SECURITY IMPROVEMENTS FOR RAIL MOVEMENTS OF SNM

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Abstract
The U.S. Department of Energy (DOE) and the Russian Special Scientific and Production State
Enterprise Eleron have teamed to lead a project to enhance the overall security of Russian Ministry
of Atomic Energy (MINATOM) transportation of Special Nuclear Material (SNM) shipments. The
effort is called the Railcar Transportation Security Project and is part of the overall DOE Material
Protection, Control, and Accounting (MPC&A) program addressing the enhancement of nuclear
material control, accounting, and physical protection for Russian SNM.

The goal of this MPC&A project is to significantly increase the security of Russian MINATOM
highly enriched SNM rail shipments. To accomplish this, the MPC&A Railcar Transportation
Security program will provide an enhanced, yet cost effective, railcar transportation security system.
The system incorporates a balance between the traditional detection, communications, delay, and
response security elements to significantly improve the security of MINATOM SNM shipments.

The strategy of this program is to use rapid upgrades to implement mature security technologies as
quickly as possible. The rapid upgrades emphasize rapidly deployable delay elements, enhanced
radio communications, and intrusion detection and surveillance. Upgraded railcars have begun
operation during FY98. Subsequent upgrades will build upon the rapid upgrades and eventually be
integrated into a final deployed system configuration.

This paper provides an overview of the program, with a summary of performance of the deployed
railcars.

BACKGROUND

Initial efforts in the DOE MPC&A program focused on security at fixed facilities. It was not until
1996 that the MPC&A program included the important task of providing security during the
transportation of SNM. However, it was soon discovered that the goal to significantly increasing the
security of Russian MINATOM SNM shipments is a complex, programmatic effort. The task of
providing rail transportation security is complicated by the involvement of many Russian
organizations, including MINATOM, MINATOM shipping/receiving sites, MINATOM
design/certification enterprises and institutes, the Ministry of Railways, the Ministry of Emergency
Situations, the Ministry of Internal Affairs (MVD), and others.
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The large scope of the problem adds to its complexity. Included in the scope of the Railcar Transportation Security project is the entire railway region of over 90,000 km of Russian rail between approximately 20 MINATOM sites. The MINATOM railcar fleet consists of a large number of various types of railcars, many of which are not consistently used or are at the end of their useful life span. The project has set requirements for upgrading railcars that have a minimum ten years of useful life and that are in good mechanical condition. Two types of railcars have been identified that meet these requirements: Russian V60 and 61-524 series railcars. These railcar types are used to ship SNM in single and multi-railcar configurations. Separate MINATOM sites own the railcars, and initial security upgrades have begun with railcars identified from Krasnoyarsk, Novosibirsk, the Siberian Chemical Combine (SCC), Mayak, Chelyabinsk-70, Electrorostal, and Arzamas-16.

This security upgrade project is concerned not only with the on-train security of single train shipments, but also with system security issues that includes the tracking and monitoring of all trains shipping SNM cargoes. All on-train and off-train security issues are addressed as part of this project. Besides the broad technical issues, the magnitude and involvement of the many Russian stakeholders makes this effort complex and delicate. A significant part of the project is to promote teamwork, cooperation, and consensus among the various Russian stakeholders and users. SNPO Eleron has been assigned responsibility by MINATOM for coordinating the Russian transportation security team that is headed by MINATOM’s deputy minister.

RUSSIAN TRANSPORTATION SECURITY CONCEPT

In early 1996, under contract to Sandia National Laboratories (SNL), SNPO Eleron formulated a rail transportation security concept that is called the Automated Transportation Security System (ATSS). This Russian ATSS concept has formed the basis for all of the work being accomplished as part of this project. A high-level depiction of the ATSS concept is shown in Figure 1.
The ATSS concept integrates three main subsystems that incorporate satellite communications and positioning. The three subsystems are:

1. The Automated System for Transport (AS-T). The AS-T comprises all security elements and functions that are part of and contained within a single railcar. These elements include alarm detection and annunciation, system intrusion delay, and communications.

2. The Automated System for Command Post (AS-CP). The AS-CP comprises all security elements for monitoring and tracking the status and location of shipped SNM. The AS-CP also supports the management of response activities during intrusion events.

3. The Automated System for Receiver/Shipper (AS-RS). The AS-RS is the subsystem that ensures that SNM is properly handled and accounted for when it leaves the shipping facility and arrives at the receiver facility. The AS-RS concept automates the transfer of the SNM and makes it transparent to the user.

Satellite communications enable the system integration of data and provide for timely communication of events for responsive command and control activities.

INTEGRATED SECURITY SYSTEM UPGRADES

The AS-T, AS-CP, and satellite communications portions of the ATSS concept are priorities for the Railcar Transportation Security project and are being used with the aid of vulnerability analysis to guide a series of security upgrade activities. These system upgrades are overlapping and can be visualized as shown in Figure 2. Although all upgrades are parallel activities, deployment of the upgrades is being sequenced to maximize security benefit and funding resources.

The first of these upgrades is Rapid Upgrades. Rapid Upgrades implementation quickly deploys mature and readily available technologies to realize a highly beneficial improvement in security capability. Railcar hardening and locks are used to enhance access delay. In addition, intrusion detection and enhanced voice communications are provided.

Security Overpack upgrade efforts have been pursued in parallel with the Rapid Upgrades. Security overpacks are hardened metal caskets used to hold SNM containers. Overpacks provide increased access delay above that provided by the railcar hardening and locks. This increased delay is especially beneficial against higher level threats.

A timely and effective security response is essential to the success of any security system and is an important part of the Railcar Transportation Security project. Railcar Security Force upgrades is an area that is very sensitive and is being approached cautiously. These upgrades are being pursued in
parallel with the Rapid Upgrades but more slowly. The MVD provides security force personnel, and MVD policy is currently in the process of being established at DOE headquarters. A special MPC&A team for MVD issues has recently been established, and the railcar security project is working closely with the MVD team to address railcar response force issues.

Integrated On-Train security systems upgrades incorporate and build upon Rapid Upgrades. The Integrated On-Train upgrades provide automation and autonomous operation. This makes operation more robust and independent of operator interaction. In addition, the On-Train upgrades provide enhanced access delay with the goal of significantly increasing the total system delay. The On-Train upgrades are being implemented in a manner that facilitates integration with future satellite communications capabilities to support data exchange with a MINATOM command and control center.

Command and Control Center upgrades will complete final deployment of the integrated railcar transportation security system. The MINATOM command and control center will provide the capability to monitor the security and location of all railcar SNM shipments in near real-time. The command and control center will be computer-based, utilizing graphical operator interfaces and geographic information system databases. When security events occur, response activities can be managed and directed from the command and control center.

**PROTOTYPE DEMONSTRATION AND EVALUATION RESULTS**

A prototype integrated railcar security system was demonstrated on a Russian railcar traveling from Moscow to Yekaterinburg and back, approximately 3600 km. This dynamic demonstration occurred in November 1997 and featured Rapid Upgrades, an integrated On-Train Security System, and a Command and Control Center located at SNPO Eleron. Satellite communications was implemented using INMARSAT-C', and the Russian GONETS² satellite system was demonstrated as a stand-alone system.

The rapid upgrade prototype enhancements were shown to be feasible and were officially endorsed by the Russian user community to be implemented in both railcar types selected for security upgrades. As part of the rapid upgrade elements, cargo doors were hardened. Locks and chains were provided to lockout and disable operation of onboard devices that an attacker might use to his advantage. Windows were protected with metal grids and impact resistant film. Two-person access control was implemented for the cargo compartment. Enhanced communications capability was provided using voice radios. And an interior intrusion detection and surveillance system was installed in the cargo compartment. Evaluation of test results of these rapid upgrade elements by Russian and U.S. personnel was positive.

In addition to the rapid upgrade elements, a prototype security overpack was placed in the cargo compartment for the entire dynamic demonstration. Upon return to Moscow, the overpack was opened and mock SNM containers were loaded into the overpack.

During the 3600 km trip, the On-Train Security System was also shown to be feasible and operated successfully. Russian and U.S. personnel manned the railcar during the trip and recorded test data for subsequent performance evaluation. Minor on-train problems associated with loose cable
connections and inadequate buffer sizes in software were responsible for three communications
losses with the command and control center. These problems were fixed and verified during and
after the demonstration trip. Other on-train elements were successfully demonstrated, including
the operator consoles, door sensors, and voice intercoms. The volumetric microwave sensors operated
inconsistently but provided useful test data for subsequent refinement and calibration.

The Command and Control Center was configured at SNPO Eleron and manned 24 hours per day
during the entire four days of the 3600 km trip. Test data was collected by both Russian and U.S.
personnel and evaluated after the test. Except for the three periods of communication loss,
communications between the railcar and the command and control center were frequent and
consistent. Text messages and predefined communications codes were used to coordinate test
sequences to generate alarms and exercise all functions of the integrated system. Test data collected
on the railcar was compared to data collected at the command and control center. Evaluation of this
data has validated the feasibility of the Russian prototypes for the security system components and
has led to the project's subsequent deployment activities for pilot operation, rapid upgrades, and
security overpacks.

PILOT RAILCAR DEPLOYMENT RESULTS

After the security system prototype demonstrations, a Pilot Operational Program was established for
deployment of rapid upgrades on railcars during a trial operational period. The intent of the program
was to provide early deployment of security upgrades for protection of SNM and to provide for
evaluation of the rapid upgrade elements in real operational circumstances prior to finalizing the
design for production implementation to the rest of the MINATOM fleet railcars identified for
upgrade.

In December of 1997, rapid upgrade security elements were installed into two different types of
MINATOM railcars. Operators from the owning sites were trained to use and maintain the upgraded
security elements, and the railcars were placed into trial operation in January through March 1998.
In addition, test and evaluation criteria were established and the operators were instructed in
methodologies for collecting operational data during the trial operational period. Installed security
components included access delay hardening, locks and two-person door locks, intrusion detection
and surveillance, and enhanced radio capability.

During the pilot operational period, the users recorded evaluation data that lead to recommended
improvements to the suite of rapid upgrade elements. As a result, design enhancements were made
to improve security, implementation methods, and ease of use for the operators.

RAPID UPGRADE AND SECURITY OVERPACK DEPLOYMENT

A design review workshop for Rapid Upgrades was held in Moscow in March of 1998. At the
workshop, the results of the Pilot Program were presented to railcar security stakeholders and users,
and the design for the Rapid Upgrades was finalized and approved by the Russian community. With
a final, approved design drawing set, a contract was placed with SNPO Eleron to begin production
to install rapid upgrade improvements into the MINATOM railcars identified for upgrade.
In June 1998, the security overpack design for the V60 type railcars was finalized, and a contract was placed with the Russian Technical Bureau for Automotive Transportation Equipment, KBATO, to produce all the V60 security overpacks and internal racks for the upgraded V60 type railcars. The design of the V60 security overpack is based upon the security overpack being used for Russian vehicle transportation. However, the V60 security overpack includes significant design enhancements to lock the cover to the overpack base, and to integrally restrain the overpack to the floor of the railcar using a blind attaching mechanism. These two enhancements provide improved access delay. A design for a security overpack to meet the needs of the 61-524 type railcars is currently in progress and expected to be completed at the end of calendar year 1998.

Deployment of the final Rapid Upgrades design began in June 1998 when the two Pilot railcars were updated in accordance with the final, approved design. In addition, at that time, the first two V60 security overpacks were delivered. These two upgraded railcars and security overpacks are the first that have been placed into operation and are providing improved transportation security for shipments of MINATOM SNM. Rapid Upgrades production installations to the remainder of the railcars identified for upgrades began on July 20, 1998, and deployments are being done at the rate of two railcars every two weeks.

CONCLUSIONS

The deployment of rapid security upgrades and security overpacks are providing a significant increase to the security of rail shipments of SNM in Russia. These two security efforts have established a successful strategy for sequencing a series of security upgrades for deployment and integration into a final security system. The participation, teamwork, and coordination of the various Russian stakeholders, users, and transportation organizations has proven to be invaluable for the acceptance and deployment of these security upgrades. In addition, the combination of expert security knowledge from U.S. and Russian project members, combined with vulnerability analysis guidance is proving to be a successful formula for maximizing security effectiveness and using project resources wisely. Future integration of security upgrades will continue using our strategy of wide Russian involvement, security validation using vulnerability analysis, and prototypes and trial operation of systems to finalize designs prior to production and deployment.

1 INMARSAT is a widely used international geostationary satellite communications system providing near full coverage of the earth surface. INMARSAT-C is one of the communications standards that can be used in INMARSAT.
2 GONETS is a Russian low-earth orbit (LEO) satellite communications system developed by Scientific Research Institute of Precise Instruments. GONETS is partially deployed with 6 of 45 constellation satellites in orbit.