

NUCLEAR SAFETY REGULATION  
IN THE PEOPLE'S REPUBLIC OF CHINA

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ABSTRACT

The present report gives a general view of how the problem of nuclear safety is dealt with in China, with particular reference to the nuclear power plants.

The most relevant nuclear legal regulations and procedures are reported. Organization of the National Nuclear Safety Administration (NNSA) of China and its working activities are presented. The report gives also the principle and practice with regard to licensing process and regulatory inspection of nuclear power plant in China.

A general outline of research and development programs and activities after Chernobyl accident is also discussed.

INTRODUCTION

China possesses abundant coal and water resources, but they are unevenly distributed. The serious shortage of energy in the coastal areas with relatively developed industry and agriculture, such as East China, Guangdong and Liaoning provinces, has seriously affected the economic growth. Therefore, the Chinese government has formulated its energy policy of developing nuclear power step by step while making major efforts to develop thermal and hydro power. Two nuclear power plants are being built in East China and Guangdong province.

China gives first priority to the safety of the people in the peaceful use of nuclear energy. The goal is to ensure safety and to protect the plant staff, the public and the environment from adverse effects during the construction and operation of civilian nuclear installations as well as the application and

handling of nuclear material and radioactive substances. For this purpose, the State Council put forward the guiding principle in the nuclear power development: Safety First and Quality First.

NUCLEAR SAFETY LEGISLATIONS

Since 1982, some relevant departments started research and compilation of nuclear safety regulations. After its establishment the National Nuclear Safety Administration has been assigning the task of organizing the relevant departments to study and enact nuclear safety regulations. Up to now, a system of the nuclear safety regulations has been identified and a plan worked out. The nuclear safety regulations of the People's Republic of China, subordinated to the system of "Atomic Energy Act". The draft of the "Atomic Energy Act" has been worked out and comments are being sought thereon.

Similar to other countries, China's nuclear safety regulations system is divided into two main categories, namely the administrative regulations and standards and criteria.

A. Administrative Regulations

Nuclear safety surveillance and control regulations -- They specify some important issues such as the scope of regulation, regulatory body and its functions, principles and procedures of the surveillance, etc. They are legal documents issued by the State Council.

Implementation Rules -- They are legal documents issued by the NNSA which specify the details concerning implementation in accordance with the nuclear safety surveillance and control regulations.

Nuclear safety codes -- They are

regulations approved by the State Council and issued by the NNSA, specifying safety goals and basic safety requirements. They are also legal documents.

Nuclear safety guides -- They are non-mandatory documents used as a guidance to state or supplement the codes or to recommend methods and procedures. When some other methods and procedures not covered in the guides are adopted, then their safety shall be demonstrated to the NNSA.

"Regulations on Surveillance and Control of Civilian Nuclear installations of the People's Republic of China" was promulgated on October 29, 1986 by the State Council. In accordance with the Regulations, the NNSA will issue details for implementation. They are "Application and Issuance of Safety Licence of Nuclear Power Plant" and "Safety Inspection and Enforcement for Nuclear Power Plant", etc.

Before that, "Safety Code for Nuclear Power Plant Siting", "Safety Code for Design of Nuclear Power Plant", "Safety Code for Operation of Nuclear Power Plant" and "Safety Code for Quality Assurance of Nuclear Power Plant" were approved by the State Council and issued by the NNSA on July 7, 1986. The NNSA will successively issue forty nine Safety Guides for interpreting and supplementing the above mentioned safety codes.

Nuclear safety regulations that are now under review and are being enacted are "Regulations on the Control of Nuclear Material", "Regulations on Radiation Protection", "Regulations on Compensation for Nuclear Damage", "Regulations on Emergency Response of Nuclear Installations", "Safety Code for Operation of Research Reactor", "Safety Code for Accelerator", "Safety Code for Nuclear Heating Reactor", "Safety Code for Radioactive Waste Management" and "Safety Code for Handling of Radioactive Substance", etc.

#### B. Standard and Criteria

They are subordinated to the system of national technical standards, classified in accordance with National Standards. The NNSA reviews those standards which are directly related to nuclear safety.

As to standards and criteria, we shall follow the international practice, provided they conform to China's nuclear

safety codes. It is allowed to use those standards and criteria which were approved by the nuclear safety authorities of equipment supplier countries and are effective at the time of import. For the nuclear power plants designed and constructed by China, it is allowed to select standards and criteria by the operating organizations themselves, but the standards and criteria must be reported to the NNSA for examination and approval.

China's nuclear safety codes are enacted on the basis of widely investigating and reviewing the experience of other countries, including the United States, France, Federal Republic of Germany, Japan, United Kingdom, Romania, Finland etc., and taking into consideration of our national conditions. For those safety codes such as siting, design, operation and quality assurance of nuclear power plant, with regard to the technical requirements, we referred more to the IAEA's codes of practice for nuclear power plant. The scientific nature, strictness and reliability of those codes are similar to the advanced ones of the western nuclear developed countries.

#### NUCLEAR SAFETY REGULATORY ORGANIZATIONS

The organizations involved in nuclear safety regulation in China are illustrated in Fig. 1.

#### National Nuclear Safety Administration

Upon approval by the State Council, the National Nuclear Safety Administration (NNSA) was established in October 1984. On behalf of the State Council, the NNSA exercises its functions and powers of independent surveillance and control with regard to all issues relevant to safety of civilian nuclear installations and materials, as well as to the radiation protection within China. The NNSA reports directly to the State Council and its main responsibilities are the following:

A. To enact regulations codes and guides for nuclear safety and radiation protection in collaboration with other departments and to conduct review of technical standards related to safety.

B. To review and assess the safety of nuclear installations and capabilities of the applicants with regard to ensuring safety, and in accordance with the regulations to take relevant official actions for issuance of licences or

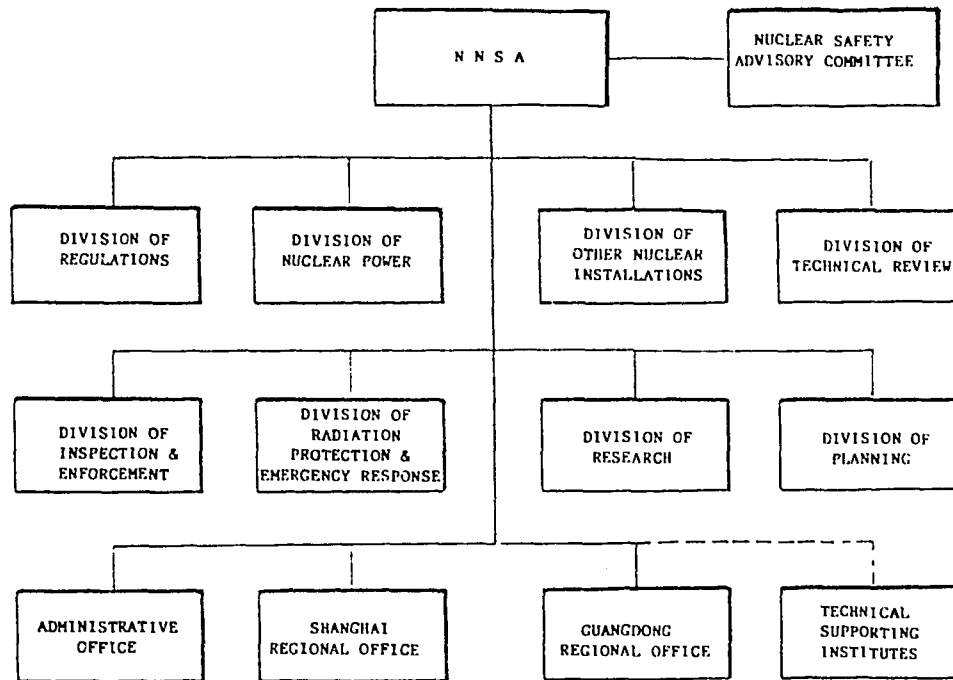


FIG.1: ORGANIZATION OF NUCLEAR SAFETY REGULATION IN CHINA

refusal of such authorizations.

C. To conduct regulatory inspection on nuclear installations, nuclear materials and radiation protection.

D. To assess and provide information of any nuclear accident and its radiological consequences, and to settle disputes related to nuclear safety if any.

E. To develop and implement research programs which are deemed necessary for its regulatory functions and for nuclear safety in general, including those within the framework of the national scientific and technological development program.

F. To develop policy related to nuclear safety and to conduct dissemination, public education and training in the area of nuclear safety.

G. To develop and coordinate international activities in the area of nuclear safety, and to negotiate and implement nuclear safety agreements with other countries and international organizations.

#### Regional Inspection Office

In accordance with "Regulations on Surveillance and Control of Civilian Nuclear Installations", the NNSA may set up Regional Inspection Offices to exercise regulatory inspection in areas where nuclear installations are concentrated. Shanghai Inspection Office and Guangdong Inspection Office were successively set up this year. They are responsible for direct and frequent inspection of the nuclear installations in East China and South China respectively, and report regularly and timely to the NNSA.

#### Nuclear Safety Advisory Committee

In order to ensure correct decision making, the Nuclear Safety Advisory Committee was established upon approval by the State Scientific and Technological Commission in June 1986. This Committee is composed of 26 leading experts in different disciplines and is an advisory organ to the NNSA.

#### Technical Supporting Organizations

Some leading institutes and univer-

sities are involved regularly or temporarily in regulatory activities to provide technical assistance to the NNSA, such as consultations, technical review and assessment, inspection mission, topic analysis and the preparation or review of codes, guides and standards.

#### THE PRINCIPLE OF NUCLEAR SAFETY

The Chinese Government always follows the fundamental policy of "Safety First and Quality First" in her nuclear power development. In accordance with this policy, the NNSA requests that the exposure of the staff and the public to radiation be kept lower than the values specified by the government in all modes of operation of nuclear installations, and lower than the limits specified by the government under accident conditions.

Design, construction and operation of nuclear installations should be done to minimize the possibility of release of radioactive substances. Various safety features and barriers are employed to limit the release of radioactive substances and to mitigate the consequences of accidents. The following safety principles are provided for by the NNSA:

##### A. Defence-in-depth

The first defence stage. It is required that nuclear installations be designed, constructed and operated with sufficient safety margins as well as inherent safety stability;

The second defence stage. It is required that automatic protection systems be actuated at once when nuclear safety of a nuclear installation is threatened in order to protect it against potential harm;

The third defence stage. It is required that release of radioactive substances be limited and consequences be mitigated during an accident.

##### B. Multiple Barriers

At least three barriers are required. They are fuel cladding, the reactor coolant pressure boundary and the containment. Measures should be taken to ensure the integrity of each barrier.

##### C. "ALARA"

Measures should be taken in design to ensure that the exposure of the public and staff to radiation dose does

not exceed the specified values and is kept as low as reasonably achievable.

##### D. Reliability

Components and systems should have the characteristics of redundancy, diversity, independence and fail-safe.

In order to meet the above mentioned safety principles, the NNSA has determined that nuclear power plants must have the following safety function:

1. Reactor can be shut down and be brought to the safety shut down condition under various operational and accidental conditions;

2. Removal of core residual heat after shut down;

3. Measures shall be taken to limit release of radioactive substances and to mitigate consequences of accidents.

#### NUCLEAR SAFETY LICENSING SYSTEM

The NNSA adopts a safety licensing system for nuclear installations under the provisions of the "Regulations on Safety Surveillance and Control of Civilian Nuclear Installations.

The above mentioned nuclear installations include:

A. Nuclear power plants (for the production of electrical and/or thermal power);

B. Reactors other than nuclear power plants (research reactors, experimental reactors and critical facilities);

C. Installations for nuclear fuel production, fabrication, storage and reprocessing;

D. Installations for radioactive waste treatment and disposal; and

E. Other nuclear installations requiring strict surveillance and control.

In conformity with the NNSA's Regulations, the applicant should submit to the NNSA documents demonstrating the adequacy of measures taken. It is then the task of the NNSA to perform a sufficient review and assessment of the technical submission to determine whether the design complies with the specified

safety objectives for siting, construction and operation.

The safety review and assessment of nuclear installations is implemented step by step and is generally divided into five phases as siting, construction, commissioning, operation and decommissioning, with five kinds of licenses in which corresponding requirements and conditions are defined.

the operating organization is responsible for the operating conditions of the plant and must ensure that its function conforms with the specified limits and conditions and that the requirements specified in the license are always followed. Figure 2 illustrates the procedure for application and issuance of licenses.

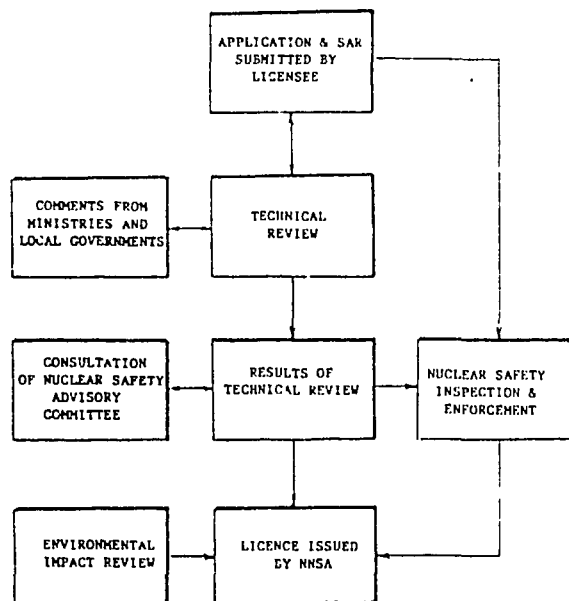


FIG. 2: PROCEDURE OF APPLICATION & ISSUING OF LICENSE

In 1984 China Commenced the construction of 300 MWe prototype PWR nuclear power plant in Qinshan which was designed by the Shanghai Nuclear Engineering and Design Institute. After its establishment the NNSA carried out the retrospective review and assessment for Qinshan Nuclear Power Plant relating to the site and construction, and issued "The Retrospective Safety Review and Assessment Report" in early 1987.

Daya Bay Nuclear Power Plant in

Guangdong will install two 900 MWe Framatome M310 type pressurized water reactors. The NNSA will carry out overall and thorough safety review and assessment to it. It is predicted that the safety review and assessment for the construction phase will be completed and the construction licence will be issued at the end of 1987.

The following methodologies are used by the NNSA during licensing process.

A. If any non-conformance to commitments or safety requirements occurs during the construction of nuclear installations, it is required that the operating organization solve this problem by experiments, analysis and demonstration without delay, and report to the NNSA timely in order to make conclusion case by case.

B. Attention is paid not only to reviewing the safety analysis report but also to the practical implementation. It is necessary to trace the design, manufacture and erection of important safety items from the beginning to the end, and to keep frequent information feedback and exchange between the safety assessment and site inspection.

C. It is necessary to keep close contact with the operating organization. Various methods (e.g. questions-answers, topic review, mutual personnel visiting and prompt transmission of documents etc.) are employed to make a well better coordination.

The NNSA also issues operator licences to the key operators of nuclear installations. The licences to operators are composed of two kinds: "Operator License" and "Senior Operator Licence". Only person holding "Operator Licence" can operate nuclear installations and only person holding "Senior Operator Licence" can operate or direct others to operate nuclear installations.

#### INSPECTION AND ENFORCEMENT

Nuclear safety inspection and enforcement are of vital importance to ensure that all activities relating to siting, design, construction, commissioning, operation, and decommissioning for nuclear installations are in conformity to the regulatory requirements and licensee commitments.

The "Regulations on Safety Surveillance and Control of Civilian Nuclear Installations" specified that the NNSA

and its regional offices have the responsibility to dispatch inspectors to manufacturing workshops, construction sites or operating nuclear installations in order to conduct nuclear safety inspection, which includes:

A. Reviewing whether the information given is accurate;

B. Supervising the construction in accordance with the approved design;

C. Ensuring the implementation of the safety codes and guides on quality assurance;

D. Checking whether the construction and operation have fulfilled the nuclear safety regulations and provisions stipulated in "Construction Licence of Nuclear Installation";

E. Examining whether the operators possess adequate competence for safety operation and implementation of emergency plan;

F. Other necessary functions

The Regulations also specify that the NNSA has the authorities when necessary, to enforce the operating organization of nuclear installations, take safety measures or stop activities endangering safety.

China is at the beginning of its nuclear power development, it is of great importance to conduct inspection on quality assurance activities of nuclear power plant. It is requested that Qinshan Nuclear Power Plant and its competent authority should establish soonest an integrated and effective quality assurance system, and in general the following is required:

1. The design, construction, manufacture and operating organizations of nuclear power plants and the administrative departments related to nuclear power industry should all amplify their quality assurance organizations, carry on quality assurance activities and establish systems in accordance with the requirements of "Safety Code for Quality Assurance of Nuclear Power Plant".

2. The above mentioned organizations and departments should carry out inspection activities according to the relation of jurisdiction (longitudinal) and the relation of contract (horizontal) to form the inspection and condition system.

The mode of quality assurance and inspection system of nuclear power in a country is closely related to its industrial structure and the tradition of the country. The quality assurance system of nuclear power industry in China is of the nature of multiple levels. The lowest level is composed of technicians and workers who create the quality. They should have high quality consciousness and take full responsibility for their work and should consciously make self-inspection, which is the basis of quality assurance. The other three levels are quality assurance organizations of vendors or A/E enterprises, operating organizations and their competent authorities respectively. They not only guarantee the quality of their own activities, but also carry out the quality assurance inspection to the lower levels.

China also has a multi-level safety inspection system for its nuclear power industry. The highest level is the NNSA that represents the government to oversee the nuclear industry on a macroscale and to perform the regulatory inspection for nuclear installations. It discharges direct and frequent supervision and inspection through its regional inspection offices. The next three levels are competent authorities, operating organizations and enterprises who contract for design, construction or manufacture. In accordance with their jurisdiction or the relation of contract, they can dispatch inspectors or entrust professional inspection institutes to carry out the inspection.

The reference documents for regulatory inspection activities of the NNSA are inspection program and various inspection procedures, in addition to the nuclear safety codes and guides.

#### NUCLEAR SAFETY RESEARCH

The development and achievement of the nuclear safety technology are among the key elements to ensure the high quality of the surveillance and control with regard to nuclear safety. It is one of the principles of the NNSA that regulatory actions to be taken should be technically sound and reasonable. The research and development in the field of nuclear safety is selected as a key project of the national scientific and technological development program within the framework of China's Seventh Five Years Plan (1986-1990).

The following issues are emphasised

within the Nuclear Safety Research Plan, 1986-1990.

- The establishment of a series of nuclear safety regulations, codes, guides and standards.
- The development of technology in connection with the licensing review process, including computer codes for safety analysis.
- The development and application of the probabilistic safety assessment.
- The development of the nuclear power plant simulation and the establishment of a training centre with a full scale nuclear power plant simulator.
- The in-service inspection and non-destructive testing.
- Structure mechanics and seismic analysis.
- The establishment of thermal hydraulic facilities and associated experiments with emphasis on accident conditions.
- Radiation protection.
- Medical treatment and other measures needed in case of nuclear emergency.

#### ACTIVITIES AFTER CHERNOBYL ACCIDENT

The TMI accident on March 28, 1979 was a terrible shock to the world, but the experiences gained and the activities in undertaken countries after the accident have quite a few positive effects on the safety of the PWRs.

The Chernobyl accident on April 26, 1986, 7 years after the TMI accident, is the most serious one in the history of the nuclear power. The NNSA has been paying great attention to the understanding of the experiences from the accident, and a preliminary plan concerning the activities to be done has been prepared.

A. Intensification of the emergency preparedness. In spite of a good safety record of nuclear power plants, the remote possibility of failures leading to a nuclear emergency situation can not be excluded, and its consequences should be very serious. The activities that have been or will be done by the NNSA in this connection are:

- To promote cooperation on early notification and mutual assistance in the case of a nuclear accident.
- To establish a nuclear emergency assessment and response centre.
- To speed up the enactment of the regulations in connection with nuclear emergencies, such as "Regulations on Emergency Response for Nuclear Installation", etc..
- To expedite the licensing review and inspection on the emergency plants of all civilian nuclear installations.
- To support the research programs on medical treatment in the case of a nuclear accident, and to promote the establishment of medical treatment centres at different levels.
- To support the development of technology in connection with nuclear emergencies, including the fire-fighting and large scale decontaminations.

B. Enhancement of the operational safety of nuclear installations.

- To attach more importance to the operational safety of nuclear installations, the fission product barriers, and the integrity of the containments.
- To attach more importance to the "safety culture" of the operators, particularly in selecting, training and examining the plant operators.
- To attach more importance to the operation inspection with emphasis on the adherence to the safety criteria and the control room procedures.
- To implement specific procedures for prevention from severe accidents and coping with it at nuclear installations.

To attach more importance to the operational experience feedback, and to establish an incident reporting system.

- To support and participate in OSART activities of IAEA.

C. Strengthening quality assurance and regulatory inspection.

- To promote the establishment of QA systems in accordance with the QA program during siting, design, manufacture

commissioning, operation and decommissioning of nuclear power plants.

- To establish a multiple level inspection system.

#### CONCLUSION

The nuclear safety surveillance and control in China is performed by an independent government regulatory body, i.e. the National Nuclear Safety Administration.

In accordance with the laws and regulations, the NNSA is given the responsibilities of surveillance and control of civilian nuclear installations, nuclear materials and the radiation protection in China.

The surveillance and control are performed at every stage of the nuclear installations, from siting, design, construction, operation, through decommissioning.

A safety review and licensing process is stipulated for nuclear installations, and a national examination and licensing process is stipulated for plant operators.

The NNSA performs regulatory duties on nuclear installations and nuclear materials.

The NNSA depends on experienced experts in various fields, using advanced analytical, computational and experimental methods, to make sure that regulatory actions to be taken are technically sound and reasonable.

Finally, the NNSA attaches great importance to the development of nuclear safety technology and regulatory experience gained in other countries, and is willing to strengthen international exchanges and cooperation in the field of nuclear safety. It will be surely of benefit and contribute to the safety in the peaceful use of atomic energy.

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