# Safeguards Inspection Regime for Reference Pyroprocessing Facility in the ROK

Jong Kyu Jeon*
*Korea Institute of Nuclear Non-Proliferation and Control, P.O. Box 114, Yuseong, Daejeon, KOREA*
**Corresponding author: jkjeon@kinac.re.kr*

## 1. Introduction

Considering the technical activities for the development of pyroprocess technology and established plans for the construction of pyroprocess facilities, the International Atomic Energy Agency (IAEA) has focused on its necessity of technical background for the pyroprocess facilities to develop the safeguards approaches. In this regard, a MSSP (Member State Support Programmes for Agency Safeguards) for the "Support for Development of a Safeguards Approach for a Pyroprocessing Plant" contracted between IAEA and the Republic of Korea in July 2008.

In this study, safeguards inspection regime for Reference Pyroprocessing Facility (REPF) were prepared based on the determination of Material Balance Area (MBA) and Key Measurement Point (KMP) for the REPF. In addition, the inspection regime for the REPF was determined as annual physical inventory verification (PIV), Random Interim Inspection (RII), and Short Notice Inspection (SNI) with the support of Near-Real Time Accountancy (NRTA), Unattended Monitoring System (UMS), and Mailbox Declaration System applied at the REPF.

## 2. Inspection Regime for the REPF

### *2.1 Assumption of Final Product (U/TRU ingots) as Safeguards Point of View*

The U/TRU ingot, the final product of the REPF, is composed of uranium, plutonium, transuranic materials such as Np, Am, and Cm and rare earth fission products (FP). The classification of U/TRU ingot as a safeguards point of view (unirradiated or irradiated direct-use material) is very important issue to develop the safeguards approach for the REPF. Due to no classification determined for U/TRU ingot by the IAEA, it is assumed by considering the characteristics of REPF, material contents, possible environment for the separation processes. As mentioned above, U/TRU ingot has rare earth fission products and transuranic material so that the separation processes of FP and TRU are needed. In addition, relatively high gamma dose rate (about 300mSv/hr for 1 ingot (6kg)) of U/TRU ingot requires the hot cell environment for the further separation processes. Therefore, U/TRU ingots are assumed as irradiated direct-use material in this study, and are not required for the frequency of inspections applied reprocessing plant.

### *2.2 Determination of MBAs and KMPs at the REPF*

The determination of Material Balance Area (MBA) plays an important role in the safeguards approach for the REPF. Throughout the optimization of MBA design for the facility, the facility operator and inspectorate are easy to confirm the material balance and to trace the material flow. From the perspective of safeguards such as material control and accountability (MC&A) and containment/surveillance (C/S), multiple MBAs are preferred depending on the material types and the atmosphere in the cell. For the REPF, 3 MBAs were determined; the spent fuel pool and head-end cell are included in the MBA-1, and MBA-2 is covered pyroprocess cell. MBA-3 is composed of storages of U/TRU ingots, U ingots and wastes.

Key Measurement Point (KMP) is the location where nuclear material is present in a form for making it possible to measure and then determine the material flow or the inventory. KMPs are classified as flow and inventory KMPs, respectively. The flow KMPs are determined as the typical flow KMPs applied in the nuclear facilities, and the inventory KMPs are pointed at the storages of Nuclear Material (NM) in each MBA.

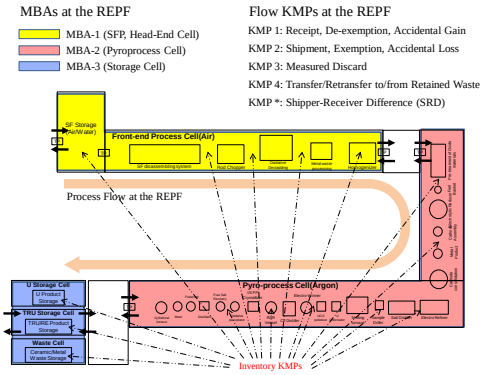


Fig. 1. MBAs and KMPs at the REPF

### *2.3 Physical Inventory Verification (PIV) at the REPF*

The IAEA and ROK have applied the inspection regime under Integrated Safeguards (IS) since July 2008. According to this changed inspection regime, timeliness goal of Spent Fuel (SF) is extended from 3 months to 1 year. In the result of extended timeliness goal under IS, the interim inspection for the timely detection every 3 months has been replaced to the Random Interim Inspection (RII) to cover extended timeliness goal (1 year), even the PIV at non-sensitive facilities is randomly selected with different selection probabilities (20~ 50%). In the case of REPF, however, this facility can be classified as a recycling facility of SFs and has the most sensitive processes among all

nuclear facility in the ROK so that the annual PIV should be applied even under the IS.

The REPF still has strong drawback for the verification of NMs in the pyroprocess cell (PC) with Ar atmosphere due to the inaccessibility of Ar hot cells and limitation of installation of sufficient safeguards equipments for the verification of diverse types of NMs in the PC.

Therefore, the PIV should be carried out under such a condition that process campaign is completed and no NMs exist at the PC. Even if the process campaign is suspended, the NMs should not be existed in the PC at least. Based on this condition for PIV, the inspectorate confirms the input and output of NMs at the PC and verifies the absence of NM at the PC including the verification activities for the NMs at the spent fuel pond, head-end cell and storage cells.

### *2.4 Random Interim Inspection (RII) at the REPF*

Different from the pure Pu or HEU with the timely detection for 1 month, U/TRU ingots produced from the REPF have mixed contents with transuranic elements and rare earth fission products including U and Pu and cannot directly be used to diversion processes. In this regard, the interim inspection for timeliness detection for 1 month does not necessarily have to be applied to the REPF and extended timeliness detection goal (maximum 1 year) can be applied to the inspection procedure for the REPF. Nevertheless, the characteristics of REPF applying the recycling processes of SFs should be considered for the appropriate inspection regime. Therefore, in this study, the frequency of RII at the REPF is determined to several times per year with the similar level to the comprehensive safeguards agreement prior to the IS but less frequent than the interim inspection at the reprocessing plant.

During RII, the same verification activities as PIVs except the pyroprocess cell are conducted. Due to the inaccessibility of Ar hot cells and difficulties on the installation of safeguards equipments at the PC, the verification of NM at the PC is focused on the identification of input/output of NMs at the PC throughout the analysis of UMS, mailbox declaration, and NRTA with process monitoring data.

### *2.5 Short Notice Inspection (SNI) at the REPF*

The required time for campaigns at the REPF is 11 days whereas the initial campaign last 37 days. The flow of NM in the REPF is so fast that the additional confirmation of safeguards relevant systems (NRTA, UMS and Mailbox) may be needed as well as the confirmation of quality control for NMs at the REPF. In this regard, the SNI, independent national inspection regime for the REPF, is added to confirm the quality control of process campaign and to verify those safeguards related systems applied at the REPF.

In the SNI, the inspectorate focuses on the random selection of strategic points to take the DA samples for the verification of declared operational information. The prioritization of selection for DA samples is determined at the strategic point where the inconsistency is found out through the information analyses of NRTA, Mailbox, and UMS, or where the current batch is possibly mixed with the following batch during the campaign. Otherwise, the strategic points are randomly selected for DA samples without any information. The inspectorate analyzes the DA samples and evaluates the quality control of processes at the REPF.

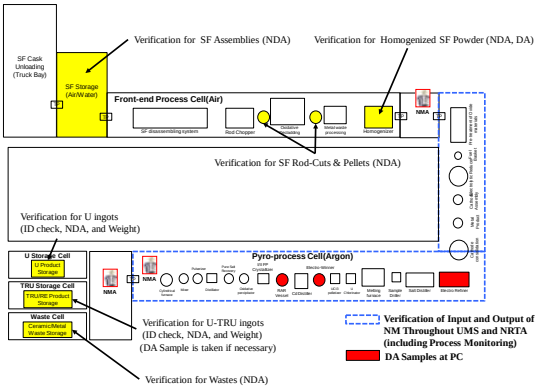


Fig. 2. Verification Activities at the REPF

## 3. Conclusions

In this study, the safeguards inspection regime for the REPF is suggested under the assumption of final product (U/TRU ingot) at the REPF. The inspection regime for the REPF was determined as the annual PIVs and several times RII per year with the support of safeguards relevant systems such as NRTA, UMS and mailbox declaration system.

In order to establish the inspection regime suggested in this study, the classification of U/TRU ingot should be determined with the consideration of the characteristics and proliferation resistance of REPF, the contents of U/TRU ingot, possible environment and consuming time for the separation processes, and so on.

Even if the U/TRU ingot is classified as unirradiated direct-use material like pure Pu or MOX, the safeguards inspection regime for the REPF suggested in this study is still applicable by changing the frequency of RIIs (several times per year to monthly interim inspection).

## REFERENCES

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