The Status of Development on a Web-Based Nuclear Material Accounting System at KAERI

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1. Introduction

The IAEA drew a broader conclusion in June 2008 that all nuclear material in the ROK has been used in peaceful activities, as there was no indication of the diversion of declared nuclear material, and no indication of undeclared nuclear material and activities in the ROK. The Integrated Safeguards (IS) has been applied to 10 nuclear facilities and 1 location outside facility (LOF) at the Korea Atomic Energy Research Institute (KAERI) since July 2008.

One of the major changes in the implementation of safeguards under the IS is to apply the concept of a Random Interim Inspection (RII) instead of an interim inspection. The RII plan is notified within a few hours under the IS. It is thus difficult for facility operators to prepare the inspection documents within a short time if they do not periodically manage and process the nuclear material accounting data at each facility.

To resolve these issues, KAERI developed a Web-based accounting system with the function of a near real-time accounting (NRTA) system to effectively and efficiently manage the nuclear material accounting data produced at the nuclear facilities and cope with a short notice inspection under the IS, called KASIS (KAeri Safeguards Information treatment System). The facility operators must input the accounting data on the inventory changes, which are the transfers of nuclear materials among the nuclear facilities and the chemical/physical composition changes, into the KASIS.

KAERI also established an RFID system for controlling and managing the transfer of nuclear material and/or radioactive materials between the nuclear facilities for the purpose of nuclear safety management, and developed the nuclear material accounting system with the functions of inventory management of nuclear material at the facility level. The KASIS is integrated with another computerized accounting system for efficiently and effectively controlling the transfers and inventory changes of nuclear material between MBAs (Material Balance Area) including managing the nuclear material inventory at the facility level.

This paper describes the outlines on the development of the Web-based nuclear material accounting system and its integration status with other accounting systems including a nuclear material inventory management system for a research reactor.

2. Safeguards implementation system at KAERI

The KAERI site consists of 11 nuclear facilities subject to IAEA safeguards as shown in figure 1 on the overall safeguards system of KAERI.

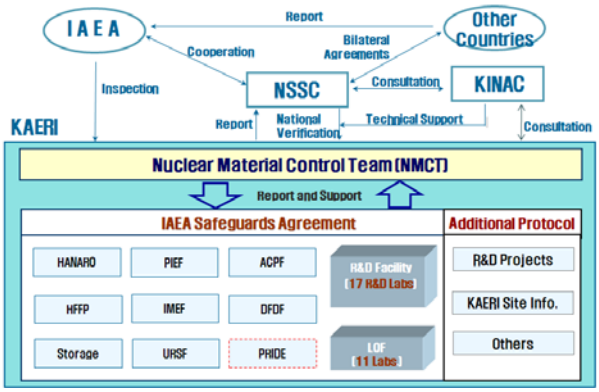

Fig 1. Overall Safeguards System at KAERI

A facility manager is designated at each nuclear facility for the implementation of safeguards work at the facility level. The facility manager should inform the nuclear material control team (NMCT) of the safeguards information to be reported to the IAEA, and maintain and manage the nuclear material accounting documents at the facility level. The R&D facility consists of 17 nuclear fuel cycle related R&D laboratories, while the LOF of KAERI consists of 11 basic R&D laboratories unrelated to the nuclear fuel cycle. The project manager in each R&D laboratory of an R&D facility or LOF should conduct the safeguards work like a facility manager. The NMCT, which is designated as a counterpart for international and domestic safeguards work at KAERI, has the responsibility for the overall implementation of the safeguards matters arising at each facility. Therefore, the NMCT has to timely collect and manage the nuclear material accounting data from the nuclear facilities although most nuclear facilities and R&D laboratories are located at different places in the KAERI site, and has to draw up the inspection documents and provide them to the IAEA inspectors during the RII.

To cope with the RII performing by a short notice, it was needed for the development of a computerized accounting system to timely collect the nuclear material

accounting data from all nuclear facilities in KAERI as a near real-time basis.

3. Development of the KASIS (KAeri Safeguards Information treatment System)

KAERI has unique characteristics in its safeguards implementation system such as (1) the various types of nuclear facilities, (2) the different locations of the nuclear facilities and R&D laboratories, and (3) the independent organization (NMCT) for the safeguards implementation. Based on these characteristics, KAERI recognized some difficulties for the preparation of RII when the IS was applied in the ROK because there was no central computerized system for collecting the nuclear material accounting data from the different nuclear facilities in KAERI. For this reason, a near real-time accounting system (NRTA) is needed for the preparation of RII under the IS.

KAERI developed a web-based nuclear material accounting system, called KASIS, for periodically managing and processing the nuclear material accounting data at each facility, and to cope with short notice inspection under the IS, as shown Fig. 2. KASIS has main features such as (1) NRTA for maintaining the nuclear material inventory for the preparation of RII under IS, (2) cross check functions for the nuclear material transfer in KAERI, (3) information sharing with other computerized accounting systems, (4) the creation of nuclear material accounting reports, and (5) the management of all kinds of information to be maintained for the safeguards implementation at the facility level.

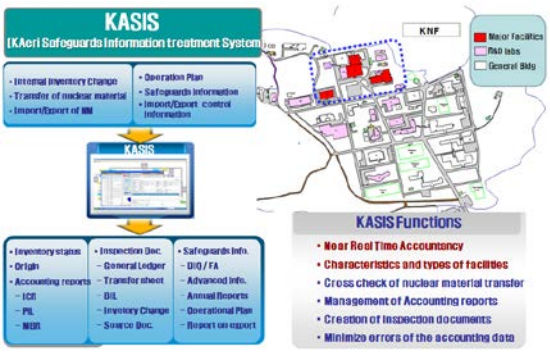

Fig 2. Schematic diagram of KASIS

The facility operators should input the accounting data into KASIS, and they should get approval for the nuclear material transfer from NMCT and health physics protection team in advance. They have to provide all inventory change information to the NMCT to reflect the inventory changes into KASIS.

KAERI has maintained a batch follow-up procedure using the re-batching whenever the inventory is changed regardless of the item counting and bulk handling facility. The unnecessary burden for drawing up the accounting reports is increased because they have to apply the re-batching procedure whenever the physical/chemical composition or number of items are changed, or chemical analysis samples are transferred to a different MBA (Material Balance Area) in the bulk handling facilities. Furthermore, the difference between the book inventory and physical inventory arises during the internal PIT (Physical Inventory Taking) because the facility operators maintain the measured value of the nuclear material in the process area based on the results of the PIT.

To resolve these issues, KAERI is classifying nuclear facilities into item counting and bulk handling facilities not only for the application of the appropriate nuclear material accountancy but for excluding the nuclear material in the process from the lists to be verified during the RIIs.

4. Status of Nuclear Material Accounting System developed at each facility

A. RFID system

KAERI established an RFID system to control and manage a small amount of nuclear material as well as radioactive material transferred between buildings without appropriate approval. To establish the RFID system, there are prerequisite conditions for controlling the transfer of nuclear material between the buildings at KAERI, as shown in fig 3.

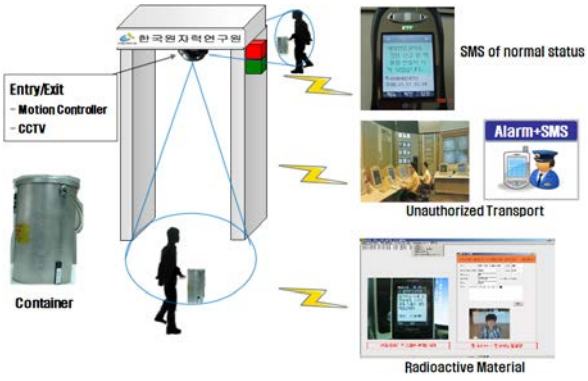

Fig 3. Concepts of RFID system

First, the shipper should use the designated container with the RFID tag under KAERI's internal regulations to recognize the RFID signal when it passes the RFID gate.

Second, the RFID gate with an RFID reader and radiation detector should be installed at the door of each building for detecting a container with an RFID tag or radiation material when passing the gate.

Third, the shipper should get approval for the transport of nuclear material from the health physics team in advance to recognize whether the transfer is authorized.

The RFID system and KASIS are connected for cross checking the transport of nuclear material through the exchange of supplemented information and for detecting

the unauthorized transfer of nuclear material or an inadequate application of the RFID system. Assuming that the nuclear material is transferred to another MBA, the shipper should fill in the application form for the transfer into the KASIS, and obtain approval from the relevant staff of the receiver, health physics team, and NMCT. When nuclear material passes the RFID gate, the RFID system sends an SMS/Pop-up message to the relevant staff. After completion of the transfer, it also sends a similar SMS message to the relevant staff.

B. Computerized inventory management system of Uranium Residue Storage Facility (URSF)

There is a URSF in KAERI for storing nuclear material that is no longer useful for the nuclear activities, and a USN (Ubiquitous Sensor Network) has been installed on the ceiling of all laboratories, offices, and corridors in KAERI for fire prevention and early detection. For a practical application of the USN installed at KAERI, the URSF developed a computerized inventory management system (CIMS) for maintaining a systematic and efficient inventory management using the wireless transmission of the USN installed everywhere in KAERI, as shown in fig 4.

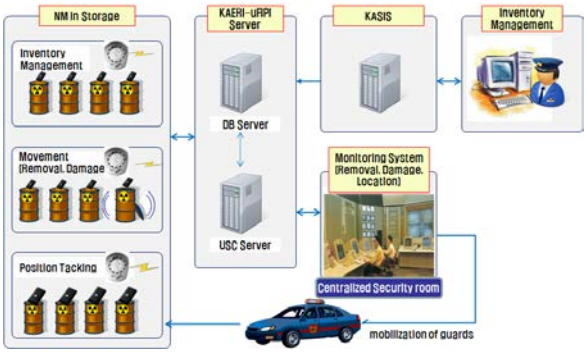

Fig 4. Concepts of CIMS

The main functions of the CIMS are inventory management, position tracking, and prevention of an unauthorized removal of nuclear material. The fixed sensor nodes of the USN installed in the ceiling of the laboratories, offices and corridors can detect fire, smoke, temperature, and infrared, and the movable sensor nodes are attached on each drum, container, and box. The fixed and movable sensor nodes of the USN can communicate their signals to each other by a 2-way communication system in a special frequency band, which prevents nuclear material from unauthorized removal or damage to the containers..

C. Accounting system of HANARO Fuel Fabrication Plant

One of the major nuclear facilities in KAERI is the HANARO fuel fabrication plant (HFFP), which fabricates research reactor fuel. The HFFP also developed its own computerized accounting system for managing the nuclear inventory and quality control data from each process. The HFFP is a bulk handling facility changing the chemical/physical composition during the fabrication of reactor fuels, and needs to frequently transfer a small amount of nuclear material to the other MBA for a chemical analysis. The facility operator should input the nuclear accounting data on the transferred nuclear material into the KASIS, the RFID system and its own accounting system, respectively. It is a tiresome job for operators to input the same accounting data into 3 different computerized systems, and thus it was necessary to integrate the KASIS with the RFID system and computerized system of HFFP, as shown in fig 5. As a result of the integration of these different systems, the operator inputs the accounting data only into KASIS, and input data are then shared with the RFID system and HFFP system. The integration of similar computerized accounting systems ensures the better management and efficient treatment of the nuclear material accounting data as well as convenient system operations.

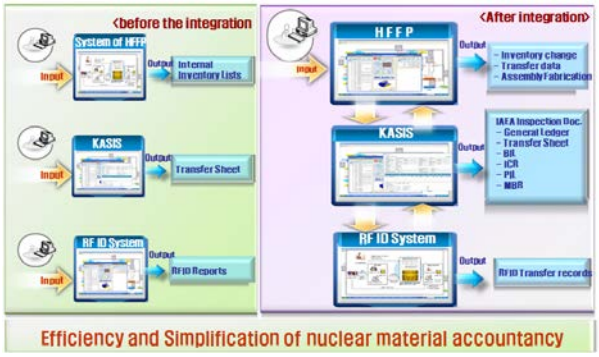

Fig 5. Integration of KASIS/HFFP/RFID system

D. Inventory Management system for Research Reactor

A research reactor should manage the nuclear material to be used for the reactor as well as the non-nuclear materials such as radio isotopes, casks, and rigs for the purpose of facility operation, and thus the computerized inventory management system at the research reactor facility can be different from the nuclear material accounting system of other nuclear facilities. A research reactor normally consists of fresh fuel storage, reactor core, temporary storage, and irradiated fuels storage for storing the nuclear material and non-nuclear materials.

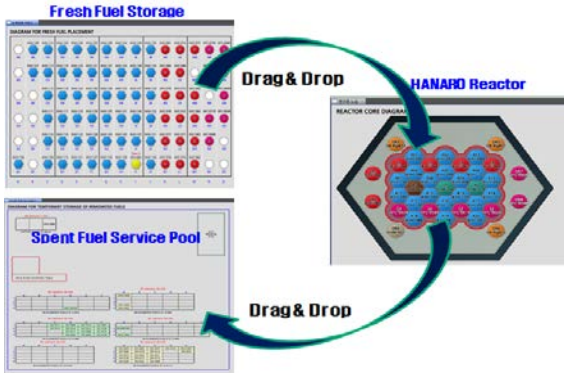

Fig 6. Overall Concept of RIMS

KAERI developed a model inventory management system for a research reactor (RIMS) to effectively manage the nuclear material as well as non-nuclear materials. The major functions of RIMS are to manage the movement history of nuclear materials and non-nuclear materials, to move the nuclear material using Drag and Drop function between the different locations, and flexible creation of each diagrams for the storages and reactor core. After development of RIMS, KAERI applied the RIMS to HANARO to provide the diagrams showing the real features of storages and reactor core, as shown in fig. 6. The RIMS is also integrated with KASIS for the treatment and management of nuclear material accounting data.

E. Inventory Management system for Post Irradiation Examination Facility (PIEF)

PIEF is used to perform PIE activities on the PWR irradiated fuels, HANARO fuels, and test fuel materials for HANARO in order to verify the irradiation performance and their integrity as well as to establish a fuel performance database. Considering the major nuclear material flow for performing these activities, PIEF stores the PWR irradiated fuels or defective rods in the pools received from power plants, and manages the location maps of each spent fuel assembly and defective rods in the pools, and the rods/rod cuts/specimens stored in the hot cell.

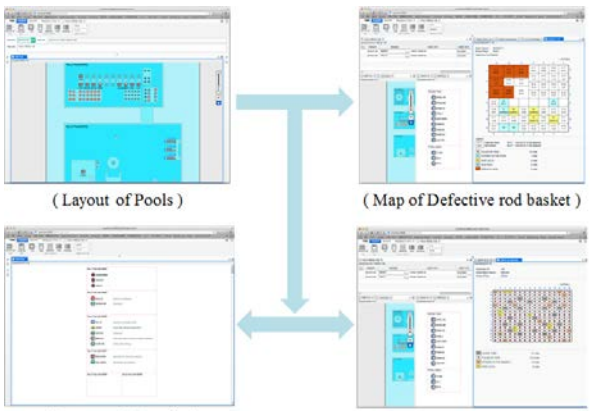

Fig 7. Inventory Management system of PIEF

The flow and PIE activities of nuclear material are simply expected as follows. The spent fuel assemblies stored in the pools are verified for their integrity and irradiation performance by a nondestructive examination. A few rods extracted from the assembly move to a hot cell for the irradiation examination using nondestructive examination as well as a destructive assay after cutting the rods. The information on the flow and activities of nuclear material including the change of physical form and the number of items in PIEF should be managed because it is an item counting facility. To manage the detailed operational activities using the irradiated spent fuels, the computerized nuclear material accounting system for PIEF was developed and integrated with KASIS, as shown in fig. 7.

F. Information management system for Expanded Declarations

KAERI has used a protocol reporter provided from the IAEA for managing and producing information of expanded declarations since the Additional Protocol (AP) entered into force in 2004 in the ROK. It is not sufficient for managing the detail information of expanded declarations under the AP at the KAERI site level.

To effectively collect and manage the expanded declarations related information from the R&D projects carried out at KAERI, the information management system for expanded declarations was developed, as shown in fig. 8. The major functions of the expanded declarations are as follows:

1) the automatic establishment of relationships on the R&D projects and site information,
2) collection of expanded declaration from the project managers through the Intranet of KAERI, creation and management of expanded declaration provided to the IAEA

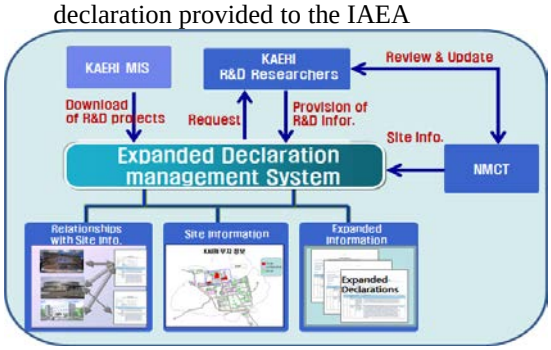

Fig 8. Schematic Diagram of Expanded Diagram

5. **The integration of KASIS with other computerized accounting systems**

The KASIS is a near real-time accounting system used to collect nuclear material accounting data and safeguards related information from 11 nuclear facilities in KAERI. The nuclear material accounting system at the major nuclear facilities in KAERI were also

developed for managing the inventory management data and quality control data for the purpose of facility operation. These nuclear material accounting systems developed at the facility level are integrated with KASIS, as shown in fig 9. KASIS is also integrated with an RFID system to prevent the unauthorized movement of nuclear material and to share the accounting data at both the safeguards and safety fields

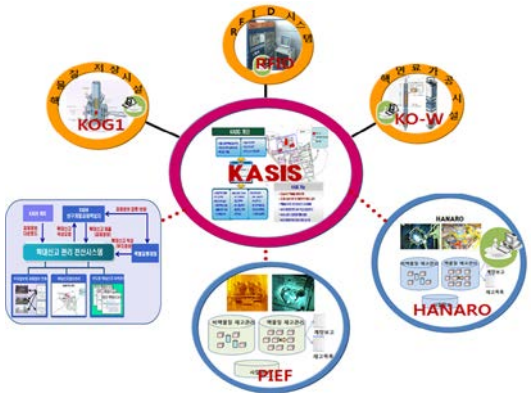

Fig 9. Integration of KASIS with other system

6. Summary

KAERI has continuously established an optimized nuclear material accounting system to effectively/efficiently manage and control the nuclear material accounting data including safeguards information at the facility level as well as to cope with the random interim inspection of the IAEA as follows.

- KASIS was developed to collect nuclear material accounting data as well as safeguards related information from 11 nuclear facilities at KAERI on a near real-time basis, to create the accounting reports for reporting the Agency, and to prepare the documents for the random interim inspection of the Agency
- The nuclear material accounting systems for major nuclear facilities subject to IAEA safeguards in KAERI were developed at the facility level based on the categorization of the nuclear facility considering the characteristics of nuclear facility and nuclear material type.
- KASIS was integrated with an RFID system installed at the gate of each building to prevent the unauthorized movement of nuclear material and to share the accounting data at both safeguards and safety fields.
- KASIS was integrated with the nuclear material accounting systems developed at the facility level.

To effectively cope with the IS, KAERI has continuously developed and established an internal computerized system for the management of nuclear material accounting data and safeguards related information. It is very important for the nuclear facility to establish a safeguards system to meet the domestic and international safeguards obligations.

KAERI will make continuous effort to reduce the burden of facility operators through improvements of the appropriate safeguards measures pertaining to RIIs.