Management Plan for the Intermediate Level Liquid Waste From the Fission ^{99}Mo Production Process in the KIJANG Research Reactor

Chul Gyo Seo*, Seung-Kon Lee, and Jong-Sik Shon

Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea

*cgseo@kaeri.re.kr

1. Introduction

Korea Atomic Energy Research Institute (KAERI) has been developing a new research reactor, which is named the KIJANG Research Reactor (KJRR). The KJRR is a radioisotope production reactor and one of its main purposes is producing fission ^{99}Mo, which is the most widely used medical radioisotope [1]. The waste generation from the fission ^{99}Mo production process is inevitable and disposal plan for the radioactive wastes should be set up for mass production of the fission ^{99}Mo.

2. Waste generation

2.1 Target

The most fission ^{99}Mo has been produced from highly enriched uranium (HEU) targets. However, to reduce the use of HEU for nonproliferation, ^{99}Mo producers are forced to convert their HEU-based process to use low enriched uranium (LEU) targets. KAERI will use the plate-type LEU target composed of UAl_x powder dispersed in Al matrix and Al-6061 cladding. The powder is produced by the KAERI's centrifugal atomization technology. 8 plates are combined into a target assembly, which is irradiated about 7 days in the core. There are 6 fission moly irradiation holes in the reactor core [2].

2.2 Waste

The irradiated target assembly is cooled during 1 day and transported into the dissolving hotcell. In the hotcell, the target assembly is dissolved in sodium hydroxide solution in the dissolver. The overall process scheme of the KAERI process is similar to the conventional alkaline digestion process, which has been used for the HEU-aluminum alloy targets. Using the LEU targets, radioactive wastes increase by decreased production yield. The use of LEU targets will cause increase of radioactive waste production about 200% [3]. In particular, reduction of the intermediate level liquid waste (ILLW), directly resulting from the dissolution of target, is very important because of their high activity and the difficulties in the waste treatment for final disposal. KAERI developed new technology to facilitate the waste treatment by converting sludge-type waste, which is difficult to handle, into independent solid and liquid wastes [4]. The scheme for the KAERI process is presented in Fig. 1 [5]. During the dissolution, unreacted uranium and majority of other fission products form precipitates, and are removed from the solution via filtration. Emission of radioactive noble gas such as Xenon is controlled via the gaseous waste treatment system with multiple steps of mitigation and confinement. The uranium precipitates will be stored during the lifetime of the KJRR. Aluminum precipitates in low level activity can be managed as solid wastes, but it is difficult to convert the ILLW into the proper form for final disposal.

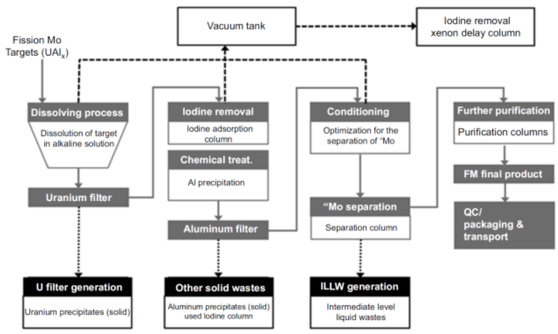

Fig. 1. Process scheme of KAERI fission ^{99}Mo production.

3. Waste management

3.1 Management plan

The ILLW will be solidified and transported to the Gyeongju low and intermediate level radioactive waste disposal facility for final disposal. The ILLW is generated the FMPF (Fission Moly Production Facticity) and treated in the RWTF (Radioactive Waste Treatment Facility). The ILLW generated in the hotcell requires a decay time of 2 years for easy handling. The operation strategy is to store the ILLW at the FMPF for at least 4 years and to transport it to the RWTF for solidification treatment and temporary storage.

3.2 Solidification treatment

KAERI does not have any experience on solidification process of the ILLW, but there are several countries producing ^{99}Mo. We have considered the treatment processes of other countries with the following basic principles:

1) The process should be specific to the waste characteristics.
2) The process should be authorized.
3) The process should be simple.
4) The process should be controllable in remote.
5) The process should not produce any secondary waste.
6) The solidified waste should fulfill the acceptance criteria of the Gyeongju facility.

KAERI has selected the conventional cementation method for solidification treatment as the first priority option. The cementation method is authorized in Belgium and South Africa, but the characteristics of the ILLW might be different. The cementation method optimized to the KAERI ^{99}Mo production process should be developed. The development schedule is depicted in Fig. 2. The cementation method is selected as the first option, but new technologies such as Synroc [6] will be considered if the technology is authorized.

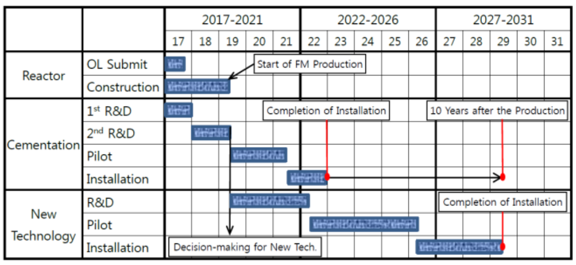

Fig. 2. Schedule for the solidification process.

4. Conclusions

KAERI has developed the ^{99}Mo production process and the production of ^{99}Mo will be followed soon after the criticality of the KJRR. The ILLW in the production process has been a critical issue, but the treatment process of the ILLW is not developed yet.

This paper introduces the treatment plan of the ILLW. KAERI has selected the conventional cementation method and development study was started last year. The development plan shows that the treatment facility could be operable within 4~10 years after start of the production. KAERI has prepared enough storage of 20 years in the KJRR.

REFERENCES

[1] W.C. Eckelmann, "Unparalleled contribution of technetium-99m to medicine over 5 decades," JACC Cardiovasc Imaging 2(2009) 364-368.

[2] Chul Gyo Seo, et al., "Silicide Fueled Core for the KIJANG Research Reactor," *KNS Autumn Meeting*, Gyeongju, Korea, 2013.

[3] International Atomic Energy Agency (IAEA), "Non-HEU production technologies for molybdenum-99 and technetium-99m," IAEA Nuclear Energy Series, No. NF-T-5.4, IAEA, Vienna (Austria), 2013.

[4] Seung-Kon Lee, et al., "Development of Fission Mo-99 Process for LEU Dispersion Target," *KNS Spring Meeting*, Jeju, Korea, 2015.

[5] Seung-Kon Lee, et al., "Development of Commercial-scale Fission Mo-99 Production System," *KNS Fall Meeting*, Gyeongju, Korea, 2016.

[6] R. B. Rozsa and C. L. Hoenig, "Synroc Processing options," LLNL UCRL-53187, 1981.