SAFEGUARDS CORRESPONDENCE IN POST OPERATION PHASE AT URANIUM ENRICHMENT PLANT

T. ISHIDA
Ningyo-Toge Environmental Engineering Center, JAEA
1550, Kamisaibara,Kagamino town, Japan
Email: ishida.tsuyoshi@jaea.go.jp

S. NAKASHIMA
Ningyo-Toge Environmental Engineering Center, JAEA
1550, Kamisaibara,Kagamino town, Japan

Abstract

The uranium enrichment facility using gas centrifuge at Ningyo-toge environmental engineering center was constructed in 1979 and safeguards measure for enrichment facility was applied at the time of operation start. It was clear that it was extremely difficult to balance protection of sensitive information and effective safeguards measure.

HSP (Hexapartite Safeguards Project; 1980-1983) discussed safeguards approach for gas centrifuge enrichment facility. Conclusion of HSP includes LFUA (Limited Frequency Unannounced Access) to detect misuse of facility to produce high-enrichment uranium. Based on HSP, various safeguards measures were developed and tested at NEP through the Pilot Plant operation. The effective and efficient safeguards measures were demonstrated and developed through long-term operation in the Demonstration Plant.

Currently, our facility has been shifted to decommissioning phase. We need new safeguards challenge in accordance with current situation. Regarding safeguards for post-operation, ELFUA (Expanded Limited Frequency Unannounced Access) is tentatively installed. ELFUA is the inspection of the decontamination process of dismantled centrifuges in addition to LFUA for maintaining transparency and, attaching the seals for main piping of centrifuge is tentatively implemented for enhancing the proliferation resistance as operation shut down. We have also developed technologies for evaluation, recovery and measurement the hold-up uranium in the centrifuges after operation shutdown as preparation of decommissioning.

In order to complete safeguards termination for enrichment plants in the final stage of decommissioning facility, we are now discussing with IAEA about removal of nuclear material, waste disposal and removal or rendering of essential equipment for its use as main theme. Regarding dismantlement of centrifuge, currently, a part of centrifuge and attached equipment are dismantled in progress. We understand that the requirement of change the status is “Permanent decommissioning of cascade”. To reach this requirement, it is important to maintain transparency for centrifuge, make essential equipment rendered inoperable and manage the hold-up uranium and waste material. Safeguards challenges for post-operation phase need to be solved step by step towards termination.

The paper will describe the safeguards challenge and perspective in enrichment facility.

1. INTRODUCTION

This study provides consideration of safeguards under decommissioning from safeguards history in enrichment facility, Ningyo-toge Environmental Engineering Center, JAEA. We demonstrated Uranium enrichment using centrifuges from 1979. And that, this facility is in decommissioning phase. During long history, we challenged various process related to Uranium technology. Accordingly, safeguards method has been changing. As enrichment plant, we need to consider and discuss “Permanent decommissioning of cascade” for termination.

2. HISTORY OF ENRICHMENT URANIUM ENRICHMENT TECHNOLOGY RELATED TO CENTRIFUGE

2.1. HSP (Hexapartite Safeguards Project)

Operation was started as a Ningyo-toge pilot plant in 1979. This enrichment facility was first full-scale safeguards facility which can produce a significant amount of nuclear material in Japan.

Since the enrichment plant using centrifuge did not involve changes in chemical form, management of material accountant could be appropriately with keeping highest level of metrological control, and it would be easy to achieve the purpose of safeguards. On the other hand, this facility also was contained sensitive information from a commercial point of view, particularly sensitive information concentrated in the cascade chamber.

It was clear that it would be extremely difficult to manage protection of sensitive information and effective safeguards measures, since enrichment technology using centrifuges produced highly enriched uranium.

Some countries argued that it was necessary for inspectors to enter the cascade room, however, we were required to regulate entry for preventing the leakage of sensitive information.

Under these circumstances, Japan, the United States, Troika (the United Kingdom, western Germany, and the Netherlands), Australia, the IAEA, and Euratom were working together to establish the effective safeguards method for centrifuge enrichment facilities. In 1980, the Hexapartite Safeguards Project (HSP) was launched as a two-year plan.

It was agreed that the limited frequency, unannounced model would be effective in the following three.

(a) less interference with plant operations, resulting in less equipment and costs for both the facility and the inspection.

(b) It is easy to implement the verification.

(c) The usefulness of equipment and measurement techniques would be demonstrated with great reliability within the time limit of HSP.

A disadvantage of the on-site model was the higher risk of sensitive information leakage.

They recommended that safeguards approach which based on the limited frequency, unannounced model should be investigated in detail to confirm each technology installation.

In 1982, they conducted demonstration for two weeks at Ningyo-toge pilot plant.

In 1983, it was decided that we would accept the Limited Frequency Unannounced Access (LFUA) system. However, it is assumed that the following three conditions are satisfied.

(a) Acceptance by all participants in HSP and equal application to all countries.

(b) Clear definition and description of the scope of the inspector's activities.

(c) Resolving issues related to the protection of sensitive information

After more than two years, HSP had completed its technical duties.

2.2. Material Unaccounted For (MUF)

In the uranium enrichment facility, MUF was observed on the positive side due to long-term operation, and Cu-MUF (cumulative) increased steadily, reaching a maximum of about 3.9t. As a result of the analysis of MUF factors, the facility determined that the existence of hold up uranium in the cascade facility was the main cause of MUF. We also considered that one of issues for termination is solving Cu-MUF. To challenge this issue, the following technologies have been developed in cooperation with the IAEA. [5]

2.2.1. MUF evaluation by uranium balance method

In the FA negotiation, we proposed a change from the conventional U235-balance method based on U235 to the cost-effective U-balance method based on U as a metrological control method to satisfy the IAEA's verification goals.

This U-balance method focused on ensuring that all uranium was within the declared enrichment range. Under these conditions, it was possible that precise measurements of enrichment uranium would not be necessary, whether depleted or enriched uranium. It was clear that this would be an extremely superior approach in terms of cost effectiveness. the Japanese side had strongly advocated the U balance method in the FA negotiation. However, " With the current level of inspection activity described in the FA, it is not possible to verify that all uranium is within declared enrichments over an extended period of time without a U235 balance approach." The Japanese side agreed to accept the U235 balance method at the Ningyo-toge uranium enrichment pilot plant. [4]

2.2.2. IF7 flushing method

Cascade attached uranium was flushed out for recovery by IF7. The decontamination method for uranium recovery in process using IF7 gas was characterized that it did not require disassembly of equipment or wet chemical decontamination. The recovery rate of retained uranium by this method was about 98%, and it was confirmed that this method was an effective method for recovering retained uranium in the cascade facility. [1][2]

a) Recovery principle

Intermediate fluorides, mainly UF4, staying in the cascade react with IF7 to form gaseous UF6 and IF5 at room temperature. Cascade retentate recovery utilizes this reaction. (See FIG.1)

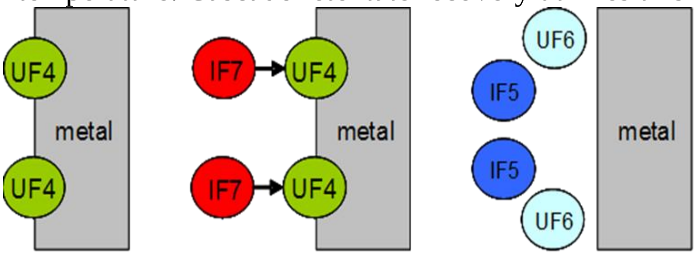

FIG. 1. IF7 flushing recovery principle [2]

b) collection method

The uranium recovery operation by IF7 supplied IF7 from the UF6 supply line, which reacts with uranium in the cascade to produce UF6 and IF5. UF6 and IF5, with unreacted IF7, were collected in a cold trap through an exhaust line. In addition, reaction product gases (UF6 and IF5) were recovered, and unreacted IF7 was resupplied. (See FIG.2)

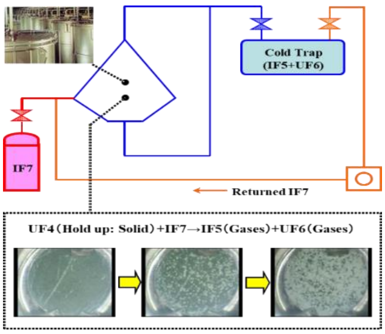

FIG. 2. IF7 flushing recovery method

2.2.3. Development of measurement and verification equipment, PNUH (portable neutron uranium hold-up counter) in cooperation with US DOE [2]

Cascade attached uranium was assumed to be an intermediate fluorine compound (UF5, UO2F2, etc.) generated from UF6. This was carried out and this method was developed to measure the amount of uranium in the entire Cascade Hall.

PNUH could move freely in the cascade area and can measure the amount of uranium in the centrifuge equipment in a brief period regardless of the operating state of the centrifuge equipment. (See FIG.3)

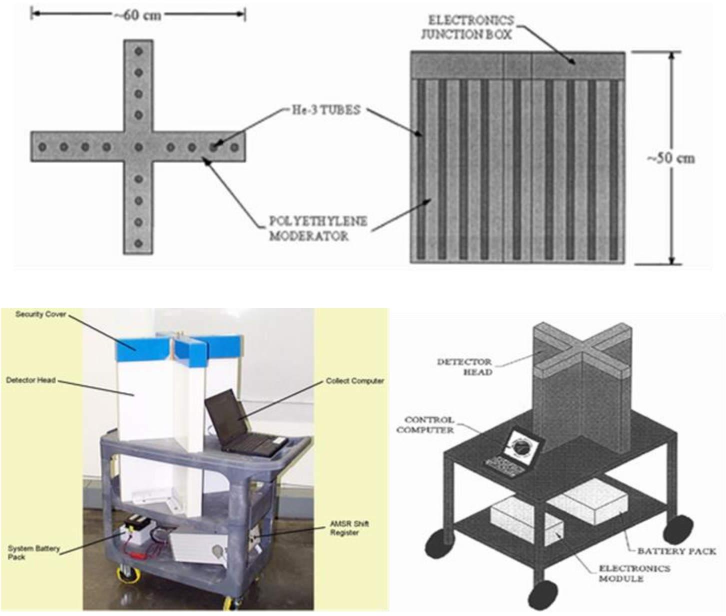

FIG. 3. Outline and appearance of PNUH [2]

3. CURRENT AND PERSPECTIVE OF ENRICHMENT URANIUM PLANT IN NEP

3.1. Facility decommissioning

NEP is currently under the decommissioning phase. We appropriately manage the nuclear material while dismantling the facility included to centrifuges. It is important to consider the approach in accordance with decommissioning phase. Present safeguards approaches would be discussed to improve referring to amount of stored nuclear material and situation of dismantling the centrifuge in the facility and so on. In addition, sensitive information related to centrifuges should be given close attention to. Though there are many more issues, which are occasionally discussed with IAEA, collaborated with other laboratories, and demonstrated the innovative technology. We positively challenge the innovative technology to establish the approach for termination. (See FIG.4)

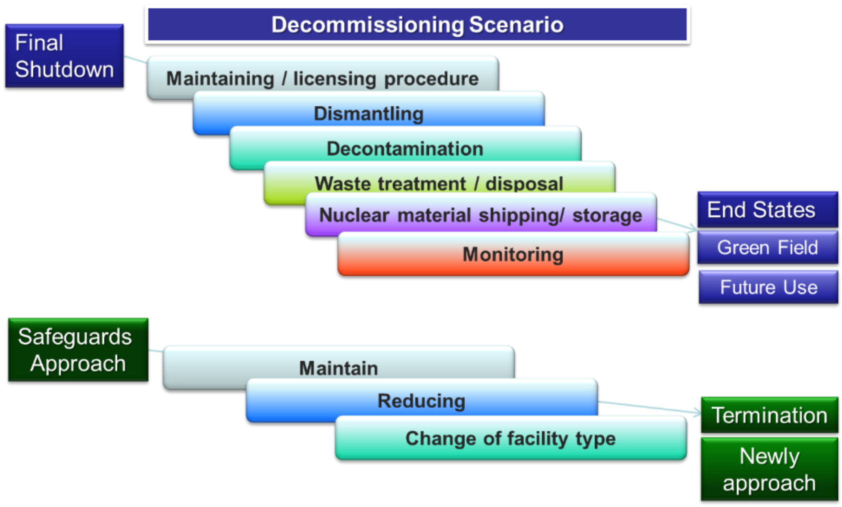

FIG. 4. Compared decommissioning flow with Safeguards Approach flow [3]

3.2. Nuclear material Management

Management of nuclear material in decommissioning phase should be considered. There are mainly useful for termination to dispose, ship, and store the nuclear materials.

Regarding disposal, it is difficult to dispose in Japan. This idea is unpredictable in that situation which there are not final disposal site. We need to consider shipping and disposing the nuclear material for other countries.

Regarding shipping, it is efficient to ship the nuclear material. Our facility has plan to ship the cylinders filled in UF6 in present. We have many cylinders in storage area. We would be progress on decommissioning and termination when this plan is completed. There are a lot of issues, shipping plan, cost, and discussing the safeguards approach during shipping UF6 cylinders. We have to solve the issues in discussion with IAEA.

Regarding storing, we need to consider storing nuclear material for a long time until decide the final disposal site. In this situation, it is essential to stabilize nuclear material and manage the waste material.

3.3. Management of waste material

Decommissioning would not be completed until the waste included uranium verify by the method which IAEA agree as formal measurement.

After decommissioning, we would have significant waste attached nuclear material. We would be required to manage the waste. Such as moving forward to next phase, it is necessary to discuss newly approach with IAEA as we have experienced. In addition, we should give attention to sensitive information such as centrifuges parts. Regarding sensitive information, it is important to vanish it completely in dismantling process.

3.4. Centrifuge decommissioning

Safeguards approach in accordance with decommission road map in NEP should be developed toward termination. There are some safeguards issues.

It is difficult to complete rendering for centrifuge. Referring to purpose of LFUA, it is important to find and detect the activity of producing the undeclared unclear materials. When producing undeclared HEU for nuclear weapons, some activities are considered;

(a) Diversion of nuclear material from the declared by the false reporting of MUF, shipper-receiver difference, or of operator declarations reflected in operator-inspector difference statistics. The diverted material is shipped to an undeclared enrichment plant for further enrichment to HEU.
(b) The introduction of undeclared feed into the plant for enrichment to a level less than or equal to the declared maximum. The product from this activity is not declared and is shipped to an undeclared enrichment plant for further enrichment to HEU.
(c) Undeclared production of HEU by reconfiguration of the cascades or operation in recycle mode. The HEU product is not declared and is shipped to an undeclared location.

Our facility is already dismantled generation and a part of piping. It is difficult to produce undeclared EU in short term. In this case, random inspection is efficient. Compared with operation status, it takes longer to produce EU because we prepare the equipment (tentative generation, piping, feed vessels and so on). Regarding frequency, we could reconsider details in accordance with situation.

In addition, we are considered in below flow, if undeclared HEU is produced ;

a, building up for capability of centrifuge
b, changing layout of cascade
c, setting the recovery equipment
d, feeding the uranium
e, running centrifuges
f, restoring the original layout of cascade
g, concealing and taking out the product

In this flow, the piping connected with centrifuges (feed, product and tail piping and so on) is important role for producing uranium. In addition, the generation for running centrifuge is necessary. In Ningyo-toge, part of piping and generations are already dismantling. We understand the enrichment facility is for termination step by step. Regarding centrifuge, there are a lot of parts related to sensitive information. It is necessary to make unrecognize the sensitive information. We need to consider preventing for diversion of sensitive information.

Regarding nuclear non-proliferation, we restrict the licensees and entry. In decommissioning, we vanish the parts of centrifuge related to sensitive information intently.

4. CONCLUSION

Safeguards approaches are improved in accordance with facility status in long history. There are a lot of issues, UF6 shipping, dismantling centrifuges, and disposal and management of waste materials and so on. In decommissioning phase, it is important to discuss with IAEA in regard to present safeguards approach. To accelerate the discussion, it is required to share, timely and correctly, the information of dismantling situation included to centrifuges as like essential equipment. In progressing the dismantling, the safeguards approach has been sophisticated while discussing with IAEA.

5. REFERENCES

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