Methodology Study of Unattended Monitoring System for Reference Pyroprocessing Facility in the ROK

Jong-Kyu Jeon
Korea Institute of Nuclear Non-Proliferation and Control, Yuseongdaero 1534, Yuseong-Gu, Deajeon, Korea
jkjeon@kinac.re.kr

1. Introduction

The Unattended Monitoring System (UMS) applied for the implementation of Safeguards at the Reference Pyroprocessing Facility (REPF) is essentially required to meet the maximization of effectiveness and efficiency of inspection efforts under the Integrated Safeguards (IS). The UMS at the REPF provides the various types of measures to detect the movements and changes of Nuclear Materials (NM) in real time so that it supplements the on-site inspection activities for the REPF, provides reference data to draw safeguards conclusions of inspection activities, and optimizes the safeguards inspection regime for the REPF based on the mitigation of inspection frequency.

This study focused on the containment and surveillance (C/S) for the movements and changes of NM in the processes by considering the structural characteristics of REPF composed of hot cells.

2. Configuration of UMS at the REPF

2.1 UMS in the Spent Fuel Pool (SFP)

The SFP at the REPF has the same structure as the SFP at LWRs, but the canal of SFP is connected to the head-end cell whereas the canal at the LWRs is connected to the containment building. The canals at LWRs are normally sealed with VACOSS and metal seals to block the removal of burn-up controlled Spent Fuel Assemblies (SFA) from the reactor core, but the seals are not needed at the canal of REPF due to the continuous introduction of SFAs to the head-end cell and no burn-up control for SFAs conducted. But, the portal monitors, surveillance, and underwater camera are installed to confirm the SFAs introduced into the head-end cell.

In the SFP, 3 surveillance cameras are applied, and 1 out of 3 surveillance cameras collects images of truck access area to cover that shipments and receipts from/to the SFP and the movement of cases from the decontamination pit to the SF unloading area. The rest 2 surveillance cameras are underwater cameras to collect images to cover SFAs from the SF unloading area to the SFP and identify the ID of SFA when the SFA passes through the canal to the head-end cell. In addition, the underwater portal monitor for gamma radiation is installed at the connection point of canal to the head-end cell to detect gamma radiation and to confirm the SFA passing through the canal. The data from surveillance cameras and portal monitor are transmitted to the main server installed in the REPF, and are eventually transmitted to the IAEA and KINAC through the Virtual Private Network (VPN).

2.2 UMS in the Head-End Cell

The head-end cell is composed of disassembling, rod chopping, collection of SF pellets (decladding of SF rod), pulverization of SF pellets, and Input Accountability Tank (IAT, homogenization of SF powder) processes. At transfer lock connected to the SFP, 1 surveillance camera and 1 portal monitor for gamma radiation are installed to cover the receipt and shipment of SFA or any types of NM from/to the SFP. In addition, 1 surveillance camera and 1 portal monitor for gamma and neutron are installed to cover the shipment of homogenized SF powder from the IAT to the pyroprocess cell and the possible receipt of any types of NM from the pyroprocess cell. The data from surveillance cameras and portal monitors are transmitted to the main server installed in the REPF, and are eventually transmitted to the IAEA and KINAC through the VPN.

2.3 UMS at the Pyroprocess Cell

The pyroprocess cell is composed of voloxidation, electro-reduction, electro-refining, and electro-winning (including minor actinide recovery) processes. At transfer port connected to the SFP, 1 surveillance camera and 1 portal monitor for gamma and neutron are installed to cover the receipt of homogenized SF powder or shipment of any types of NM from/to the head-end cell. In addition, 1 surveillance camera and 1 portal monitor for gamma and neutron are installed to cover the shipment of U ingots, U/TRU ingots and various types of wastes to the storage cell and the possible receipt of any types of NM or wastes from the storage cell. In the electro-refining and electro-winning processes, 2 additional surveillance cameras are installed to cover the movement of U-TRU and LiCl-KCl eutectic salt mixture due to the most sensitive processes (electro-refining and electro-winning processes) in the REPF, respectively.

2.4 UMS at the Storage Cell

The storage cell is composed of U ingot storage, U/TRU ingot storage, and metal/ceramic waste storage. At transfer port connected to the pyroprocess cell, 1 surveillance camera and 1 portal monitor for gamma and neutron are installed to cover the receipt of U ingots, U/TRU ingots, and metal/ceramic wastes or shipment of any types of NM from/to the pyroprocess cell.

2.5 UMS outside of Hot Cells at the REPF

In the case of the storage cell, truck access area is normally installed to transfer final products (U ingots and U/TRU ingots) and wastes to other facilities like SFR fuel fabrication plants or disposal center. It means that the containment and surveillance at the truck access area are very important to block the nuclear material transfer to other facilities. Therefore, various types of seals including metal, COBRA, EOSS, and TROVAN (KINAC seal) are applied to block the transfer through the rear doors or side doors of hot cells, and surveillance cameras are installed outside of hot cells to collect the images for the any movement of big objects to strengthen the C/S for the possible removal routes at the REPF. The data from surveillance cameras and E-type seals are transmitted to the connected main server installed in the REPF, and are eventually transmitted to the IAEA and KINAC.

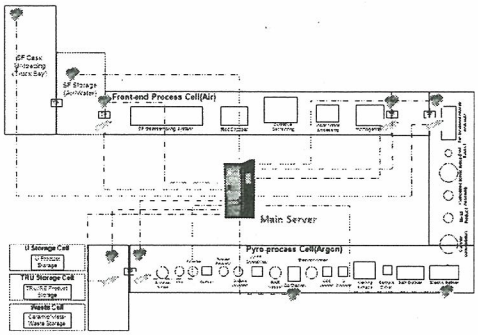

Fig. 1. Overall Scheme of UMS at the REPF

3. Conclusion

In this study, the application of UMS at the REPF is essentially required to optimize the safeguards approach for the REPF. It also provides the effectiveness and efficiency of verification results to draw safeguards conclusions and to mitigate inspection frequency.

The UMS at the REPF provides the reference data to implement on-site inspection activities with the real-time verification of declared information from Near-Real Time Accountancy (NRTA) and mailbox declaration system.

4. References

[1] "Guidelines for Developing Unattended and Remote Monitoring and Measurement Systems", ESARDA Working Groups on Containment and Surveillance (C/S) and Techniques and Standards for Non Destructive Analysis (NDA), ESARDA Bulletin No. 33.

[2] Safeguards Techniques and Equipment, 2003 Edition, IAEA.