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Study on the Safeguards Approach to Pyroprocessing Technology

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1. Introduction

In the nuclear non-proliferation regime, IAEA safeguards system works to control the nuclear material and to prevent transferring the sensitive technology.

We, Republic of Korea, under the comprehensive safeguards agreement and additional protocol, are required to send accountancy report as well as information research and development activities related to the nuclear fuel cycle.

Except for small quantity nuclear materials used for research and other commercial use, most of domestic nuclear materials are imported raw materials for fuel and spent fuel.

For the nuclear materials, procedures and methods of accounting and control are well established and implemented.

According to the environmental change, reprocessing technology is studied as one of options to reduce high level waste in Korea. Since it can change the type of nuclear materials required safeguards, KINAC, as a control agency, is required to establish the foundation of safeguards technology for the reprocessing facilities considering the characteristics of the system.

In this paper, we will discuss about the environment and current status of the reprocessing technology and safeguards.

2. Current Status of Reprocessing Technology

Reprocessing technology was first introduced to separate plutonium to use in the nuclear bomb. After the commercial reactors appeared, reprocessing technology was limited with a concern about nuclear proliferation.

Recently, the Global Nuclear Energy Partnership (GNEP) initiative was suggested to encourage the peaceful use of nuclear energy and at the same time limit the nuclear materials' flow by separating the nuclear suppliers and the recipients. It suggested to 1) reduce proliferation/Safeguards risk by limiting the number of countries processing enrichment and reprocessing facilities 2) prevent proliferation by advanced fuel cycle centered in existing fuel-cycle states 3) reduce repository burden by separating out all the actinides, and therefore 4) assure secured fuel supply.

In the GNEP initiative, reprocessing came to the front as a mean to securely provide nuclear fuel. Also, reprocessing can serve as a solution to decrease the toxicity and volume of waste, which is a pending issue in most of countries.

As a state with advanced nuclear technology, we need to catch up with the global trend and at the same time bring out promising solution to the shortage of resources and the high-level waste problem. Research on the reprocessing technology is required in this regards.

To close off the possibilities of proliferation, pyroprocessing is chosen as a proliferation resistant technology in reprocessing the spent fuel.

3. Safeguards at Reprocessing Facilities

3.1 Safeguards Criteria by IAEA

In the safeguards manual, basic safeguards criteria on the reprocessing facilities are described for each type and state of nuclear materials. Listed inspection methods are similar to other facilities; they are 1) review of record and reports 2) Physical Inventory Verification (PIV) and 3) verification of inventory changes. To implement the safeguard to the specific facility, detailed design information and the characteristics of the facility are considered. There are some examples of existing reprocessing plants.

In the Tokai reprocessing plant, safeguards are implemented based on the Material Balance Areas (MBAs), which are classified as spent fuel receiving/storage/main processing area concentrated on precise accountancy. For the Plutonium verification, some advanced measurement systems are developed. For the timeliness of the monitoring, it adopted Near Real Time Accountancy (NRTA) [1].

Rokkasho Reprocessing Plant (RRP) is featured by large throughput, continuous processing, automated operation and limited inspector access, which required devising effective and efficient safeguards. In the RRP, solution monitoring, extended C/S, automated data collection and evaluation systems are adopted. [2]

In addition, research and development programs for the safeguards of RRP are still on going with support of IAEA. [3]

3.2 Safeguards Development in GNEP initiative

Since GNEP initiative claims to stand for reprocessing, it also considers adopting appropriate safeguards technology to the GNEP facilities. GNEP try to apply proven techniques and state-of-the-art measurement technologies satisfying the international safeguards requirements to the prototype facilities. Through these activities, KMP (Key Measurement

Point) and MBA (Material Balance Area) of the target facilities are identified for material accounting and monitoring. It is planned to use these facilities as a test bed to advance safeguards.[4)]

GEN IV Proliferation Resistance methodology can be directly adapted to the GNEP systems, however, safeguards technologies for pyroprocessing methods and other advanced reprocessing techniques still need to be further developed.

4. Discussion

Reprocessing technology is studied in the KAERI, and safeguards research for the Advanced Fuel Cycle Processing Facility (ACPF) is also studied in parallel.

KINAC, as a control agency, need to establish the foundation of safeguards technology for the reprocessing facilities.

In the development of the safeguards approach to the reprocessing, we are planning to work on both quantitative and qualitative approach.

As a quantitative approach, we will review the materials accountancy. For this purpose, we need to identify nuclear materials flow during the process and quantify the MUF (Material Unaccounted For) issued during the process. Based on this, acceptability of the process and the improvability can be reviewed.

As a qualitative approach, we need to technically investigate the process. We will try to find efficient way to monitor the nuclear materials. It needs further study on the pyroprocessing technology itself.

5. Conclusion

Pyroprocessing technology is still in the Lab. Scale and yet to be tested in the large scale. It has many challenges on the way. To prevent the proliferation concern of other countries, Korea decided to develop the pyroprocessing technology, which is known to be proliferation resistant, among reprocessing methodologies.

For the pyroprocessing technology, non-proliferation consensus between the interested parties is indispensable. Once the pyroprocessing is proved to have acceptable proliferation resistance, then the next step will be the establishment of reliable safeguards system in the state level.

In this regard, closer cooperation between research institute and the control agency is necessary.

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