ENHANCING MOBILE RADIOACTIVE SOURCES SECURITY THROUGH TECHNOLOGY SOLUTIONS

E. Hunsicker, ORS - NNSA
B. Kluse, ORS - PNNL
M. Carr, ORS - PNNL

Abstract

Mobile radioactive sources are used in the oil, gas, and radiography industries across the globe. These radioactive sources are of sufficient curie quantities to be desirable sources for actors with malicious intent. The fundamental security challenge for these mobile radioactive sources is the control and accountability of the sources when they are in transit or in use in the field. Working with industry partners in the well-logging and radiography industries, the U.S. Department of Energy/National Nuclear Security Administration's (DOE/NNSA) Office of Radiological Security (ORS) has developed the Mobile Source Transit Security (MSTS) system to aid in the overall security of these mobile sources.

The MSTS system uses various cloud-based electronics to provide near-real-time status and increased situational awareness for mobile source users. The system is integrated into the industries' standard equipment and vehicles. In the event a source is lost or stolen, an alarm immediately notifies key personnel. The MSTS system also provides integrated device tamper alarms, encrypted communication, enhanced inventory control when the sources are in storage, and state-of-health communication. This paper highlights the components and operation of the MSTS system for both industries and identifies the approach ORS has taken to transfer the technology to commercial partners to assist with broader deployment.

Security Challenges of Mobile Radioactive Sources

The International Atomic Energy Agency (IAEA) Nuclear Security Series No. 11 [1] states "sources used in field applications (e.g., radiography and well-logging) are typically contained in devices designed for portability and are frequently transported between job sites. The ease of handling of these devices and their presence in vehicles outside secured facilities make them attractive for unauthorized removal."

Existing practices for safety and security of mobile sources rely heavily on authorized personnel's adherence to security procedures, rather than technical equipment. Addressing the challenges of mobile source security requires a holistic look at all operational use phases and a combination of technology and strong procedures/protocols for both operator and management personnel.

ORS has worked with industry partners from both the well-logging and radiography industries to understand the operational use of these mobile sources and the security practices commonly used. Through this partnership, ORS has documented current security practices, and regulatory, transportation, and safety requirements. ORS has identified areas for improvement and best practices

within each phase of operations. ORS has considered operational impact, overall cost to industry users, and long-term sustainability when developing the MSTS approach.

INDUSTRIAL RADIOGRPAHY INDUSTRY BACKGROUND

Radiography cameras (also commonly referred to as projectors) contain a radioactive source within shielding. These cameras are used for legitimate purposes around the world. Although there are three main manufacturers of radiography cameras in the United States, the cameras themselves are of various sizes and configurations. The operational use of radiography cameras can be categorized into the following three phases:

Storage –where the radiography cameras are stored when not in use. Often referred to as the "home base." This includes any fixed location where the camera is kept for an extended period. Configurations of home base storage arrangements vary from site to site and the approach for storage varies from company to company, and from country to country.

Transport –the phase when the source is removed from the home base and placed within the transport vehicle. This phase continues until the radiography camera arrives at the location where it will be used in the field. Transport vehicle configurations and security requirements vary greatly between companies, as do the requirements for how the cameras are stored during transport. The transport phase also includes the period when the source is in the vehicle returning from the field to home base.

Field Use – phase in which the radiography camera is in use, away from transport vehicle.

INDUSTRIAL RADIOGRAPHY MOBILE SOURCE TRANSIT SECURITY SYSTEM

The MSTS system for industrial radiography was developed to provide increased situational awareness of radioactive sources as they move from the home base to the field and back. The system has been designed to be cost-effective, reliable, and robust, with the capability to complement existing security systems and procedures. Wi-Fi communication through a telematics device on the radiography vehicle provides near real-time alerts and alarms back to the home base. System components are described as follows:

Persistent Monitoring Tag (PM-Tag) – Integrated into the jacket or bolted onto the radiography camera, the PM-Tag communicates (Fig. 1) alerts and/or alarms to the secure transport box (STB) through a Bluetooth Low Energy (BLE) device or to the home base through the cellular communication module within the PM-Tag. The PM-Tag includes a solid-state radiation detector that detects the source's presence within the radiography camera and tamper detection on the PM-Tag housing.

FIG. 1. PM-Tag and a QSA 880 Sentinel Jacket with Integrated PM-Tag

Secure Transport Box (STB) - Padlocked to a mounting plate in the transportation vehicle, the STB stores the radiography cameras on the truck (Fig. 2). The STB charges the camera's PM-Tag through a wireless Qi charging technology. The STB also maintains a BLE connection to the PM-Tag to monitor the presence of the source. The STB communicates status and alerts via the MSTS system's telematics (cellular).

FIG. 2. STB with QSA 880 Sentinel

Telematics – The telematics device located on the transport vehicle provides a cloud-based service for communication. The MSTS system communicates via cellular means to transmit data from the PM-Tag to the telematics device.

Data Cloud - The MSTS system transmits data to the cloud. A remote monitoring station with the appropriate software can pull data from the cloud server to monitor status and alerts from the MSTS system. This portion of the system is provided by a cloud service provider.

The PM-Tag and the STB are the primary components of the MSTS system installed on the radiography camera and transport vehicle. To maintain continual operation when in storage, the MSTS system has several components that are integrated into the storage room located at the home base. MSTS system components specific to the home base are described as follows:

Persistent Monitoring Tag Charging Mat (PM-Mat) - The PM-Mat is similar to the STB. It provides a docking station for the radiography camera and PM-Tag while in storage (Fig. 3). The PM-Mat can be installed within a storage room or a storage container.

FIG. 3. PM-Mat for storage location

Vault Control Unit (VCU) - The VCU is the computer processing portion for the home base storage location. The VCU communicates with the PM-Mat(s) while the cameras are in storage.

Home Base Station Computer and Monitoring Application Software - The status and alerts transmitted from the MSTS system can be downloaded from the cloud provider. This is accomplished via a monitoring software application on a computer.

I**ntegrated Secure Container (ISC)** – The ISC is a stand-alone container, developed by ORS, which incorporates detection equipment, access control, PM-Mat(s), VCU, and features that enhance overall delay (Fig. 4). These containers can hold up to 12 radiography cameras and are an option for facilities that do not have separate storage rooms within their home base facility.

FIG. 4. ORS Integrated Secure Container

Beyond security, this holistic approach provides a user with enhanced operational benefits, including the ability to monitor radiation readings of each camera, maintain electronic controls of cameras while they are in storage, and identify who accessed the storage rooms. Procedures are a critical component to any security strategy and the introduction of technological solutions for detection and assessment require updates to internal procedures and protocols with local response agencies.

INTEGRATION OF MSTS WITHIN RADIOGRAPHY

ORS has system integration activities ongoing with QSA Global, Inc., Industrial Nuclear Co (INC), and Source Production & Equipment Company (SPEC). These three radiography camera manufacturers represent a large percentage of the radiography camera market. A bolt-on system has been developed for camera manufacturers who do not have an integrated solution. These systems are fixed to the

exterior of the radiography camera and house the PM-Tag. Functionality of the PM-Tag is the same as the integrated system. All MSTS system designs for radiography will accommodate a single design of the STB and PM-Tag Mat. This will allow use of the STB and PM-Tag Mat interchangeably for sites that may have multiple makes and models of cameras.

WELL-LOGGING INDUSTRY BACKGROUND

Well-logging operations use radioactive sources to characterize exploration and production wells for the oil and gas industry across the globe. These sources are transferred from storage bunkers to transport containers and are then inserted into the well-logging tools at the job site. Approved personnel handle the sources with specialized tools and have detailed safety procedures that they are required to follow. The operational use of well-logging radioactive sources can be summarized in the following three phases:

Storage – the location where the well-logging radioactive source(s) are stored when not in use, referred to as the "home base." This includes any fixed location where the sources are kept for an extended period when not in use. Configurations of home base storage rooms vary from site to site and the approach for storage varies from company to company, as well as country to country. Sources are commonly stored in either vault-type configurations or shielding containers. When the source is transported to the field, it is either moved to a separate transport container or transported in the same container in which it is stored.

Transport – is the span of time during which the sources are moved to/from the storage room, placed within a transport container and/or on a vehicle and transported to/from the location of use.

Field Use – the sources are loaded to/from into the well-logging tools and lowered down into the formation to perform the analysis.

WELL-LOGGING MOBILE SOURCE TRANSIT SECURITY SYSTEM

Similar to the MSTS system for radiography, the well-logging system was developed to provide increased situational awareness of radioactive sources as they move from the home base, to the field, and back. Communication through a telematics (satellite and/or cellular) device on the well-logging vehicle provides near real-time alerts and alarms back to the home base. Components are installed within the transport vehicle and on the shielded transport container. System components are described as follows:

Master Control Unit (MCU) - Mounted inside of the transport vehicle where the sources are stored, the MCU (Fig. 5) is the central controller for the well-logging MSTS system. It monitors and processes all data coming from the eTag(s) and rTag (see below) in the system and sends out status and alerts from the system via the telematics components (satellite and/or cellular). The MCU is recharged using the truck's power.

FIG. 5. Master Control Unit

Radiation Tag (rTag) - The rTag (Fig. 6) houses the solid-state radiation detector that monitors changes in radiation levels indicating a change in the source's status (i.e., within its storage container, in use/outside storage, or absent). The rTag sends alerts and/or alarms to the MCU through BLE. The rTag is charged using the truck's power.

FIG. 6. rTag

Electronic Tag (eTag) - Attached to the shielded source container being tracked, the eTag (Fig. 7) provides tracking status through BLE to the MCU to monitor presence of the item. Tamper detection is integrated into the eTag.

FIG. 7. eTag

I**n-Cab Unit (ICU)** - Located in the cab of the truck, the ICU (Fig. 8) provides MSTS status and alarms to the driver in the cab of the truck via colored light indicators. It also provides a duress capability to the driver that is transmitted through the MCU.

FIG. 8. In-Cab Unit

To maintain situational awareness when in storage, the home base security system (HBSS) is installed within a storage room to monitor eTags. The HBSS is powered using facility power and comprises an MCU and rTag. If sources are stored in transport containers, the eTags can remain on the container, providing continuing monitoring of the container and source. eTags can also be fixed to the source handling tools to track their location. HBSS should be considered an additional element to the overall security of a home base/storage room and complement the other intrusion detection system components.

INTEGRATION OF MSTS WITHIN WELL-LOGGING

The well-logging MSTS system uses a secured web-based application to monitor the status of the system during operation. A smartphone or tablet is used to access the web-based application that is hosted on the MCU. Authorized users use the web-based application to identify the status of the system. Users can select as status: 1) Checking the source out of storage, 2) placing the source in the transport vehicle, 3) setting the system to transport, and 4) arriving at a job site and identifying that the source is in use. This requires that policies and procedures are established to ensure that authorized users understand how to place the system in the proper setting. The system also has the capability to establish a pre-determined route that the transport vehicle is taking to a job site, triggering notifications should the vehicle travel outside the established route.

When in use, the system will send alerts and alarms to the web-based application that can be accessed by authorized users from the well-logging company. These alerts and alarms should be fully understood and integrated into a site's security procedure to assist with timely notification to responding agencies. While in storage, the MSTS system is one component of a holistic security strategy, and when in the field it provides increased situational awareness of the location of the source and the status of the source.