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Radioisotope Production Plan and Strategy of Kijang Research Reactor

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1. Introduction

Korea Atomic Energy Research Institute (KAERI) launched a research reactor construction project in 2012. This reactor will be located at Kijang, Busan, Korea and be dedicated to produce mainly medical radioisotopes. Tc-99m is very important isotope for diagnosis and more than 80% of radiation diagnostic procedures in nuclear medicine depend on this isotope. There were, however, several times of insecure production of Mo-99 due to the shutdown of major production reactors worldwide. OECD/NEA is leading member countries to resolve the shortage of this isotope and trying to secure the international market of Mo-99. The radioisotope plan and strategy of Kijang Research Reactor (KJRR) should be carefully established to fit not only the domestic but also international demand on Mo-99.

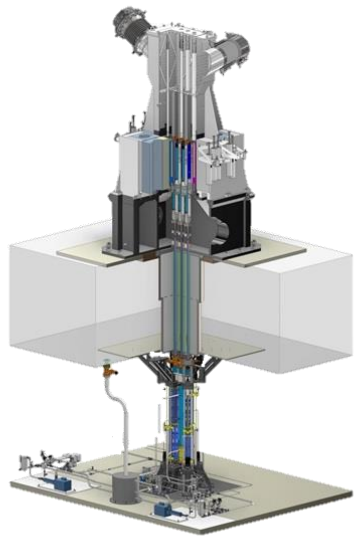

Fig. 1. Reactor and control rod mechanism motored from the bottom

2. Progress of KJRR Project

The KJRR project duration is six years and April, 2015 is the start of 4th year of the project. The request for construction permit has been submitted in Nov. 2014 and it would be issued within the next 18 months from April, 2015. The project target is to make the reactor critical before April, 2018. The U-Mo fuel will be loaded first time in the world. The irradiation tests for mini-plates of 65% burnup in average and for full-plate with maximum burnup of 85% will be performed at HANARO. The irradiation test for mini-plate of 45% burnup in average has been already done. The lead test assembly will be irradiated at ATR, Idaho National Lab, U.S. from June, 2015. The burnup data for these plates and assembly will be valuable to obtain operation permit for KJRR. The fission moly target fabrication facility will be constructed and commissioned by Oct. 2016. The radioisotope and radiopharmaceutical production facility will be installed and commissioned by Nov. 2017 and the GMP will be approved by Mar 2018.

2.1 Characteristics of KJRR

The KJRR is a 15 MW thermal power reactor. It is controlled by four Hf rods of 1st shutdown system motored from the core bottom (Fig. 1) and has two Hf rods of 2nd shutdown system. The core box has 7X9 Be lattice which consists of 16 standard fuels, 6 follower fuel assemblies, 6 fission moly targets with on-power loading, 3 flux traps, and 3 irradiation holes with on-power loading-One among them transported by hydraulic system. Outside core box, there are 5 NTD holes in the graphite block and a fast neutron irradiation hole in Al block. There is one thermal pneumatic transported system (PTS) in the Graphite block and one epi-thermal PTS in Al block.

The reactor operation days per year are 300 days with 6 cycles of 50 days each. Two fuel assemblies are consumed per cycle. The core flow direction is downward.

The reactor building, fission moly production building, radiowaste treatment facility building, and radioisotope production building are neighboring each other (Fig. 2).

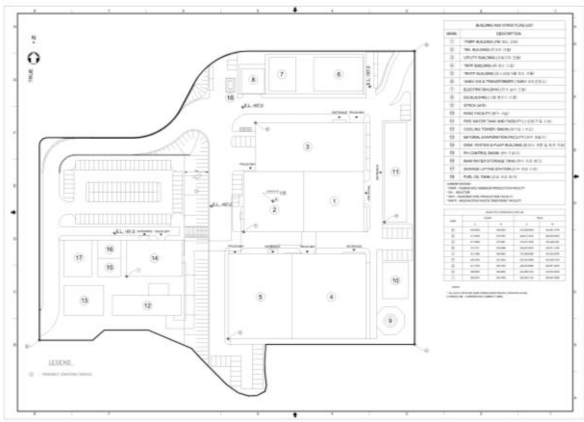

Fig. 2. Facility layout of KJRR

2.2 Radioisotope Production Plan of KJRR

Radioisotopes that to be produced from KJRR are Mo-99 (Fission), Ir-192, I-131, I-125, Lu-177, etc. The amounts of radioisotopes to be produced from KJRR are summarized in Table 1. It is expected the maximum production capacity of KJRR for the listed radioisotopes shall cover about 15~20% of the international demands. Even though the market sharing of KJRR is highly dependent on the business efforts, it is still expected to produce one quarter of the full capacity, which is more than enough to meet the national demand, in the first year of the reactor operation. It is prospect that KJRR shall have ability of the full-production after five years of the of radioisotope business.

Table 1. Radioisotopes to be produced from KJRR

Radioisotope	Capacity (Ci/yr)
Mo-99(Fission)	100,000
Ir-192	300,000
I-131	4,000
I-125	100
Lu-177 & Others	1,000

Currently, the technologies to meet the commercial production of the radioisotopes are available at KAERI except Mo-99 (Fission). The processing technology for the fission based Mo-99, is still under development while designing the facility. The technology shall be available within two years.

The radioisotope production facility of KJRR shall have the ability of processing accelerator-based radioisotopes irradiated from other sites, such as Kyung-Ju proton accelerator. Centralized production of radioisotopes shall be beneficial in cost-saving and safety. In addition to commercial radioisotopes, research-purpose radioisotopes shall be produced in a frame of RI supply chain to support the nation's science and technology development.

2.3 Six Principles of OECD/NEA HLG-MR[1]

The NEA established the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) in 2009. The ministers and representatives of 13 countries including Australia, Canada, Korea, South Africa, USA, etc., share a common interest in ensuring the security of supply of the most widely used medical isotope, Mo-99. They commit, with the aim of jointly promoting an internationally consistent approach to ensuring the long-term secure supply of medical radioisotopes, to implement the HLG-MR principles in a timely and effective manner, and to 1) take co-ordinated steps, within our countries' powers, to ensure that Mo-99 or Tc-99m producers and, where applicable, generator manufacturers in our countries implement a verifiable process for introducing full-cost recovery at all facilities that are part of the global supply chain for Tc-99m; 2) encourage the necessary actions undertaken by Mo-99 processing facilities of Tc-99m producers in our countries to ensure availability of reserve capacity capable of replacing the largest supplier of irradiated targets in their respective supply chain; 3) take the necessary actions to facilitate the availability of Tc-99m, produced on an economically sustainable basis, as outlined in the HLG-MR principles; 4) encourage all countries involved in any aspect of the Tc-99m supply chain, and that are not party to the present Joint Declaration, to take the same approach in a co-ordinated manner; 5) take the necessary actions described above by the end of December 2014 or as soon as technically and contractually feasible therafter, aware of the need for early action to avoid potential shortages of medical radioisotopes that could arise from 2016; 6) report on an annual basis to the OECD Nuclear Energy Agency (NEA) on the progress made at the national level and support an annual review of the progress made at the international level, both in light of this Joint Declaration.

3. Conclusions

The implementation strategy of 6 principles of HLG-MR should be established that is appropriate to national environments. Ministry of Science, ICT and Future Planning and Ministry of Health and welfare should cooperate well to organize the national radioisotope supply structure, to set up the reasonable and competitive pricing of radioisotopes, and to cope with the international supply strategy. Consistent communication among government, facility, users, and commercial sectors is very much required for national welfare using radioisotopes.

REFERENCES

[1] http://www.oecd-nea.org/med-radio/