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Study on the License Requirements for the SRO/RO of the Kijang Research Reactor

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1. Introduction

The purpose of the study is to propose an appropriate regulatory position for the Kijang reactor operator license requirement by the review of the applicability and compatibility of HANARO SRO/RO license holders for Kijang reactor operation.

As the area using radioactive isotope became gradually enlarged both inside and outside of the country[1], the Kijang research reactor is planned and now under construction next to the HANARO research reactor now being operated in Taejon. For the operation of Kijang research reactor which is targeted to start commercial operation in early 2019, it is required to retain the minimum number of SRO/RO (Senior Reactor Operator/Reactor Operator) license holders at site according to the domestic Nuclear Safety Act, who had already passed the written examination and plant operation test to get the license[2,3]. However, lack of experienced operators is expected in the early stage of commercial operation of the Kijang reactor under the present license system. In this paper, therefore, an establishment of revised operator license system is discussed for the new research reactor

2. Status of Research Reactors

According to the recent IAEA statistics[4], there are about 747 research reactors in the world including 246 in operation, 139 shut down, 344 decommissioned, and 18 under design or construction. In the country, there are 5 research reactors including 2 in operation, 2 decommissioned, and 1 under construction. The status of domestic research reactors are summarized in Table 1.

Table 1: Status of Domestic Research Reactors

	TRIGA Mark-Ⅱ	TRIGA Mark-Ⅲ	AGN-201	HANARO	Kijang
Location	Seoul (KAERI)	Seoul (KAERI)	Gyunghee Univ..	Taejon (KAERI)	Kijang, Pusan
Operation	1962.3 ~ 1995.1	1972.5 ~ 1995.12	1982. 12	1995. 2	2019 planned
Status	Decon'd	Decon'd	Operating	Operating	Under Construc
Thermal Power	250 KW	2 MW	10 W	30 MW	15 MW
Design/ Fabricate	GA, US	GA, US	AGN, US	KAERI/ AECL	KAERI/ Korea Co
Major Purposes	· Education · Research · Isotope Produce	· Basic/ap Research · Isotope Produce	· Education · Practice · Neutron Test	· Basic/appl. Research, · Isotope Pro · Fuel/Rx.Mat	· Isotope Produce · Neutron Irrad. Serv

3. Comparison of HANARO and Kijang Reactors

As KAERI designs Kijang research reactors based on the design and operation experience of the HANARO reactor over 20 years, the basic design concept of the two reactor systems are similar except system power and some improvements. To make an appropriate regulatory position about the applicability and compatibility of HANARO SRO/RO license to the Kijang operator license, design and operation characteristics of the two research reactors are to be reviewed and compared.

3.1. Comparison of Design Characteristics

At first, the design characteristics of the two reactors are investigated through the detailed study of the FSAR of the HANARO and the PSAR of the Kijang reactor[1,5]. There are schematic views of those two reactor assemblies in Fig.1 and Fig.2 for reference. The design characteristics of the two reactors can be concluded to be very similar, however, there still exist slight differences in some details such as the design concept of the nuclear fuel assembly, the circulation method of core cooling, the reserved pump and heat exchanger for the primary cooling system, the residual heat removal system, reactor action in pool cooling water loss accident, engineering safety features, purification and clean-up system, and so on.

3.2. Comparison of Operation Characteristics

The operational characteristics are investigated by the review of technical specifications, the operation procedures, the emergency operation procedures even Kijang has yet limited data. There are some differences in type of operation, system shut down conditions, and operation constraints. For example, HANARO has four operational modes consist of shut down mode with all stationary and control rods inserted, standby mode with all stationary rods withdrawn and control rod inserted, startup and power mode with partial rods withdrawn. Kijang reactor, however, has three operational modes of shut down, startup, power up without standby mode in comparison with HANARO. Both reactors have limiting safety system settings in the reactor safety system for automatic safe shut down in accidental condition. Besides, There exist a number of differences derived from the gap of design concept between these two

reactors such as reactor safety system settings, conditions for reactor shut down, engineering safety features actuation, emergency makeup water system and siphon shutoff valve, and etc.

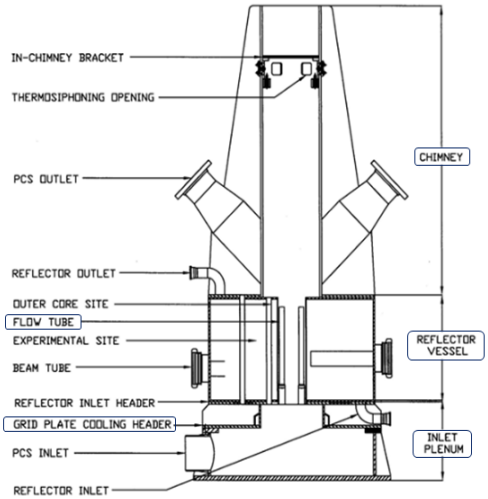

Fig. 1. Shape of HANARO Reactor Assembly

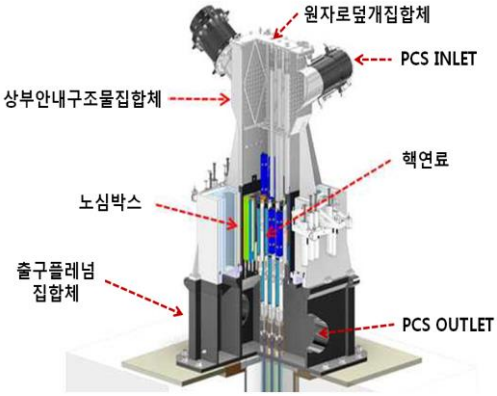

Fig. 2. Shape of Kijang Reactor Assembly

4. Operator License System for Research Reactors

4.1. Domestic License System[2]

According to the notice of the nuclear safety and security commission, the sort of SRO/RO licenses of the research reactor is classified by the regular thermal power level. And because the thermal power level of the HANARO reactor is in the same category of the Kijang reactor, the operator licenses are the same type to each other legally.

By the way, the operating man-power secure plan for the Kijang reactor have strategy to encourage experienced HANARO SRO/RO license holders to apply and get the Kijang license, to make up the expected lack of operators in the early stage of commercial operation and to assure as high administrative effectiveness and reliability of safe operation of the Kijang reactor as possible.

Table 2:. Domestic Research Reactor License System

	RO	**SRO**
Apply Qualifi-cation	• 4-yr. Eng. College Grad. and 1-yr Operation (Non-nucl. Eng) 0.5-yr Operation (Nucl. Eng) •2-yr. Eng.College Grad. and 2-yr Operation (Non-nucl. Eng) 1.5-yr Operation (Nucl. Eng) •2-yr. High School Grad. and 3-yr Operation	•4-yr. Eng. College Grad. and 3-Yr Operation (Non-nucl. Eng), 2-Yr Operation (Nucl. Eng) •2-Yr Operation as RO • SRO License Holder for Same Type Reactor abroad
Written Exam Subject	•Structure, Material, Design of Reactor Facility •Reactor Operation and Control •Manage of Radiation Safety •Reactor Theory •Nuclear Codes and Standards	•Same Subjects for RO •Handling and Managing of Nuclear Fuel and Materials
Test Subject	•Knowledge of Pre-op. Test Procedure and Manipulate •Control Panel Signal Reading and Action •Use and Interpretation of Instrumentation •Dynamic Characteristics and Operation of Nucl. Facilities •Function and Usage of Radiation Detection System •Defense of Radiation Damage •Emergency Planning	

4.2. US License System[7,8,9]

Table 3: RO/SRO License for Research Reactor in US

	RO	SRO-Instant	SRO-Upgrade
Apply Qualifi-cation	•Train at Nuc. Facil. •High school or higher grad.	• Train at Nuc. Facil. •High school or higher grad. •3yr Nucl. Career	•RO 1yr Career at Same Site • Same as SRO-I
Written Exam Subject	•Type A : Nuc Theory, Therm., Op. Char. •Type B : Nor/Abnor Op. Proc, Rad. Control •Type C :Rx and Rad. Monitoring System (Difficulty differs bt. RO/SRO)		•Exempt
Test Subject	•Type A (Admin./Manage) : Rad Control, Fuel Handling, Emer. Plan •Type B (Nuc. Facility) : Nuclear System Design, Operation Capability •Type C (Operation) : Measures at Trans and Acc. Condi. -Normal Cond.: Sys & Prelim. Oper., CRDM Control at Man/Auto Oper. -Reactivity Cond.:Rx Startup, Power Output, Test Instrum.Manipul., -Panel Trouble: Rx, Controller, Rad. Monitor Trouble, -Component Trouble: CRDM, Pump Trouble, Pipe Loss -Major Transient(Auto Protection): Rx Trip, Eng. Safety Features run -Major Transient(Start Emer. Plan): Measures next to Rx Auto Protection		

The US operator license system, for reference, is reviewed about such as qualification for application and the condition of exemption request of license holders for license application to similar power level or group of research reactors. As summarized in Table 4, it can be said that they have similar way of regulation in operator license system for research reactors.

5. Op. License System Setup for Kijang Reactor

5.1. Background and Considerations

To assure high reliability and safety of the Kijang reactor in the early stage of operation, it is recommended to have as many experienced research reactor RO/SRO participation as possible. For the purpose, diverse comparison and review of the design and operation characteristics of the two reactors are done. In addition, the applicability of HANARO SRO/RO license to the Kijang reactor operation with or without further conditions should be discussed. And ideas are required to give reasonable benefits and duties to the SRO/RO license holders of HANARO when they apply for the new license of the Kijang reactor.

5.2. Detailed Classification of Research Reactors

As it is unreasonable to allow HANARO RO/SRO directly to operate Kijang with no condition, the present license system should be discussed for revision to have them enough familiar to the technical differences of design and operation between the two reactors. Table 3 proposes a couple of options and expected points for license system revision.

Table 4: Opinion on License System Revisions

Op	License System	Note
1	• **Common License Group** -10MW : HANARO , Kijang	- Low Safety Reliability when Tech. Difference Increase -Licensee needs big Knowledge
2	• **Separate License Group** - 1kW, 2MW Group plus - 10-30MW : Kijang -30-200MW : HANARO	- Legal Revision Required - Detailed Classification with range enlarged to 200MW - Need Incentive for Application

5.3. Consideration of Written Exam Exemption

Written examination exemption for a couple of subjects is now allowed for RO/SRO license holders to apply another operation license of similar power level reactor. In consideration of the exemption system, it can be considered to allow all written subjects exemption when HANARO operators apply Kijang operator license when they complete a period of technical experience like design, pre-op test, simulator or classroom training for Kijang reactor. This will help to encourage the experienced HANARO RO/SRO to get the same license for Kijang. As a reference, the US system allows exemption of all written subjects except fuel handling and control when a RO of a research reactor apply to SRO of another research reactor. However, in consideration of the object of recent revision of Atomic Law, it is desirable to discuss later for about exemption of all subjects.

6. Conclusions

The design and operation characteristics of the two (HANARO and Kijang) reactors are concluded to be very similar to each other, however, there still exist slight differences in some minor portions.

It is recommendable to allow an independent license for each reactor if two reactors of the same power level have recognizable differences in the design and operation characteristics.

And in consideration of the object of recent revision of Atomic Law, it is desirable to discuss later for about exemption of all written subjects when an operator license holder applies to a similar operator license of the same power level research reactor

Acknowledgement

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