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The Nuclear Safety Regulation on Research Reactors in China

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1. Introduction

There are total about 17 civilian research reactors in China, including experimental reactors, nuclear heating reactors and critical facilities, etc. At present, there are 2 research reactors under planning to decommission. The paper presents the fundamental safety policy, regulation codes and guides, safety regulation model, and safety activities on research reactors. The brief information of all research reactors in China are as follow:

	Facility Name	Thermal Power (kW)	Type	Status	Criticality Date
1	CARR	60,000.00		CONS	
2	CFER	65,000.00	FAST BREEDER	CONS	
3	HFETR	125,000.00	TANK	OPER	1979/12/27
4	HFETR CRITICAL	0.00	CRIT ASSEMBLY	SHUT	1979/06/20
5	HTR-10	10,000.00	HIGH TEMP GAS	OPER	2000/12/21
6	*HWRR-II*	*15,000.00*	*HEAVY WATER*	*OPER*	*1958/09/01*
7	MJTR	5,000.00	POOL	OPER	1991/03/02
8	MNSR IAE	27.00	MNSR	OPER	1984/03/10
9	MNSR-SD	33.00	MNSR	OPER	1989/05/01
10	*MNSR-SH*	*30.00*	*MNSR*	*OPER*	*1991/12/18*
11	MNSR-SZ	30.00	MNSR	OPER	1988/11/01
12	NHR-5	5,000.00	HEATING PROT	OPER	1989/11/03
13	PPR PULSING	1,000.00	POOL, UZRH	OPER	1990/08/01
14	SPR IAE	3,500.00	POOL	OPER	1964/12/20
15	TSINGHUA UNIV.	1,000.00	POOL-2 CORES	OPER	1964/10/01
16	ZERO POWER	0.00	CRIT ASSEMBLY	SHUT	1966/01/01
17	ZPR FAST	0.05	CRIT FAST	OPER	1970/06/29

2. The Fundamental Safety Policy for Research Reactor Regulation in China

The fundamental safety policy for research reactor regulation in China basically is the same as the safety policy for nuclear power plants, and it can be described briefly as follows:

Based on

*The “as low as reasonably achievable (ALARA)” principle for normal operation

*The “defense in depth” principle for deviations from normal operation

Prevent of

*The occurrence of anomalies

*The escalation of anomalies into accidents

*The excessive release of radioactive materials into environment

Through

*The establishment of safety guides and standards

*The suitable site selection and safety design

*The quality assurance for manufacturing, construction and operation

*The periodic testing and inspection, etc.

3. Regulation Codes and Guides for Research Reactor in China

The national laws and the administrative regulations are suitable for all nuclear installations, however the **department rules** for research reactors have only three:

(1) Code on the Application and Issue of the Safety Licenses of research reactor issued by NNSA on March 1, 2006

(2) Code on the safety of research reactor design (HAF1000-1) issued by NNSA on June 6, 1995

(3) Code on the safety of research reactor operation (HAF1000-2) issued by NNSA on June 6, 1995.

Guiding documents:

(1) Decommissioning of research reactors and critical assemblies (HAF1004) issued by NNSA on April 18,1992,

(2) Format and contents of the safety analysis report for research reactors (HAF1001) issued by NNSA on Dec.16, 1996,

(3) Emergency plan and preparedness of research reactors (HAF1006) issued by NNSA on Aug.27, 1991,

(4) Management of research reactors for safe operation issued by NNSA on April 3,1989, (HAF1002)

(5) Management of critical assemblies for safe operation and experiment (HAF1003) issued by NNSA on April 3,1989,

(6) Application and modification of research reactors (HAF1005) issued by NNSA on Dec.16, 1996,

Technical documents (for RRs Decommissioning):

(1) Methodology and Technology of Decommissioning Nuclear Facilities(HAF·J0063) issued by NNSA on Mar.25, 1997

(2) Factors Relevant to the Decommissioning of Land-Based Nuclear Reactor Plants(HAF·J0064) issued by NNSA on Mar.25, 1997

(3) Format and Content of the Safety Analysis Report for Research Reactor Decommissioning(HAF·J0072) issued by NNSA on Jan.25, 1998

4. Nuclear Safety Regulation Model on Research Reactors in China

By the way of summing up regulatory experience for RRs in China and drawing lessons from international experience feedback, the NNSA has preliminarily established the regulatory model in decommissioning stage for RRs to improve the nuclear safety regulation in our country, and put our regulatory control in order, regular and scientific situation. The NNSA covers the regulatory actives in operation stage are as follows:

4.1 Documents Review

4.1.1 Operational Events Report

The NNSA conducts the review and technical analytic evaluation on the operational event reports submitted by the operating organization. The results of event evaluation will be fed back to the regional surveillance office of the NNSA and .the operating organization.

4.1.2 Special Permitted Application

The NNSA conducts the review and approval for the special permitted application on deviating the technical specifications, and the regional surveillance office of the NNSA and .the operating organization will be informed of the review results, and if necessary, the regional surveillance office of the NNSA will conduct the surveillance on its implementation.

4.1.3 Modification

The NNSA conducts the review on the significant modification items applied during the operational period of RRs by the operating organization. After permitted by the NNSA, the regional surveillance office will conduct the surveillance on its implementation.

4.1.4 Periodic Safety Evaluation

A periodic comprehensive safety evaluation is performed for the operating RRs according to the update safety standards and practice to judge whether or not the reactor is safe, and the related facilities are sufficient for the safety operation of the reactor.

4.2 Surveillance during Operation Period

4.2.1 Daily Inspection

The inspection activities conducted by the on-site inspectors include the main control room tour, inside plant tour, periodic testing and maintenance observation. The on-site inspectors hold the regular coordinating meeting with the operating organization to trace the operating situation and problems occurred in RRs.

The inspectors submit the daily and weekly reports to inform the NNSA of the daily operating situation of RRs in time.

During the daily inspection, the on-site inspectors conduct the inspections by selecting some topical items from the maintenance program, periodic testing program submitted by the operating organization.

4.2.2 Routine Inspection

The inspections are conducted according to the annual nuclear safety surveillance program. The specific implementation of the inspection is conducted according to the requirements of the safety surveillance rule of nuclear installations. The selection of inspection items is made by the nuclear safety inspection procedures in operational stage for RRs formulated by the NNSA.

4.2.3 Non-routine Inspection

The inspection items, implementation time and contents are decided by the annual management situation of the operating organization and the operating conditions such as refueling, long-term shutdown, etc. The implementation of the inspection refers to the routine inspection procedure. Besides, the post abnormal event inspection belongs to the non-routine inspection, and it is mainly the response to a certain abnormal event, and it is very specific with high technical requirements and needs to invite some experts with related specialties to join the inspection.

4.3 Reporting System for Regulatory Inspection

4.3.1 Weekly Report

The regional surveillance office reports to the NNSA through the weekly report about the related activities of the last week, operational events and findings.

4.3.2 Routine/Non-routine Inspection Report

Finishing the routine/non-routine inspection, the inspection team prepares the inspection report, and after approved by the NNSA, the inspection report is sent to the operating organization. The NNSA and its regional surveillance office will trace to check the implementing situations.

4.3.3 Year Report

The regional surveillance office sums up the regulatory inspection experience during last year and submits the year report to the NNSA.

4.3.4 Feedback Report on Operating Experience

According to the operating event report in RRs, the NNSA conducts the technical evaluation for the feedback of operating experience, and puts firth the related nuclear safety regulatory requirements, and carry out the safety tendency analysis to allow our regulatory work to shoot the arrow at its target.

5. Safety Challenges Encountered of the Research Reactors

In total 17 research reactors in China, there are some research reactors which were built in late 1950's and in 1960's. For example, The HWRR is a 10 MW research reactor operated by the China Institute of Atomic Energy (CIEA), it is one of the oldest research reactors in the world. The safety challenges encountered of those old research reactors are as follows:

5.1 Inborn safety deficiency

The specifications and safety criteria existing at that time was far away from modern standards, so the design and construction were of course imperfect and had some back fittings. Their safety deficiency was inborn even the reactors had undergone some major refurbishments.

5.2 Relative lack of human and budget resources

At the beginning, the operating organization was constituted by young people, highly enthusiastic about the promises of nuclear energy; some of them had undergone training abroad (in the former Soviet Union). Sufficient budget was available, as the country wanted to acquire its own know-how in reactor technology. But nowadays China has a big nuclear power program and many experienced people were recruited by nuclear power plant, few experienced people left the reactor and many young inexperienced people had to be hired. In order to satisfy the request of the license concerning minimum experience for particular jobs, an important training and retraining program had to be established.

5.3 Aging and material degradation problem

In recently years, some problems due to aging and material degradation were discovered. For example, the primary heat exchangers of the HWRR had to be replaced due to accelerated corrosion. In 1996 some fuel assembly tube jacks were abrasion because of hydro-vibration, flow rate of leakage increased gradually, this led to the fuel cooling become worse and the outlet temperature get higher gradually. Later fuel assemblies in some serious tubes had to be taken out. Later on safety assessments concentrated on the more and more sophisticated devices aging and material degradation. This led to a revision of the maximum credible accident.

In order to ensure the safety of those old research reactors, the operating organizations are considering decommissioning of them. The HWRR and Miniature Neutron Source Reactor (Shanghai) are two of them.

6. Safety Activities in China for Research Reactor Decommissioning

At present, the HWRR and the Miniature Neutron Source Reactor (Shanghai) are planning to decommission.

CIAE, the operating organization of the HWRR, has participated in a Technical Cooperation Project conducted by the IAEA (CPR/9/034) since 2003. The project offered the expert service, technical visit and training for decommissioning of the HWRR. In the end of 2007, the HWRR will be shut down. Now CIAE is preparing the decommissioning plan and program for it.

For Miniature Neutron Source Reactor (Shanghai), the main reason lead it to decommission is the groundwork of the reactor hall is going down because of the construction activities near the reactor and the lower groundwater in Shanghai. In order to ensure the safety more efficiently, the operating organization want to remove the reactor core as soon as possible. They plan to submit the safety analysis report of the removing, transporting and storing of the reactor core in July.