, holding symposiums and hearings, etc., and meanwhile, release relevant information timely through mass media (like newspaper, TV, broadcast, internet, etc.), brochure, notice, bulletin, etc. The NPPs inform the public and the media about the safe production and environmental protection performance as well as arrange correspondents and the public to visit the NPPs schematically Regulatory bodies set up specialized governmental websites to release administrative information according to the law.

(8) Establishing good relationship for communication. Through periodically convening annual coordination meeting, nonscheduled dialogues, symposiums, visits, exchange, etc., regulatory bodies have established good interactive relationship with the NPPs and enhanced transparency and reliability of safety review and safety regulation. 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.

4.1.4 Control of Nuclear Safety Regulatory Body

China has adopted a safety licensing system for NPPs. The MEP (NNSA) is responsible for approving and issuing safety licenses for NPPs. Before approving the

issuing of safety licenses, the MEP (NNSA) rigorously and independently examine the license applicant's conditions. These conditions are continuously checked and examined in the later safety surveillance activities which not only go into the NPP operating organization but also go deep into the design, construction organizations and suppliers, if necessary.

Nuclear safety surveillance exercised by the MEP (NNSA) is independent and compulsory. The MEP (NNSA) has the right, if necessary, to take compulsory actions to demand the licensees to adopt safety measures or to stop any activities that endanger the safety, moreover, to penalize the licensees in the way of warning, improving in a limited period, halting for rectification and revoking nuclear safety licenses.

The MEP establishes its own independent surveillance system around the NPPs to conduct supervisory monitoring on the NPP's effluents and the level of environmental radioactivity.

The Ministry of Health performs surveillance and management of the health of the NPP personnel engaged in radioactive work.

4.1.5 Safety Management of the National Energy Administration

Safety management of the National Energy Administration mainly includes:

(1) To draft out developing program and access conditions of nuclear power; through building up and perfecting the management system of nuclear power construction, restricting nuclear power market access and reasonably arranging nuclear power projects NEA, ensures nuclear power construction in order.

(2) To reinforce the establishment of nuclear power standard system. According to the current status of nuclear power development in China, on the basis of fully utilizing existing resource of nuclear power standards, NEA prepares serialized nuclear power standards step by step as application requirement, which will be followed in construction, equipment manufacture and operation of nuclear power.

(3) NEA consolidates construction and operation reporting system, operation assessment and experience feedback of nuclear power; and carry on inspection of nuclear power safety and periodically organize the activities for inspecting the NPPs; in order to improve capability and level of nuclear power construction and safety of operation.

(4) To boost independent construction of nuclear power technology and equipment and improve the level and quality of equipment manufacture.

(5) To emphasize on summing-up and exchange of nuclear power experience; through compiling " China Nuclear Power Report" and organizing activities of summing-up and exchange of experiences in the nuclear power industry, China nuclear industry identifies and improves and deficiencies in construction and operation of nuclear power.

4.2 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.**

4.2.1 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. The nuclear safety review charging system, which was put into force in 2001, works as a financial resource supplement of the MEP (NNSA).

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:

(1) 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.

(2) 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" has definitely stipulated the emergency preparedness fund for nuclear accident. 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 NPP to take out the insurance of third party liability. All nuclear power plants put into operation have performed this obligation and insured nuclear accident damage liability.

4.2.2 Human Resources

Along with the rapid development of nuclear industry in China, the demand of human resource increases very quickly. Therefore, the Chinese government is preparing personnel education and cultivation plan to meet the increasing demand for human resources of nuclear power in China. When drawing up nuclear power development plan, Chinese government also makes target for personnel cultivation.

At present, the human resources needed by the nuclear power development in China are mainly supplied by the following ways:

(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, NNPs 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 programme 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.

4.2.2.1 Training and Assessment of Personnel in NPPs

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 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.

Considering the operators' significance to safety, the management of training, examination and qualification for operators in NPPs is much stricter, more details is described in 5.3.3.10.

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 recent years, Systematic Approach to Training (SAT) was further popularized and applied to all NPPs in China. a. Presently, post task analysis, training demand analysis, formulation of training target and training outline, implementation of training/assessment and validity 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.

4.2.2.2 Qualification, 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.

4.2.2.3 Registered Nuclear Safety Engineer System

In order to improve the quality of professional personnel in the field of nuclear safety and normalize the management of key nuclear safety posts, the Chinese government enacted the "Temporary Regulations on the Professional Qualification of Registered Nuclear Safety Engineer" in November, 2002, 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. Furthermore, 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 2009, five national examinations of professional qualification of registered nuclear safety engineers have been completed. 995 people have acquired the qualification certificate of registered nuclear safety engineer.

In 2009, the MEP (NNSA) released the "List of Key Posts for Registered Nuclear Safety Engineer with Professional Qualification (the first batch)", which stipulated minimum number of registered nuclear safety engineers for key posts in the operating organizations of operating the NPPs, nuclear installations design organizations, specialized nuclear power engineering companies, etc., including such key posts as nuclear safety comprehensive management, quality assurance, radiation protection, reactor operation, radiating environment monitoring and assessment, etc..

4.3 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.

4.3.1 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 NPP, 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, repair 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 and assessment and test shall be provided for the personnel of undertaking important safety work, 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, for persistent improvements.

4.3.2 Functions of the Regulatory Body

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 power safety, and constantly boosts human performance and level of human factors management in the industry.

4.3.3 Measures in the operation management

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. Through constantly strengthening posts responsibility system and surveillance system, utilities build up 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 special 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 sheets 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, etc, 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) Making and using human error prevention cards to remind staff for preventing human errors; Popularizing operators' codes of conduct, control human error by

improving human behavior and habits, utilities should insure the nuclear power units to be operated safely, steadily and economically; utilities formulate personnel performance management, programme, build up human factors laboratory, and cultivate and improve the personnel's skill for preventing human errors.

In the past three years, the Chinese government has done a great deal of work for improving personnel behaviors, reducing human errors and improving personnel performance.

(1) In the aspect of organization and management: high-level regulators attach importance to improvement of human factors problem, establish human factors management committee, set up human factors check and assessment indicators and constantly build up and perfect all relevant regulations and rules.

(2) In the aspect of human factor training: intensify training for prevention of human errors; setting up human errors laboratory and the course for human factors analysis paying attention to analysis and study of cases, developing and compiling all sorts of human factors training materials, and carrying out international exchange and cooperation in the side of prevention of human errors.

(3) In the aspect of work implementing: promoting application of tools for preventing human errors, fulfilling the principle of conservative decision-making, popularization of codes of conduct, perfecting and optimizing procedure for operation, building up unexpected events response and decision-making system, carrying out risk classifying control, conducting surveillance system for operation, and adopting three-way communication and the method of calling out the names of those voted for while counting ballots.

(4) In the aspect of experience feedback: the MEP (NNSA), National Energy Administration, CAEA, the operating organizations of the NPPs, enterprise group and technology support organizations have built up multi-layer experience feedback system, held human factors symposium, and timely carried out analysis and feedback of human-factor events.

(5) In the aspect of human factors research: doing in-depth research in the aspects of individual, system, organization management, culture, etc., exploring and seeking for approaches to reduce human errors.

4.4 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.

4.4.1 Quality 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". 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.

4.4.2 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", 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 indication of 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;

(11) Identifying and correcting conditions in prejudice of quality. For significant conditions in prejudice to quality, determining the cause of such conditions, and taking corrective actions to prevent repetition;

(12) Establishing and executing quality assurance recording system, controlling numbering, collection, indexing, filing, storing, 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;

(13) Establishing and executing internal and external auditing system to verify the implementation and effectiveness of QAP. Take 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.

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

Chinese NPPs set considerable store by establishing 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 an adequate power is established to prevent and control effectively the activities endangering safety and quality until the problems are fully resolved.

4.4.3.1 Establishment of QAP

The QAP of a NPP is normally divided into four parts such as design, commissioning, operation and decommissioning, prepared by the operating

organization of the NPP according to requirements of safety codes 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 codes and relevant contracts, establish and implement separate QAP applicable to the undertaken work. The separate QAP of contracting organization should be submitted to the operating organization for review and approval. For organizations related to civilian nuclear safety equipment, their separate QAP also should be submitted to the MEP (NNSA) for putting on record.

4.4.3.2 Execution, 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, the selection and training of appropriate personnel, the use of appropriate equipment and procedures, the creation of a satisfactory environment, a 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.

4.4.3.3 Management Review

Managing departments periodically reviewed suitability and validity 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, utilities analyze their causes, carefully work out and implement corresponding corrective measures, and timely inform relevant organizations and departments in written form.

During the period from 2007 to 2009, the NPPs developed the following work and improvements in the field of quality assurance while implementing China's nuclear safety codes:

(1) From the beginning of project constructing, the NPPs under construction

engineered the whole project construction management system, built up comprehensive management system including quality, environment, occupational health and safety, and through planning, implementing, managing, evaluation and improvement of comprehensive management system, ensured the realization of general objective of the nuclear power project.

(2) According to the description of QAP, the NPPs under construction have built up a quality management validating system with such many levels as owner, supervisor, 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 codes and standard, and meanwhile, receive management and supervision from sides of the group, the industry and government.

(3) The NPPs in operation constantly perfected the existing quality assurance system, and gradually advanced the establishment of comprehensive management system, which based on existing quality assurance system and integrating ISO9001 quality, ISO14001 environment and OHSAS18001 occupational health safety standard system. In the meantime, the NPPs in operation timely revised and updated the "Operation Quality Assurance Program", organized and developed inspection and supervision of quality assurance in key fields, 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 validity of implementation of QAP.

(4) The group company consolidated and optimized resources of qualified suppliers of all NPPs, utilities carried out unified, classifying and grading management of suppliers from equipment, materials, spare parts and components, services, etc., developed periodically qualification review and evaluation of existing qualified suppliers, conducted supervision, assessment and relevant information sharing of suppliers quality system, working process and actual performance, supervised manufacture of important nuclear safety equipment in the factories and intensified quality supervision, quality validation and acceptance of key links.

(5) 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 and the NPPs.

4.4.4 Control Activities of Regulatory Body

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 Code on the Safety of Nuclear Power Plant Quality Assurance and relevant safety guides;

(2) Performing nuclear safety supervision 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) Organizing technical review on significant non-conformance and performing effective surveillance on the disposing process;

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 code 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.

4.5 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, 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.

4.5.1 Licensing Process for Different Stages of an NPP

Assessment and validation on safety of the NPPs means in comparison with mandatory requirements of existing safety codes/standards and practices of the industry, by means of review, supervision, inspection, test, analysis and review, assessing safety conditions of SSCs in the NPPs, and ensuring a high level of safety in the life-time of the NPP.

For NPPs, the Chinese government implements licensing system. Operating organization of the NPP needs systematically conduct safety assessment and validating activities at different stages in line with requirements of codes and standards, forms corresponding analysis report submitted to nuclear safety regulatory departments 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. In the review of

nuclear safety licenses, the MEP (NNSA) will keep a close watch on safety assessment and validating activities from siting, construction, the first fuel loading, and operation to 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 constructing the NPP, applicant must, before initiation of construction, submit "Application for the Construction of Nuclear Power Plant", "Preliminary Safety Analysis Report of NPP (PSAR)" and other relevant materials to the MEP (NNSA). The "Preliminary Safety Analysis Report (PSAR)" must definitely describe characteristics of the plant site in detail and meanwhile, 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 present 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 operating 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 to applicant as to be permission of decommissioning work.

4.5.2 Safety Assessment and Verification Practices in NPPs

4.5.2.1 Probabilistic Safety Assessment

According to stipulations of relevant nuclear safety codes, 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 Assessment (PSA) methodology must be implemented as input of periodic safety review so as to understand the relative contribution in all different aspects of NPP to safety.

"Policy of Technology: Application of Probabilistic Safety Analysis Technology in Nuclear Safety Field" promulgated by the MEP (NNSA) in 2009 clearly pointed out: in the activities of nuclear safety, we actively promote the use of probabilistic safety analysis method, 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 regulated its definite guidance about method, scope and target to be met of the probabilistic safety analysis.

In 2006, Qinshan NPP finished the development work of Probabilistic Safety Assessment (PSA) for grade Ⅰ full power internal events incurred initially, which passed the review of the MEP (NNSA) at the end of 2007. Henceforth, it was gradually applied to fields related to production, involving the NPP's change and transformation, rectification of weakness, risk analysis of maintenance plan, the setting of time allowed off the production line for equipment, improvement of operating process and detailed rules of test, improvement of training outline for reactor operators, etc. According to the status quo of the NPP and the development of application for probabilistic safety analysis technology, the NPP will update the existing model of Probabilistic Safety Assessment (PSA) and further extend its scope of application.

Daya Bay NPP, finished its research work of probabilistic safety assessment for stopping the reactor in 2007, Currently, probabilistic safety assessment (PSA) technology is mainly applied to risk assessment and management of routine production activities, risk tracking and assessment of historical conditions of units, risk analysis of project transformation, data support of application for special permission, risk analysis of important events relating to safety, etc.. Meanwhile, Daya Bay NPP also developed a safety management tool based on probabilistic safety assessment (PSA).

Third Qinshan NPP has completed events tree analysis, failures tree analysis, analysis of common cause failure, human reliability analysis and quantitative

calculation of the event sequence. After completing the evaluation report of PSA, it will be submitted to the MEP (NNSA) for review. Tianwan NPP is step by step applying the probabilistic safety analysis technology to optimization of supporting its start process after the NPP's outage. The probabilistic safety assessment work on the Unit 1 and Unit 2 of Qinshan Phase Ⅱ NPP is in its early stage for preparation.

According to requirement of relevant codes, newly constructed nuclear power project has completed corresponding probabilistic safety assessment (PSA) and submitted the report on probabilistic safety assessment (PSA) to regulatory departments for review. As the complement and assistance of deterministic methodology safety analysis, the probabilistic safety analysis verifies whether the design is in line with general target of safety or not, identifies the weak links existing in the NPP, balances the design of NPP and assesses the program of design improvement.

4.5.2.2. 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, test and calibration of the instrumentation, tests and inspections of the safety-related systems.

Periodical tests are the main measures for implementing plant monitoring program. They 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 being commercial operation.

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., did analyses and feedbacks on all sorts of collected monitoring data, timely identified unfavorable trend and took corresponding measure for correction and improvement.

4.5.2.3 In-Service Inspection

According to the requirements of nuclear safety codes, guides and related technical standards, NPPs have developed in-service inspection programs to assess possible development of defects and reliability of components. The in-service inspection programs were put into use after approved by the MEP (NNSA). Besides the items required by the Technical Specifications, some in-service items were added according to experience feedback from home and abroad.

During the past three years, Chinese NPPs have completed 29 in-service

inspections during the outages of reactor for overhaul. 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, widen the scope and increase frequency of inspection, repair the deficiencies or change the component. Qualified inspectors implement in-service inspection in accordance with approved inspection procedures, make use of qualified inspection equipments, and enforce strict quality assurance and quality surveillance in the process of inspection, in order to assure the effectiveness of the inspection results. Through previous in-service inspections, some deficiencies in NPPs have been discovered and corrected, which has 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 departments 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 keep under the regulation of the safety regulatory departments.

4.5.2.4 Aging Management

The NPP, according to requirement of relevant codes, formulated and implemented aging management program and took measures such as monitoring, testing, sampling and inspection to assess the expected aging mechanisms in the design of NPP 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.

Qinshan NPP, according to general goal of aging management, prepared and completed the "Aging Management Program of Qinshan Nuclear Power Plant," identified management model of aging and lifetime and technical proposal, and built up the organization of aging management of NPP. According to the requirement of aging management program and the comments on periodic safety review, Qinshan has completed the screening of structures, equipment and components relating to nuclear safety, which need aging management. According to result of screening, at present, the plant has finished assessment on aging status and lifetime expectation of pressure vessels, steam generator and pressurize surge line, and prepared corresponding

separate aging management program, and is developing the project of safety shell aging management and the project of cable aging assessment and management.

Daya Bay NPP and LingAo NPP have formulated the five-year plan on aging and lifetime management, and by aiming at the preliminary list chosen of system of aging and lifetime management, structures and spare parts, implemented specific analysis and assessment of aging and lifetime step by step, prepared and completed the aging analysis guides of such projects as flow-accelerated erosion, reactor pressure vessels reactor internals, etc., pushed on implementation of aging management measures as planned, and meanwhile, carried out a series of research and work on the economic assessment model of aging and lifetime of important equipment, obsolescence management , etc..

Qinshan Phase Ⅱ NPP and Third Qinshan NPP, according to respective status of nuclear power plant, are gradually developing aging management work, including preparing corresponding program, procedure and flow of aging management and carrying out aging mechanism analysis of key equipment and development of database. Tianwan NPP has gradually started the initial work of aging management after being put into operation.

4.5.2.5 Periodical Safety Review

The operational NPPs, according to requirement of relevant codes, will implement periodical safety review once in every ten years after beginning operation of commercial of NPP. 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 involves all aspects of nuclear safety, including 14 safety elements in 5 categories.

Durability 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 action 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 ten-year safety review; its result shows that the two NPPs are able to continue steady safety operation. The two NPPs have taken actively corrective action to correct weak links discovered in the review and set about preparation of the second ten-year safety review. In the coming several years, according to requirement of codes, LingAo NPP, Qinshan Phase Ⅱ NPP and Third Qinshan NPP will develop periodical safety review in succession.

4.5.2.6 Internal and External Assessment in NPPs

For 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.

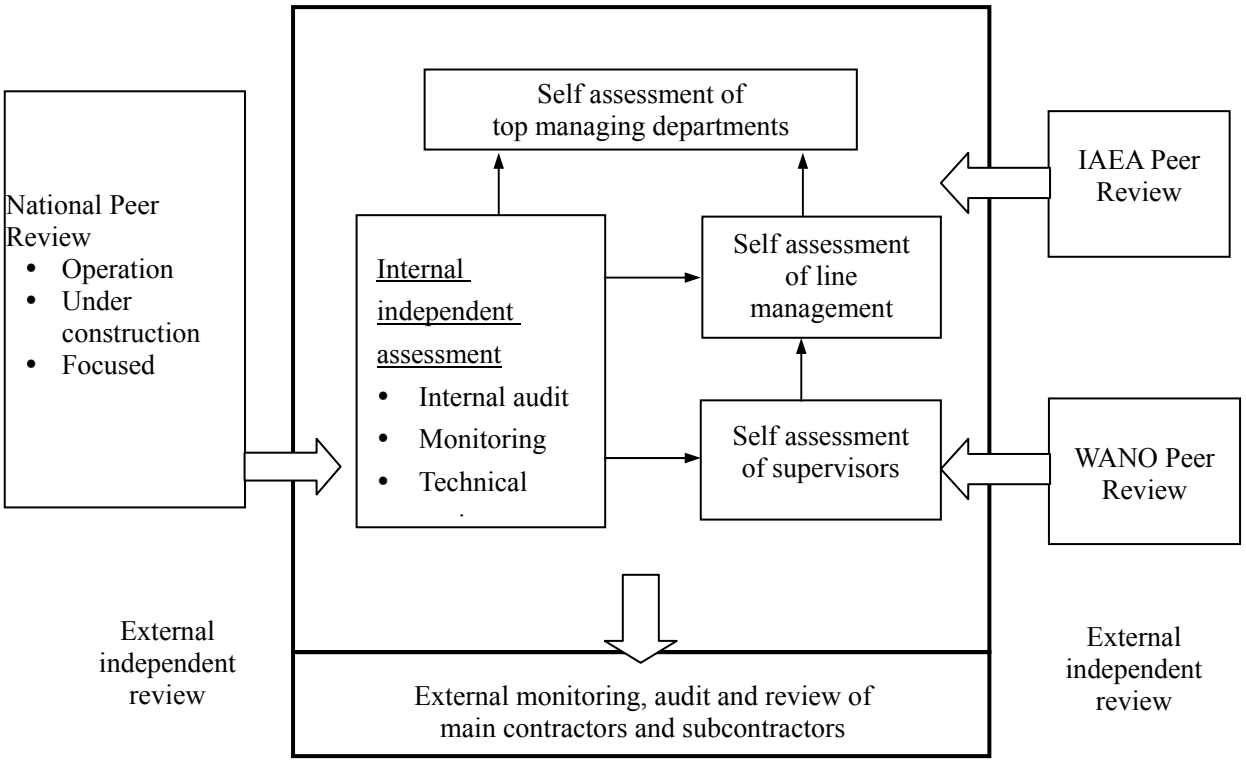

Figure 5 Assessment System of NPPs

Internal assessment 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 important input to 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 managing 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 tasks, service and process, review and confirmation of design documents, review of procedures and records, observation of independent assessment, and periodical walk-down of facilities.

From 2007 to 2009, for NPPs in operation, China continuously implemented comprehensive domestic nuclear assessment and follow-up, and meanwhile, according to actual demand of NPP, conducted focused assessment of operation in specific fields of the industry and the group 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, etc., China organized related technical support organizations to develop performance objective and criteria of assessment, successively implemented project construction 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, Chinese NPPs also actively accepted reviews of IAEA-OSART and peer review of WANO. From 2007 to 2009, China's NPPs totally accepted 5 reviews from abroad.

The results of all 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.

With a view of extensively popularizing and utilizing internal and external assessment results, relevant organizations prepared the comprehensively analytical report on NPP operation assessment results, analyzed and summed up all peer reviews from home and abroad (not including WANO TC review) since the first operation in 2002, popularized good practices acquired from the reviews and assessments into the industry, summed up and analyzed common problems discovered in the process of assessments, put forward suggestions for improvement, and provided China's nuclear power management with important reference.

4.5.3 Review and Control Activities of Regulatory Body

The MEP (NNSA), by way of formulating codes, guides, policies and standards of safety, put forward requirements for safety assessment and verification of NPPs, and by way of nuclear safety review, nuclear safety inspection, periodical safety auditing, etc., regulated related activities within the lifetime of the NPP to confirm the NPP and its activities in conformity with goal, principle and guides.

At different phases of NPPs, emphases for review of regulatory body are different. At the phase of siting, emphasis is laid on the suitability of the chosen plant site and the feasibility of design benchmark relating to surroundings of the plant site and implementation of plan for emergencies; at the phase of construction, regulatory body reviews the design principle of the NPP so as to draw the conclusion about whether the NPP can be safely operated after completing construction of the NPP; at the phase of commissioning, 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 complete with eligible records of quality assurance; at the phase of operation, 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; at the phase of decommissioning, 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, by way of nuclear safety surveillance, the MEP (NNSA) inspected the implementations of nuclear safety management requirement and conditions stipulated in the licenses 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, reviews and experience feedbacks of the operating NPPs; popularized the application of risk directing technology to the operating NPPs; gradually and systematically adopted the system of operation safety assessment indicators for assessing safety status of the NPP; 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 requirements of nuclear safety codes and relevant safety regulations and guides, by way of nuclear safety review and on-site supervision, issued construction permits for accumulatively 18 units (detailed content is shown in the passage of 3.3.2); approved the "Ten-year Safety Review Program for LingAo Nuclear Power Plant"; following the release and implementation of "Regulations on the Safety Regulation for Civilian Nuclear Safety Equipment" and successive issuances of supporting rules and systems, further regulated the examination and approval of nuclear safety equipment and 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.

4.6 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.

4.6.1 Basic Requirement of Radiation Protection

Chinese government promulgated a series of laws, regulations and state standards to ensure the implementation of radiation protection goals.

(1) The "Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China" 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 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 state 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) On Oct. 27, 2001, the National People's Congress reviewed and approved the "Act of Prevention and Treatment on Occupational Diseases of the People's Republic of China", 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 state 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. 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.

• When, 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 requirement 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)The effective dose equivalent limits and the annual discharge limits of airborne and liquid radioactive effluents to any members (adults) of the general public caused by the release of the radioactive substance of each NPP to the environment are clearly stipulated by the state standard, "Rules on the Environmental Radiation Protection of Nuclear Power Plant" (GB6249-86) as follows:

— The annual effective dose to any members (adults) of the general public caused by the discharge of the radioactive substance of each NPP shall be less than 0.25mSv.

— In addition to satisfy the requirement set by the upper item, the annual discharge of each PWR NPP in normal operation shall be lower than the discharge limits listed in the following table:

Table 1 The Annual Discharge Limits of Each PWR NPP in Normal Operation (Unit: Bq)

Radioactive airborne effluents			Radioactive liquid effluents	
Noble gas	Iodine	Particles (Half life≥8d)	Tritium	Other nuclides
2.5×10^{15}	7.5×10^{10}	2.0×10^{11}	1.5×10^{14}	7.5×10^{11}

4.6.2 Application of ALARA Principle in NPPs

4.6.2.1 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 to reduce radiation levels;

— 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.

4.6.2.2 Application of ALARA Principle in NPP Operation

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

(1) Perfecting radiation protection management system. While maintaining effective operation of original management system, according to previous experience

and practice, NPPs constantly amended and perfected radiation protection program and relevant procedures, and by way of management of radiating areas, training of radiation protection for all 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, normalized with plan as well as monitored independently.

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

(3) Improving source control technology. For example, use the primary circuit water strainer with smaller aperture; replace silver gasket of nuclear power plant; develop and research the equipment for eliminating a part of heavier radiation, etc.

(4) Strengthening pollution protection measures. For example, strengthen surveillance for the conditions of starting radioactive system and equipment; set witness point of radiation protection for open ended operation.

Because most of radiation exposure of NPP staff mainly occurs in the period of refueling outage, NPPs have attached high importance to radiation protection activities. 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 operators.

4.6.3 Personnel Exposure Control

4.6.3.1 The Occupational Exposure

The survey of the occupational exposure shows that the annual average 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 Annex 4.

4.6.3.2 Radiation Exposure of the Public

The 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 is far below the dose equivalent limit set by the national standards.

4.6.4 Environment Radioactivity Monitoring

According to critical nuclides, critical exposure and transfer paths and critical public groups defined in the environmental impact report(EIR), NPPs have established environment monitoring programs for monitoring the radioactivity in environment, to ensure that the requirements in related state 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 investigation of pre-operation

The NPPs fulfill a two-year investigation of the ambient radioactivity and the ocean ecosystem. The plants 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 put into 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 routine 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", besides monitoring in NPPs, NPPs also must make arrangement for identifying NPPs' any possible radioactive influence on surrounding areas. 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.

Through monitoring and analysis of living organisms, air, soil and sea and others in the ambient background, it indicated that in the past three years, operating NPPs in China brought no 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 state standards during operation.

The percentage of radioactive effluents to the limits of state standards from 2007 to 2009 of Chinese NPPs is listed in Annex 5.

(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 incident

The NPPs have established a monitoring plan for environmental emergency submitted to the provincial environmental protection department 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 sequential radiation detectors, the contamination monitors, the air samplers and the environmental media samplers, etc., which are periodically checked, calibrated and tested, if necessary, to ensure that these emergency response facilities are available when they are used.

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

The NPPs evaluate the dose equivalent imposed upon the general public and the impact on the environment in the normal operation and in the incident 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.

4.6.5 Control Activities of the Regulatory Body

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

— To stipulate 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 in where the NPP is located have built up peripheral regulatory monitoring system to monitor and assess surrounding environment of the NPP and then check the monitored data with those from the NPPs, and compare with the 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 addition, from 2007 to 2009, the regulatory body performed the following important activities in the control of radiation protection:

(1) The "Regulations for the Safety Transport of Radioactive Material" has been promulgated. And the "Regulations on Safety Management for Radioactive Waste" has also been formulated and listed into the legislation plan of the State Council.

(2) The MEP (NNSA) promulgated "Safety Review Principle for Second Generation Improved Nuclear Power Project" as supplementary stipulations of the "Code on the Safety of Nuclear Power Plant Design" and the "Safety Assessment and Verification of Nuclear Power Plants", and in the review principle, put forward the requirement of optimizing and analyzing radiation protection. Furthermore, the MEP (NNSA) completed the review of environmental impact reports submitted by a batch of newly constructed NPPs, and by way of building up data transmission system with NPPs, carried out real-time monitoring of safety operating status of NPPs and

improved capability of responding to nuclear and radiation accidents.

(3) The Ministry of Health has successively completed the pre-assessment of hazards of occupational diseases in newly constructed NPPs and the review of preventive facilities design for occupational diseases, inspected prevention and treatment of occupational diseases in Tianwan NPP, Third Qinshan NPP and Unit 1 and Unit 2 of LingAo NPP and advised space for improvement on problems existing in radiation protection.

4.7 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

4.7.1 Basic Requirements for Emergency Preparedness

The“ Act of Protection and remedy of Radioactive Contamination of the People's Republic of China” specifies that operating organizations should, according to scale and nature of nuclear installations, formulate on-site emergency response plan and make full preparation for emergencies. When nuclear accidents emergency occurs, operating organization of nuclear installations immediately take effective emergency response measures to control accidents and report the emergency to the competent department of nuclear installations administration, competent department of environmental protection administration, administrative departments of health, public security departments and other relevant departments.

The “Act of Emergency Response for Unexpected Events of the People's Republic of China” specifies that the country should establish emergency response system with

unified leadership, comprehensive coordination, classifying management and dominant management of local leadership.

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".

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.

4.7.2 Emergency Preparedness Measures

4.7.2.1 Emergency Preparedness 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.

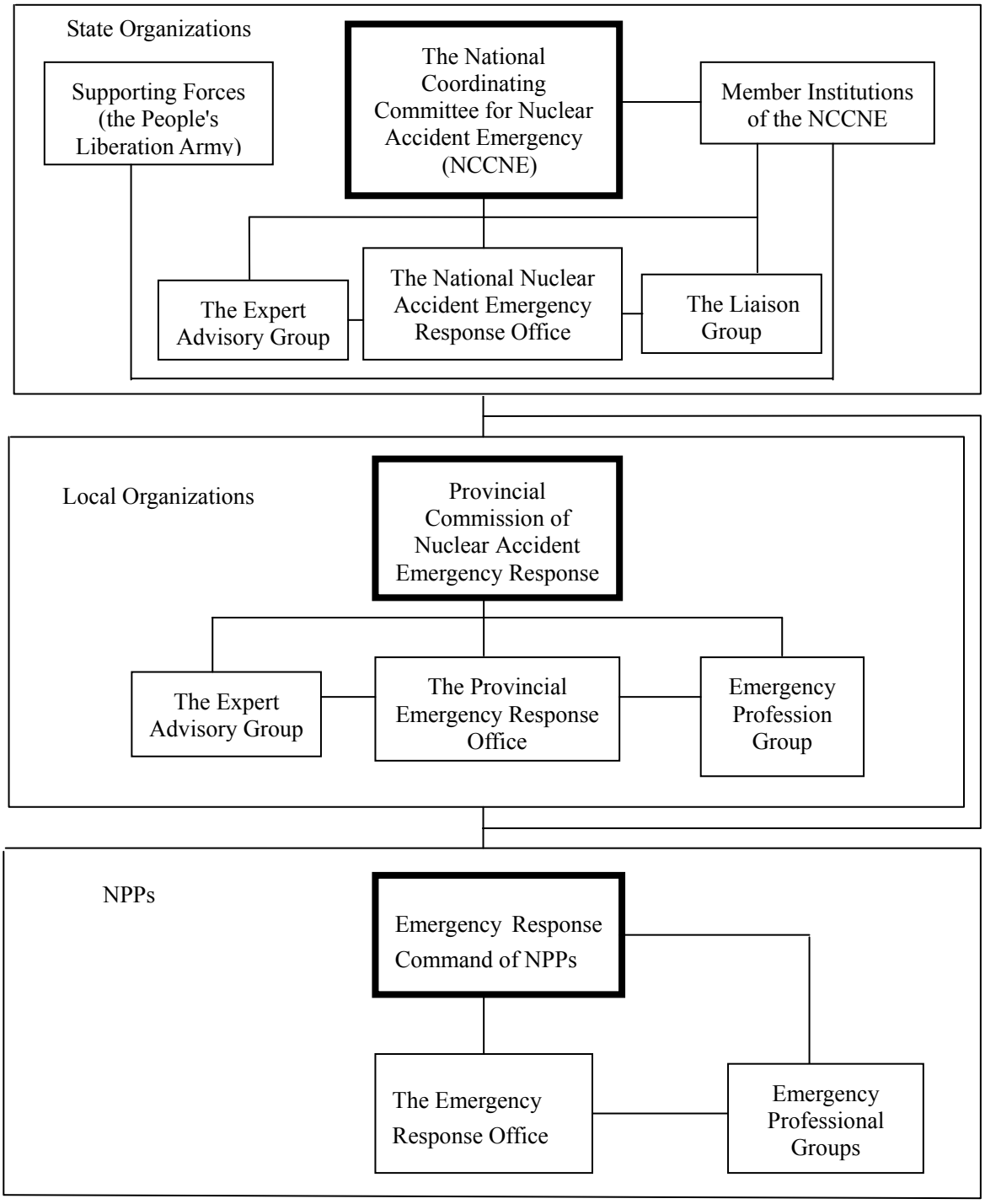

Figure 6 Organizational Structure of National Nuclear Emergency Response System

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) The relevant departments of the MEP (NNSA), the Ministry of Health, and the Army conduct relevant emergency activities for nuclear accident according to respective responsibilities.

4.7.2.2 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.

4.7.2.3 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 and approved by the MEP (NNSA), and the 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 and the national nuclear accident emergency plan is reviewed and approved by the State Council.

4.7.2.4 The Public's Acquaintance with Emergency Preparedness

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 2008, the MEP (NNSA) prepared and issued the drafts of "Emergency Preparedness for Operating Organization of Nuclear Power Plant" and "Emergency Plan for Operating Organization of Civilian Nuclear Fuel Circulating Facilities" for collecting opinions from the public.

4.7.3 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 exercises are carried out periodically for operating NPPs to verify, improve and strengthen the abilities of emergency preparedness and emergency response.

Since the convocation of the fourth contracting parties' review meeting of the "Convention on Nuclear Safety", Chinese nuclear power plants, according to requirement of emergency response codes, have carried out single drills, comprehensive exercises and united exercises for many times. On Nov.10, 2009, China implemented the first large-scale three-level united exercises for national nuclear accidents emergency response, comprehensively verified national capability of responding to unexpected events of nuclear and radiation, perfected mechanism of operation and trained all personnel involved. During the exercise, CAEA invited delegations from Japan and South Korea to observe the exercise and learn from each other, and reported the activity to International Atomic Energy Agency according to the "Convention on Early Notification of a Nuclear Accident".

4.7.4 Progress of Emergency Preparedness Activities

(1) Perfecting planning system and organization structure.

In accordance with the "National Nuclear Emergency Planning", related member organizations of the National Coordinating Committee for Nuclear Accidents Emergency have compiled and revised the emergency planning. The provincial people's governments of Jiangsu, Zhejiang and Guangdong have perfected nuclear accidents emergency planning and implementing procedures.

Through strengthening cooperation between military forces system and local governments, China enhanced specialized technological forces for nuclear accidents emergency response. In the meantime, China has reinforced its nuclear accidents emergency response organizing system of Zhejiang Province, Guangdong Province and Jiangsu Province at where the NPPs are located, and improved the capability of comprehensive coordination and specialized technological support for provincial level nuclear accidents emergency response organizations. Liaoning province, Shandong province and other provinces and municipalities have formed provincial nuclear accidents emergency response management organizations. Therefore, the country's nuclear accidents emergency response organization system has been enhanced further.

In addition, the "Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant" are being revised. The drafts of relevant nuclear safety guides have been prepared and released for comments from the public. Related departments of the country are researching and preparing "Standard Format and Contents of Nuclear Accidents Emergency Planning", "Rules on Management of Nuclear Accidents Emergency Planning" and "Assessing Standard of Nuclear Accidents Emergency Preparedness", and meanwhile, organized relevant tests and gradually

practiced the system of approval at different levels and periodical assessment.

(2) Advancement of capability building and technological level

As the main contents of national nuclear accident emergency planning of "The Eleventh Five-year Plan", the country has approved and established such many technical support capability construction projects as radiation protection of nuclear emergency response, monitoring, medical rescue, etc., and is organizing and building 6 national rescue teams for nuclear emergency response. The National Development and Reform Commission and the Ministry of Health have invested in the construction of many bases for medical treatment and cure of nuclear radiation. Sichuan Province and Gansu Province nuclear accidents emergency response commanding centers supported by the central finance have been established and put into operation. The CAEA carried out the study on technical requirement of nuclear installations for prevention and disposal of nuclear terrorist attack events. The Ministry of Health conducted national survey of medical resource and capability for emergency response of unexpected nuclear and radiation events, and specially explored and studied key hygienic technology of nuclear and radiation accidents emergency response. The State Meteorological Administration conducted the study on monitoring analysis and forecast assessing technology for nuclear accidents pollution diffusion. The National Bureau of Oceanography implemented the study on such subjects as automatic measuring of γ-radiation dose from nuclear accident and its quick assessment system, etc. China has been improving constantly its technical level of emergency response for nuclear accidents.

(3) At the phase of siting, initiate the arrangement of emergency response.

In 2007, relevant departments of China government further strengthened nuclear accidents emergency response management in the earlier stage of nuclear power project. Operating organizations actively responded to the management requirement and submitted their respective accidents emergency planning in the site area of the newly constructed nuclear power project.

4.7.5 International Arrangements

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. Nowadays China has carried out bilateral cooperation and technical exchange activities with France, USA, Canada, Russia, Ukraine, Japan, Korea, etc. In 2008, China participated in the ConvEx-3(2008) international nuclear emergency response exercise.

4.8 International Cooperation on Nuclear Safety

Chinese government pays great importance to international cooperation on nuclear safety. China signed and approved those international conventions like "Convention on the Physical Protection of Nuclear Materials" and its amendments, "Convention on Early Notification of a Nuclear Accident", "Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency", "Convention on Nuclear Safety", and "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", and strictly implements the duties under these conventions.

Under the principle of "around China and for China", the Chinese government has developed multilateral and bilateral cooperation in nuclear safety field.

(1) China has developed resentful cooperation with IAEA and actively participated in important international cooperation projects such as Generation IV Nuclear Energy Cooperation Forum (GIF), International Thermonuclear Experimental Reactor, and Global Nuclear Energy Partnership, etc..

(2) IAEA held the international ministerial conference on nuclear energy in the 21st century in Beijing. CAEA undertook this event.

(3) China submitted the Chinese national report to IAEA about implementing the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" and candidly and sincerely answered related questions.

(4) China actively participated in multi-country design assessment plan of the nuclear energy agency of Organization for Economic Cooperation and Development (OECD) and officially formed 5 task forces to comprehensively carry out multi-country design assessment plan.

(5) China has signed intergovernmental cooperating pacts for peaceful utilization of nuclear energy to develop cooperation in many aspects, and provided supports of equipment, technology and personnel for other developing countries' nuclear energy

development.

(6) China has signed bilateral nuclear safety cooperative agreements or memorandums with many countries, and in way of personnel training, technological exchange, exchange of experts' visits, cooperative research, review consultation, etc., carried out multi-level multi-directional exchange and cooperation.

The Chinese Government believes that active international cooperation on nuclear safety is of great significance in ensuring nuclear safety and by way of bilateral and multilateral nuclear safety cooperation, will be beneficial to all the parties involved.

5. SAFETY OF NUCLEAR POWER PLANTS

5.1 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.

5.1.1 Regulations and Requirements on Nuclear Power Plant Siting

Referred to the nuclear safety standards of IAEA and other countries, the MEP (NNSA) established nuclear safety regulations and guides on nuclear power plant siting, which mainly are the "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 Annex 3).

5.1.2 Licensing Process of Siting

According to the regulations of "Act of Protection and Remedy of Radioactive Contamination of the People's Republic of China", the siting of nuclear installations shall be carried through scientific demonstration and handled procedures of review and approval according to relevant national regulations. Before handling the review and approval procedures of siting nuclear installations, the environmental impact report shall be compiled, and reported to the MEP (NNSA) for review and approval.

5.1.3 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.

5.1.3.1 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.

5.1.3.2 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.

5.1.3.3 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.

5.1.3.4 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.

5.1.3.5 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.

5.1.4 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.

5.1.4.1 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.

5.1.4.2 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.

5.1.4.3 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.

5.1.5 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.

5.1.6 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.

5.1.7 Public Participation

The Chinese government encourages the public to participate in nuclear power construction projects. 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 review and approval stage 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 7 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 No.1 and No.2 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.

5.2 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.

5.2.1 Regulations and Requirements of the Design and Construction of NPPs

5.2.1.1 Regulations 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 Annex 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. For details see the requirements of defense-in-depth in Section 5.2.3.

(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 discharge 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 tend 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 serious 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.

5.2.1.2 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. The general requirements of quality assurance are described in 4.4. 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 on site 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.

5.2.1.3 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.

During the report period (from 2007 to 2009),on the basis of the facts that there're many nuclear power projects under construction, China actively explored and developed the constructing experience feedback activities and actively promoted the establishment of experience exchange system of NPPs under construction. The National Energy Administration and the MEP (NNSA) co-chaired the constructing and operating experience exchange meeting to promote the institutionalization and standardization of NPP relevant activities. Newly-built NPPs signed technical support agreements with relevant foreign and domestic nuclear technical support organizations and established the external technical expert database. All kinds of experience exchange meetings carried out for the earlier stage of NPPs siting, quality assurance were organized and developed. Chinese NPPs actively established cooperation and communication channels, participated in domestic and foreign discussion forums and exchange meetings and carried out international exchanges at various levels.

5.2.2 Process of Review and Approval of the Design Qualification and the Construction Permit

(1) The applicant engaged in the nuclear island design should apply to the Ministry of Construction for the qualification license. After passing through the qualification review, the Ministry of Construction will issue the qualification license for nuclear island design to the applicant.

(2) The applicant engaged in design, manufacture, installation and non-destructive testing of the civilian nuclear safety equipment must obtain the corresponding license issued by the MEP (NNSA).

(3) The overseas enterprises engaged in design, manufacture and installation and non-destructive testing activities of the civilian nuclear safety installations for civil nuclear installations within Chinese territory must register at the MEP (NNSA). After the applicant's registration passed the review of the MEP (NNSA), registration confirmation certificate will be issued to the applicant. Only the enterprises with registration confirmation certificates can engage in design, manufacture and installation and non-destructive testing service of the civilian nuclear safety

equipment for civil nuclear installations within Chinese territory.

(4) After the site is selected, the applicant for the "Nuclear Power Plant Construction Permit" shall submit documents listed below to the MEP (NNSA) 12 months before pouring concrete to the nuclear island base.

— "Application for the Construction of Nuclear Power Plant";

— "Environmental Impact Report of Nuclear Power Plant";

— "Preliminary Safety Analysis Report for Nuclear Power Plant";

— "Quality Assurance Program of Nuclear Power Plant (both in the design and construction stages)".

The MEP (NNSA) organizes specialists concerned for reviewing and performing assessment. After confirming that the contents of documents listed above accord with the requirements of nuclear safety regulations, the MEP (NNSA) issues the applicant the "Construction Permit of Nuclear Power Plant".

5.2.3 Defense-in-Depth Conception and Its Applications

5.2.3.1 Defense-in-Depth Conception

The defense-in-depth is a basic principle for fulfillment of nuclear safety. 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 guarantee these activities are placed under the defense of overlapping measures, even if one kind of malfunction happens, it will be detected, compensated or corrected by appropriate measures.

Chinese NPPs have carried through the concept of defense-in-depth in the entire design, which embodies in the following aspects:

— Provide multiple physical barrier 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.

5.2.3.2 Five Layers of the Defense-in-Depth

The five layers 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. In order to obtain this purpose, Chinese NPPs have adopted the following measures in design:

— The NPP is designed correctly and conservatively to acquire adequate margin of safety according to appropriate quality level and project practice. Adequate attention is paid to all aspects of quality, such as the selection of materials, technical specifications, the use of construction and operating experience, the equipment qualification, human factors, aging and wearing consideration, the safety analysis of various conditions and independent verification of safety assessment, procedures of inspection, maintenance and testing, and the controls of components manufacture and the construction in the NPP. These relate not only to the functional aspects of the process and safety systems together with their auxiliary installations within various echelons of defense, but also in particular to the set of physical barriers against the escape of radioactive substances.

— Wherever possible, the equipment is designed according to appropriate approved codes and standards. It is a design proven by previous equivalent application conditions, and is selected to be consistent with the reliability goals required for safety. Where codes and standards are used as design rules they are identified and evaluated before hand.

(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 (e.g. the chemical and volume control system, the feed water

control system and the reactivity control system, etc.) are provided, and the operating procedures are established to prevent or minimize damage from postulated initiating events, and to prevent equipment failures and human errors from evolving into the design basis accidents.

(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. These very unlikely events are anticipated in the design basis of Chinese NPPs, which provide inherent safety features, fail-safe design, additional equipment and procedures to control their consequences and to achieve stable and acceptable conditions following accident conditions.

(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). The most important object of this echelon is to protect the confinement function. This aim is achieved by providing supplementary measures and procedures to prevent the accidents from developing, by mitigating the consequences of the selected severe accidents, and by supplying accident management procedures.

(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. Appropriate emergency control centers are established, and the plans for on-site emergency and off-site emergency are formulated by China.

5.2.3.3 Three Physical Barriers of the Defense-in-Depth

During the design process of Chinese NPPs, the second application of the defense-in-depth concept is the provision of multiple physical barriers in NPPs to prevent the escape of radioactive substance to outside. These barriers include the fuel matrix, the fuel cladding, the reactor coolant system pressure boundary and the containment.

(1) Fuel elements

In designing fuel elements, the deterioration factors such as external pressure of the coolant, chemical effects, static and dynamic loading, etc. are considered. The in-core irradiation testing of fuel elements verifies that it can withstand its intended irradiation in the reactor core.

Fuel elements can keep their integrity under design-basis accidents.

The fuel is monitored by performing continuous measurements of overall reactor coolant activity and by performing periodic measurements of the concentration of certain isotopes in the reactor coolant. Plant Technical Specifications and the operating instructions provide the maximum permissible activity in the primary coolant.

(2) Reactor coolant system pressure boundary

The design pressure and temperature for each component in the reactor coolant system are selected to be above maximum coolant pressure and temperature under all normal and anticipated transient load conditions, at the same time each component is designed to have its stress under allowable stress limit.

The reactor coolant system components achieve an adequate margin of safety by using proven materials and various design standards, proven fabrication technologies, non-destructive testing in the factory and integrated hydrostatic testing of assembled components. In addition to the loads imposed on the system under normal operating conditions, consideration is also given to abnormal loading conditions, such as pipe ruptures and earthquakes.

In designing the reactor vessel, the embrittlement effect under irradiation is considered. In the overall life of the NPP, the vessel is monitored with samples to find out whether the brittle effect of the reactor vessel under irradiation is in compliance with each anticipated conditions.

Multiple pilot-operated safety valves and pressure relieving devices are provided for the reactor coolant system.

Transient analyses have been included in reactor coolant system design, which conclude that design conditions are not exceeded during normal operating condition. Protection and control set points are based on these transient state analyses. The margin of the system includes the effects of thermal lagging, coolant transportation time, pressure drops, system relief valves characteristics, and instrumentation and control response characteristics.

The reactor coolant system has provisions for inspection, testing and surveillance of critical positions.

By controlling water chemistry conditions of the first and the secondary circuit reactor coolant, the protection of components against corrosion is ensured.

(3) Containment

The containment is designed to enclose the nuclear steam supply system (NSSS). The containment design ensures that, in the condition of normal operation and if the loss of coolant accident (LOCA) happens, the leakage rate from the containment is less than 3‰ per day of the mass of gas contained in the containment at accident pressure.

The containment is designed to allow periodic integrated leakage testing at the design pressure.

The containment structure, including access openings and penetrations, is designed to accommodate the transient peak pressure and temperature associated with the postulated LOCA of the design basis.

The containment spray system has adequate cooling capacity to prevent over-pressurization of the structure. The containment pressure will return back to near atmospheric pressure within one day following a loss of coolant accident (LOCA) or a steam line break accident.

The containment is designed to absorb the dynamic effects brought by some special and credible external events (missiles, etc.).

Containment design, construction and testing all comply with the requirements of the approved standards.

5.2.4 Measures against Event Prevention and Mitigation

5.2.4.1 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. The design for optimized operator performance is mentioned in 5.2.6.

5.2.4.2 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 retaining of the accident management procedure to operating personnel of the NPP regularly.

During the report period (from 2007 to 2009), a series of design improvements were made on second-generation improved NPPs under construction in China, for example, installing perfect combustible gas control systems and adopting pressure relief function extension of pressurized to further improve the safety and reliability of nuclear power units and strengthen the accident prevention and mitigation capacity of the units.

The accident emergency response measures of Chinese nuclear power plants are described in 4.7.

5.2.4.3 Countermeasures against 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

Although above requirements are put forward for the newly built nuclear power plants, 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 severe-accident management guides 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.

The MEP (NNSA) has organized and completed the technical documents as "Technical Policy of Severe Accident Management of Operating NPPs" and is compiling the guidance document of severe accident management program of NPPs to strengthen severe accident management.

5.2.5 Adoption of the Proven and Up-to-Standard Process and Technology

(1) Operating organizations of NPPs are required to adopt the developed and up-to-standard process and technology by the MEP (NNSA). Documents (e.g., the SAR) submitted to the MEP (NNSA) by operating organizations of NPPs must describe the adopted process and technology, which shall be validated and verified.

(2) The codes and standards adopted in the design process of Chinese nuclear power plants have been identified and evaluated before their application, in order to confirm their applicability and adequacy and to ensure that the quality satisfies the required safety function.

(3) The manufacture and construction methods are laid down carefully. The staff members are selected correctly and are well trained, their qualification is reviewed. The manufacture and construction of SSCs are done by the domestic and foreign experienced contractors and suppliers. The operating organizations review their contract and supplying capability, engineering experience of manufacturing and construction, and the corresponding files and records that illustrate their qualification.

(4) Design and design improvement of Chinese NPPs

During the report period, Tianwan NPP has been put into commercial operation; Unit 3 and Unit 4 of Qinshan Phase II NPP and Unit 3 and Unit 4 of LingAo NPP have shifted from the civil engineering construction to the equipment installation and system commissioning stage. Following common principles were kept for the design improvement of newly started nuclear power units:

— Meet the requirements of China's nuclear safety regulations and standards;

— Comply with the requirements of nuclear power technology development;

— Consider the constructing and operating experience feedback of similar domestic and foreign units;

— Consider the requirements of weak link improvement put forward by probabilistic safety assessment;

— Make reference to applicable parts of design requirements of the third-generation NPPs AP1000 and EPR and other advanced NPPs in the world.

In accordance with above principles, on the basis of Unit 1 and Unit 2, Unit 3 and Unit 4 of LingAo NPP made 15 significant design improvements and more than 400 minor improvements. Subsequent nuclear power construction projects as Unit 1, Unit 2, Unit 3 and Unit 4 of Hongyanhe NPP, Unit 1 and Unit 2 of Ningde NPP, Unit 1 and Unit 2 of Yangjiang NPP adopted all these improvements. In addition, the 8 units of Hongyanhe NPP, Ningde NPP and Yangjiang NPP also carried out more than 50 important technological improvements.

Unit 1 and Unit 2 of Fuqing NPP and the extension project (Fangjiashan nuclear power project) of Qinshan NPP carried out many important technological improvements according to the special condition of their own and on the basis of taking Unit 1 and Unit 2 of LingAo NPP as the reference plant.

Unit 1 and Unit 2 of Sanmen NPP and Unit 1 and Unit 2 of 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.

Unit 1 and Unit 2 of 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.

5.2.6 Optimized Design for Operating Personnel

The working areas and the working environment of the operating personnel of Chinese NPPs should be optimally designed according to ergonomic principle. The principles mentioned in the Fourth National Report have been kept continuously.

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.

5.2.7 Regulatory Activities of the MEP (NNSA)

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 Unit 2 of Tianwan NPP, and issued the letter of ratification of the first fuel loading;

(2) Organized and completed the nuclear safety review of construction permit documents of 18 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 and carried out nuclear safety surveillance and inspection according to "the Regulations on the Safety Regulation for Civilian Nuclear Equipment" and the supported nuclear safety laws. In addition, MEP(NNSA) organized and completed the registration management and safety inspection and surveillance of some overseas applicants. By the end of 2009, in China there're 140 licensees on design, manufacture, installation and non-destructive testing of the civilian nuclear safety installations, among which 97 licensees of nuclear safety mechanical equipment, 23 licensees of nuclear safety electrical equipment, 4 licensees of non-destructive testing and 16 licensees of installation. There're altogether 88 overseas enterprises that passed the review of the MEP (NNSA) and held the registration confirmation certificate.

(4) Organized and completed the surveillance of important project activities, significant nonconformance items for 20 units under construction during the design and construction period.

5.3 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.

5.3.1 Basic Requirements of Nuclear Power Plant Operation

Basic requirements of the "Code on the Safety of Nuclear Power Plant Operation" issued in 2004 are as follows:

(1) Operating organization of the NPP

As the licensee, the operating organization shall undertake all responsibilities for the safety operation of NPP. The organization structure and responsibilities shall be clearly specified; the competent management and sufficient qualified personnel shall be arranged. In order to guarantee safety operation, mitigate accident result and make correct response to the emergency status under any operation state of the NPP, the

post responsibility, authorization level and liaison channel inside and outside shall be definitely prescribed.

In addition, the code has also specified definitely requirements to operating organizations in aspects of experience feedback, emergency preparation, quality assurance, practicality protection and fire protection safety operation and so on.

(2) Training and qualification of personnel

The operating organization shall define the qualification and experience necessary for personnel performing duties that may affect safety. Suitable qualified personnel shall be selected and given the necessary training and instruction to enable them to perform their duties correctly for the different operating status of the plant and in the event of an accident, in accordance with the appropriate operating or emergency procedures.

(3) Commissioning of NPP

Detailed commissioning program and quality assurance program which specify the implementation and report responsibility, shall be established, the commissioning program shall be approved by National Nuclear Safety Supervision Department. After the National Nuclear Safety Supervision Department ratified the first fuel loading, the operating organization can load nuclear fuel into reactor core for the first time, and carry out the NPP commissioning with nuclear fuel. The operating organization could carry through commissioning of the next phase only after finishing appraisal and inspection to the results of former phase's commissioning, fulfilling all goals and meeting all the management requirements of nuclear safety.

(4) Operational limits and conditions

Operating organization of NPP shall establish operational limits and conditions technologically and in management. The operational limits and conditions shall reflect the final design and be submitted to the National Nuclear Safety Supervision Department for assessment and approval before the operation of NPP. The operational limits and conditions shall contain the requirements for different operating status (including the reactor scram)

The operational limits and conditions shall form an important part of the basis on which the operating organization is authorized to operate the plant. The operators directly responsible for the operation shall be thoroughly familiar with the intent and content of the operational limits and conditions in order to comply with the provisions contained therein.

(5) Operating instructions and procedures

A comprehensive administrative procedure shall be established by NPP which contains the rules for the formulation, improvement, demonstration, acceptance, modification and withdrawal of operating instructions and procedures (hereinafter referred as "procedures").

Before the operation, operating organization of NPP shall establish operating procedures which are completely suitable for normal operation, anticipated operation incidents and accidents, in accordance with the policy of the operating organization and the requirements of the National Nuclear Safety Supervision Department.

A periodic review to the whole procedures shall be made. Any modification shall be informed to operators and other holders of these files. The modification shall comply with the procedures of written instructions, and it only takes effect after approved by the authorized personnel. The operators shall have full knowledge for the procedures and their modified aspects.

Otherwise specified in the procedures, the operators cannot modify actual configuration of NPP (including the temporary modification) before receiving written instruction from the authorized personnel. This modification could deviate operational limits and conditions under no circumstance.

(6) Reactor core management and fuel handling

The operating organization shall be responsible and shall make arrangements for all the activities associated with reactor core management and on-site fuel handling in order to ensure the safe use of the fuel in the reactor and safety in its movement and storage on the site.

Management procedures of fuel and reactor core internals including the removal of new and used fuel, storage on the site and preparation for dispatch from the site, shall be established. Package, transportation and dispatch of the new and used fuel shall accord with related national codes and applicable international regulations

(7) Maintenance, test, surveillance and inspection

The operating organization shall prepare and implement a program of maintenance, testing, surveillance and inspection of those SSCs. This program shall take into account operational limits and conditions as well as any other applicable regulatory requirements and it shall be re-evaluated in the light of operating experience.

(8) Modification

Proposed modification to SSCs, which affect the bases on which the operating license was issued, to the operational limits and conditions, and to procedures and other documents originally approved by the National Nuclear Safety Supervision Department shall be submitted to the MEP (NNSA) for prior approval.

(9) Radiation protection

The operating organization of NPP shall work out and implement radiation protection program The verification of correct implementation and fulfillment of the goal of radiological protection program shall be carried out through supervision, review and inspection. The correction measures shall be adopted if necessary.

(10) Radioactive waste management

The operating organization of NPP shall establish and implement program of radioactive waste management. The limit volume of effluent shall be established, and the discharge methods and procedures shall be monitored and controlled, so as to make discharge accord with regulations. The operating organization shall perform a safety analysis for radioactive discharges which demonstrates that the assessed radiological impacts and doses to the general public are kept as low as reasonably achievable.

(11) Periodic Safety Review (PSR)

Systematic safety reassessments of the plant in accordance with the regulatory requirements shall be performed by the operating organization throughout its operational lifetime. The scope of the PSR shall cover all safety aspects of an operational NPP, including emergency plan, accident management and radiation protection.

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.

5.3.2 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.

5.3.2.1 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 following documents:

— "Final Safety Analysis Report (12 months before the first fuel loading)";

— "Environmental Impact Report of Nuclear Power Plant";

— "Commissioning Program of Nuclear Power Plant (six months before the first fuel loading)";

— Qualification certificates of operators for the nuclear power plant (one month before the first fuel loading);

— "Emergency Response Plan of the Operating Organization of Nuclear Power Plant (six months before the first fuel loading)";

— "Report of the Construction Progress of the Nuclear Power Plant (six months before the first fuel loading)";

— "In-service Inspection Program of the Nuclear Power Plant (six months before the first fuel loading)";

— The results of the pre-service inspection (one month before the first fuel loading);

— "Commissioning Report of Nuclear Power Plant Before Fuel Loading (one month before the first fuel loading)";

— The certificate of the NPP possessing nuclear material (one month before the first fuel loading);

— The list of operation rules of nuclear power plant (one month before the first fuel loading);

— "Maintenance Program of Nuclear Power Plant (six months before the first fuel loading)";

— "Quality Assurance Program of Nuclear Power Plant (commissioning stage)";

The MEP (NNSA) organizes relevant experts to review and assess above mentioned documents 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.

5.3.2.2 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.

5.3.3 Measures Taken to Assure the Operation Safety

5.3.3.1 Safety 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.

(1) The scope of safety analysis includes

— Verification of operation limits and conditions satisfying the requirements for normal operation of nuclear power plant;

— The postulated initiating events related to nuclear power plant design and its location;

— Analysis and evaluation of event sequences resulted from postulated initiating events;

— Comparison of the results of the analyses with the radiological acceptance criteria and design limits;

— Establishment and confirmation of the design criteria;

— Responses of automatic safety systems to anticipated operational incidents and accident conditions.

The applicability of the analysis methods should be verified prior to the safety analysis. The safety analyses of the nuclear power plant design are timely modified according to the significant changes and operating experience of nuclear power plant.

In addition to defining the design bases according to above processes, the probabilities and the consequences of the severe accidents are also considered to achieve following objectives:

— Confirm that the sudden escalation of the consequence of the postulated initiating events may not immediately lead to the design-basis accidents (DBAs).

— Determine those installations which may decrease the probabilities of the severe accidents or mitigate the consequence of the severe accidents.

— Provide suitable emergency procedures, and perform probabilistic safety analyses if necessary.

(2) 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.

5.3.3.2 Establishment and Periodic Revision of Operation Limits and Conditions

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. 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 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.

The operation limits and conditions are reviewed periodically throughout the operating life of the nuclear power plant in the light of accumulated experience and technological developments. The operating organization is responsible for preparing the working procedures to revise operation limits and conditions, and perform the revision of the operation limits and conditions according to the procedures.

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).

5.3.3.3 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) Further promoted the application of Reliability-centered Maintenance Technology (RCM) and carried out RCM analysis and field application to the system; the management system of crucial sensitive equipments has been initially established. Meanwhile the RCM analysis database, the equipment maintenance status witness database of crucial sensitive equipments have been developed by advanced information technology and the equipment management process has been regulated;

(2) Actively promoted the work of equipment aging and lifetime management and established the equipment reliability management system by sourcing information from operating experience.. The IPM (Integrated Program Management) database has been developed and the preventive maintenance system has been established.

(3) Aiming at the outage work, NPPs established preventive measures in advance by applying three-level risk analytical method; the outage risk was well controlled as a whole.

5.3.3.4 Management of the Design Modifications and the Equipment Transformations of the Operating NPP

The modifications of important safety SSCs and the modifications of operation limits and conditions affecting the bases of issuing the operation license, as well as the modifications of the procedures and other documents originally approved by the MEP (NNSA), shall be approved by the MEP (NNSA) before implementation.

Prior to the implementation of the design modifications, the procedures for stipulating and reviewing the modification schemes are prepared by the operating organization of nuclear power plant. The review of the modification schemes is the responsibility of personnel other than the stipulators of the modification schemes.

After implementing the modifications, all drawings and other documents are modified correspondingly to ensure that the drawings and the documents used by the relevant personnel of nuclear power plant are the latest version.

In processing each modification, the requirements of quality assurance related to the design, the purchase of materials and services, the construction, and the management of files, drawings and records, etc. are followed.

In order to strengthen the plan of modifying the engineering and equipment, the priority of the projects is determined to give prominence to the important tasks. The control and the management of the working process are strengthened, and all levels of reviews are rigorously performed to enhance the working quality. Continuous modifications and enhancements of the working procedures of the engineering modifications are performed to improve the availability of these procedures on the

basis of summarizing the past experience and using the successful experience.

The NPPs in China have always paid much attention to the technical innovation of the system and the equipment. The following improvements were made in the past three years:

The Qinshan NPP smoothly implemented several technical modifications including replacing of pressure vessel head and relevant component system and I&C comprehensive modification (reactor protection system and relevant equipments),

The Daya Bay NPP has completed major technical improvements as dead pipe section transformation at the entrance of the residual heat removal system, improvement of preventing boiler effect, rack support improvement of the nuclear island relay and the jet pipe improvement of the emergency diesel engine.

Qinshan Phase II NPP changed the inhibitor type of the cooling water system.

LingAo NPP has completed major technical improvements as die pipe section transformation at the entrance of the residual heat removal system, improvement of preventing boiler effect, refueling machine improvement of nuclear fuel handling and storage system, improvement of K1-class AIR-LB connection of penetration, pipeline test improvement of the containment spray system.

Third Qinshan NPP has completed major technical improvements as improvement of recycling cooling water system and fast switch improvement of the electrical system.

Tianwan NPP has carried out many design changes and key equipment improvement activities such as the change and improvement on the negative pressure ventilation system in annular space of the reactor building and the safety building and integral improvement of rotary sieve.

The NPPs operated in China effectively guarantee their safe and stable operation by continuous technical improvement.

5.3.3.5 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.

The accident response procedures of Qinshan Nuclear Power Plant are designed by reference to the relevant criteria of the similar foreign nuclear power plants. The procedures are composed of the event-oriented optimal recovery procedures, the status trees for judging the conditions of the critical safety function and the symptom-oriented function recovery procedures. The optimal recovery procedures cover the design basis accidents and the multi-failures with high probability. The

function recovery procedures embody the conditions uncovered in the optimal recovery procedures. The optimal recovery procedures instruct the operational personnel to restore the plant from design-basis accidents and multi-failures. A set of systematic means are provided for the operational personnel to cope with the impact to critical safety functions by using the critical safety function recovery procedures and the status trees. By using these two procedures, the operational personnel may continuously monitor the critical safety functions of the plant, conduct the best-recovery operation, and systematically respond to the conditions uncovered in the optimal recovery procedures.

According to the principles for managing the design-basis accidents and the functions of engineering safety features, the accident response procedures of the Daya Bay NPP and the LingAo NPP 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).

Tianwan NPP, Qinshan Phase II NPP and Third Qinshan NPP have amended their accident procedures respectively.

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.

Chinese NPPs actively carried out researches and development on severe accident countermeasures. On the basis of PSA work and with relevant safety research and practice of NPPs of the same kind, Chinese NPPs determined the order of chief events which may cause serious accidents, adopted necessary prevention and mitigation measures on the reasonable and feasible basis, and explored management guideline of serious accidents.

5.3.3.6 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 NPP s, 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 exchange channels with international organizations as IAEA and WANO, Chinese NPPs can get technical supports from the international peers if necessary.

5.3.3.7 Event Reporting System of Operating NPP

According to the requirements of the "Reporting System of Operating Organizations of NPPs", during commissioning and operation, the operating organizations of Chinese nuclear power plants shall report the following events to the MEP (NNSA), the competent department of nuclear industry and other related organizations.

(1) Any event that violates the Technical Specifications of the nuclear power plant.

(2) Any event that brings the characteristics of safety barriers or important equipment of the nuclear power plant to be seriously degraded, or one of the following conditions occurs:

— An unanalyzed working condition that would significantly endanger safety;

— A working condition beyond the design basis of the nuclear power plant;

— A working condition not taken into account by the operation procedures or emergency response procedures of the nuclear power plant;

(3) Any natural event or other external event that would pose actual threat to the safety of the nuclear power plant or clearly hinder site personnel on duty in their performance necessary for the safety operation of the nuclear power plant.

(4) Any event that would result manual or automatic activation of the engineering safety features and the reactor protection system (with the exclusion of the preplanned tests of this kind).

(5) Any event that would prevent the fulfillment of the three basic safety functions of structures or systems and the mitigation of the event consequences.

(6) Any common-cause event that would affect several independent systems, trains or channels with the three basic safety functions and the function of mitigating the event consequences to lose effectiveness simultaneously.

— The shutdown and the maintenance of the safe shutdown conditions,

— Residual heat removal,

— The confinement of radioactivity, and

— The mitigation of the accident consequences.

(7) Any event that would result uncontrolled release of radioactivity.

(8) Any internal event that would pose actual threat to the safety of the nuclear power plant or clearly hinder site personnel in their performance of duties necessary for the safety operation of the nuclear power plant.

(9) Any event that is not covered by the above eight items is defined by the MEP (NNSA), the competent department of nuclear industry, and the operating organization as a significant event important to safety, or the event that is commonly concerned by the public, according to the nature and consequence of the event.

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 4.7.2.2).

Except the above-mentioned 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.

During the three years, there were 49 operational accidents occurred in Chinese NPPs: 6 level I accidents and no Level II or more serious accidents occurred. See Annex 6 for details.

5.3.3.8 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 fourth national report.

Exchanging and sharing operating experience are achieved by Chinese nuclear power plants mainly through the following ways.

(1) Event Report

NPPs establish the reporting system on internal and external events and status according to the requirements of the regulatory body. All information of abnormal operation conditions is collected, classified, screened and analyzed, and the corrective

measures are defined and taken according to the systems of 24-hour event sheet, the notification of internal operational events, operational event report and status report. When an event reaches a degree that it should be reported externally, it shall be reported to the MEP (NNSA), the National Energy Administration, etc., according to the requirements in the corresponding event reporting criteria.

(2) Activities of Competent Department of the Government

The MEP (NNSA) and the National Energy Administration try various ways to enhance the operating experience exchange and carry out operating experience and information exchange and sharing in a larger scope:

— Organize all kinds of academic conferences to carry out experience exchange and publicize operating experience information by publications and websites.

— Support the research and development of major research projects;

— Actively promote the establishment of operating experience exchange system.

(3) Experience Feedback Activities of NPPs

Through various approaches, experience feedback departments of NPPs has collected, screened, analyzed and utilized internal and external operating experience information,

The source of experience feedback includes: abnormal operation conditions occurred in the plant; suggestions on correction actions proposed in the meetings of experience feedback engineers; good practices of the plants; reports on special topics and internal summary material; documents and reports from the MEP (NNSA) and the National Energy Administration; Important information from IAEA and WANO, etc.; technical documentation provided by equipment vendors; information exchanged among the peers with electrical power industry; other meeting information, technical reports and up-to-date technical feedback.

The experience feedback department of each NPP shall adopt diversified and various means to widely spread the operating experience information within the plant. e.g. the intranet and E-mail system of the plant; bulletins, information notifications and reports of the plant; all propaganda pamphlets, periodic magazines and publications of the plant.

The NPPs put emphasis on utilizing the operating experience in routine work, training and evaluation. The main ways include: the hand-over meeting of operation shift; the working plan and the briefings before execution; the regular meeting system of the management level; the formulation and implementation of the outage plan. The operating experience has been used in initial training, retraining and examination for each kind of personnel. By using case study, special topic lectures, simulator exercises, mockup/laboratory exercises, post training and evaluations, the personnel training is effectively combined with the operating experience spreading to improve the training quality and the personnel initiative to participate in accident prevention.

(4) Operating experience exchanges among nuclear power plants

The six operating NPPs in China shall fulfill experience exchange activities of operation periodically every year according to their agreement. Moreover, the NPPs often hold activities of various specific experience exchanges, invite relevant research institutions to join in and strengthen the experience feedback with design organization. All these activities achieve good results.

(5) Positive participation in activities of international nuclear industry

As the members of some international organizations such as IAEA, WANO, COG, FROG, etc., China has actively taken part in all kinds of operating experience exchange activities. China has organized or participated in activities of sub-groups of IAEA Asian Nuclear Safety Network (ANSN), IAEA PRIS/IRS and other relevant activities. Some NPPs in China signed agreements for sister plants with similar foreign NPPs for deep technical exchange and information sharing in many areas.

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. According to the requirements of "Code for Practice of Operating Experience Exchange of Nuclear Power Plants (Trial)" and 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 and other relevant information.

(1) Chinese government hosted some high-level activities as International Ministerial Conference on Nuclear Energy in the 21st century and the International Nuclear Energy Development Forum.

(2) The National Energy Administration and the MEP (NNSA) co-chaired the under-construction and operating experience exchange meeting to promote the institutionalization and standardization of NPP relevant activities.

(3) The MEP (NNSA) established "experience feedback" special column on its official website to deeply analyze events and regularly release and share information.

(4) Aiming at problems with common concern, a series of experience exchange activities on special topics were developed. The contents involved in areas as probability safety analysis, human factor management, severe accident management, welding, nondestructive inspection and oil immersed power transformer.

(5) Technical support organizations developed all kinds of relevant special reports.

5.3.3.9 Control and Storage of the 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 conditions.

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:

(1) Taking following measures to control the amount of gas wastes:

— Avoiding the damage of fuel assemblies through the proper operational modes of the reactor, and unloading the damaged fuel assemblies as soon as possible if practical;

— Decreasing the leakage of the pressure boundary of reactor coolants;

— Keeping impurities in the reactor coolant as the lowest as practically possible.

(2) Taking the following measures to control the amount of the liquid waste:

— Avoiding the damage of fuel assemblies, and unloading the damaged fuel assemblies as soon as possible if practical;

— Deceasing the leakage of the reactor coolant system and other systems;

— Elaborately planning and seriously carrying out the maintenance work, especially emphasizing the prevention measures to avoid enlarging the pollution;

— Taking measures to avoid the contamination of the equipment and the rooms to decrease the times of decontamination;

— Choosing the optimal decontamination procedures;

— Reducing the amount of the secondary waste by means of selecting appropriate waste disposal methods.

(3) Taking the following measures to control the solid waste:

— Meticulously planning and fulfilling the maintenance tasks;

— Carefully controlling the transportation of radioactive substances;

— Effectively manipulating the disposal systems of gaseous and liquid waste;

— Providing procedures to effectively control the contamination;

— Making good isolations of the areas producing wastes.

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. The monitoring includes the measurement of physical and chemical parameters, the discrimination and the activity measurement of radioactive nuclides.

In order to accord with approved limits, the measurement of the effluent discharge is conducted in each discharge point. The discharge amount of the radioactive effluents of Chinese NPPs during operations is far lower than the discharge limits stipulated by the national standards (see Annex 5).

Chinese NPPs have enough facilities to store wastes produced during the normal operation and the anticipated operational occurrences. 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.

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 "Safety Management Regulations of Radioactive Wastes" is under active formulation. 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.

5.3.3.10 Examination 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 2009 are listed in Annex 7.

5.4 Good Practices Relevant to Safety

In order to further improve the nuclear safety level, all relevant organizations do continuously follow international advanced experience and good practices on nuclear safety supervision and management and NPP operating management in order to make the Chinese nuclear safety level keep pace with the international advanced level.

(1) Strengthened the establishment of nuclear and radiation safety regulation system. Made formulation plan or revision plan on nuclear and radiation safety regulation complying with China's actual conditions and brought the revision and perfection of laws and regulations into routine work. Issued a series of new rules and

supporting nuclear safety regulations and constantly perfected the existing nuclear safety law and regulation system.

(2) Strengthened the establishment of management system of regulatory body. Made human resources for supervision suitable for nuclear power development status by adding offices and departments and extending staffing; strengthened safety review and on-site surveillance and inspection by strictly implementing every administrative licensing procedure; arranged various forms of systematical training to continuously strengthen the team development of nuclear safety surveillance and improve nuclear safety surveillance capacity and level.;

(3) Strengthened the surveillance and management of civilian nuclear safety equipment. Issued "Regulations on the Safety Regulations for Civilian Nuclear Equipment" with its supporting regulations and carried out licensing system for enterprises engaged in design, manufacture and installation and non-destructive testing of the civilian nuclear safety equipment and supervised and inspected relevant activities by nuclear safety surveillance department and its assigned organizations; carried out registration management to overseas enterprises engaged in design, manufacture and installation and non-destructive testing activities of the civilian nuclear safety equipment and safety surveillance to imported civilian nuclear safety equipment;

(4) Strengthened the surveillance and management of preliminary work of nuclear power construction projects. The regulatory body should take part in NPP siting in the early period to make comprehensive evaluation of pre-selected sites and attach importance to site resource protection. Pre-selected sites cannot be explored without permission. Strictly control the starting and the construction speed of nuclear power projects;

(5) Promoted the application of PSA technology in China. By mandatory requirements of regulations, MEP(NNSA) constantly promoted the application of probability safety assessment technology in operating NPPs and newly-built NPPs through a series of measures as issuing nuclear safety reviewing principles and probability safety assessment technology policy, making communications between surveillance part and the part being supervised, carrying out special experience exchange and discussion on PSA in nuclear power industry, etc.

(6) Strictly controlled the access system of nuclear power enterprises. Formulated nuclear power development planning and practiced access system of nuclear power enterprises; guided and regulated the development of nuclear power industry in good, quick and safe pace. At present there're 3 enterprises (China National Nuclear Corporation, China Guangdong Nuclear Power Group and China Power Investment Corporation) that obtain permission to construct nuclear power projects and other enterprises can participate in nuclear power construction and operation as equity participating parties;

(7) Actively promoted the specialized construction of nuclear power. Coping with

the quick development situation of nuclear power, every nuclear power corporation integrated and optimized all kinds of resources and founds specialized companies on nuclear power operation, engineering construction and technical service. Shared the resources of the corporation and avoid overlapping input by collectivizing and specialized operations. Made effective management, supervision and coordination on safety, quality, progress and investment to promote the harmonious, healthy and stable development of nuclear power.

(8) Attached great importance to talents training. Took many ways as advanced planning and joint training of "enterprise and university", expanding enrollment scale and vigorously promoting training intensity; developing various nuclear power talents training plan perfecting training system and guarantying resource input to constantly strengthen human resources construction in order to fulfill the talents need in every level of nuclear industry.

(9) Actively carried out domestic and foreign peer review activities. On the basis of orderly carrying out domestic and foreign peer review activities, industry, actively carried out special review activities at corporation's level; study developed the peer review standard of nuclear power engineering construction and made constant improvement by practice. Meanwhile some NPPs accepted the first management review at the preliminary stage of nuclear power project design and construction from IAEA. Industry constantly improved the safe construction, operation and management level of nuclear power by comprehensive and multi-level internal and external review activities.

(10) Actively promoted the standardized construction of nuclear power. Introduced international advanced nuclear power technology at the same time attached great importance to design improvement and technological improvement on second-generation improved nuclear power units and promoted systematized and standardized construction of second-generation improved units in order to constantly improve the safety and reliability of NPPs.

6. PLANNED ACTIVITIES AND THEIR PROGRESS ON IMPROVING NUCLEAR SAFETY

In the future China will further increase the proportion of clean energy in the entire energy structure and strive to make non-fossil energy account for about 15% of primary energy consumption by 2020. The development of clean energy including nuclear power is picking up speed. Nuclear power operation obtains good performance and at the same time great development of nuclear power brings new challenge to China on keeping high-level nuclear safety. Chinese government and the nuclear power industry actively respond to it and plan a series of measures on keeping high-level nuclear safety and promote the synchronous development of nuclear safety surveillance and nuclear power.

6.1 Revision and Improvement of Laws and Regulations Relevant to Nuclear Safety

China will further strengthen the legislation work on special projects of nuclear safety fields, focus on emphasis, and implement step by step to carry out the establishment work on nuclear safety regulation and standard system of nuclear power. Nuclear safety regulatory bodies has formulated the Five-year Plan on nuclear and radiation safety regulations and planned to carry out the legislation work on Safety Management Regulations of Radioactive Wastes, Act of Nuclear Safety, Management Regulations of Nuclear Power and the Atomic Energy Act. Some nuclear safety regulations and guides are under contemplation or under revision and improvement. At the same time study on safety planning of nuclear power is carried out.

6.2 Human Resources

In order to effectively exercise surveillance and management responsibilities of nuclear safety, team construction of nuclear safety surveillance and management organizations should be strengthened. Aiming at the quick development of China's nuclear power and the surveillance status of various reactors and Multi-national technology, Chinese government plans to give much importance to aspects of organizations and staffing. Take full advantage of the experience and technology of domestic and international relevant organizations and personnel; develop and strengthen nuclear safety surveillance capacity by bilateral cooperation or multilateral cooperation.

In pace with increased number of nuclear power units, nuclear safety regulatory bodies increase the staff accordingly. According to the plan, the staff number of the MEP (NNSA) will gradually expand to 1,000. Many ways as training before taking the post, six-month professional training, degree training and communication training

with staff from enterprises are adopted to new members of nuclear safety regulatory bodies to increase their technical capability.

Aiming at the quick development of China's nuclear power, the nuclear power industry needs a lot of high qualified, experienced and professional engineering technical personnel and management personnel, especially compound talents with management and technology experience.

Chinese government and nuclear power corporations formulate active personnel education and training plan through benchmarking and analysis with international nuclear power industry. Take enterprise-university joint training form to realize large-scale pre-training of nuclear professional talents; add the nuclear power major in universities to improve nuclear power personnel supply. Relying on nuclear power construction and operating projects, properly increase staffing; speed up the training of engineering technical personnel to meet different level needs by using stepped personnel training system introduce and train nuclear power research, equipment and high-end service personnel relying on major projects, scientific and technological brainstorm items and international cooperative activities; train senior management personnel by the method of introducing whole set management and training course system with utilizing domestic senior trainers; recruit professional personnel needed by nuclear safety surveillance and management from other domestic industries to augment the nuclear safety surveillance and management team. On the basis of these measures, China will constantly improve the personnel training system to meet the quick development needs of nuclear power as much as possible.

6.3 Improve the Technical Capability of Nuclear Safety Surveillance and Management

Chinese government is speeding up the technical capability construction of nuclear safety surveillance and management by measures as increasing research funding, optimizing nuclear power research system and developing international cooperation. Emphasis should be laid on improving capability of nuclear safety review, independent verification and testing, development and surveillance on research. Improve the surveillance capability of nuclear installations safety, nuclear safety equipment, the monitoring capability of radiation environment, the surveillance capability of radioactive substance transportation, safe disposal of radioactive waste and nuclear technology application. Develop new supervising and managing technology and information system in order to improve the effectiveness of nuclear safety surveillance and management.

In order to carry out surveillance and inspection to the emergency preparedness and the response work of the NPP at different stages, the MEP (NNSA) plans to establish a complete set of Emergency Decision Support and Command & Control System of Nuclear and Radiation Accidents which further improves the emergency respond capacity of nuclear accidents.

6.4 Aging Management of NPPs

Aging management shows its importance along with the increased in-service years of some NPPs. China's nuclear safety regulations the "Code on the Safety of Nuclear Power Plant Design" and the "Code on the Safety of Nuclear Power Plant Operation" make general requirements on the aging management during design and operation stage. "Nuclear safety guide Periodic Safety Review of Nuclear Power" makes specific requirements on the aging management of operating NPPs. By periodic safety review, MEP(NNSA) assesses the safety level of current operating NPPs with current nuclear safety requirements. Every NPP is required to compile aging management program and develop aging management work and actively accumulate aging management experience.

On the basis of ten years' periodic safety review, aging management of Qinshan NPP and Daya Bay NPP is gradually materialized. LingAo NPP, Qinshan Phase II NPP and Third Qinshan NPP are carrying out preparatory work of the ten years' periodic safety review on schedule.

6.5 Application of Probability Safety Assessment Technique

The MEP (NNSA) actively promotes the application of probability safety assessment technique and requires the NPPs in operation to complete level 1 probability safety assessment report, which should be reported to the MEP (NNSA) for review so as to promote the development of the probability safety assessment work of operating NPPs. The nuclear safety regulation the "Code on the Safety of Nuclear Power Plant Design" clearly specifies that the results of deterministic safety analysis and supplementary probability safety analysis, which will protect against accidents and mitigating the consequences by using suitable iteration process, must be taken into consideration. Probability safety assessment has become one of important methods to assess and measure whether a NPP meeting the safety objective and with the reasonable and balanced design.

The MEP (NNSA) makes management requirements of "constantly making improvement and further improving the safety level to make it higher than referenced NPPs" on second-generation improved nuclear power projects. Specified requirements are made to the probability safety assessment in nuclear safety review principles. The probability safety assessment report, as the license application documents, together with the safety analysis report should be submitted for the review of nuclear safety regulatory bodies. Aiming at design ideas and safety concept of the probability safety assessment of the third-generation pressurized water reactor AP1000 item, it is required to describe the key details of the probability safety assessment and severe accidents in Chapter 19 of the safety analysis report and separate detailed probability safety assessment report should be submitted for the review of nuclear safety regulatory bodies. To the third-generation pressurized water

reactor EPR item, relevant provisions of nuclear safety regulations issued by the Chinese government should be observed likewise.

The MEP (NNSA) has initially established the operating safety performance indicator system of NPPs, and gradually promotes the application of the risk-informed technology in NPPs, and studies and formulates relevant documents on risk-informed safety management of operating NPPs.

6.6 Publicizing and Popularizing of Nuclear Power and Nuclear Safety Knowledge

The Chinese government shall establish more extensive connection channels to carry out more effective public propaganda education and popularize nuclear power knowledge among the public on information disclosure and public participation. Holding briefing conferences of nuclear power safety status with the participation of social media at proper time to improve the public participation level in NPP siting, design, construction and operation section; strengthening the public propaganda of nuclear power and the publicity of nuclear power science and establish special science areas on nuclear power safety in science and technology centers above the provincial level; publicity activities of nuclear power safety should be well done by the mass media as TV and broadcast; providing open visit day of NPPs for the public and NPP personnel shall explain nuclear power safety knowledge to the public.

Annex 1 The List of Nuclear Power Plants in China (by December 31, 2009)

NPP Name		Unit No.	Reactor Type	Nominal Power MW(e)	Date of the Construction	Date of the First Connection to the Grid	Date of Commercial Operation
Qinshan NPP		CN-01	PWR	310	1985-03-21	1991-12-15	1994-04-01
Daya Bay NPP	Unit 1	CN-02	PWR	2×984	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	2×650	1996-06-02	2002-02-06	2002-04-15
	Unit 2	CN-05			1997-04-01	2004-03-11	2004-05-03
LingAo NPP	Unit 1	CN-06	PWR	2×990	1997-05-15	2002-02-26	2002-05-28
	Unit 2	CN-07			1997-11-28	2002-09-14	2003-01-08
Third Qinshan NPP	Unit 1	CN-08	CANDU	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	2×1060	1999-10-20	2006-05-12	2007-05-17
	Unit 2	CN-11			2000-09-20	2007-05-14	2007-08-16
LingAo NPP	Unit 3	CN-12	PWR	2×1080	2005-12-15		
	Unit 4	CN-13			2006-06-15		
Qinshan Phase II NPP	Unit 3	CN-14	PWR	2×650	2006-04-28		
	Unit 4	CN-15			2007-01-28		
Hongyanhe NPP	Unit 1	CN-16	PWR	4×1080	2007-08-18		
	Unit 2	CN-17			2008-03-28		
	Unit 3	CN-18			2009-03-07		
	Unit 4	CN-19			2009-08-15		
Ningde NPP	Unit 1	CN-20	PWR	2×1080	2008-02-18		
	Unit 2	CN-21			2008-11-12		

Fuqing NPP	Unit 1 Unit 2	CN-22 CN-23	PWR	2×1080	2008-11-21 2009-06-17		
Yangjiang NPP	Unit 1 Unit 2	CN-24 CN-25	PWR	2×1080	2008-12-16 2009-06-04		
Extension Project of Qinshan NPP(Fangjiashan Nuclear Power Project)	Unit 1 Unit 2	CN-26 CN-27	PWR	2×1080	2008-12-26 2009-07-29		
Sanmen NPP	Unit 1 Unit 2	CN-28 CN-29	PWR	2×1250	2009-03-29 2009-12-15		
Haiyang NPP	Unit 1 Unit 2	CN-30	PWR	2×1250	2009-09-24		
Taishan NPP	Unit 1 Unit 2	CN-31	PWR	2×1700	2009-11-18		

Note: Data of nuclear power plants in Taiwan Province of China is left open for the time being.

Annex 2 Performance Indicators of Operational Units (from 2007 to 2009)

Table 1 ***Performance Indicators of Operational Units (2007)***

NO.	Item \ Year / Unit		2007								
			Qinshan NPP	Daya Bay NPP		Qinshan Phase II NPP		LingAo NPP		Third Qinshan NPP	
			CN1	CN2	CN3	CN4	CN5	CN6	CN7	CN8	CN9
1	Unit Capability Factor (%)		82.22	91.20	88.80	64.12	88.30	83.16	87.73	86.42	97.55
2	Unplanned Capability Loss Factor (%)		0.08	0.21	2.27	0.00	0.00	6.59	3.55	0.82	0．00
3	Automatic Scrams per 7,000 Hours Critical (Times)		0.00	0.00	1.76	0.00	0.00	0.00	0.89	0.00	0.00
4	Collective Radiation Exposure (Man·Sv)		0.997	0.527	0.527	0.393	0.393	0.615	0.615	0.286	0.286
5	Safety System Performance:	High-Pressure Safety Injection System	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0001
		Auxiliary Feed-Water System	0.0001	0.0004	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0096
		Emergency AC Supply System	0.0004	0.0004		0.0013		0.0003		0.0032	
6	Fuel Reliability (Bq/g)		0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
7	Chemistry Performance		1.01	1.00	1.00	1.01	1.01	1.00	1.02	1.00	1.06
8	Industrial Safety Accident Rate		0.19	0.00		0.08		0.11		0.07	
9	Forced Loss Rate (%)		0.10	0.23	0.90	0.00	0.00	0.02	3.89	0.94	0.00
10	Grid Related Loss Factor (%)		0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Contractor Industrial Safety Accident Rate		0.00	0.33		0.00		0.00		0.00	

Table 2 ***Performance Indicators of Operational Units (2008)***

No.	Item \ Unit \ Year		2008										
			Qinshan NPP	Daya Bay NPP		Qinshan Phase II NPP		LingAo NPP		Third Qinshan NPP		Tianwan NPP	
			CN1	CN2	CN3	CN4	CN5	CN6	CN7	CN8	CN9	CN10	CN11
1	Unit Capability Factor (%)		95.55	99.79	86.25	85.35	85.21	92.11	85.42	91.21	87.32	70.97	81.2
2	Unplanned Capability Loss Factor (%)		2.99	0.19	4.73	0.48	0.31	0.08	0.17	0.00	0.48	2.65	0.03
3	Automatic Scrams per 7,000 Hours Critical (Times)		0.82	0.00	0.91	0.00	0.92	0.00	0.00	0.00	0.00	1.10	0.00
4	Collective Radiation Exposure (Man·Sv)		0.149	0.413	0.413	0.294	0.294	0.886	0.886	0.394	0.394	0.279	0.279
5	Safety System Performance	High-Pressure Safety Injection System	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
		Auxiliary Feed-Water System	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Emergency AC Supply System	0.0005	0.0010		0.0073		0.0004		0.0006		0.0013	
6	Fuel Reliability (Bq/g)		0.037	0.037	0.037	0.037	0.037	0.142	141.603	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	0.00		0.00		0.00		0.00		0.00	
9	Forced Loss Rate (%)		1.02	0.19	5.20	0.18	0.36	0.09	0.20	0.00	0.55	3.60	0.03
10	Grid Related Loss Factor (%)		0.16	0.05	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
11	Contractor Industrial Safety Accident Rate		0.24	0.00		0.00		0.00		0.15		0.08	

Table 3 ***Performance Indicators of Operational Units (2009)***

No.	Item \ Year / Unit		2009										
			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 (%)		87.43	91.23	99.99	82.66	88.21	90.38	91.09	91.93	95.37	74.12	80.70
2	Unplanned Capability Loss Factor (%)		1.96	0.01	0.00	0.62	0.55	0.63	0.01	0.00	0.00	0.73	0.02
3	Automatic Scrams per 7,000 Hours Critical (Times)		0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
4	Collective Radiation Exposure (Man·Sv)		0.453	0.63	0.08	0.355	0.355	0.86	0.67	0.374	0.374	0.274	0.274
5	Safety System Performance:	High-Pressure Safety Injection System	0.0000	0.0000	0.0000	0.0004	0.0006	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000
		Auxiliary Feed-Water System	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000
		Emergency AC Supply System	0.0000	0.0000		0.0141		0.0001		0.0002		0.0000	
6	Fuel Reliability (Bq/g)		0.037	0.037	0.037	0.037	0.037	0.037	16.779	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	0.00		0.00		0.00		0.00		0.00	
9	Forced Loss Rate (%)		2.19	0.02	0.00	0.74	0.62	0.69	0.02	0.00	0.00	0.97	0.02
10	Grid Related Loss Factor (%)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.00	0.00
11	Contractor Industrial Safety Accident Rate		0.20	0.00		0.06		0.00		0.09		0.00	

Annex 3 Laws, Regulations and Guides of China on Nuclear Safety

(By the end of December 31, 2009)

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)

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

   (Promulgated by the State Council on October 29, 1986)

2. Regulations on Nuclear Materials Control of the People's Republic of China

   (Promulgated by the State Council on June15, 1987)

3. Emergency Management Regulations for Nuclear Accidents of Nuclear Power Plant

   (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 for the Safety Transport of Radioactive Material

(Promulgated by the State Council on September 14, 2009)

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 Siting (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. Standard of Surveillance of Environmental Radiological Health and Public Health Survey

    (Issued by Ministry of Health, 1985)

19. Management Rules of the Radiological Health Protection of Nuclear Installations

    (No. 25 Decree by Minister, Issued by the Ministry of Health, 1992)

20. Surveillance and Evaluation Standard of the Public Dose During Normal Operation and Accident Condition of Nuclear Installation

    (Issued by Ministry of Health, 1992)

21. Management Rules of the Medical Emergency Response under Nuclear Accident

    (No. 38 Decree by Minister, Issued by the Ministry of Health, 1994)

22. Intervention to the Public Protection and the Derived Intervention Level During Nuclear Accident or Radiation Emergency

    (Issued by Ministry of Health, 1995)

23. Management Rules of the Safety of Electricity Production of NPP Connected to the Grid

    (Issued by the Ministry of Electric Power Industry on April 28, 1997)

24. Management Methods for License Examination of Operators of NPP (Tryout)

    (Issued by China Atomic Energy Authority on September 6, 1999)

25. Management Rules for Review and Approval for Transfer and Transit Transportation of Nuclear Products(Tryout)

    (Issued by China Atomic Energy Authority on January 27, 2000)

26. The Basic Standard on the Ionization Radiation Protection and Radioactive Source Safety (GB18871-2002)

    (Issued by General Administration for Quality Supervision, Inspection and Quarantine)

27. Reporting System of Nuclear Accident Emergency for NPP

    (Issued by China Atomic Energy Authority on December 11, 2001)

28. Specifications on Medical Treatment of Radiation Damage

    (Issued by the Ministry of Health, China Atomic Energy Authority on May 22, 2002)

29. Management Rules of Emergency Crossing the Boundary for Radioactive Influence due to Nuclear Accident

    (issued by China Atomic Energy Authority in 2002)

30. Management Methods for Operation Assessment of NPP (Tryout)

    (Issued by China Atomic Energy Authority on June 4, 2002)

31. Management Rules of Nuclear Accident Emergency Exercise for NPP

    (Issued by China Atomic Energy Authority on February 28, 2003)

32. Management Rules of Operating Experience Exchange for NPPs (Tryout)

    (Issued by China Atomic Energy Authority on April 4, 2005)

33. Supervision and Management Rules on Firefighting Safety of NPPs

    (Issued by China Atomic Energy Authority on December 20, 2006)

34. Management Methods for Occupational Health of Radioactive Workers

    (No.55 Decree Issued by Ministry of Health, on June 3, 2007)

35. Rules on Management of Special Revenue for Emergency Preparedness of Nuclear Accident

    (Jointly Promulgated by the Ministry of Finance and the China Atomic Energy Authority, on July 29, 2007)

IV. Guiding Documents (Safety Guide)
Series for General

1. Emergency Preparedness for The Operating Organization of Nuclear Power Plant (HAD002/01)

   (Issued by NNSA on August 12, 1989)

2. Emergency Preparedness of Local Government for Nuclear Power Plant (HAD002/02)

   (Issued by NNSA, the National Environmental Protection Administration and the Ministry of Health on May 24, 1990)

3. Interfering Principles and Levels for Public Protection During the Emergency of Nuclear Accidental Radiation (HAD002/03)

   (Issued by NNSA, the National Environmental Protection Administration on April 19, 1991)

4. Levels of Derived Intervention of Public Protection During the Emergency of Nuclear Accident Radiation (HAD002/04)

   (Issued by NNSA, the National Environmental Protection Administration on April 19, 1991)

5. Emergency Preparedness and Response of Medicine During Nuclear Accident

(HAD002/05)

(Issued the Ministry of Health and NNSA on June 24, 1992)

6. Preparation of the Quality Assurance Program for Nuclear Power Plants (HAD003/01)

   (Issued by NNSA on October 6, 1988)

7. Quality Assurance Organization for Nuclear Power Plants (HAD003/02)

   (Issued by NNSA on April 13, 1989)

8. Quality Assurance in the Procurement of Items and Service for Nuclear Power Plants (HAD003/03)

   (Issued by NNSA on October 30, 1986)

9. Quality Assurance Record System for Nuclear Power Plants (HAD003/04)

   (Issued by NNSA on October 30, 1986)

10. Quality Assurance Audit for Nuclear Power Plants (HAD003/05)

    (Issued by NNSA on January 28, 1988)

11. Quality Assurance in the Design of Nuclear Power Plants (HAD003/06)

    (Issued by NNSA on October 30, 1986)

12. Quality Assurance During the Construction of Nuclear Power Plants (HAD003/07)

    (Issued by NNSA on April 17, 1987)

13. Quality Assurance in the Manufacturing of Items for Nuclear Power Plant (HAD003/08)

    (Issued by NNSA on October 30, 1986)

14. Quality Assurance During Commissioning and Operation of Nuclear Power Plants (HAD003/09)

    (Issued by NNSA on January 28, 1988)

15. Quality Assurance in the Procurement, Design and Manufacture of Nuclear Fuel Assemblies (HAD003/10)

    (Issued by NNSA on April 13, 1989)

16. Guide for Nuclear Emergency—Protective Actions and Recovery Decision for Post-Emergency of Serious Accident

    (Issued by National Atomic Energy Authority on September 28, 2000)

17. Emergency Preparedness and Response for Transportation Accident of

Radioactive Materials

(Issued by National Atomic Energy Authority on September 28, 2000)

18. Format and Content of Report of Environment Impact of Nuclear Power Plant (NEPA RG-1)

(Issued by the NEPA in1997)

Series for NPP

19. Earthquakes and Associated Topics in Relation to Nuclear Power Plant Siting (HAD101/01)

(Issued by NNSA and the National Seismic Administration on April 6, 1994)

20. Atmospheric Dispersion in Relation to Nuclear Power Plant Siting (HAD101/02)

(Issued by NNSA on November 20, 1987)

21. Site Selection and Evaluation for Nuclear Power Plant with Respect to Population Distribution (HAD101/03)

(Issued by NNSA on November 20, 1987)

22. External Man-induced Events in Relation to Nuclear Power Plant Siting (HAD101/04)

(Issued by NNSA on November 28, 1989)

23. Hydrological Dispersion of Radioactive Material in Relation to Nuclear Power Plant Sitting (HAD101/05)

(Issued by NNSA on April 26, 1991)

24. Nuclear Power Plant Sitting - Hydrogeological Aspects (HAD101/06)

(Issued by NNSA on April 26, 1991)

25. Site Survey for Nuclear Power Plants (HAD101/07)

(Issued by NNSA on November 28, 1989)

26. Determination of Design Basis Floods for Nuclear Power Plants on River Sites (HAD101/08)

(Issued by NNSA on July 12, 1989)

27. Determination of Design Basis Floods for Nuclear Power Plants on Coastal Sites (HAD101/09)

(Issued by NNSA on May 19, 1990)

28. Evaluation of Extreme Meteorological Events for Nuclear Power Plant Sitting

(HAD101/10)

(Issued by NNSA on April 26, 1991)

29. Design Basis of Tropical Cyclone for Nuclear Power Plants (HAD101/11)

(Issued by NNSA on April 26, 1991)

30. Safety Aspects of the Foundation of Nuclear Power Plants (HAD101/12)

(Issued by NNSA on February 20, 1990)

31. General Design Safety Principles for Nuclear Power Plants (HAD102/01)

(Issued by NNSA on July 12, 1989)

32. Seismic Analysis and Testing of Nuclear Power Plant (HAD102/02)

(Issued by NNSA on May 13, 1996)

33. Safety Functions and Component Classification for BWR, PWR, and Pressure Tube Reactor (HAD102/03)

(Issued by NNSA on October 30, 1986)

34. Protection against Internally Generated Missiles and Their Secondary Effects in Nuclear Power Plants (HAD102/04)

(Issued by NNSA on October 30, 1986)

35. External Man-induced Events in Relation to Nuclear Power Plant Design (HAD102/05)

(Issued by NNSA on November 28, 1989)

36. Design of the Reactor Containment Systems in Nuclear Power Plants (HAD102/06)

(Issued by NNSA on May 19, 1990)

37. Design for Reactor Core Safety in Nuclear Power Plants (HAD102/07)

(Issued by NNSA on July 12, 1989)

38. Reactor Cooling Systems and Their Related Systems in Nuclear Power Plants (HAD102/08)

(Issued by NNSA on April 13, 1989)

39. Ultimate Heat Sink and Directly Associated Heat Transport Systems for Nuclear Power Plants (HAD102/09)

(Issued by NNSA on April 17, 1987)

40. Protection System and Related Facilities in Nuclear Power Plants (HAD102/10)

(Issued by NNSA on October 6, 1988)

41. Fire Protection in Nuclear Power Plants (HAD102/11)

    (Issued by NNSA on May 13, 1996)

42. Design Aspects of Radiation Protection for Nuclear Power Plants (HAD102/12)

    (Issued by NNSA on May 19, 1990)

43. Emergency Power Systems at Nuclear Power Plants (HAD102/13)

    (Issued by NNSA on February 13, 1996)

44. Safety-related Instrumentation and Control Systems for Nuclear Power Plants (HAD102/14)

    (Issued by NNSA on October 6, 1988)

45. Fuel Handling and Storage System Design in Nuclear Power Plants (HAD102/15)

    (Promulgated by NNSA on January 23, 2007)

46. Safety Important System Software of Nuclear Power Plants Based on Computer (HAD102/16)

    (Issued by NNSA on December 8, 2004)

47. Safety Assessment and Verification of Nuclear Power Plant (HAD102/17)

    (Issued by NNSA on June 5, 2006)

48. Operation Limits, Conditions and Procedures of Nuclear Power Plant (HAD103/01)

    (Issued by NNSA on December 8, 2004)

49. Commissioning Procedures for Nuclear Power Plants (HAD103/02)

    (Issued by NNSA on April 17, 1987)

50. Core and Fuel Management for Nuclear Power Plants (HAD103/03)

    (Issued by NNSA on November 28, 1989)

51. Radiation Protection During Operation of Nuclear Power Plants (HAD103/04)

    (Issued by NNSA on May 19, 1990)

52. Staffing, Recruitment, Training and Authorization for Personnel of Nuclear Power Plants (HAD103/05)

    (Issued by NNSA on February 13, 1996)

53. Organization and Safety Operation Management of Nuclear Power Plants Operating Organization (HAD103/06)

    (Issued by NNSA on June 5, 2006)

54. In-service Inspection for Nuclear Power Plants (HAD103/07)

    (Issued by NNSA on October 6, 1988)

55. Maintenance of Nuclear Power Plants (HAD103/08)

    (Issued by NNSA on June 1, 1993)

56. Surveillance of Items Important to Safety in Nuclear Power Plants (HAD103/09)

    (Issued by NNSA on June 1, 1993)

57. Fire Protection Safety of Nuclear Power Plants Operation (HAD103/10)

    (Issued by NNSA on December 8, 2004)

58. Periodic Safety Review of Nuclear Power Plants (HAD103/11)

    (Issued by NNSA on June 5, 2006)

Series for Nuclear Fuel Cycle Facility

59. Standard Format and Content of Safety Analysis Report of Uranium Fuel Processing Facility (HAD301/01)

    (Promulgated by NNSA on July 24, 1991)

60. Design of Storage Facilities for Spent Fuel (HAD301/02)

    (Issued by NNSA on July 10, 1998)

61. Operation of Storage Facilities for Spent Fuel (HAD301/03)

    (Issued by NNSA on July 10, 1998)

62. Safety Evaluation of Storage Facilities for Spent Fuel (HAD301/04)

    (Issued by NNSA on July 10, 1998)

Series for Radioactive Waste Management

63. Management of Radioactive Effluents and Wastes in Nuclear Power Plants (HAD401/01)

    (Issued by NNSA on May 19, 1990)

64. Design of Radioactive Waste Management System for NPP (HAD401/02)

    (Issued by NNSA on January 16, 1997)

65. Design and Operation of Incinerators of Radioactive Waste (HAD401/03)

    Issued by NNSA on February 15, 1997)

66. Classification of Radioactive Waste (HAD401/04)

    (Issued by NNSA on July 6, 1998)

67. Siting for Near Global Surface Disposal Site of Radioactive Waste (HAD401/05)

    (Issued by NNSA on July 6, 1998)

68. Siting for Geology Disposal Warehouse of Radioactive Waste (HAD401/06)

    (Issued by NNSA on July 6, 1998)

Series for Regulation of Nuclear Material

69. Nuclear Material Accounting in Conversion of Low Enriched Uranium and Component Manufacturer(HAD501/01)

    (Issued by NNSA on September 23, 2008)

70. Physical Protection of Nuclear Installations (Tryout) (HAD501/02)

    (Issued by NNSA on September 23, 2008)

71. Surrounding Intrusion Alarm System of Nuclear Installations(HAD501/03)

    (Issued by NNSA on July 25, 2005)

72. Access Control of Nuclear Installations (HAD501/04)

    (Issued by NNSA on September 23, 2008)

73. Physical Protection of Nuclear Material Transportation (HAD501/05)

    (Issued by NNSA on September 23, 2008)

74. Standard Format and Content of Physical Protection of Nuclear Installations, Nuclear Material Accounting and Safety Analysis Report (HAD501/06)

    (Promulgated by NNSA on September 23, 2008)

75. Nuclear Material Accounting of Nuclear Power Plants (HAD501/07)

    (Issued by NNSA on September 23, 2008)

Annex 4 Occupational Exposure of NPPs in China(From 2007 to 2009)

NPP \ Item / Year		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	2007	0.650	8.450	0.997	0.450
	2008	0.153	3.577	0.149	0.057
	2009	0.336	4.257	0.453	0.192
Daya Bay NPP	2007	0.378	9.476	1.053	0.068
	2008	0.307	5.988	0.826	0.051
	2009	0.278	5.240	0.715	0.044
Qinshan Phase II NPP	2007	0.347	8.164	0.785	0.088
	2008	0.300	4.881	0.588	0.059
	2009	0.345	7.899	0.710	0.071
LingAo NPP	2007	0.456	8.533	1.231	0.083
	2008	0.600	12.169	1.772	0.116
	2009	0.502	10.586	1.531	0.099
Third Qinshan NPP	2007	0.277	5.900	0.572	0.0495
	2008	0.364	9.102	0.788	0.0701
	2009	0.327	6.415	0.748	0.0638
Tianwan NPP	2007	0.136	2.693	0.327	0.0326
	2008	0.209	3.460	0.557	0.0396
	2009	0.244	3.200	0.548	0.0384

Annex 5 Percent (%) of Radioactive Effluents to the Annual Discharge Limits Set by National Standards(From 2007 to 2009)

NPP \ Item / Year		Gaseous Effluents			Liquid Effluents	
		Noble gas	Halogen	Aerosol	Tritium	Other Nuclides
Qinshan NPP	2007	1.40E-01	5.75E-03	2.18E-03	2.43E+00	7.55E-02
	2008	2.24E-01	1.60E-02	5.45E-03	1.92E+00	4.81E-02
	2009	1.74E-01	1.28E-02	4.25E-03	2.47E+00	7.53E-02
Daya Bay NPP	2007	6.20E-02	9.30E-03	1.97E-03	4.74E+01	1.44E-01
	2008	5.08E-02	5.33E-03	1.23E-03	4.37E+01	7.45E-02
	2009	4.36E-02	5.73E-03	1.31E-03	3.99E+01	6.68E-02
Qinshan Phase II NPP	2007	1.88E-01	5.36E-03	5.75E-04	1.58E+01	3.95E-01
	2008	3.22E-01	3.17E-03	6.10E-04	2.48E+01	3.91E-01
	2009	3.47E-01	3.09E-03	8.50E-04	1.90E+01	1.89E-01
LingAo NPP	2007	5.52E-02	7.53E-03	2.99E-03	3.15E+01	3.37E-02
	2008	2.34E-01	3.48E-02	2.24E-03	3.38E+01	2.87E-02
	2009	4.44E-02	1.67E-02	1.89E-03	3.25E+01	3.40E-02
Third Qinshan NPP	2007	6.00E-02	4.75E-04	1.03E-03	*	2.12E-01
	2008	8.72E-02	7.81E-04	1.38E-03	*	3.88E-01
	2009	1.00E-01	8.69E-04	1.38E-03	*	5.65E-01
Tianwan NPP	2007	3.00E-01	3.25E-02	4.04E-03	7.47E+00	5.57E-01
	2008	1.60E-01	5.53E-03	1.62E-02	1.18E+01	6.35E-01
	2009	1.51E-01	1.01E-02	3.42E-03	1.37E+01	3.88E-01

Notes:

1. *The discharge of radioactive effluents is related to the power level of nuclear unit.*
2. *In calculating gaseous effluents and liquid effluents, for a value below the detectable limit, Tianwan NPP assumes it the detectable limit and other NPPs assume it half the detectable limit.*
3. ** At present, there is no release limit of tritium set by the national standards（GB6249-86）for CANDU reactor, so the percentage of tritium is not listed here.*

Annex 6 NPP Operational Events (From 2007 to 2009)

Statistic Table of NPP Operational Events from 2007 to 2009

Plant \ INES Level		0			1			≥2		
		2007	**2008**	**2009**	**2007**	**2008**	**2009**	**2007**	**2008**	**2009**
Qinshan NPP		3	3	1	1	0	0	0	0	0
Daya Bay NPP	Unit 1	0	0	2	1	0	0	0	0	0
	Unit 2	1	1	0	2	0	0	0	0	0
Qinshan Phase II NPP	Unit 1	0	2	0	0	0	0	0	0	0
	Unit 2	0	3	0	0	0	0	0	0	0
LingAo NPP	Unit 1	2	1	1	0	0	0	0	0	0
	Unit 2	3	1	0	1	0	0	0	0	0
Third Qinshan NPP	Unit 1	2	1	0	0	0	0	0	0	0
	Unit 2	0	3	0	0	0	0	0	0	0
Tianwan NPP	Unit 1	6	1	3	1	0	0	0	0	0
	Unit 2	1	1	1	0	0	0	0	0	0
Total		18	17	8	6	0	0	0	0	0

Annex 7 Licensed Reactor Operators and Senior Reactor Operators

(By the End of 2009)

Items \ Plant		Qinshan NPP	Daya Bay NPP	Qinshan Phase II NPP	LingAo NPP	Third Qinshan NPP	Tianwan NPP
Reactor Operators (RO)	Number of RO	32	51	50	59	41	42
Senior Reactor Operators (SRO)	Number of SRO	24	67	76	60	40	57