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EVOLUTION OF A NEW BREED OF TID; NOT JUST FOR TAMPER INDICATION

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ABSTRACT

Although the application of passive Tamper Indicating Device (TID) systems will always have their place in specific material storage applications, the implementation of an active seal system with remote interrogation / monitoring capabilities presents opportunities not previously achievable. This paper discusses the Savannah River Site (SRS) K-Area's progress over the past few years to successfully implement and operate a remote material monitoring system using an active seal platform.

Active TID systems are evolving to allow true remote monitoring of seal state data as well as incorporating monitoring of other variables such as material condition, facility status and/or environmental surroundings. Since 1996, K-Area has been testing and evaluating various TID systems for site-wide use. From the origins of a joint effort between SRS/Sandia National Labs/Russian Federation in 1999 to demonstrate transparency with active monitoring systems to having the first International Atomic Energy Agency recognized dual containment/surveillance system utilizing active seals in the United States, K-Area has been successful in implementing a system which utilizes an internally authenticated active TID to provide remote material monitoring.

The Sandia-developed T-1 Electronic Sensor Platform (ESP), the primary component of the "dual surveillance" system installed in K-Area, has received "authorization for use" by both DOE-SRS and the IAEA. This paper reviews the implementation history of the active seal and the associated Material Monitoring System (MMS) in K-Area and discusses the benefits realized, the operational pitfalls which have been experienced, and the potential future dividends which could be realized with this system.

INTRODUCTION

The Savannah River Site has served the United States Department of Energy as one of the primary facilities for the production and processing of nuclear materials as well as the stabilization and storage of legacy nuclear materials. Over the past several years the Savannah River Site has been working with the Sandia National Laboratories to develop and implement near real-time remote nuclear material monitoring systems that take advantage of advanced Radio Frequency (RF) and embedded sensor technologies.

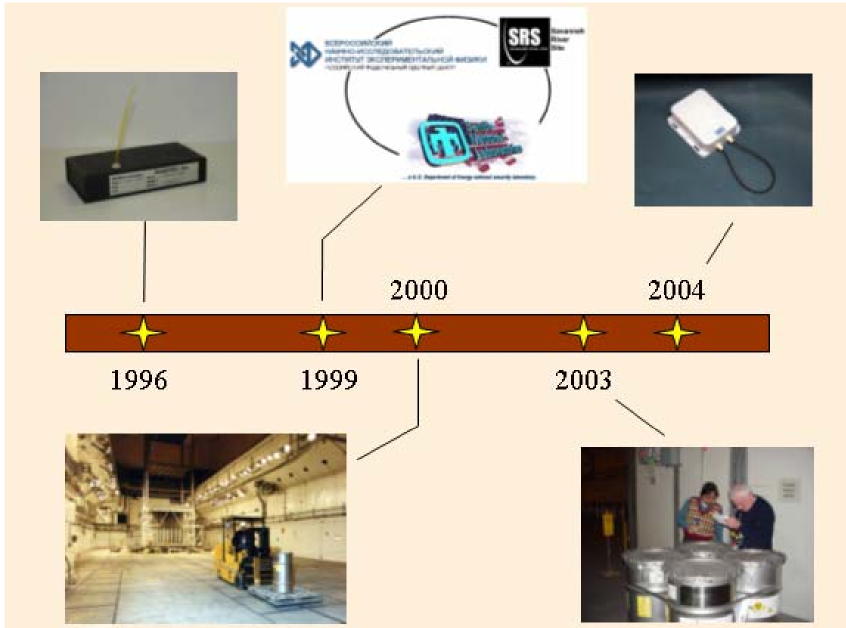

Figure 1: From early seal testing in 1996 to full-scale deployment of the joint-use, IAEA-accepted, T-1 Electronic Seal Platform in 2003; the newer Sandia-developed T-1A platform is now being manufactured for use.

The primary purpose of utilizing remote nuclear material monitoring systems is to reduce the radiation dose to personnel that would result from physical Daily Administrative Checks (DACs) and physical inventorying of material required by the associated Material Control and Accountability (MC&A) plans.

DISCUSSION

I. System Purpose

The Savannah River Site Material Control and Accountability program is built around Department of Energy Order, DOE M 474.1-1A, *Manual for the Control and Accountability of Nuclear Materials*. In order to satisfy the material inventory and daily administrative check requirements set forth by the order while maintaining personnel radiation doses As Low As Reasonably Achievable (ALARA), K Area needed a remote but robust method for material safeguards monitoring of nuclear materials. Additionally, it was expected that some or all of the materials being stored would require additional safeguard measures based on proposed agreements between the United States and the International Atomic Energy Agency (IAEA) inspection regime.

II. Basic System Information

Based on prototype testing and ongoing support initiatives, Sandia National Labs Material Monitoring System (MMS) and Los Alamos National Labs NTvision video surveillance system were chosen for implementation in multiple SRS K Area material storage locations. The Sandia MMS for the Savannah River Site K Area is centered around the T-1 Electronic Sensor Platform (ESP). The ESP provides the tamper indications via a set of electronic sensors including case switches, temperature sensors, motion sensor, battery voltage sensor, and the fiber-optic cable seal system. The ESPs communicate wirelessly at approximately 916 MHz to their respective data collection computers via an antenna system and interrogator-transceivers (See Figure 2).

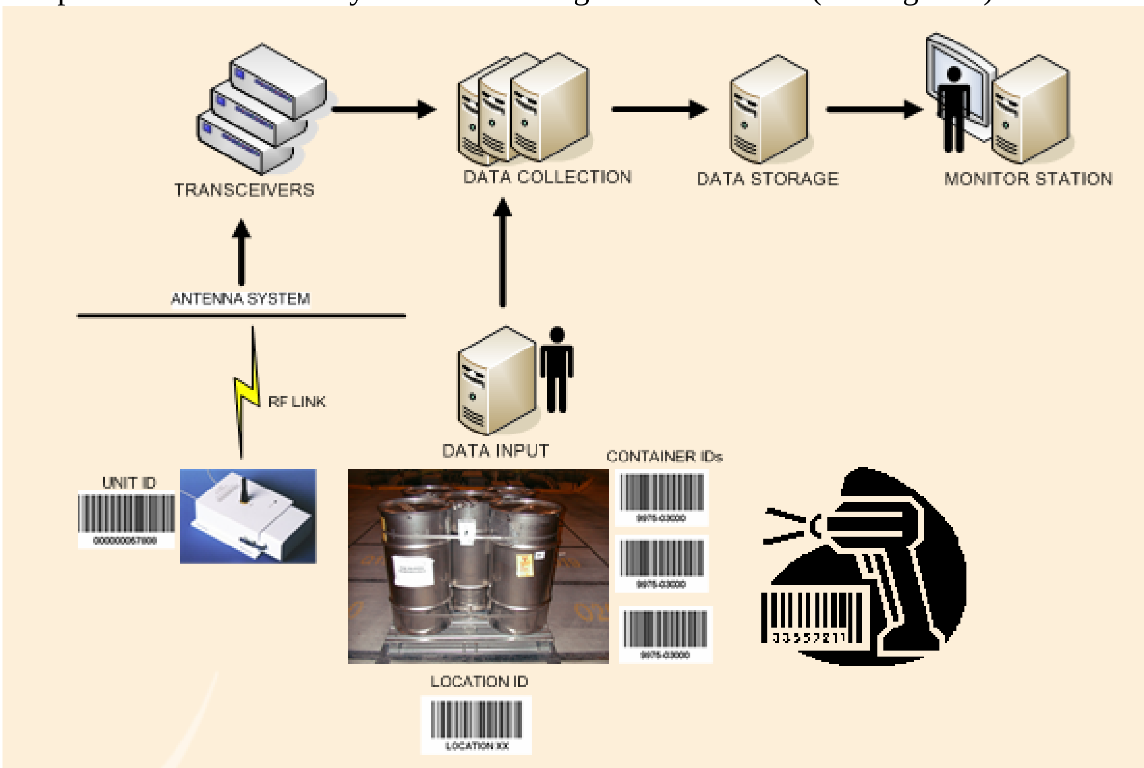

Figure 2: T-1 Electronic Sensor Platforms (ESPs) communicate via Radio Frequency link to their respective transceivers. In some monitoring applications ESPs are assigned to material storage containers and storage locations using barcode readers and a dedicated data input computer.

Some of the K Area MMS installations utilize a custom graphical user interface with barcode data input automation to reduce the likelihood of data entry errors and to make the data input process more efficient. All of the fields in the data entry screens allow for either barcode or keyboard input and the custom user interface provides multilevel views of the storage area sensor nodes' status.

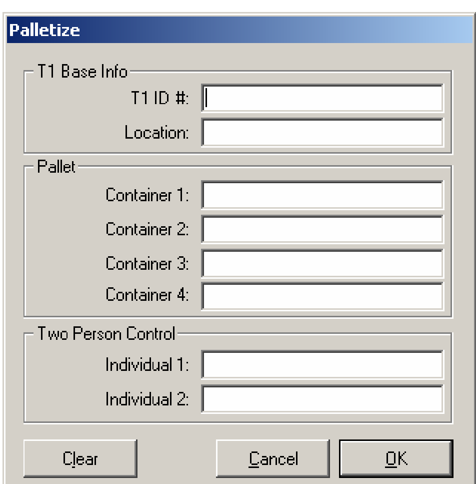

Figure 3: Data input screen for assigning ESPs to storage containers and storage location.

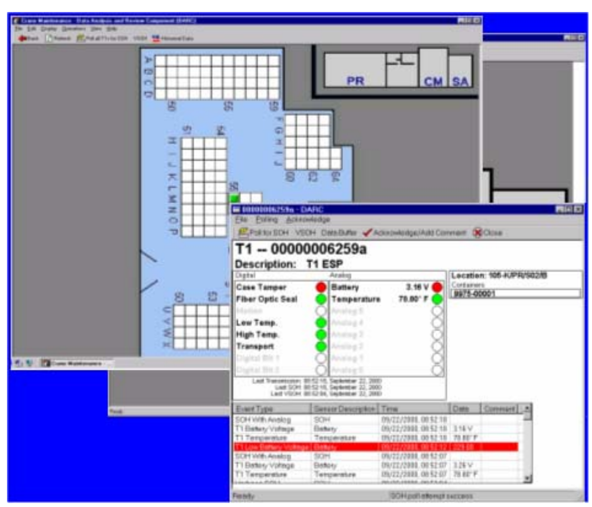

Figure 4: Multi-level graphical user interface screens for monitoring ESPs.

III. System Performance

The K Area active-seal material monitoring systems have been operating for nearly 5 years with very few problems. The benefits already realized from the use of the active seal material monitoring systems include (1) Maintaining personnel doses ALARA (2) Reducing administrative and operating costs, and (3) Support of international material safeguards regimes as required by U.S. government agency agreements.

Although these benefits have been realized from the implementation of the K Area monitoring systems, some problems and technical issues have been encountered. One such problem was a loose amplifier antenna connection for one of the storage areas. This caused a large scale failure of communication of ESP State-of-Health messages. As a result of the finding, all of the other antenna system connections were checked for integrity.

Another unexpected problem that was experienced was the ESP low battery voltage setting would cause a deteriorating ESP (i.e. one with a low battery voltage) to continuously send both low battery voltage and battery voltage return to normal messages. Due to the normal cycling of the ESP voltage level that occurs during the various modes of operation/communication, coupled with the relatively low steady-state ESP voltage level, caused the unit to cycle between acceptable and unacceptable voltage levels. As a result of the continuous battery event transmissions, some routine state-of-health messages for other ESPs were masked. As a result of the battery voltage event issue, several corrective actions were identified. First, it was emphasized to operating personnel that ESPs with low battery events should be reworked with a new battery as soon as possible in order to prevent the transmission of nuisance battery voltage alarms and to prevent masking of other ESP transmissions. Additionally, Sandia technical personnel have added hysteresis to the low battery voltage event threshold in the next generation T-1A ESPs to prevent the expected short-lived voltage droop from causing nuisance low battery voltage events.

CONCLUSION

The implementation and operation of the SRS K Area Material Monitoring Systems have demonstrated how advanced monitoring technology can be deployed to improve both the effectiveness and efficiency of nuclear material safeguards programs. As implementation of such a system equates to decreased facility resource commitment, additional benefits include; extended facility monitoring, increased engineering controls, administrative data collection and decreased personnel exposure due to remote monitoring. Additionally, by installing such a system, the automatic protection of the specific assets significantly decreases the time and money associated with the Safeguard and Security function of your facility.

REFERENCES

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