# Performance Testing in the Secure

# Transport of Nuclear, Radiological, and

# other High-Risk Materials

Greg Verner

Y-12 National Security Complex

Oak Ridge, Tennessee USA

Email: [greg.verner@cns.doe.gov](mailto:greg.verner@cns.doe.gov)

G. Scott Stockwell

Y-12 National Security Complex

Oak Ridge, Tennessee USA

Allyn Milojevich

Y-12 National Security Complex

Oak Ridge, Tennessee USA

Abstract

Performance tests are vital because they provide essential information used in the determination of asset risk and the analysis of protection effectiveness. By establishing and verifying detection, assessment, response, interruption, and neutralization data, one can determine baseline protection effectiveness and consider upgrade scenarios and improving effectiveness. Performance testing can be applied to any layer of PPS at a fixed site or any mode of transport. In an example of road transport by box truck, we can test one layer of a PPS. In this example, we will focus on the delay associated with breaching times of different types of tie down mechanism used to secure containers while in transit.

## OVERVEW

A long-established methodology for determining the effectiveness of an overall physical protection system (PPS) is through a healthy and robust performance testing program. Performance tests are vital because they provide essential information used in the determination of asset risk and the analysis of protection effectiveness. By establishing and verifying detection, assessment, response, interruption, and neutralization data, one can determine baseline protection effectiveness and consider upgrade scenarios and improving effectiveness. Performance testing also addresses the needs of multiple stakeholders, including the vulnerability assessment teams, site/facility personnel, and safety, and provides management with an independent, objective assessment of overall physical protection systems.

Performance testing can be applied to any layer of PPS at a fixed site or any mode of transport. In an example of road transport by box truck, we can test one layer of a PPS. In this example, we will focus on the delay associated with breaching times of different types of tie down mechanism used to secure containers while in transit. This test will be limited scope in nature and will use three different methods of breaching (mechanical, ballistic, and explosive). During the test, we will attempt to breach the tie down chains and the locking mechanism multiple times with each method.

At the conclusion of the test, objectives and evaluation criteria will be analysed to ensure the system is performing as required, deficiencies are identified, and stakeholders are provided with feedback/results. For example, the results from this particular set of tests can be used to determine figures of merit associated with delay mechanisms to determine response time needs in relation to the delay associated with breaching the tie downs.

The paper and presentation will discuss adapting fixed facility performance testing plans to transport, best practices for transport performance testing, and how to implement analyses into protection strategies.

## TRANSPORTATION SECURITY VULNERABILITIES

The threats to nuclear and radiological material include both unauthorized removal (theft) of material for use in a device or sabotage in place to cause environmental, psychological, and socioeconomic damage. To prevent either of these incidents, a robust physical protection system (PPS) is designed and implemented to mitigate vulnerabilities associated with the facility in question. An integrated PPS is comprised of a number of components that perform three key functions: detection, delay, and response. Detection systems are made up of components such as sensors, communication lines, assessment systems, alarm communication and display systems, and entry and access control systems. These systems are designed to signal the unauthorized access, or attempted access, of a person or object into the area being protected; provide timely verification of an unauthorized intrusion attempt and present critical tactical information to response personnel; and provide a means for transfer of the information to all points where appropriate action can be taken. Delay systems incorporate passive and/or active barriers and may be integrated with the detection systems. Delay systems impede adversary penetration into, or out of, the area being protected and provides sufficient time (after detection) for proper assessment and response by the protective force. When functioning properly, detection and delay elements provide defence in depth. Response systems include guard and protective forces (PF), as well as equipment (weapons, vehicles, communication systems, etc.) to assist in performing the response function. Effective protective force tactical response interrupts adversary activity and prevents the adversary from achieving its goals through the timely execution of the facility’s protection strategy. To ensure efficient integration of protection components, it is vital to performance test all aspects of a PPS to assure an efficient and effective system.

The transportation of nuclear and radiological material around the world is vital to supporting the application of nuclear technology for electrical generation, medical application, and a host of other industrial activities. However, high-risk materials are most vulnerable during transportation. The physical protection elements are, by design, less robust than at a fixed facility with fewer protective force elements immediately available. The enemy has the advantage by being able to prepare for an attack along the transport route and strategically attack when the transport is most vulnerable. It is important to assess specific vulnerabilities during transport and design a physical protection strategy to mitigate those vulnerabilities. It is especially vital to effectively performance test transportation related physical protection systems as they are so vital to effective protection of high-risk materials.

The paper will discuss performance testing, and best practices for performance testing transportation related physical protection systems and response.

## PERFORMANCE TESTING CONCEPTS

Performance tests are a vital aspect of an effect performance assurance program. An effective performance assurance program:

* Determines the effectiveness of the safeguards and security program
* Determines effectiveness of individual protection elements (working alone or in support of the entire physical protection system)
* Identifies system strengths & weaknesses
* Corroborates procedures
* Confirms training effectiveness
* Provides data for vulnerability analyses
* Integrates material control and accountability and physical protection

Performance tests are used to verify the effectiveness of physical protection systems as they pertain to detection, assessment, delay, response, interruption, and neutralization. Because they can test individual components to a system as a whole, performance tests range in complexity from simple demonstrations of component operability to major tests involving a large number of protective force personnel. The more complex a performance test is, the more expensive it is to execute, as well as requiring higher levels of coordination.

Section Four describes performance testing methodology and a variety of performance testing approaches. Despite the type of performance test or whether the test is on a fixed site or a transportation security system, there are several key principles for effective performance testing:

* Establish achievable and measurable test objectives
* Properly control the test environment
* Conduct tests safely while assuring a realistic test for the system and/protective force
* Objectively analyse the test results and provide corrective actions to improve the detection, delay, and/or response capabilities associated with the physical protection system

## PERFORMANCE TEST METHODOLOGY

Regardless of the type of performance test implemented, a consistent approach will assure the best results for improvement.

Figure 1. Performance testing methodology

Performance tests are vital to determine protection effectiveness of a physical protection system. They also identify training and operational needs that are required to improve mission capabilities and skills, which makes coordination between the performance testing organization and the analytical, operational, and training organizations important. Planning is critical to a successful performance test, initially identifying the purpose of the test and clearly delineate what is being tested and why it is important. Next, it is important to identify the scope which defines exactly what will and what will not be tested. Lastly, it is important to identify test objectives with the goals of the test.

After the parameters are determined, one must identify the test criteria, including the person, item, or process being tested and the expected reaction to the test. This becomes the standard for assessing the results of the test. Finally, specific scenario events can be developed, which include a logical series of events with enough detail to assure that the test has sufficient situational, visual, and audible input to elicit the appropriate response. It is also important to identify test controls, resource requirements, and assumptions and risks, including documenting the development process, the execution, and the results.

There are a range of performance tests, from Alarm Response and Assessment Performance Tests (ARAPTs) to Force on Force (FOF) exercises. ARAPTs are conducted without prior notice and are designed to evaluate protective force response to a specific alarms that are based on simulated adversary actions that are consistent with the design basis threat (DBT) and the vulnerability and security risk assessment (VA/SRA) results. For instance, a door alarm could be triggered, and the protective force evaluated against whether they responded within the identified timeframe with the appropriate level of response. The goal is to determine protective force readiness and its ability to respond to alarms.

FOF exercises are major performance tests of an entire physical protection system, including protective force elements. Tests must be consistent with the identified (DBT) and vulnerability assessment results. FOF exercises reflect adversary weapons and tactics as identified in the DBT and must be well planned, announced in advance to all participating parties, and conducted during specific times.

This paper will focus on Limited Scope Performance Tests (LSPT), which are useful in testing various aspects of a robust transportation security system.

## LIMITED SCOPE PERFORMANCE TESTS (LSPT)

Limited scope performance tests (LSPT) are either scheduled or unannounced and used to determine the protective force capabilities in a particular area or in response to a particular alarm. LSPTs should realistically test the effectiveness of a specific operation or procedure, including any element of the protective force responsibility.

Planning the test is the most important aspect of any performance test, and for a LSPT it is particularly important to identify the main purpose, scope, and objectives as they can vary from test to test and are tailored according to identified needs. Planners could choose to focus on one or more functional areas or one or more tasks supporting those functional areas. Once test parameters are determined, the test criteria must be established, which identifies the acceptable response from the person being tested in reaction to the test stimuli. The test should be coordinated with key stakeholders, and could include representatives from the performance testing organization, physical systems organization, and environmental health and safety organization. Once all stakeholders have agreed to the performance test, it is important to identify trusted agents to act as controllers and evaluators.

During the LSPT, the controllers will assess the physical protection systems of the transport vehicle and the protective forces (PF) performance. These will be site and organizational specific, but generally the evaluators will consider the following:

* Did the PF respond efficiently and effectively to the test stimuli (alarm, etc.)?
* Did the PF follow protocols to move safely and tactically?
* Did the PF contain the target vehicle and secure the material?
* Did the PF establish communications with Local Law Enforcement Agencies (LLEA)?
* Did the transport vehicle duress or interior alarm system function

An example LSPT related to nuclear transportation security would be a response to a theft attempt of material during transport. The goal would be to evaluate driver, PF, LLEA and State response to a nuclear security event involving the unauthorized removal of nuclear material during transport. The Escort vehicles are designed to withstand an initial hostile action so the PF inside the vehicle can then deploy and contain the situation. The PF employs a containment strategy in which the ultimate goal is to prevent target material from leaving the area. This strategy involves securing avenues of escape, immobilizing the transport vehicle, and engaging hostile forces from cover while adversaries attempt to access and acquire target material.

As soon as hostile action is initiated, LLEAs are called via radio communication. This communication is initiated from the point PF vehicle and takes roughly 30 seconds. Upon confirmation of hostile action, via sensors within the transport vehicle or radio communication from the PF, state response agencies also begin to respond over a period of 6 hours. See Table 4.

Table 4. Example Response Force Characterization and Times

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Response Team | Material Risk | | | | Primary Weapon System | Location | Truck Vehicles | Response Force Time |
| High | Medium | Low | Very  Low |
| Escort Protective Force | 11 | 7 | 0 | 0 | 7.62 mm rifle (11) | Convoy | Armoured vehicles (2), soft vehicle (1) | Instant |
| Local Law Enforcement Agency | 6 | 6 | 6 | N/A | 7.62 mm rifle (6) | Local area | Soft vehicles | (2) at 17 min  (2) at 25 min  (2) at 45 min |
| State Response | 12 | 12 | 12 | N/A | 5.56 mm rifle (12)  7.62 mm machine gun (1)(1) | Regional locations | Armoured vehicles (2) | 6 hours |

The purpose of this LSPT would be to test response elements and their capabilities during an attempted theft, as well as to test communication/coordination and the PPS of the transport vehicle during an event. Multiple agencies could be involved depending on the breadth of the performance test’s design.

At the end of any performance test, the controllers will immediately clean up any debris, assure equipment is accounted for, and answer any questions that evaluators may have in regard to their performance. There is typically some immediate verbal feedback, but most of the assessment will be completed during the writing of the after-action report.

## CONCLUSION

The most important aspect of any performance test is recording the results and writing a thorough after-action report. The purpose of the after-action report is to assure that all relevant information regarding the test is recorded and understood. The test details are recorded, and the results are compared to the test objectives outlined during performance test preparation. Performance test evaluators must be able to place their observations in the context of the performance test. It is important to capture an in-depth discussion of what the performers did well and less well, and all technical enhancement opportunities that came out as a result of the performance test should be captured and recorded.

The analysis captured in the after-action report is a process that involves the critical considerations of all aspects of the performance test. If no deficiencies were identified during the performance test, the analysis is simple. However, there are typically at least one deficiency identified during a performance test and it is important to determine that deficiency’s effect on the entire system. It should be determined if the deficiency is isolated or systematic and how the potential deficiency could affect the physical protection system as a whole. Issues should be presented and resolved through the facility or organization’s corrective action process. It is important to determine causal analysis, develop corrective action plans, and track the issue through to resolution.

In order to best develop effective performance tests for the transport of high-risk materials, it is important to assess the process from shipping through receiving. This may include multiple facilities, contractors, and first responders. The physical protection systems associated with the transport system has multiple elements that can be performance tested to assure potential deficiencies are identified and corrective actions put in place.