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Update on Monitoring Technologies for International Safeguards and Fissile Material Verification

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Abstract

Monitoring technologies are playing an increasingly important part in international safeguards and fissile material verification. The developments reduce the time an inspector must spend at a site while assuring continuity of knowledge. Monitoring technologies' continued development has produced new seal systems and integrated video surveillance advances under consideration for Trilateral Initiative use. This paper will present recent developments for monitoring systems at Embalse, Argentina; VNIIEF, Sarov, Russia; and Savannah River Site, Aiken, South Carolina.

Introduction

Beginning in 2000, the U.S. will ship excess nuclear material to the K-Area Material Storage (KAMS) facility at the Savannah River Site (SRS). The material, sealed in shipping containers, will remain in interim storage until disposition plans and facilities are ready to take the next steps toward disposition of the material. During storage, the containers will be made available for inspection by the International Atomic Energy Agency (IAEA). The trilateral partners, U.S., the Russian Federation, and the IAEA are developing a verification regime under the Trilateral Initiative. A description of the proposed verification regime for KAMS and a discussion of the outstanding issues are in a previous paper [1].

The IAEA uses the concept of containment and surveillance (C/S) to maintain continuity of knowledge on material that it has accepted for inspection. Monitoring technologies and a combination of host nation declarations and physical inspections give the IAEA the necessary confidence that they can draw independent conclusions about the location and status of the material. The proposed verification regime for KAMS follows this approach, but adds a few new technology advances and makes maximum joint use of monitoring equipment for both domestic safeguards and international verification. The resulting monitoring system reduces the time IAEA inspectors must spend at the site, minimizes the intrusiveness of inspections, and reduces the radiation exposure to all parties.

Monitoring Approach at KAMS

Since the nuclear material in KAMS storage is sealed in shipping containers, an item-monitoring approach is proposed for IAEA verification. The item to be monitored is a shipping container or a pallet of five shipping containers as explained below. A dual C/S monitoring system could use

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radio frequency tamper-indicating devices (RFTID) to monitor the items' integrity. The RFTID is an active fiber optic seal with other tamper-detecting features. The second C/S element could be video surveillance.

The steps required to prepare an item for continuous monitoring during long term storage include the following: An RFTID is applied to give each container a unique identity (ID). Radiation measurements are made to verify that the material in the container is consistent with declarations. Five containers are secured to a pallet, and another RFTID is applied to all the containers on the pallet. Then the individual container RFTIDs are removed. Finally, the pallet is moved to its assigned location in the storage room. The RFTIDs continuously monitor each item while in storage.

It is anticipated that each of these steps is performed by facility personnel without continuous presence of IAEA inspectors. In addition, each of these steps must be performed without undue interference with the procedures required to meet domestic safeguards requirements.

Joint use of monitoring equipment promises cost savings, resource efficiencies, and dose minimization. Preliminary planning specifies joint use of the RFTIDs. The message authentication technique built into the RFTIDs should make this practical. Joint use of video surveillance systems is also being considered.

Monitoring Steps at KAMS

The best way to describe how containers of material are initially accepted for inspection and how monitoring is maintained at KAMS is to consider how the material moves through the process as shown in Figure 1. This is a simplified description since not all of the procedures required for domestic safeguards are included. The acronyms used in Figure 1 are listed in Figure 2.

Containers are received at KAMS and unloaded from the transport vehicles in step 1. At step 2, the containers are moved to a staging area. At step 3, domestic receiving checks are performed. Step 4 moves a container to the measurement area. At step 5, a gross weight measurement is made for domestic purposes. At step 6, an RFTID is applied to the container. When the RFTID seal is closed, it reports this event to the monitoring database. At this time, the operator scans the bar codes on the RFTID and the container. By correlating the times that these actions occur, an association of RFTID and container is established. A DCM-14 camera views these actions and records the seal application including a time reference. The neutron multiplicity measurement system measures a container at step 7. The measurement values are associated with a particular container by reading the container's bar code immediately before a measurement is made. DCM-14 cameras also record this activity. At step 8, five containers are fastened to a pallet, and an additional RFTID is applied to the five containers. Bar code readings associate the containers with the new RFTID. Then, the five individual container RFTIDs are removed. The DCM-14 cameras record all of these actions. At step 9, a storage grid map with bar codes is scanned to tell the monitoring system the assigned location for the pallet, and the pallet is moved to that location. At step 10, the pallet is in storage and the RFTID will report immediately if the fiber optic seal is opened or another tamper condition is detected. In addition, the monitoring system periodically polls the RFTID for its state of health.

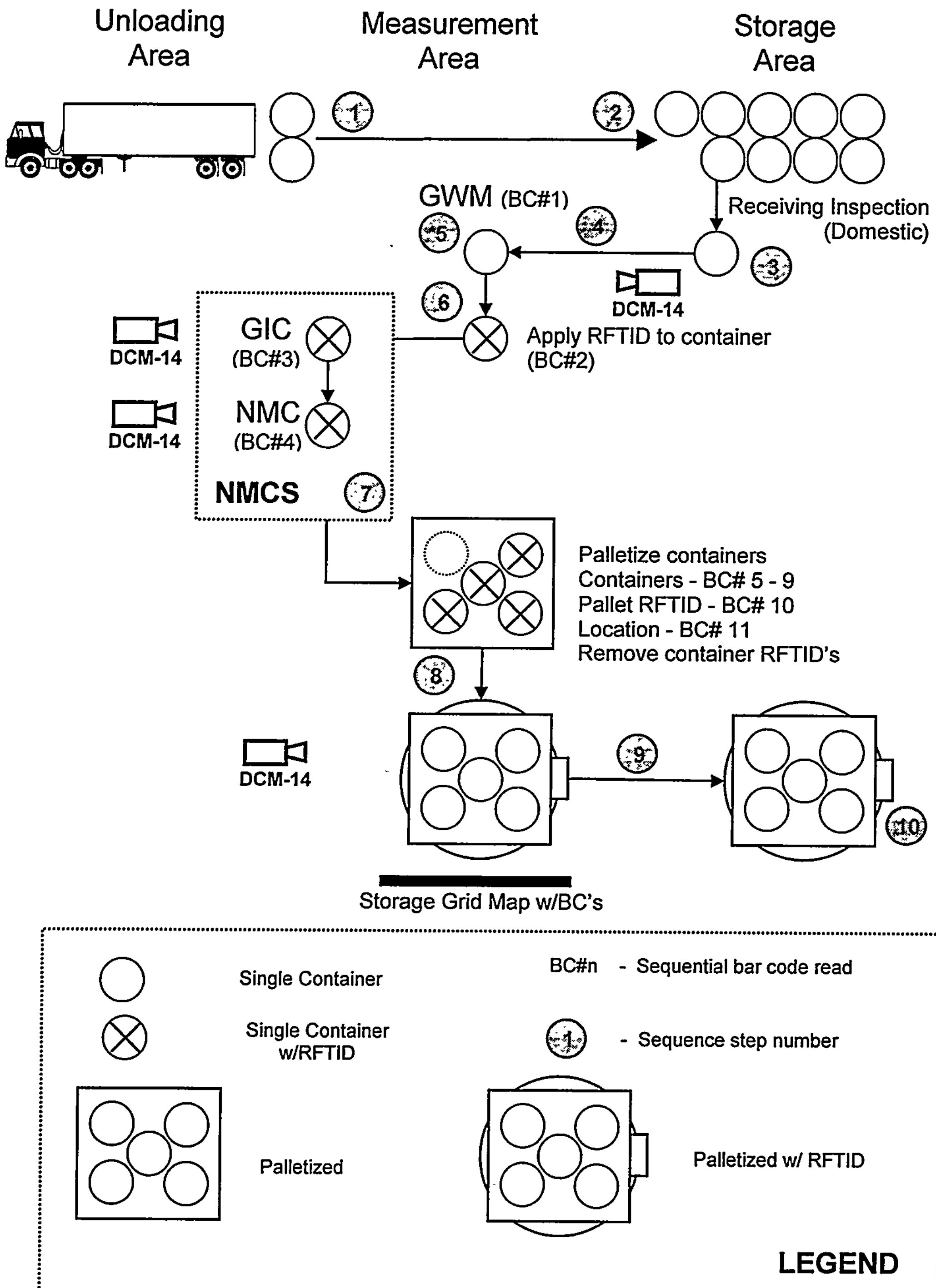

Figure 1. Material Movement for Initial Receipt and Storage

Acronym	Definition
BC	Bar Code
DCM-14	Dr. Neumann digital surveillance video camera
GIC	Gamma Isotopic Counter
GWM	Gross Weight Measurement
ID	Identification
NMC	Neutron Multiplicity Counter
NMCS	Neutron Multiplicity Counting System
RFTID	Radio Frequency Tamper Indicating Device

Figure 2. Acronyms for Material Movement

Bar codes are read throughout this process to enter data into the monitoring database. Bar codes are used because reading bar codes is quick and it avoids mistakes that occur when a keyboard is used.

IAEA physical inspections are part of the verification regime. Part of the physical inspections will be to repeat some of the measurements to verify that nothing has changed. This can be done using the procedures in steps 6 through 9 to maintain continuity of knowledge on each item.

Monitoring Equipment for KAMS

The RFTID selected for KAMS is the T-1 Electronic Sensor Platform (ESP) used with the Material Monitoring System (MMS). The T-1 ESP is shown in Figure 3. The MMS is a computer system that collects data from the T-1, stores the data in a monitoring database, and controls the dissemination of the data to authorized users.

MMS is constructed on Microsoft Windows NT servers and uses the Microsoft SQL server for the monitoring database. All application software is object-oriented design to facilitate adding custom features for specific applications. MMS can monitor several types of sensors at multiple sites. A number of users can get permission to access data from the monitoring database. The elements of MMS are preferably connected by ethernet but connections by Internet and point-to-point modems are also accommodated. Additional information about MMS was presented in an earlier paper and poster paper at this annual meeting [2, 3].

The T-1 ESP contains a fiber optic seal and several tamper sensors including high and low internal temperature, low battery voltage and case-opening. The T-1 is battery operated with a battery life of at least four years. Each T-1 has a unique ID established during manufacture. All messages from the T-1 are authenticated. Each message has a date and time tag. The T-1 also has a mechanism to detect the loss of messages and an internal buffer to store the most recent 100 events. The T-1 will report its state of health when polled by the MMS. Additional features of the T-1 ESP were presented in another paper [4].

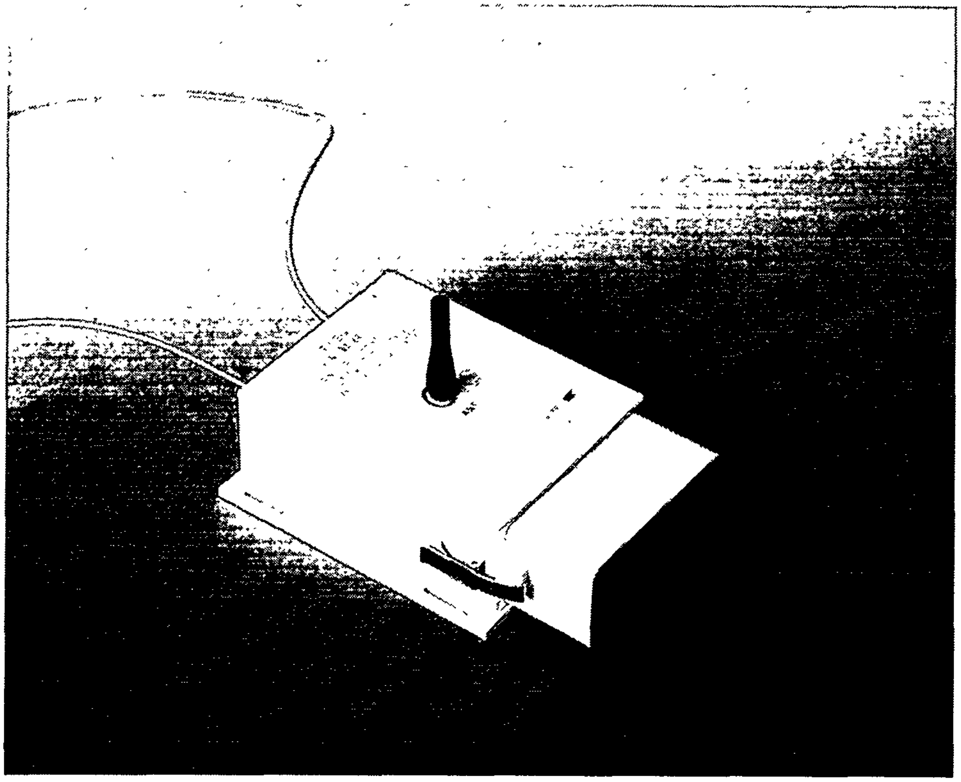

Figure 3. T-1 Electronic Sensor Platform

The T-1 communicates with MMS over a two-way radio link. The radio link is very low power and is intended to communicate with a transceiver in the same room.

The authentication technique used by the T-1 employs a private-key algorithm. This feature allows the IAEA to generate and control access to the keys, thereby assuring that messages came from a particular T-1 and have not been modified. Each T-1 has a different key. The message is transmitted in plain text while the authentication algorithm adds a digital signature. Only the key holders can perform message verification. Computer programs automate the key management function.

DCM-14 surveillance video cameras, owned and operated by the IAEA, provide surveillance of application and removal of RFTIDs and radiation measurements. These cameras are part of the VXI Digital Image Surveillance (VDIS) system and are routinely used for a number of IAEA applications [5].

An NTVision system provides video surveillance of the storage area. Images can be captured based on external triggers, scene change detection, or at periodic intervals. Internet technologies are used to distribute image data.

Upgrades at Embalse, Argentina

A remote monitoring system for the IAEA at Embalse was upgraded this summer. Four of six sensors were replaced with improved units. A new model of the Integrated Nuclear Material Monitor (INuMM) was used which featured a store and forward capability. Two new DCM-14 digital surveillance cameras were installed. The monitoring database was replaced with a version of MMS. The monitoring software operates on a computer with Windows NT server, the IAEA preferred software platform. More detailed information was presented in another paper [7].

Facility-to-Facility Storage Monitoring Field Trial

Sandia National Laboratories (SNL) and the Russian Federal Nuclear Center – All Russian Research Institute for Experimental Physics (VNIIEF) have been collaborating since 1993 to develop storage monitoring technologies. Current work focuses on new tags/seals and electronic sensor platforms. The Russian Federation has developed a family of smart bolts and a radio tag ESP with capabilities similar to the T-1 ESP. A magazine-to-magazine field trial was just concluded to investigate system issues with these technologies. A facility-to-facility field trial is underway to investigate operation issue. More detailed information was presented in another poster paper [8].

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