INTRA-SITE SECURE TRANSPORT VEHICLE TEST AND EVALUATION

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ABSTRACT

In the past many DOE and DoD facilities involved in handling nuclear material realized a need to enhance the safely and security for movement of sensitive materials within their facility, or "intra-site". There have been prior efforts to improve on-site transportation; however, there remains a requirement for enhanced on-site transportation at a number of facilities. The requirements for on-site transportation are driven by security, safety, and operational concerns. The Intra-site Secure Transport Vehicle (ISTV) was designed to address these concerns specifically for DOE site applications with a standardized vehicle design. This paper briefly reviews the ISTV design features providing significant enhancement of on-site transportation safety and security, and also describes the test and evaluation activities either complete or underway to validate the vehicle design and operation.

INTRODUCTION

Many DOE and DoD sites have recognized the need to securely and safely move Special Nuclear Material (SNM) and sensitive materials within their facilities. The results of site surveys and assessments often have concluded that sites could benefit from the utilization of an on-site transporter with enhanced security and accident mitigation features. The assessments indicated that the principle cause for the security vulnerabilities was insufficient access delay provided by the existing transporters to allow effective and timely security response. Adequate delay may be achieved by increasing the number of armed escorts or by providing delay through an improved transporter. Enhancing the transporter was desirable by providing improved delay and ballistic protection together with enhanced safety, while potentially reducing the required number of accompanying security escorts.

A standardized Intra-site Secure Transport Vehicle was developed at Sandia National Laboratories as a cost-effective way of providing significant security and safety improvements for on-site transportation for the DOE. The safety enhancements incorporated into the vehicle design include a high-strength vault and cargo tie-down design providing impact protection, and the use of intumecsent foam for increased accident fire safety. Improved security features include an integrated vault barrier / armor design providing access delay, an RF-activated immobilization system, and an electronic locking system coupled to an internal, distributed locking boltworks in the vehicle cargo doors.

Testing and evaluation completed on the ISTV design to date has included a detailed system premature probability study, multiple immobilization and entry control system tests, ballistic and security attack testing of the wall panel design, and testing of other security features incorporated into the various vehicle systems. The ISTV currently is undergoing operational test and evaluation by the Sandia National Laboratories Logistics Management Center in support of the movement of SNM and other high-value cargo at the Laboratory.

ISTV DESIGN DESCRIPTION

ISTV Vault and Chassis

In the ISTV, the robust vault structural and panel design has been utilized to provide enhanced and

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complementary access delay, ballistic protection, and safety capabilities. These basic design features are passive, which substantially reduce concerns with safety, prematures or failures of active systems, and costs associated with command and control and implementation of active delay systems. The ISTV vault is an integral structure incorporating panels of high-hard steel corrugated armor, intumescent rigid foam, inner and outer stainless steel skins, and other barrier materials on a tubular steel frame. The vault structure has been designed fracture tough with special steels for primary load members and secondary load paths incorporated into the design. The corrugated armor together with the nine-inch overall thickness of the wall panels provide the enhanced access delay and ballistic protection for the cargo. The ISTV vault wall panels also incorporate intumescent rigid foam. Intumescent foam has excellent insulating characteristics and the foam char expands in a fire environment tending to seal any punctures of the vault resulting from the accident. The specific design goal for the ISTV is to provide thermal protection for vault cargoes for 20 minutes in a 1000° C fire. The ISTV wall areal density is approximately 160 kg/m^2.

The ISTV vault cargo volume was designed to accommodate typical container sizes and weights transported by the DOE. The interior volume is 1.98 m wide by 1.98 m high by 4.1 m long. The ISTV prototype vehicle payload capacity is 5000 kg. The vehicle capacity is dependent upon the chassis selected for the vehicle and whether the cab armor option is selected. The ISTV vault is designed to be allowed to be placed on different chassis types. This allows site specific chassis selection based on requirements for features such as minimum turning radius, all-wheel drive, or compatibility with other vehicles in a fleet. The chassis being used for the ISTV prototype is a tandem axle Ford LN-8000. The GVWR for this chassis is 24,545 kg which allows for the additional weight of cab armor if required. The vehicle has a turbocharged diesel allowing operation at 88 km/hr and on 10% grades. The chassis also includes air brakes, cold weather starting package, and a number of heavy-duty auxiliary systems.

Aircraft-type cargo tie-down tracks are provided in the vault floor and at three locations on the vault side walls. This arrangement allows flexible cargo tie-down schemes for containers, palletized loads, or side wall racks. A summary of the principle ISTV design and operating features is included as Figure 1.

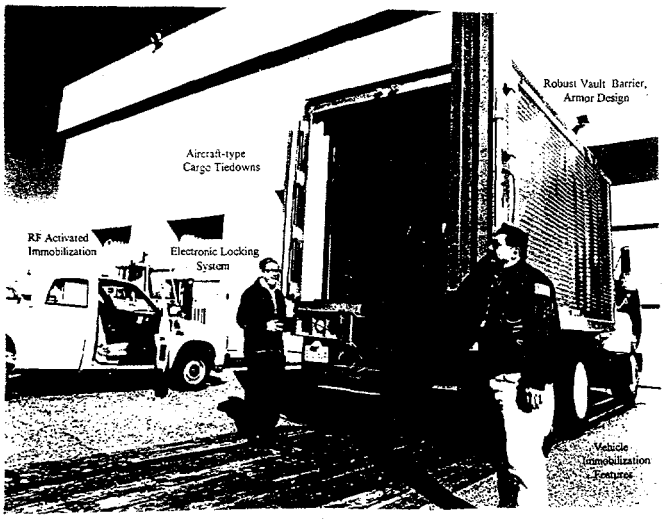

Figure 1. ISTV Operating Features

Entry Control System

The ISTV incorporates a slightly modified entry control system from the Hirsch Company. The system provides two-person entry control with 3 - 8 digit individual code entry from a plug-in, limited-view, scramble pad pendant. The Hirsch electronic lock provides up to 1000 user valid codes with limited try features and easy code entry and recode. The Hirsch system output controls an electromechanical door lock incorporated into the curbside door of the vehicle. The lock incorporates aircraft quality actuators for operating the mechanism upon receipt of a valid code set. The primary actuator is controlled by the Hirsch system while the second is a timer-controller backup. The lock mechanism drives multiple, distributed locking pins that physically lock the door to the vault

frame. Hinge-side locking is provided by a passive locking wedge. The door lock also utilizes stressed glass and thermal relockers to provide additional attack protection. The streetside door is locked manually from the interior of the vault. Both doors also utilize standard cam locks on the door exterior.

ISTV Immobilization

Immobilization capabilities are provided for the ISTV to preclude an adversary from simply driving the vehicle offsite. The ISTV prototype incorporates a number of vehicle chassis immobilization features that can be activated either from the vehicle cab or from an escort vehicle via RF link. The RF system consists of up to four escort vehicle transmitters that can communicate with the ISTV out to at least 16 km. These portable units operate from escort vehicle power with internal battery backup. A panel within the ISTV cab also allows immobilization systems to be activated. In addition to long range, the RF system provides for multiple messages, jam resistance, volatile or non-volatile key code storage, authenticated messages without special algorithms, and a number system test features.

Chassis immobilization features include several engine fuel shutoff devices, an accelerator linkage disablement device, and controlled braking of the vehicle to a stop in approximately 50 seconds. The chassis immobilization hardware is based largely on commercial equipment to facilitate maintenance and reduce costs. Finally, the ISTV immobilization system is reversible either by a variable timer or by a manual internal reset. After the preset time-out or reset the immobilization systems will automatically reset to the operable condition allowing the vehicle to continue.

ISTV OPERATIONAL TEST AND EVALUATION

The ISTV prototype vehicle began operational test and evaluation (OT&E) by the SNL transportation and logistics organization in the Fall of 1994. The OT&E is scheduled to continue for approximately 18 months to provide application experience in the operation and maintenance of the vehicle in a realistic operational setting. Prior to the start of the ISTV OT&E a number of functional and validation tests also were completed. The following summarizes the testing and operational experience to date.

Immobilization System Premature Evaluation

The ISTV immobilization system was designed to be fully reversible with no long-lasting effects resulting from activation. This allowed simplifying the control system and reducing costs by utilizing commercial components. However, the immobilization system is an integral part of the vehicle delay and an evaluation was performed to determine the approximate system probability of premature in a typical operating environment. The results of this evaluation indicated that the system premature probability is negligible at $\sim 2 \times 10^{-15}$/ trip.

RF System and Immobilization System Testing

The RF system activating the ISTV immobilization was extensively exercised to determine the effects of terrain, multi-story buildings, and range on the immobilization performance. The results of this testing indicated that the system could be successfully activated at distances line-of-sight to the horizon. Also, the portable transmitters (Figure 2) have sufficient power to reliably activate the system at facilities without line-of-sight when the vehicle is shadowed by buildings or terrain.

As part ISTV demonstrations, testing, and operator training the immobilization system has been exercised more than 80 times without failure.

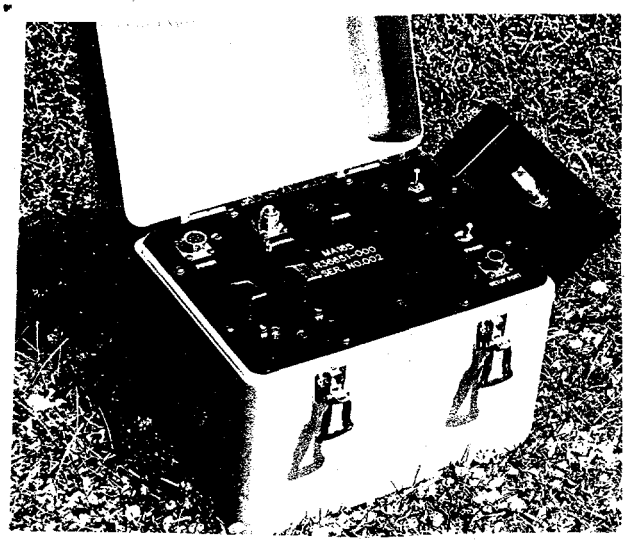

Figure 2. Portable Immobilization Unit

Figure 3. ISTV Wall Panel Testing

Entry Control System Testing

The Hirsch-based entry control system and associated locking boltworks has been successfully operated more than 200 times as part of demonstrations, testing, and operator training. In addition, the boltworks relocking features were security tested as part of the design validation. Also, the ISTV vault was instrumented to measure vibration spectra under severe road conditions at various locations where electronic packages are installed. This environment was anticipated in the design and resulted in selected electronic component vibration isolation and stress relief. Both the immobilization and entry control systems have undergone scheduled preventive maintenance at six month and one year intervals, and there have been no failures of the systems in the 7500 miles that the ISTV has been driven over the past three years.

Security Testing

Extensive ballistic and security adversary testing of the ISTV wall panel design was completed to validate the access delay and ballistic protection of the cargo. The results of the security testing is classified; however, the ISTV fully meets the enhanced security requirements outlined by DOE site users in the ISTV requirements document.

SUMMARY

Many facilities have recognized the need to improve the safety and security of transportation of sensitive materials on their respective sites. Sandia National Laboratories has developed the Intra-site Secure Transport Vehicle as a cost-effective means of providing significant security and accident safety improvements for on-site transportation of SNM or sensitive materials at DOE facilities. The prototype ISTV currently is in operational test and evaluation at SNL. Preliminary results from the validation testing and operational evaluation indicate that the vehicle fully meets the original DOE application requirements. The ISTV systems have been exercised several hundred times as part of demonstrations, testing, and training with no failures. The formal ISTV OT&E is scheduled to continue through December 1995.

REFERENCES

1. "System Requirements, Intra-site Secure Transport Vehicle (ISTV)"; SS-R35834-000, Org 9611, Sandia National Laboratories, Albuquerque, NM.

2. M. Plugge, Intra-site Secure Transport Vehicle (ISTV) Interim Development Report, RS9611/93/10082, Sandia National Laboratories, Albuquerque, NM, February 1993, (CNSI).