The Experience of Short Notice Random Inspection Rehearsal at Fuel Fabrication Plant in KOREA

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1. Introduction

The Korean nuclear fuel fabrication plant (KNFC) established to manufacture the nuclear fuels at the end of 1988 and has been supplying all domestic needs of the LWR and CANDU fuels. In the Agency's safeguards criteria, KNFC is classified as a bulk facility and is defined to be verified with one physical inventory verification (PIV) and two interim inspections should be carried out under the zone approach, which has been applied for LEU and NU fresh fuels. In order to conduct effective inspections in KOR under Integrated safeguards and to apply Integrated Safeguards to all facilities in ROK, Short Notice Random Inspection under traditional safeguards is essential through the experience of SNRIs in KNFC. The objective of the SNRI implementation is to provide, on a random basis, full verification coverage of the nuclear material involved in transfers into and out of the fuel fabrication/conversion plant. Inventory changes involving powder, UF_6, and fuel assemblies will be reported to the SNRI mailbox. This study is to figure out the optimal application of SNRIs in KNFC under traditional safeguards and to prepare the implementation of SNRIs under Integrated Safeguards through the analysis of two SNRI rehearsals conducted in KNFC in 2006.

2. Two SNRI Rehearsals at KNFC

With the implementation of an SNRI regime under Traditional Safeguards at the KOR- facility, an annual PIV at KOR-, together with the SNRIs will be conducted. In States with DNLEU fuel fabrication plants and an approved SNRI regime in place for flow verification, no measures to detect borrowing of fresh LEU fuel assemblies are required at LWRs and CANDU reactor Facilities.

2.1 The SNRI Rehearsals at KNFC

The SNRI rehearsals under traditional safeguards were conducted at KNFC on September 25 to 26, 2006 and November 13, 2006, respectively after the discussion from SNRI Procedure Review Meeting. The advanced notice for this SNRI rehearsal was notified to the facility 2 hours before the inspection is started. The mailbox declaration data for received nuclear material and products (fuel assemblies for LWRs and fuel bundles for CANDUs) and the list of inventory items (LII) for UF6 cylinders, natural UO2 powder, fuel assemblies for LWR, and fuel bundles for CANDUs were provided from the operator and were examined for correctness and internal consistency.

2.2 Mailbox Declaration

Major inventory changes and fresh fuel production are reported as a daily declaration through a mailbox system by the facility operator. For mailbox declarations of *arrival*, *birth*, *death*, *return to/from the process and shipment* of nuclear material from the facility, the following transaction codes are used:

A = Arrival of NM
B = Birth;
D = Death;
R = Return to/from process;
S = *Shipment from the facility*.

The mailbox postings by the facility operator for every working day when the transactions subject to mailbox declarations occur must be carried out by 18:00 on the following day at latest.

2.3 Nuclear material verification

Based on the procedure for SNRI under traditional safeguards at depleted, natural and low enriched uranium conversion and fabrication plant, received nuclear materials such as UF6 and UO2 powder, and fuel assemblies and fuel bundles should be item counted and ID checked to clarify flow verification and no borrowing of fresh LEU fuel assemblies and NU fuel bundles from LWRs and CANDUs.

The verification methods, for LEU and NU as required by the procedure for under traditional safeguards, are as follows:

- Fresh fuel assemblies, UF6 cylinders, fresh fuel bundles, and NU Powder are verified for gross and partial defects in LEU and NU strata.
- NU powder is verified for bias defect by taking DA samples. In the case of UF6 cylinders, it was difficult to verify by taking DA samples from UF6 cylinder using a sampling kit due to the safety regulations in KNFC. Therefore, they are verified for bias defect by taking a DA sample as a form of converted UO2 powder in the UF6 conversion process.

- The verifications of fabrication processes were replaced by taking DA samples at rod loading stations.
- The items subject to SNRI verification are classified as material in residence and material out of residence when they are verified.

2.4 Sample size calculation

Based on the procedure for SNRI under traditional safeguards at depleted, natural and low enriched uranium conversion and fabrication plant, received nuclear materials such as UF6 and UO2 powder, and fuel assemblies and fuel bundles should be verified to clarify flow verification and no borrowing of fresh LEU fuel assemblies and NU fuel bundles from LWRs and CANDUs. The basic formula used for estimating the total number of samples (n) to be selected in each stratum is:

$$n = N(1 - \beta^{1/d})$$

Where
n is the number of items in the stratum,
β is the non-detection probability,
d is [M/x], the number of defects in the stratum rounded up to the next integer,
M is the goal amount,
X is the average nuclear material weight of an item in the stratum.

2.4 Nondestructive Assay and Chemical Analysis

UF6 cylinders are verified for gross, partial and bias defects. IMCG, which is a combination of Inspector 2000 and HpGe detector, is applied for the verifications of the gross and partial defects. For bias defect, as mentioned above, they are verified by taking a DA sample as a form of converted UO2 powder in the UF6 conversion process.

Natural UO2 powder was verified for gross, partial and bias defects. IMCN, which is the verifier using Inspector 2000 and NaI detector, is applied. HM-5, was used for the verification of LWR fuel assemblies and CANDU fuel bundles.

Fresh fuel assemblies for LWRs are verified for gross, partial defects and by serial number identification where applicable. UNCL, Uranium Neutron Coincidence Collar, is applied for the verification of partial defects and HM-5 is used for the gross defects.

The DA samples collected from rod loading stations and UO2 conversion process were analyzed to identify the precise content of U-235 and Uranium by TIMS and Mass spectroscopy.

3. Conclusion

Throughout trial and error from two rehearsals of Short Notice Random Inspection (SNRI), diverse schemes have been provided to enhance the effectiveness and efficiency of the national inspections with IAEA for SNRI at KNFC under Integrated Safeguards. However, the advance notification with 2 hours for SNRI can be a burden to both the national authority and the facility operator to prepare SNRI within 2 hours.

The further study for an access time for IAEA inspection team is being conducted by comparison of some cases in other countries.

REFERENCES

[1] NNCA, "Safeguards Implementation Department of NNCA 2006 Annual Report", NNCA/RR-01/2005

[2] IAEA, "IAEA Safeguards Criteria", 1999-03-10, TS No 9.

[3] Won-Woo Na, Seung-Ho Ahn, Jong-Kyu Jeon, Jang-Soo Shin, "Introduction of an Integrated Safeguards Approaches for Depleted, Natural and Low Enriched Uranium Conversion and Fabrication Plants", Korean Nuclear Society Spring Meeting, 2006.

[4] Jong-Kyu Jeon, Won-Woo Na, Seung-Ho Ahn, "Methodology for Physical Inventory Verification of Depleted, Natural and Low Enriched Uranium Conversion and Fabrication Plant in KOREA", Korean Nuclear Society Autumn Meeting, 2006.