A Study on the Implementation of Safeguards System at PIEF

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1. Introduction

In accordance with the Comprehensive Safeguards Agreement (CSA) entered into force in 1975 and State level Approach (SLA) for safeguards in 2015, the Post Irradiation Experiment Facility (PIEF) was subject to safeguards in 1985. Since then, it has been severely inspected by the International Atomic Energy Agency (IAEA), because it has been conducting post irradiation examinations on irradiated nuclear materials and has been storing spent fuel assemblies and rods delivered by nuclear plants. PIEF contributes to develop technologies for reactor safety, fuel design and fuel fabrication improvements and is devoted to supplying various informative PIE data for R&D projects performed by KAERI. In addition, it includes hot cell examinations of irradiated materials, surveillance tests and a life assessment of structural components. PIEF has another laboratory to carry out cutting-edge radiochemistry technology. This laboratory aims to develop technologies on actinide chemistry and the burn-up characteristics of nuclear fuel. In fact, the two laboratories are associated with each other and might have been constructed for similar goals. Therefore, PIEF consists of several KMPs (Key Measurement Point) for the safeguards in relation to two laboratories. According to the CSA contracted between ROK and IAEA, KMP indicates a location where nuclear material appears in such a form that it may be measured to determine a nuclear flow or inventory. In light of the characters of PIEF handling the spent fuel assemblies and rods, the IAEA has enforced the inspection level, frequency and inspection methods for the safeguards of PIEF and the authority of the Korean government asked KAERI to establish efficient and effective methods for IAEA inspections. Since 2008, Integrated Safeguards (IS) have been implemented in the ROK. In association with this agreement between IAEA and ROK, IAEA has carried out a Random Interim Inspection (RII). To cope with this IAEA requirement, the PIEF operator and the Nuclear material Control Team (NMCT) at KAERI should set up the easiest ways to supply timely inspection materials.

2. Safeguards Implementation

2.1 Major changes at each path of Safeguards Agreements at KAERI

To introduce and manage the technology of nuclear energy, the Korean government founded the Korea Atomic Energy Research Institute (KAERI) in 1959. Since then, KAERI has been at the center of safeguards of the ROK. Figure 1 shows the established Material Balance Areas (MBAs) which are subject to safeguards at KAERI. Among them, PIEF was established in 1985 which has pools for the unloading, dismantling and storing of low enriched spent fuel assemblies and rods, concrete hot cells for PIE and lead cells for burn-up measurements. This facility which has two stories above ground and three underground levels has performed post- irradiation experiment for reactor safety, fuel design and fabrication. PIEF continuously participates in an exchange program of foreign countries such as HALDEN nuclear fuel and materials DB, JAEA JMTR and Studsvik cladding integrity project.

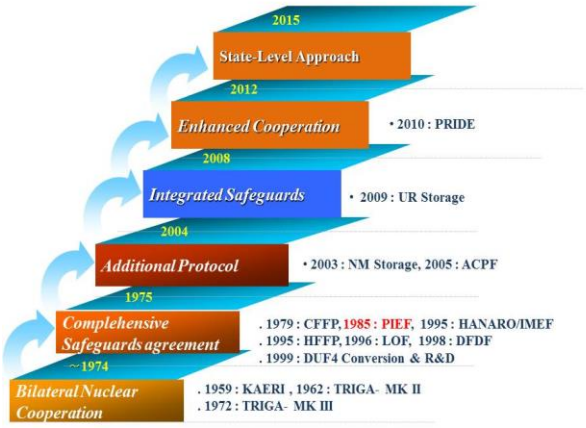

Fig.1. Established MBA in each path of Safeguards

2.2 History of Safeguards at PIEF

PIEF was constructed in 1985 and was tested for the operation from 1986 to 1990. In 1991, it started normal operation. To obtain an approval as a nuclear facility from the IAEA, it should be notified as much in advance as possible of the expected construction schedule. Accordingly, the facility operator should submit the design information before construction. PIEF submitted the initial design information in May, 1983 and provided the final design information in May, 1986. Based on the design information of the facility provided by PIEF, the IAEA issued a facility attachment (FA) of PIEF to confirm the design information of the nuclear facility in 1988. This facility attachment was revised several times and finally applied to the PIEF in 1998. A major change of PIEF in which a radiochemistry analysis laboratory was included, occurred in 1994. To comply with the safeguards agreements such as the CSA and additional protocol, PIEF added a radiochemistry analysis laboratory to the Design Information Questionnaire (DIQ). The major history of safeguards on PIEF is shown in Table 1.

Table 1.Major history of safeguards on PIEF

year	Major history of Safeguards
1985.05	The initial application of safeguards
1994.02	Add the radiochemistry analysis Lab.
1995.05	Submit the advance notification report concerning handling the spent fuel to USA
1998.09	IAEA set up the Unattended Radiation Monitoring system
2002.09	Submit the information to IAEA on the radiochemistry data and handling Th
2009.04	Elimination of IAEA Surveillance equipment
2011.05	Exchange the MMCA by IAEA
2013.05	Re-determine and apply the concept of MBP during PIV
2014.05	Exchange the MMCA by IAEA
2016.04	Implement the Environmental Sampling
2017.04	Implement the Environmental Sampling

2.3 Endeavors to increase the efficiency of accounting for and control of nuclear materials

Since 2008, the IAEA has implemented Random Interim Inspections (RIIs) in ROK. PIEF also needs to prepare for RIIs. The facility operator should submit the accounting reports (e.g., General ledger, inventory change report and nuclear material control report) within two hours after the inspector announces an RII and IAEA inspector obliges to visit and inspect the facility. In fact, two hours is not enough to be ready for an inspection. To achieve a timely response to an RII, PIEF needs several tasks in advance, such as providing the correct information for accounting and control of nuclear materials it owns, and arranging the facility for inspection. In relation to this environmental change in IAEA inspections, the nuclear material control team at KAERI suggests a new Web-based electronic system for coping with such an RII. Furthermore, the IAEA is strengthening its inspection levels and asking PIEF to set up efficient and effective methods for accounting for and control of nuclear materials. In response to these requirements, PIEF decided to establish a Web-based system designed to increase the practical use and facilitates the end-user to account for and control of the nuclear materials. Currently, PIEF has created hand-made inventory management reports through Excel spreadsheet. Actually, using spreadsheet is not a bad method for controlling complex data. However, it should be revised to reduce human-errors. Accordingly, NMCT and PIEF decided to set up a Web-based system for the accounting for and control of nuclear materials at PIEF. The followings are the basic requirements for designing a Web-based system.

- History management of the movement of nuclear materials at PIEF
- Drag and drop focused on helping the end-user
- Web-based contents similar to the real features
- Integration into KASIS (KAeri Safeguards Information treatment System) to support SSAC
- Information sharing with other computerized accounting system
- Creation of nuclear materials accounting reports

Fig. 2 shows the expected function analysis diagram of the safeguards system at PIEF.

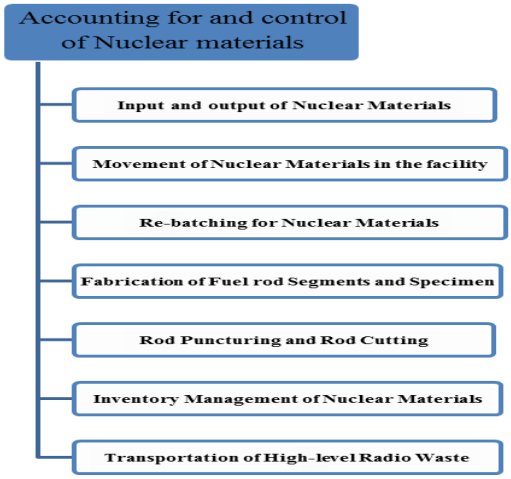

Fig. 2 Function Analysis diagram of Safeguards System

Although this Web-based system was designed and developed well, it seems to have many complex equations and procedures applied to IAEA safeguards. Actually, this Web-based system has not yet been finished. Even though PIEF has tried to complete this system, there are some practical limitations to its execution.

- The possibility of making a mistakes owing to the complex structure of the storage of nuclear materials
- Difficulties in tracing the relevant history, when moving the storage positions while making the rod segments and specimen
- The lack of a relevant budget to finish the Web-based program

4. Conclusions

This paper studied the implementation of safeguards system at PIEF. PIEF must be a complex facility to account for and control of nuclear materials. It has two laboratories, which are not easy for handling nuclear materials. To cope with this current difficulty, PIEF has designed and attempted to build a Web-based system to control the nuclear materials. Although, PIEF recognizes the practical difficulties building a Web-based system for safeguards purposes, it is making every effort to complete this safeguards system as soon as possible.

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