Use of Radio Frequency Identification Tracking of Packages Containing Radioactive Material - 10446

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ABSTRACT

The U.S. Environmental Protection Agency has undertaken a project to find an effective tracking system to prevent inadvertent or intentional loss of radioactive sealed sources and, thereby, protecting public health and the environment. Also, if radioactive sources are inadvertently or intentionally being imported or transported without proper authorization, it is critical that they be recovered before harm to the public or the environment occurs. Physical tracking of the sources can be a very effective approach to increase safety and security of these sources, particularly while they are in commerce.

INTRODUCTION

The Federal Response Plan (FRP) was released in 1992. It integrated all levels of government in a common incident-management framework and provided incident coordination roles for many Federal agencies. Following the terror attacks in the United States (U.S.) in 2001, the U.S. Government decided to establish enhanced common incident management and response principles and to develop common planning frameworks. As a result, a new document, called the National Response Plan (NRP), replaced the FRP in 2004; it was updated in 2006. As a result of evolving conditions relating to both man-made and natural disasters, a new edition of the NRP was deemed necessary and was released in January 2008 – it is called the National Response Framework (NRF). [1]

Appended to the NRF is a group of seven Incident Annexes. These annexes describe the concept of operations for specific hazardous situations or an element of an incident requiring a specialized approach, e.g., biological, food and agricultural, and cyber. The annex relevant to this paper is the nuclear/radiological incident annex (NRIA). [2]

While the number of radiation sources in the world is uncertain, there are some specific statistics that provide examples of the scope of the potential problem. First, according to the U.S. Nuclear Regulatory Commission (NRC), there were 74 events between 1999 and 2008 involving loss or theft of the highest risk sources, with an average of less than one source per year not recovered. [3] Second, in the early 1990s, the Department of Energy (DOE) started the Off-Site Source Recovery Project (OSRP). OSRP provides recovery and storage of sealed sources that exceed Class C waste criteria, do not have a disposition path, and present public health and safety concerns because they are vulnerable to loss, theft, or abandonment and other sealed sources that are considered to be a high risk for theft and misuse by terrorists. Through 2009, OSRP had recovered 21,323 sealed sources. [4] Third, and finally, it has also been reported that, in

the U.S., an average of about 460 sources of all types of radioactive material are reported lost or stolen each year. [3]

EPA'S ROLE IN SOURCE AND PACKAGE TRACKING

Two of the goals of EPA's Radiation Protection Program are: (1) to promote the responsible management of natural and man-made radiation sources and materials and (2) to protect people and the environment from unnecessary exposure to radiation. In addition, under the NRIA and the National Oil and Hazardous Substances Pollution Contingency Plan, the U.S. Environmental Protection Agency (EPA) is responsible for leading the response to found orphan radioactive sources, among other types of incidents[1]. In particular, the NRIA states that EPA is responsible for Federal radiological response to transportation incidents that involve foreign, unknown (orphan), or unlicensed radiological sources that have actual, potential, or perceived radiological consequences in the United States or its territories, possessions, or territorial waters and that are not addressed by Customs and Border Protection or the U.S. Coast Guard.

To meet its goals and responsibilities by reducing the incidence of responses resulting from lost, stolen, or abandoned radiation sources, in 2005, EPA began investigating the use of radio frequency identification (RFID), combined with radiation detection. RFID was determined to be a promising technology that might be used to track packages containing radiation sources in near real-time while they are in-transit in the commercial supply chain. The accomplishment of near real-time tracking would be facilitated by the integration of radiation detection and RFID systems and could also expedite shipments by authenticating their legitimacy without the need for multiple inspections. To investigate the feasibility of combining these technologies, EPA established an interagency agreement with DOE's Oak Ridge National Laboratory (ORNL). Since 2005, EPA and ORNL have worked with State response personnel, private-sector supply chain stakeholders, Federal agencies, and international partners on RFID tracking and monitoring of medical, research, and industrial radioisotopes in commercial supply chain (through the RadSTraM – Radiological Source Tracking and Monitoring – project). This project has also been selected by the U.S. Department of Commerce (DOC) to be part of an international demonstration project on RFID tracking of packages containing radiation sources (addressed in more detail below).

[1] Orphan sources are radiation sources that are outside of regulatory control. They may never have been subject to regulation, or they may have been regulated initially but then were abandoned, lost, misplaced, stolen, or removed without authorization.

THE RADSTRAM PROJECT

Three phases were planned for this project:

I. Testing equipment in a laboratory setting and tracking shipments under typical commercial shipping conditions, but using only government facilities within Tennessee as origin and destination points.
II. Expanding the system explored in Phase I by using government and commercial facilities, in conjunction with interstate air and ground shippers.
III. Integrating hardware and software on laboratory and industrial scales and demonstrating feasibility.

Phases I and II

The first two phases have been completed successfully. Phase I served as the critical component for addressing procedures and protocols needed to establish an operational system. During the first phase, RFID was used to track radiological commodities under typical "in commerce" shipping conditions. The project tracked a series of shipments between ORNL and Oak Ridge Associated Universities (ORAU) utilizing commercial less-than-truckload service, commercial truckload service, and the ORAU private fleet. The testing included single and multiple shipments under different loading and shielding scenarios. The scenarios included in-transit as well as overnight storage, and they were tracked using bulk radiological monitors at the I-40 Watt Road weigh station. The testing coupled data from the RFID system with data collected from radiation portal monitors. This set of tests verified that active RFID tagging can be applied to the tracking of interstate shipments of radioactive material. Furthermore, it was demonstrated that RFID systems are robust and mature enough to be scaled into a nationwide system, with the caveat that there is some central database or network that can present the data to a variety of users. [5]

Phase II was used to implement the procedures, protocols and lessons learned during Phase I into a real-world environment to test proof-of-concept, with a range of tag types, for large-scale deployment. RFID systems were used to track, locate and identify express air and truck shipments of medical radioisotopes shipped by a commercial air express service between a medical radioisotope production facility in Massachusetts and ORNL in Tennessee. An RFID manifest system consisting of a standalone database and web client was developed to manage data from the tags. These shipments were tracked successfully and, importantly, the web-based manifest system provided improved data handling relative to Phase I. [6]

Phase III

The third phase is underway as part of a larger international project, sponsored by EPA, the Department of Commerce (DOC), U.S. Postal Service (USPS), Universal Postal Union (UPU), DOE, ORNL, and the European Union (EU), called the "Global

Radiological Source Sorting, Tracking and Monitoring" (GRadSSTraM) Project. The overall goal of Phase III of RadSTraM is to demonstrate the integration of hardware and software using Web 2.0 technology.[2]

THE GRADSSTRAM PROJECT

At the 2007 EU-U.S. Summit, the leaders of DOC and the EU European Commission committed to pursue jointly directed Lighthouse Priority Projects. These projects are intended to "foster cooperation" and "reduce regulatory burdens" with respect to transatlantic commerce. The Transatlantic Economic Council (TEC) Lighthouse Project on Radio Frequency Identification (RFID)[3] has been directed to "develop a joint framework for cooperation on identification and development of best practices for Radio Frequency Identification (RFID) technologies…." The RFID Lighthouse Priority Project commits both sides to endeavor to align U.S. and EU regulatory and policy approaches on RFID technologies, including pilot projects in the public sector.

The EU and DOC jointly cited the RadSTraM project as a candidate RFID Lighthouse Project to meet the mutual goal of a "joint framework for cooperation on identification and development of best practices for RFID technologies." Concurrently, the Universal Postal Union (UPU)[4] identified the proposed collaboration as a candidate pilot for tracking and monitoring shipments of radioisotope packages between the United State Postal Service (USPS) and European Post Agencies.

The EPA, USPS, UPU, ORNL, and EU expect to collaborate with universities, international policy-makers, and major private-sector supply-chain stakeholders, e.g., GS1 and EPCglobal[5], to extend the findings of the first two phases of the RadSTraM Project through the GRadSSTraM Project. The GRadSSTraM collaborators will develop their own Phase I, II and III tasks. To clarify, Phase III of RadSTraM is part of Phase I of GRadSSTraM.

The RadSTraM Project Phase III (as part of the GRadSSTraM Project Phase I) tasks include an international, intra-government pilot program to test and assess the efficacy of RFID systems, selected sensor integrations, faceted classification architecture,

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[2] Web 2.0 technology refers to internet web sites where users can share and change information and data, as opposed to simply reading information.

[3] The "Transatlantic Economic Council (TEC) Lighthouse Project on Radio Frequency Identification (RFID)" has been directed to "develop a joint framework for cooperation on identification and development of best practices for Radio Frequency Identification (RFID) technologies…." The RFID Lighthouse Priority Project commits both sides to endeavor to align U.S. and EU regulatory and policy approaches on RFID technologies, including pilot projects in the public sector.

[4] Established in 1874, the Universal Postal Union (UPU), with its Headquarters in Berne, Switzerland, is the primary forum for cooperation between postal-sector players and helps to ensure a universal network of up-to-date products and services.

[5] GS1 is an international, not-for-profit association dedicated to the development and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across multiple sectors. The EPCglobal Network is a method for using RFID technology in the global supply chain by using RFID tags and readers to pass identifying numbers to authorized users.

and Web 2.0 applications for transatlantic radioisotope shipments transported via the international postal system and will demonstrate the following performance objectives:

1. Validate the performance of Web 2.0-enabled RFID tracking systems to monitor Express Post shipments in the international supply chain.
2. Quantify the reliability of these tracking systems with regards to probability of tag detection and operational reliability at checkpoints and chokepoints in the supply-chain process network.
3. Determine if the implementation of these systems will help to reduce regulatory burden and enhance transatlantic trade.
4. Demonstrate that RFID tracking and monitoring is ready for testing using commercial isotope shippers and carriers.
5. Demonstrate that information security can be achieved using a faceted classification system architecture.

STATUS OF THE RADSTRAM PROJECT

In April 2009, a concept of operations was agreed to by the international stakeholders. RFID tags have been procured by USPS and will be used by ORNL for the tests in this phase. A preliminary test package containing an RFID tag by itself was sent from ORNL to England's National Physical Laboratory (NPL)[6] on 30 June 2009. It was successfully tracked through the trans-Atlantic route system and received on 7 July 09. In November 09, four more packages were shipped. These shipments were used to begin supplying data for the database that is being developed by ORNL using a Web 2.0 application. The plan is to complete a total of 10 shipments by early 2010 to complete RadSTraM Phase III (which is part of the GRadSSTraM Phase I testing). The plan for these tests includes using:

- Packaging configured with active, passive, or hybrid RFID tags or a combination thereof.
- Testing configuration and RFID listeners installed at ORNL, NPL, and USPS/Royal Mail designated terminal and distribution facilities.
- Web 2.0 data collection and distribution engine for disparate and distributed data integrated with ORNL, NPL, USPS and Royal Mail process networks. [7]

WEB 2.0 TRACKING

Along with the integration of radiation detection and RFID technologies, the creation of an on-line tracking system that is capable of integrating supply chain partners' shipping information without a large outlay of capital for a new system has been the biggest innovation of this project. It is apparent that most, if not all, of the information needed by nuclear supply chain partners already exists but resides in proprietary or "stove-piped" databases. Generally companies have developed, or own, their own

[6] The National Physical Laboratory (NPL) in Teddington, UK is the UK's National Measurement Institute and is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology.

tracking systems. These systems are generally proprietary and not compatible with other companies' systems. With the advent of recent Web technology that allows sharing of information interactively, but separate and apart from anyone's individual system, it is possible to construct a method to share data within a select group of stakeholders behind a secure firewall. This is similar in concept to the Facebook program in which participants need a password and acceptance from the initial party to add to and share the information on the webpage.

The collective technological solution for end-to-end nuclear source visibility in the commercial supply chain must address the following challenges:

1. Information sharing among massive and proprietary enterprise commercial sector tracking systems;
2. Information sharing of discrete and microelements of the supply chain information base in a secure and efficient manner;
3. Information sharing among emerging tracking technologies and legacy tracking systems;
4. Acceptance of an external mechanism to loosely couple multiple, incompatible enterprise systems; and
5. Exploitation of legacy commercial and federal databases to reveal query-driven information requests in real time.

The web interface developed for RadSTraM is intended to provide supply chain visibility and exceptions-based reporting for nuclear sources by supplying necessary data as determined by a mutually agreeable protocol that does not require the sharing of proprietary data other than the identity and contents of the package and its location and condition (and other parameters, to be determined later) residing in proprietary or agency/company-centric systems to with supply chain stakeholders.

CONCLUSION

EPA has successfully tested the feasibility of using an RFID-based tracking system in intrastate and interstate shipping. EPA is proceeding with testing in international commerce and development of Web 2.0 information-sharing technology. If successful, this testing will result in the establishment of a new system that will be available to the nuclear supply chain industry with the potential to further secure radioactive sources in the commercial supply chain to reduce the incidence of sources becoming orphaned, to expedite commerce by allowing the authentication of shipments without requiring inspections at every entry station, and to increase the security of the sources to prevent them from being used for illegal purposes.

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