CASE STUDY

ARG-US RFID

The Watchful Guardian

2013 Winner of the Active RFID Contest

Conducted by the Association for Automatic Identification and Mobility (AIM) RFID Experts Group | www.aimglobal.org

EM Environmental Management

safety • performance • cleanup • closure

DOE PACKAGING CERTIFICATION PROGRAM

Argonne NATIONAL LABORATORY

Problem

Our primary technical problem was to support the U.S. Department of Energy (DOE) in modernizing its management of the life cycle of nuclear materials and enhancing long-term safety, safeguards, and security, through the development of an integrated RFID system.

Solution

Our solution is ARG-US, an RFID technology that features long-life, customizable sensor tags (Figures 1 and 2) with an integrated communication platform for real-time tracking and monitoring of nuclear and other hazardous materials. Potential markets for ARG-US RFID include civilian nuclear industries; hazardous materials and chemicals companies; or any high-risk, high-value materials handlers.

ARG-US — meaning "watchful guardian" — can continuously monitor and track tagged packages containing nuclear and other hazardous materials during storage, processing, transportation, and disposal. ARG-US enhances the environmental health, safety, and protection of both materials and personnel in facility operations involving sensitive nuclear and other radioactive materials. It also streamlines information management and inventory control and extends the lifetime maintenance cycles of storage drums.

ARG-US is a patented technology (U.S. Patent #8,013,744 B2 for the Radio Frequency Identification [RFID] Surveillance Tag, September 6, 2011). In addition, we received RFID Journal's "Most Innovative Use of RFID" Award in 2011.

Results

Commercialization

In July 2012, Argonne National Laboratory and Evigia Systems, Inc. (Ann Arbor, Michigan; www.evigia.com), reached a licensing agreement on the ARG-US RFID technology. According to Dr. Navid Yazdi, President of Evigia, the agreement "enables us to immediately enter new markets with the Evigia EV-3 platform and Argonne's ARG-US technology and deliver a complete, readily deployable wireless sensing solution for these vitally important nuclear and hazardous material transportation and storage operations."

Further, Dr. Yazdi believes, "ARG-US will have a significant impact on the RFID industry, resulting in accelerated adoption of automation and sensing technologies that will cut operating costs and improve the safety, security, and safeguards of hazardous materials."

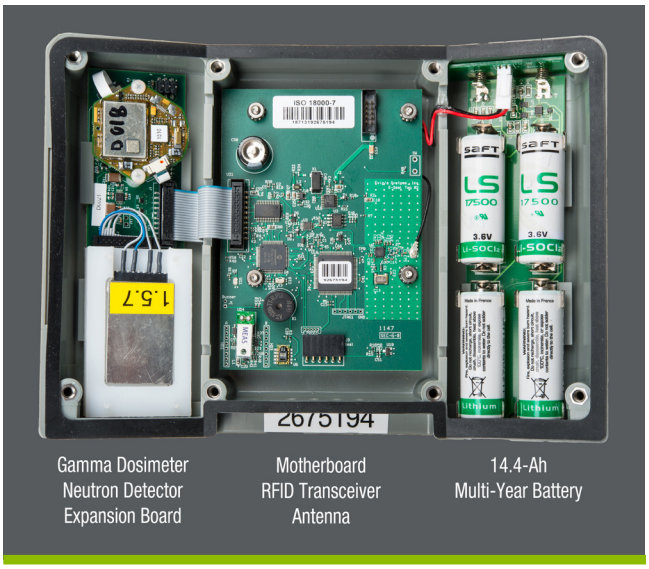

Figure 1. Photo of Mk-III Tag Showing Custom-Installed Detectors in Expansion Board, Antenna, and Long-Life Battery

Deployment

We have successfully deployed ARG-US in the U.S. Department of Energy national laboratory system.

K-AREA MATERIAL STORAGE (KAMS) FACILITY AT THE DOE SAVANNAH RIVER SITE, AIKEN, SC

At KAMS, the ARG-US technology was deployed in two phases of field-testing and application. During Phase I (March–September 2010), we deployed 20 Mk-II RFID tags (without radiation dosimeter) in the Category I vault to monitor temperature and other environmental parameters of 9975 packages for six months. The RFID tag-recorded temperature and humidity data throughout the period corroborated the measurements obtained by independent temperature monitoring and testing equipment. Other sensory functions of the tags, such as drum-lid closure and shock, also performed reliably in tests randomly conducted during the period.

During Phase II (March–August 2012), 12 Mk-III RFID tags with radiation dosimeters were distributed in the Category II 910B vault at KAMS. Much smaller than the Category I vault, this vault contains significantly fewer 9975 packages, but the movement of packages is more frequent. In contrast to Phase I field-testing, during which the tag data were collected weekly, the Mk-III tags used in Phase II were programmed to be polled automatically every six hours from the beginning of the testing. Temperature and humidity data gathered from the Mk III tags during the first two months of Phase II testing all showed consistent behavior that accurately reflected the environmental exposure conditions of the packages within the 910B vault. Dosimeter data were collected from four Mk-III RFID tags over slightly more than three months, during which the prevalent

gamma dose rate in the vault was ≤1 mR/h. The cumulative doses from the four tags ranged from ≈900 to 1500 mR after three months.

Continuous temperature monitoring by the ARG-US RFID system enabled extension of the intervals for periodic leakage rate testing of radioactive material transportation packagings from one year to as many as five. The extension not only enhances safety and ALARA (as low as reasonably achievable) by reducing handling by workers and their exposure to radiation, but it also cuts annual operating costs during the storage of the packagings by US$2500–3000 per package. The cost savings for thousands of drums could easily be millions of dollars over five years.

NEVADA NATIONAL SECURITY SITE

The Nevada National Security Site (NNSS) is a massive outdoor laboratory and national experimental center located 65 miles north of Las Vegas. Established as the Atomic Energy Commission's on-continent proving ground, the NNSS has seen more than four decades of nuclear weapons testing. Argonne staff delivered an ARG-US RFID system to NNSS in June 2010. Shortly after the delivery of the system, two 9977 packagings at the NNSS were due for requalification.

The two 9977 packagings (with the RFID tags) left NNSS on July 14, 2010, in a commercial shipment to the Savannah River National Laboratory, Aiken, SC. The drums were outside the communication range of the RF reader during and after the shipment, but the tags continued to record events in their non-volatile memories, whenever successive temperature readings deviated from the threshold settings of the tags. The deviation thresholds for the two tags used in the shipment were chosen to be ±2 and ±3°C, respectively, and the temperature data of the tags were again consistent and differed by 1°C because of the difference in the settings of the deviation thresholds.

The ability to set thresholds for each sensor in the ARG-US RFID tags — coupled with non-volatile tag memories for event recordings and subsequent data retrieval — greatly enhance the versatility of the system in applications where continuity of knowledge must be maintained throughout the life cycle of the sensitive nuclear and other radioactive materials.

The requalified 9977 packagings (with the Mk-II RFID tags) continue to be used in shipments supporting Department of Homeland Security/Domestic Nuclear Detection Office tasks throughout the country and have included Category IV quantities of radioactive materials.

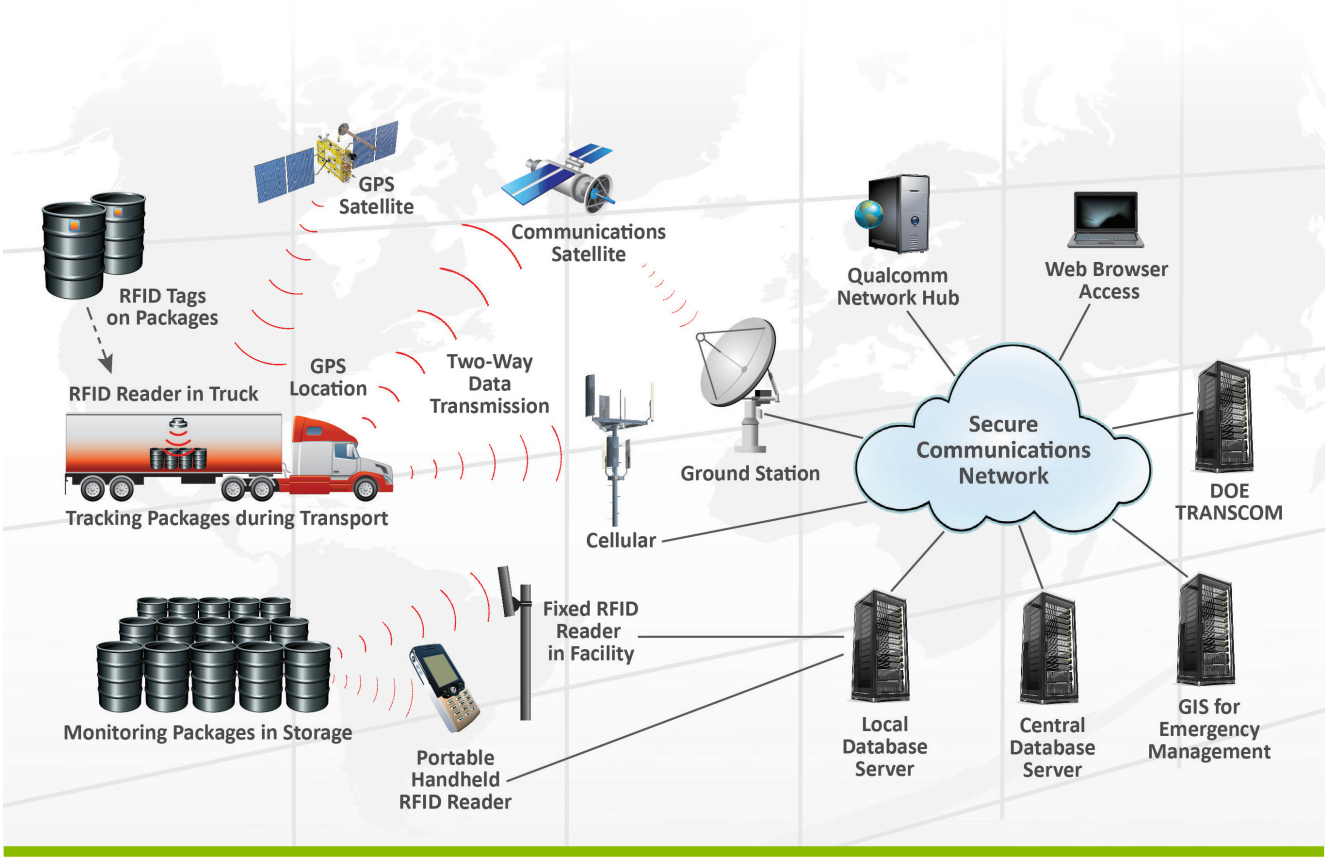

Figure 2. Schematic of ARG-US RFID Tracking System

SHIPMENT OF RADIOACTIVE MATERIAL IN UNIRRADIATED ZERO POWER REACTOR (ZPR) FUEL PLATES

In April 2011, DOE decided to move a substantial inventory of radioactive material in unirradiated ZPR fuel plates from Oak Ridge National Laboratory (ORNL) to NNSS. The Type B transportation package used in the shipment campaign is known as Model 5X22 — it consists of an outer steel drum, measures ≈22.5 in. (diameter) by 34.75 in. (height), and has a heavy-duty clamp ring and forged lugs.

The contents planned for the shipment were already approved under the U.S. Nuclear Regulatory Commission (NRC) CoC USA/9250/B(U)F-85, Revision 11; however, the NRC CoC did not include an ARG-US RFID tag as an attachment to the package. DOE conducted a review of the impact of attaching an ARG-US RFID tag to a 5X22 package and concluded that the use of the ARG-US RFID tag was justified, as was the case with other certified transportation packagings: 9975, 9977, 9978 (all Type B), and 9979 (Type AF).

The shipment of the 5X22 packages in a commercial truck left ORNL on June 5 and arrived at NNSS on June 7, 2012. The 5X22 packages were monitored and tracked in near real-time at the RFID Command Center at Argonne National Laboratory (Figure 3). The temperature and humidity data, transmitted near real-time via radio and satellite links, were accurate and consistent, as in the other deployments (see Figure 3, which is a screen capture that shows the status of the tags below the image).

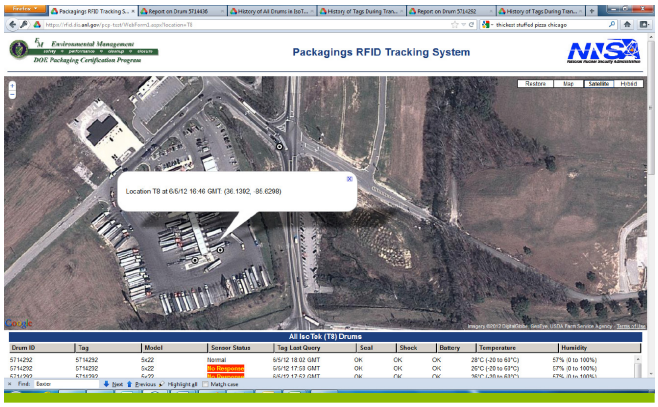

Figure 3. Screen Capture of the Truck Location at the Loves Travel Stop, near I-40 Exit 280, Baxter, TN (16:35 GMT, June 5, 2012)

Other Results

We have made progress to qualify the ARG-US RFID tag as a tamper-indicating (TID) seal for all of the modern packagings certified by DOE. The qualification followed the guidelines in the USNRC Regulatory Guide (RG) 5.80 “Pressure-Sensitive (PS) and Tamper-Indicating Device Seals for Material Control and Accounting of Special Nuclear Material,” December 2010. Evaluation of seal functionality and limitations defined in RG 5.80 found that the ARG-US RFID tag seal meets or exceeds all of the performance criteria for the PS/TID seal. The accreditation of the ARG-US RFID tag as a TID seal for Types B and AF transportation packagings can significantly reduce the cost of verification and exposure of workers to radiation, after a shipper-receiver agreement on its use for verification purposes is reached between sites.

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