A Study on Comparison of HANARO and KIJANG Research Reactor in Nuclear Safeguards

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1. Introduction

As one of major national projects for nuclear science and engineering in Korea, the KIJANG Research Reactor(KJRR) project was commenced in order to develop the core research reactor(RR) technologies for strengthening the competitiveness of the RR export and also to stabilize the supply of key radioisotopes for medical and industrial applications [1, 2].

This paper is about applying IAEA safeguards at new nuclear facility (KJRR). The beginning of this project is comparing of HANARO and KIJANG research reactor in nuclear safeguards for nuclear material accountancy method.

2. Consideration for Research Reactor Safeguards

2.1 Research Reactor

A reactor used as a research tool for basic or applied research or for training. Some reactors are used for radioisotope production. The fission heat is generally removed by the coolant at low temperature and is usually not used. A wide variety of research reactors exist, such as swimming pool reactors and high flux reactors. Most of research reactors are treated, for safeguards purposes, as item counting facilities.

2.2 Facility Classification in Safeguards

In nuclear safeguards, usually facility can divided into two classes which are item counting facility and bulk handling facility by nuclear material handling characteristic.

An item counting facility where all nuclear material is kept in item form and the integrity of the item remains unaltered during its residence at the facility. In such cases, IAEA safeguards are based on item accountancy procedures (e.g. item counting and identification, non-destructive measurements of nuclear material and the verification of the continued integrity of the items). Examples of item facilities are most reactors and critical assemblies (critical facilities), and storage installations for reactor fuel.

A bulk handling facility where nuclear material is held, processed or used in bulk form where appropriate, bulk handling facilities may be organized for safeguards purposes into multiple material balance areas (MBAs), for instance by separating activities relating only to the storage and assembly of discrete fuel items from those involving storage or processing of bulk material. In a bulk MBA, flow and inventory values declared by the facility operator are verified by the IAEA through independent measurements and observation. Examples of bulk handling facilities are plants for conversion, enrichment (or isotope separation), fuel fabrication and spent fuel reprocessing, and storage facilities for bulk material.[3]

3. HANARO and KIJANG Research Reactor

3.1 HANARO Research Reactor

HANARO is the nation's sole 30 MW research reactor, and ranks 10th in the world in terms of its performance. It is the only world-class multipurpose high performance research reactor in which diverse research is being concurrently conducted in various areas such as thermal neutron beam utilization, cold neutron beam utilization, radioisotope production, and fuel and material irradiation tests.

3.2 KIJANG Research Reactor

A new research reactor construction project (hereafter, "KJRR project") was launched in April, 2012, in order to secure the supply of key radioisotopes for medical and industrial applications and to develop and qualify the core technologies of research reactor (RR). The KJRR project aims to establish a RR with 15 MW and utilization facilities for radioisotopes production and the relevant research and development (R&D) at Kijang-Gun, Busan City in Korea. The Korea Atomic Energy Research Institute (KAERI) entrusted by the government has proceeded with the project in cooperation with the Kijang municipality. The KAERI undertakes system design, licensing and commissioning of the facility while the Kijang municipality is assigned to provide the infra-structure like water or electricity. Preliminary safety analysis report (PSAR) is being prepared to apply for construction permit. The KJRR is under detail design and is expected to put into operation in 2018.[4]

3.3 Comparison of HANARO and KIJANG Research Reactor

Table 1. Nuclear Fuel Comparison of HANARO and KIJANG Research Reactor

	HANARO RR	KIJANG RR
NF Physical Form	Metal Rod	Metal Plate
NF Chemical Form	U3Si-Al	U-7Mo
Enrichment (wt.% of U-235)	19.75%	
Cladding Material	Aluminum	

There are some differences between HANARO and KIJANG research reactor. For example, there is nuclear fuel comparison as Table 1. However the biggest difference is there is Fission Moly Production Facility. There is scheme for Fission moly process as Fig. 1.

In nuclear safeguards, KIJANG RR will be applied not only item accounting facility but also bulk handling facility by Fission Moly Production Facility.

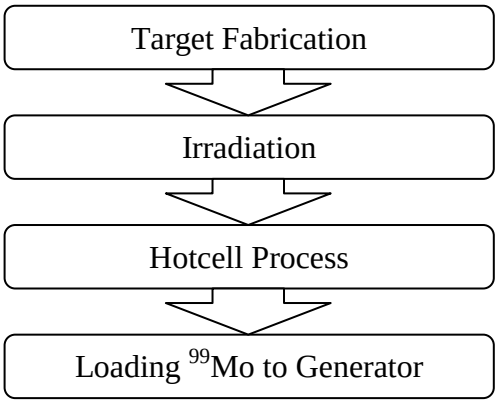

Fig. 1. Scheme for the KAERI's fission Mo-99 process in Nuclear Safeguards [5]

4. Safeguards for KIJANG RR

4.1 Draft for setting up the Key Measurement Point (KMP)

The first step for facility which is starting the nuclear material accounting is setting up the key measurement point.(KMP) There are my opinion of setting up KMP for KJRR safeguards on the basis of existing research reactor.

- KMP A : Fresh Fuel and FM Target Storage
- KMP B : Reactor Core
- KMP C : Spent Fuel Storage
- KMP D : FMPA Hotcells
- KMP E : FMPA Labs and other locations

4.2 Consideration for Application method of facility nuclear material accounting

The facility which is mixed between Item counting facility and Bulk handling facility is uncommon. There is similar case, ANSTO from Australia. There is OPAL research reactor which has also fission moly production facility. But, there are separated between research reactor and fission moly facility. In my view, KJRR would be separated between KMP A, B, C and KMP D, E like as ANSTO. And then do the nuclear material accounting like as different MBA (Material Balance Area).

4. Conclusions

As mentioned before, research reactor is basically item counting facility. In Fig 1, first two processes are belonging to item counting. But last two processes are for bulk handling. So KIJANG RR would be treated item counting facility as well as bulk handling facility by fission moly production facility. For this reason, nuclear material accountancy method for KJRR is not easy compared to existing one. This paper accounted for solution of KJRR nuclear material accountancy briefly. Future study on the suitable nuclear material accountancy method for mixed facility between item counting facility and bulk handling facility will be conducted more specifically.

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