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The Study on Domestic and Foreign Cases for Decommissioning of DPRK Nuclear Facilities

Ye Ji Baek *, Joo Youn Hhu, Jung Hyun Lee , Yong Soo Hwang
Korea Institute of Nuclear Non-proliferation and Control, 1534, Yuseung-daero, Yuseung-gu, Daejon, Korea
**Corresponding author: byj8712@kinac.re.kr*

1. Introduction

DPRK activities such as nuclear weapon development or nuclear testing not only threaten our country's security but also have an adverse effect on nuclear nonproliferation and security in the international society. Therefore, denuclearization of the DPRK is prior task that is essential to peace on the Korean Peninsula. [1,2]

The fundamental purpose of denuclearization of the DPRK is to safely decommission facilities related to developing nuclear weapons and to depose related radioactive waste and nuclear materials.[3]

Understanding descriptive references and physical properties of the facility and its purpose important for decommissioning nuclear facilities. Although it was impossible to collect data on DPRK nuclear facilities to perform complete decommissioning, we were able to understand the process used at DPRK nuclear facilities with open source data.[3]

This study has been conducted to establish overall measures for decommissioning DPRK nuclear facilities. DPRK nuclear facilities in this study include a IRT-2000 type nuclear research reactor, a 5 MWe graphite moderated reactor, nuclear fuel fabrication facility, and a nuclear fuel reprocessing facility, which are considered as facilities that produce or manufacture nuclear materials needed for nuclear weapons or related to such activities.

2. Analysis

2.1 Status on DPRK nuclear facilities

IRT-2000, a pool-type light-water reactor provided by the former Soviet Union has been in use for over 50 years since it began operations in 1965 and its original 2 MW reactor has been upgraded to 8 MW. The 5 MWe graphite moderated reactor is a core facility of the DRPK's nuclear weapon program. Plutonium from this reactor's spent fuel is crucial for the program's implementation. It commenced operations in 1986 and is assumed to produce 5–7kg of plutonium annually. The nuclear fuel fabrication facility that produces and stores the natural uranium used for the 5 MWe graphite moderated reactor produces about 50 tons of magnox nuclear fuel annually. The nuclear fuel reprocessing facility is a facility that had chosen the PUREX method, which is the standard aqueous nuclear reprocessing method. It is assumed that the nuclear reprocessing facility has been used a total of 4 times since 1989 (in the 1990s, 2003, 2005, and 2009).[2]

Fig. 1. DPRK Nuclear facilities in Yongbyon.[2]

2.2 Decommissioning similar facilities with research reactors

Georgia's IRT-M Tbilisi, which is the same type of IRT research reactor as that of the DPRK, has been operational for about 30 years since its completion in 1959. Nearly 200 fuel assemblies were used during its operation; thereafter, it has been either eliminated or used as a reprocessing facility by Russia and the United States of America. It was supposed to be decommissioned in 1990; however, it was later decided that it would be used as a nuclear reactor for educational purposes due to the lack of financial and technical resources.[3] Moreover, our country's first research nuclear reactors, Triga Mark II and Mark II, have been also decommissioned immediately after hitting their first critical mass in 1962 and 1972 respectively, with the help of UK. Approximately 20 people were part of the decommissioning process, which cost approximately 23 billion dollars. About 395 tons of radioactive waste was created.[5]

2.3 Decommissioning of similar facilities with 5 MWe graphite moderated reactors

UK's Calder Hall nuclear reactor, which DPRK had copied when manufacturing the 5 MWe graphite moderated reactor, has been shut down after 45 years of operation and is still undergoing the process of decommissioning. Spain's Vandellos-1 was also decommissioned in 1989, 17 years after it began operations in 1972; the site was prepared for the dormancy period of 25 years, which allows for a significant decrease in the reactor's radiological levels. Vandellos-1 is also in the process of being decommissioned and its radioactive waste until today is calculated to be about 1,763.7 tons and is expected to increase at the time of completion of the decommissioning.[3]

2.4 Decommissioning similar nuclear fuel fabrication facilities

Decommissioning of Germany's Siemens nuclear fuel manufacturing facility was decided in 1995 and the decommissioning process commenced in 1999. In 2002, the dismantling, including the removal of the building, was completed. It was possible to complete the decommissioning process within a short period because the wet type decontamination process was not implemented except on the pipes.[3] Furthermore, a domestic uranium conversion facility was established in the 1980s as a part of the RUFIC fuel business and was operated for about 10 years until the completion of 12 years of decommissioning after the decision to decommission due to the deterioration in the facility and equipment. The decommissioning of the conversion facility is significant because the decommissioning was solely done based on domestic technology and nuclear reactor decommissioning experience.[2,4]

2.5 Decommissioning of similar nuclear fuel reprocessing facilities

Eurochemic in Belgium, which used the same PUREX reprocessing method used in the DPRK, was operational for 8 years since it began operations in 1966. Decommissioning began in 1989 and the process continued for 30 years until 2014. The long process period is thought to be due to a lack of knowledge and technology on the decommissioning of a reprocessing facility at the time. The amount of demolition waste was assumed to be about 30,000 tons at the time and the actual waste amount was 2,800 tons after the completion of decommissioning.[3]

Table 1. Estimate of decommissioning waste in DPRK nuclear fuel reprocessing facility by Eurochemic[3]

	Decommissioning waste of Eurochemic (ton)	Estimate of decommissioning waste in DPRK nuclear fuel reprocessing facility (ton)
Metal	2,010	2,552
Concrete	28,658	36,395
Heavy concrete	472	599
Other materials	187	237
Total	31,327	39,785

3. Decommissioning characteristics of facilities

In the case of IRT-2000, high radioactive levels are to be expected due to a long operational period; however, it is assumed that it would be not much different from the decommissioning of domestic nuclear reactors for research in that there will be no technical and waste difficulty. In the case of the 5 MWe graphite moderated reactor, there might be difficulties when disposing waste and graphite due to a lack of experience in decommissioning and operating gas-cooled reactors; however, help from several countries following the six-party talks in the spirit of international cooperation is expected. The DPRK nuclear fuel fabrication facility only used natural uranium so there will be neither a chemical processing facility nor nuclear criticality. Therefore, there is no singularity regarding the decommissioning. Furthermore, there will be no technical difficulties based on domestic experience in decommissioning uranium conversion facilities; however, we must be prepared for the disposal of immense amounts of radioactive waste and the high costs resulting from ground pollution. Decommissioning of a reprocessing facility is not an easy task. There will be limitations to a process that uses domestic technology, and a possible political debate may arise. In addition, difficulties due to lack of storage capacity and facilities of high-level radioactive waste is also expected.[2]

4. Conclusions

This study was able to analyze domestic and foreign cases, and collect data on the approximate amount of waste and time required time; however, data on applied technology, input manpower, required cost, and waste disposal method was insufficient. In the future, more accurate analysis and research is needed on how decommissioning is prepared, processed, completed and dealt with as well the regulations or systems that are followed.

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