PLAN OF NEW RESEARCH REACTOR CONSTRUCTION IN KOREA

I.C. LIM, M.S. KIM, S.J. CHOI, J.J. HA
Korea Atomic Energy Research Institute (KAERI),
Research Reactor Utilization·Development Department,
Daejeon,
Korea

Abstract

The project to build a new research reactor in Korea will start from 2012. The objectives of this project are to achieve the self-sufficiency in medical and industrial RI supply, to enlarge the national silicon doping capacity and to develop and validate key technologies for research reactor engineering. The site will be a place in Gijang-gun which is a county near Busan that has several nuclear power reactors. The feasibility study to review its necessity in economic and strategic view was completed and the budget is under the review of the Korean National Assembly.

1. INTRODUCTION

In Korea, HANARO (High-flux Advanced Neutron Application ReactOr) has been operating since 1995, and is being utilized for neutron scattering experiments, material and fuel tests for power reactor application, RI production, silicon doping, neutron activation analysis, and neutron radiography. The technologies obtained during its design, construction, operation, and the strong, continuous support from the Korean government, have made HANARO into a well utilized multi-purpose research reactor. Korea has been considering building a new research reactor since 2009 and a decision was made to start the new research reactor project from 2012 considering its contribution to the public, industry and research reactor technology development. This paper describes its background, feasibility study, reactor characteristics in concept and utilization plan.

2. BACKGROUND OF PROJECT

Korea is importing many radio-isotopes, including Mo-99. In 2009, the import amount of open RI source was about 25 000 Ci and that of sealed RI was about 71 000 Ci, respectively. The RIs produced in commercial scale using HANARO are only I-131 and Ir-192. Thus, Korea has experienced a Mo-99 shortage, which arose from the outage of major Mo production reactors. The self-sufficiency of RI demand became a very important issue for the health care of public.

Since 2003, HANARO has provided the commercial neutron transmutation doping (NTD) service for silicon and it is believed that HANARO is sharing about 10 to 15% of the world NTD service. The increase of the use of green cars and that of renewable energy will bring the growth of power device market and will need more doping capacity. A study showed that the demand of NTD silicon from the hybrid car will reach to 157~510 tons in 2020 and 786~2550 tons in 2030[1]. Also, the increase of renewable energy utilization will need more power device using NTD silicon as well.

Korea has developed many research reactor technologies but has no experience in the plate type fuel technology and the bottom-mounted control rod drive mechanism (CRDM). Those are required to enlarge the research reactor system engineering capability.

Thus, Korea decided to build a new research reactor to fill the self-sufficiency of RI demand, to increase the NTD capacity and to develop and validate research reactor technologies. The surplus in RI production can be exported to the regional countries, which will help to maintain the world Mo-99 production capacity [2]. The increase of capacity in RI production and NTD will also contribute to the development of RI industry and power device industry in Korea. The project includes the installation of reactor, RI production/research facility, LEU target production facility for Mo-99 production, NTD facility and a radioactive waste treatment facility.

3. SITE SELECTION AND FEASIBILITY STUDY

3.1. Site selection

The plan to build a new research reactor was informed to the local governments and the proposals to host the facility were asked. 9 local governments applied and their proposals were evaluated by a site selection committee using established criteria. The criteria dealt with the following aspects:

— Safety;
— Public acceptance of the residence;
— Support from the local government;
— Consideration of emergency preparedness plan;
— Meteorological conditions;
— Effect of external events;
— Infra for utilization;
— Accessibility;
— Conditions of inhabitancy.

In parallel, a preliminary site evaluation to review the geologic, seismic and hydrologic conditions of the proposed sites was conducted.

Through these processes, a place in Gijang-gun was selected as the site of new research reactor. Figure 1 shows the location of site.

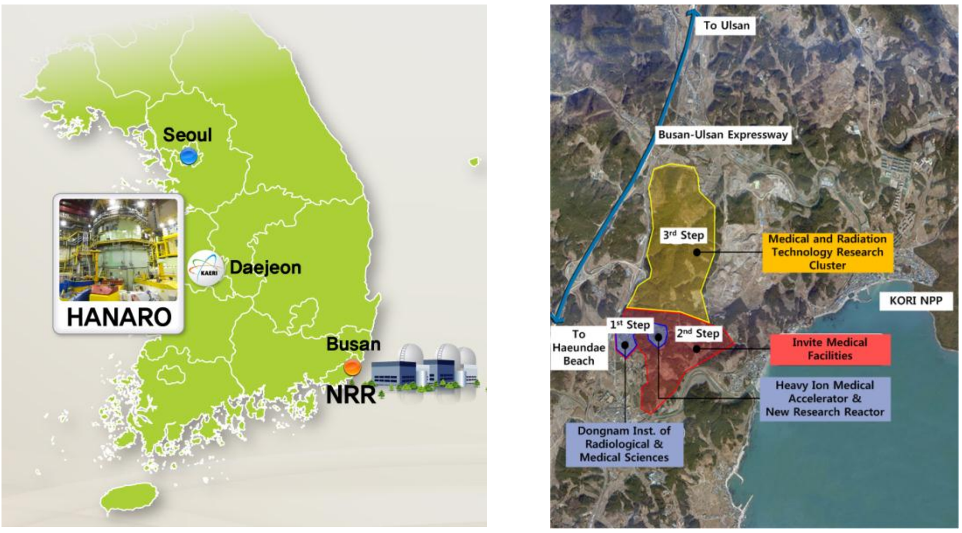

Fig. 1. The Location of Proposed Site for New Research Reactor.

Gijang-gun has several nuclear power plants in operation and thus, has no difficulty in the site characteristics and in the public acceptance as well. In addition, Gijang-gun is close to

Busan which is the second largest city in Korea and has an international airport and a harbor. These will provide the good accessibility for people as well as the easy transportation of products.

3.2. Feasibility study

The feasibility study was conducted by the KDI (Korea Development Institute), which is a national research institute supporting the Ministry of Strategy and Finance. The feasibility study reviewed the following aspects:

— Maturity of technologies required for the project;
— Economic study investigating the cost and benefit of the proposed project;
— Strategic review.

The feasibility study showed a positive sign and the project was included in the government budget proposal to the Korean National Assembly.

4. CHARACTERISTICS OF NEW RESEARCH REACTOR

4.1. Utilization requirements

The current utilization requirements for RI production are summarized in Table 1.

TABLE 1: REQUIREMENTS FOR RI PRODUCTION

RIs	Requirements		
	No. of holes	Hole diameter (cm)	Neutron flux ($cm^{-2}s^{-1}$)
Fission Mo and other Fps	4	5~8	~$2x10^{14}$
Ir-192, P-33, Lu-177, Co-60 (Medical purpose)	4	4~6	~$3x10^{14}$
I-131, I-125, Cr-51, Re-186, Sm-153	3	4~6	>$1x10^{14}$
HTS and PTS for short half-life RI2	1 for each	3	~$1x10^{14}$
Others for research purpose	4-5	3	~$5x10^{13}$

For NTD, 2 holes for 5” ingot in diameter, 3 holes for 6” ingot and 2 for 12” ingot will be provided.

4.2. Reactor

The major characteristics of the reactor in concept are summarized in Table 2. The new research reactor will be the first reactor in the world which will use the U-Mo fuel in full scale. Also, the used of bottom-mounted CRDM will make it easy the loading and unloading of RI targets. In view of safety, it will be equipped with the secondary shutdown system, the ASTS (Automatic Seismic Trip System), the PAMS (Post Accident Monitoring System), the emergency control room and a diesel generator in an appropriate size.

TABLE 2: REACTOR CHARACTERISTICS IN CONCEPT

Item	Value
Reactor power(MW)	~20
Reactor type	Pool type
Max. thermal neutron flux ($cm^{-2}s^{-1}$)	> $3.0x10^{14}$
Operation day per year	~300
Reactor life(year)	50
Fuel	LEU U-Mo plate type fuel
Reflector	Beryllium
Coolant and flow direction in operation	H_2O, downward forced convection
Reactor building	Confinement

5. PROJECT SCHEDULE AND UTILIZATION PLAN

The proposed project schedule is in Table 3. The PSAR for construction will be submitted by July 2013 and construction permit is expected to be issued by March 2014. The FSAR will be submitted by the end of 2015 and, the fuel loading and the initial criticality will be achieved in Sept. 2016. The normal operation will start in Feb. 2017.

TABLE 3: PROPOSED PROJECT SCHEDULE

Key activity	Year						
	2011	2012	2013	2014	2015	2016	2017
Design and engineering	—	—	—	—			
Long need item procurement			—	—	—	—	
Site preparation		—	—	—			
Procurement and construction				—	—	—	
Commissioning						—	—
Licensing		—	—	—	—	—	—

The major isotopes to be produced in the new research reactor will be Mo-99, I-131, I-125 and Ir-192. Their production capacities will be 100,000, 3,000, 100 and 300,000 Ci per year, respectively. The technologies to produce I-131, I-125 and Ir-192 have been already established. However, the technology to produce Mo-99 will be developed in parallel with the facility development. Considering these, the target for Mo-99 production in the first year is to fulfil the national demand and its capability will be expanded year by year. The production capability for other major isotopes is expected to reach its capacity from the beginning.

As for the silicon doping, the installation of 6” and 8” irradiation rigs will start from 2017. However, the installation of 12” ingot rigs will be made in conjunction with the large diameter ingot irradiation technique development and the availability or needs of 12” ingot irradiation. When the planned installations are finished, the doping capacity will reach 150 tons per year.

The new research reactor is a large scale national facility which will be used for 50 years. The new application techniques could be devised in its life time of 50 years. Thus, the flexibility of the reactor and systems which will allow the installation of future demand will be considered during the conceptual and basic design.

6. CONCLUDING REMARKS

The new research reactor will be an infra to fulfil the national needs in RI production, irradiation service and technology validation and, will be equipped with improved safety features. It will also serve as a regional reactor whose benefit can be shared with the neighbouring countries. When the new reactor is built, the utilization of HANARO will be mainly the researches using neutron scattering instruments and material irradiation facilities and it will be a backup for the RI production and NTD [3].

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