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Transportation Security Administration

Office of Security Technology
Airport Perimeter Security Projects for FY06

FINAL REPORT

Washington Dulles International Airport
Gatekeeper Vehicle Screening Device

U.S. Department of Homeland Security
Transportation Security Administration
Office of Security Technology
Advanced Surveillance Program (ASP)
701 South 12th Street
Arlington, VA 20598-6016

[redacted]

OVERVIEW

INTRODUCTION

In FY 2006, TSA announced opportunities for general perimeter security enhancement projects at airports with typical configurations and existing barriers, such as fencing and concrete barricades. The announcement requested information from airport authorities on existing airport perimeter security vulnerabilities and proposals to mitigate those vulnerabilities through the inventive use of available technologies at intended perimeter access points (such as vehicle gates), perimeter boundaries, and terminals.

In FY 2008, TSA reissued the APS announcement to all airports, along with a second announcement addressing small to medium-sized airports with few or no barriers around their perimeters. The second announcement was for the Virtual Perimeter Monitoring System (VPMS) project intended to test a more elaborate solution that would better fit a smaller airport. The VPMS solution was developed by the Navy.

TSA requested airports provide white papers explaining the security deficiencies to be addressed and proposals, including technologies to be deployed and full life-cycle project cost estimates. 65 airports responded to the FY 2006 request and 35 airports responded to the FY 2008 requests. The airports proposed projects of varying complexity, from installation of a single piece of equipment to sophisticated, integrated systems.

Six airports were selected in FY 2006 to participate in the APS projects. In FY 2008 and 2009, TSA selected six additional airports for participation in APS and three airports for VPMS projects.

The attached report covers the test results of only one of the 15 total test sites. TSA plans to release each report singularly as the test results are completed and made available.

IMPLEMENTATION

Washington Dulles International Airport (IAD) was selected based on its proposal to purchase and implement the Entry Point Control System (EPCS), manufactured by Gatekeeper, Inc. of Reston, Virginia. Gatekeeper EPCS is an automated imaging system designed to search for vehicle-borne improvised explosive devices that may be attached to the undercarriage of a vehicle entering an Airport Operations Area (AOA). Three Gatekeeper EPCS units were installed at [redacted] and used to screen vehicles ranging from compact cars to oversized vehicles, such as tractor trailers. The airport requires the Gatekeeper EPCS to effectively provide an alarm for onsite screening personnel when a suspicious object is present on the undercarriage of a vehicle traveling into the AOA.

National Safe Skies Alliance (Safe Skies) monitored the project and progress during the installation to confirm the work was completed and the system met the original implementation plan description. Safe Skies conducted an independent verification and validation (IV&V) to confirm proper operation of the system from the technical hardware and user operation perspective. The IV&V assessment concluded December 5, 2008. IAD authorities verified the Gatekeeper units met airport security requirements. The operational test and evaluation results were reported in March 2009 to TSA through the attached final report.

Testing at IAD assessed the Gatekeeper system's capabilities in vehicle recognition, as well as foreign object detection. The operators' interactions and understanding of the system's user interface and operational maintenance issues were also evaluated. [redacted]

The Safe Skies Lead Test Engineer (LTE) generated a site survey document based on a preliminary survey of the location prior to the installation of the security technology improvement. The LTE developed operational testing procedures used as the basis for determining if the system met the security requirements of IAD airport authorities. Representatives of TSA, Safe Skies, and IAD convened to discuss and verify support requirements prior to the implementation of evaluation procedures. The resulting operational data was analyzed by the Safe Skies statistical team and combined with the site survey information to generate the final report.

SUMMARY

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

DHS/TSA 2600.02.01.09-054	# Washington Dulles International Airport: GateKeeper Vehicle Screening Device Operational Evaluation Report

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	March 2009 Final Report	

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This report was prepared by John Hunsucker of National Safe Skies Alliance

17. Abstract
This evaluation report illustrates some of the primary features of the Gatekeeper vehicle screening system and the operational functionality of the enhancement as it is currently installed and operated at the perimeter of IAD. Testing operations took place at [redacted] where the three GateKeeper units are installed. Scenarios were performed December 1 – 5, 2008.

Testing of this system was made possible through funding and resources allotted from the TSA Airport Perimeter Security program. The statements included in this document are in reference to the Critical Issues that were approved in the project's Final Test Plan (DHS/TSA 2600.02.01.08-107, August 2008).

18. Key Words
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EXECUTIVE SUMMARY

Washington Dulles International Airport (IAD) utilized Airport Perimeter Security (APS) program resources, provided by the Transportation Security Administration (TSA), to purchase and implement the GateKeeper Entry Point Control System (EPCS), designed to screen the undercarriage of vehicles entering an Air Operations Area (AOA). Three GateKeeper EPCS units have been installed at [redacted] and have been used to screen vehicles ranging from compact cars to oversized tractor trailers. As required under the APS program, National Safe Skies Alliance (Safe Skies) provided independent verification and validation services and operated along with airport authorities to verify that the GateKeeper met the airport's security expectations. The OT&E was conducted December 1 – 5, 2008.

The primary features of interest were the system's capabilities in vehicle recognition[1], foreign object detection, its end user interface, and operational maintenance issues. To this end, Safe Skies collected data that addresses the object detection rates and threshold settings with respect to various vehicle types, logistical and staffing requirements, limitations, training, and other maintenance tasks. However, a critical limitation[2] in the GateKeeper software prevented a detailed examination of the vehicle recognition aspect of the device. Data was collected that will illustrate the functions of the GateKeeper and verify its operational capabilities.

The Gatekeeper implements several technologies in order to expedite and optimize identification of vehicles and undercarriage mounted foreign objects (i.e., Improvised Explosive Devices). Pressure sensors activate an infrared (IR) light source which illuminates the undercarriage as the vehicle continuously moves over the unit. The unit utilizes a front- and rear-mounted camera to take multiple images of the vehicle from different angles, which it then transmits to the main computer terminal where the end user may view and screen the image. Figure 1 below shows the GateKeeper unit LED arrays and the camera screens.

[1] Vehicle recognition, for the GateKeeper, is ability to correctly identify a vehicle based on the live images.

[2] Critical limitation refers to the absence of the reference image database, the primary source for all vehicle comparison.

[redacted]

[redacted]

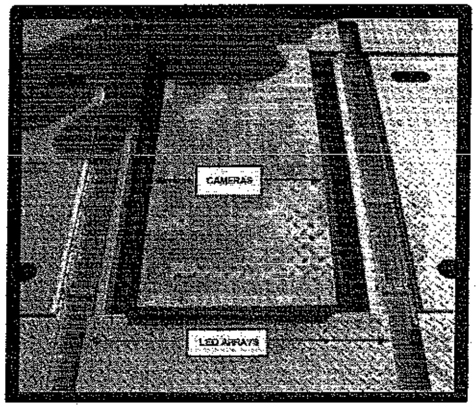

Figure 1. GateKeeper LED Arrays and Cameras

Simultaneously, a license plate reader and video camera take live images of the incoming vehicle, Figure 2. The license plate image is processed and the vehicle's plate number is compared to entries in the GateKeeper database. This does not imply that the GateKeeper system contains vehicle registration information for every vehicle, but if a vehicle has been through the gate once before it should have a record of the license plate. If a match registration is found in the database, it will pull the reference image[3] for that specific vehicle and immediately compare the live images to the references. If a license plate match is not found, the system will search its reference image database for an undercarriage that is relatively similar. The camera simply takes images of the vehicle and driver for record purposes.

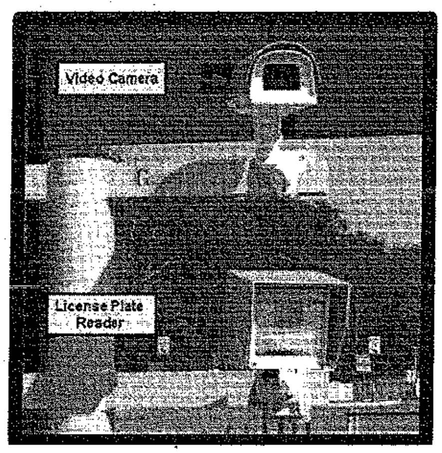

Figure 2. License Plate Reader and Video Camera

[3] The *reference image* is the primary template for comparison and determines whether the undercarriage of a given vehicle has changed or if a foreign object is present.

[redacted]

[redacted]

Depending on the threshold[4] setting, the system will automatically identify potential foreign objects and alert the end user by circling them in red on the monitor. The foreign object detection capabilities of the enhancement depend on several critical features, including quality and availability of nominal reference images, nominal real-time imaging, and foreign object detection threshold settings.

[redacted] The image processing software can process images quickly and provide end users with a simple method for screening vehicles. However, "out of the box" the system does not include a vehicle reference database; the system must be populated "organically" by the end users. The original testing procedures were designed under the assumption that a populated database would be included. Without a reference database, there is no means for the system to make a comparison of a vehicle as the system cannot identify make, model, or year until the database is sufficiently populated. This fact limited the extent of the evaluation because building the reference database would require every conceivable vehicle to drive over the system at least one time, involving a tremendous amount of resources and more time than could be allotted by the evaluator, or, presumably, the end user. It was not made apparent until the time of testing that the system was fundamentally limited in its capacity, and that the planned scenarios would not be suitable for implementation. To accommodate the actuality of the situation, the scenarios and data collection tasks were altered on site to collect as much data as possible for later evaluation.

To test the foreign object detection capabilities, eight different makes and models of vehicles were selected. As no reference images were available, the test engineer created reference images for each vehicle prior to the test implementation. Reference images were generated by driving a vehicle of the system and examining the resulting image for clarity and contrast. A good quality image will have a balance of both. Each reference image was of high quality, and verified to have good content and contrast by the GateKeeper personnel.

[redacted]

[4] The *threshold* setting is the amount or level of sensitivity that is used on the comparison between the reference image and the new image. High threshold settings will, in general, produce a greater number of nuisance alarms. Conversely, if the threshold setting is too low the system may not identify a foreign or suspicious object.

[5] The normal vehicle inspections of the undercarriage involve the use of a mirror-on-a-stick. The screener holds the mirror under the edge of the vehicle and looks at the reflection for anything out of the ordinary.

[redacted]

[redacted]

[6] The *vehicle identification system* is the portion of the overall unit that automatically identifies the vehicle based on the license plate reader and the correct correlation of the vehicle to that particular license plate.

[redacted]

[redacted]

Table 1. Object Detection Results Summary

[redacted]

[redacted]

[redacted]

ACRONYMS

ACB&P	Access Control, Biometrics, and Perimeter
AOA	Air Operations Area
APS	Airport Perimeter Security
CI	Critical Issue
FAA	Federal Aviation Administration
IAD	Washington Dulles International Airport – FAA designation
IED	Improvised Explosive Device
IR	Infra-Red
IV&V	Independent Verification and Validation
LED	Light Emitting Diode
LTE	Lead Test Engineer
MOE	Measure of Effectiveness
MOP	Measure of Performance
OT&E	Operational Testing and Evaluation
PTZ	Pan-Tilt-Zoom
SIDA	Security Identification Display Area
TSA	Transportation Security Administration

[redacted]

[redacted]

1. INTRODUCTION

Washington Dulles International Airport (IAD) utilized Airport Perimeter Security (APS) program resources to purchase and implement a vehicle screening system. The Gatekeeper Entry Point Control System (EPCS) is an automated imaging system designed to search for improvised explosive devices (IED) that may be attached to the undercarriage of a vehicle entering an Air Operations Area (AOA). Three Gate Keeper EPCS units were installed at IAD [redacted] and have been used to screen vehicles ranging from compact cars to tractor trailers.

1.1 Background

The Transportation Security Administration (TSA) established the APS program to support the expansion and implementation of security technology at the perimeters of United States airports. Through this program, airports may purchase and integrate commercial off-the-shelf technologies into their security networks to enhance their overall perimeter security infrastructure. As a requirement of the program, participating airports are required to submit the security technology for independent verification and validation by a third party independent evaluator. At the request of the TSA, National Safe Skies Alliance (Safe Skies) provided the OT&E services for IAD, and operated along with airport authorities to verify that the response of the security technology improvements met the airport's security expectations.

1.2 Purpose of Document

This Independent Verification and Validation Report illustrates the implementation and general user feedback of the GateKeeper EPCS with respect to IAD personnel. The results reference Critical Issues (CI) that were approved in the project's Final Test Plan (DHS/TSA 2600.02.01.08-136, August 2008).

2. SCOPE

2.1 Objective

The airport's expectation of the GateKeeper system was that it would effectively provide additional screening information regarding the undercarriage of a vehicle intending to pass through the gate area and into the AOA. To resolve this expectation, Safe Skies' IV&V focused on:

- Time constraints of the GateKeeper screening process
- Detection rates
- Vehicle identification information
- Maintenance and environmental impacts
- Feedback from security personnel regarding user interface, operations, etc.

[redacted]

2.2 Limitations and Assumptions

The CIs were developed under the assumption that the GateKeeper system would possess a fully populated reference database. Upon implementation, however, it was discovered that the database is "organic" (i.e., it is populated gradually and continuously by the variety and volume of commerce traffic that passes through the gate area). This aspect of the system affected many of the OT&E results because the original scenarios and observations were dependent on how well the system processed normal commercial traffic. The OT&E was written to test the image database and the software, not build the database for the software.

Lane 4's device experienced some maintenance-related issues involving the interior heating element. This failure caused condensation and ice to build up on the outer surface, which rendered the images unusable for testing or screening purposes. Thus, all testing was conducted on Lanes 3 and 5.

3. SYSTEM INSTALLATION

3.1 System Description and Operation Overview

The GateKeeper EPCS, manufactured by Gatekeeper Security of Sterling, VA, is a vehicle screening system designed to inspect the undercarriage of a vehicle for objects that may pose at threat to secure areas. Full specifications are attached as Appendix A.

Each GateKeeper system installed in a single lane consists of five main components:

- Screening/imaging sensors (Figure 5)
- Vehicle ID camera (Figure 4)
- Processing Terminal
- Image processing software
- License plate reader (Figure 4)

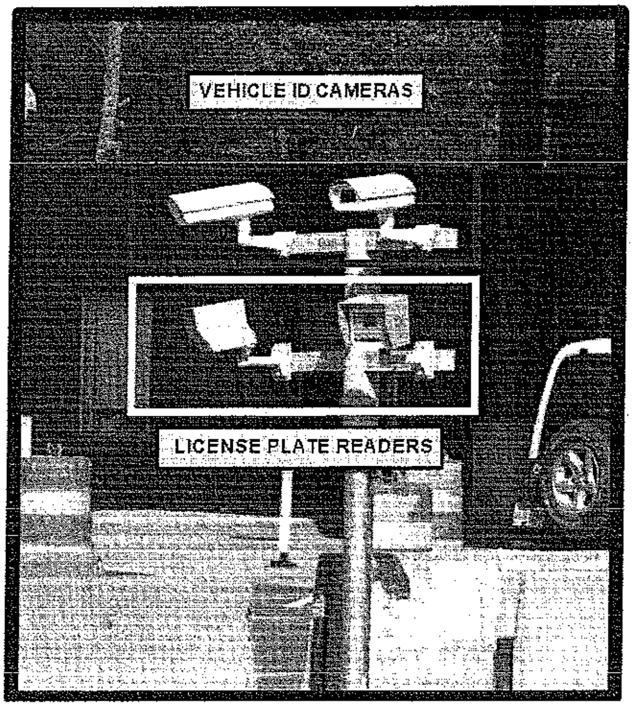

Figure 4. License Plate Readers (BOTTOM) and Video ID Cameras (TOP)

System operation begins as a vehicle rolls over a pressure switch at the front base of the unit's ramp. This switch activates an array of LEDs, the license plate reader to take an image of the front end license plate tag and the vehicle ID camera to take a front angle snapshot of the vehicle.

The LED arrays (Figure 5) emit bright IR light that illuminates the undercarriage, allowing the system to take a series of well-lit images.

[redacted]

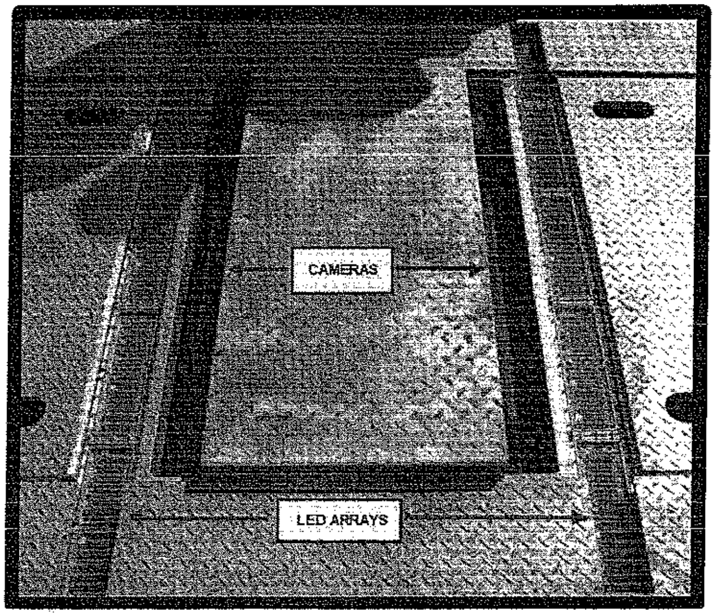

Figure 5. GateKeeper LED Arrays and Cameras (Right Side is the Front Angle and the Left Side is the Rear Angle)

The images are then processed and displayed at the Processing Terminal. The units at IAD utilize two reference cameras that take images from both a front and rear angle (Figure 6 and 7). This allows for the end user to see more of the vehicles undercarriage. [redacted]

[redacted]

[redacted]

[redacted]

The Processing Terminal is a PC with a touch-sensitive monitor. The image processing software and image database[8] are installed on this unit.

[redacted]

[8] The Gatekeeper image database is a collection of images of various vehicles with different make, model, and manufacture dates. These images are acquired through a vehicle enrollment procedure or downloaded from another source. Images include a front and rear angle view of the vehicle.

[redacted]

The image processing software compares live front and rear images of the vehicle's undercarriage to a reference image stored in the database. The system finds a correct reference image by analyzing the live image of the license plate to determine if it matches an index in the database. If the vehicle has previously processed through the system, the database would have a record of the license plate and the vehicle undercarriage. If the existing tag number is found, the live images will be compared to the reference images stored in the system database.

If the license plate number is not found in the database, the software searches for a similar vehicle undercarriage in the reference image database for comparison. [redacted]

Figure 8 shows an example of the screen that end users would see while using the system.

[redacted]

Figure 8. Processing Terminal Screen with a Live Vehicle Image

The end user can use the mouse or touch the screen in order to zoom in/out or move the image to a better view. The screen includes the image taken by the vehicle ID camera in the bottom left-

[redacted]

hand corner, the reference image in the bottom right-hand corner, and the live image in the top half of the screen. The end user may also compare the live and reference images side by side.

3.2 System Layout and Screening Practices

The following images illustrate the location of [redacted] the GateKeeper units as they are installed at IAD, and the processing terminals that are operating in the guard stations on either side of the checkpoint.

[redacted]

[redacted]

Installed on the overhang are six integrated camera domes that monitor each screening lane and some of the vehicle waiting areas. The cameras are fixed and do not record video; they are strictly used for real-time observation. All lanes are equipped with drop-arm barriers, which rise and lower to allow vehicles to pass. All lanes of traffic narrow down to two entrances into the AOA, where tire-shredding spikes are installed to impede vehicles that do not obey the gate entrance regulations.

[redacted]

Typical vehicle inspections require that every interior compartment be opened by the vehicle operator and inspected by a guard on duty. Also, the undercarriage of the vehicle must be manually inspected. This is performed with a "mirror-on-a-stick," in which a mirror attached to an arm extension is positioned to provide the screener with a view of the underside of the vehicle, Figure 10.

[redacted]

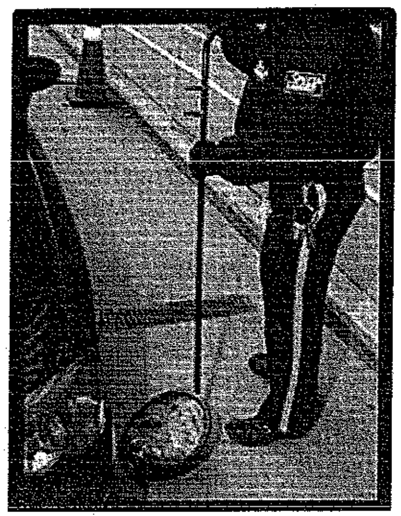

Figure 10. Mirror-on-a-Stick Vehicle Screening Method

Staffing requirements change with each shift. The early morning rush between 5:30 a.m. and 8:00 a.m. is the busiest time of day. During this time, there are 8 – 10 screening personnel and 5 lanes of traffic open. Throughput varied depending on the size of the vehicle and the number of passengers. From 8:00 a.m. until 6:00 p.m., there were 4 – 6 screening personnel, 3 – 4 lanes of traffic. From 6:00 p.m. – 5:30 a.m., there are 2 – 3 screeners and only one lane open.

3.3 Installation

The entire installation at IAD consists of the following major components:

- Large Vehicle screening/imaging units (2) * Lane 4 Heating Element Failed[9]*
- Small Vehicle screening/imaging units (1)
- Processing Terminal (3)
- Image Processing Software packages (3)

Three of the six screening lanes were equipped with a GateKeeper unit. The escort lanes for oversized vehicles and shuttle buses both had Large Vehicle sensors installed. Figure 11, below, illustrates the Large Vehicle sensors installed in Lane 5, and the correlating license plate reader and vehicle ID cameras.

[redacted]

[redacted]

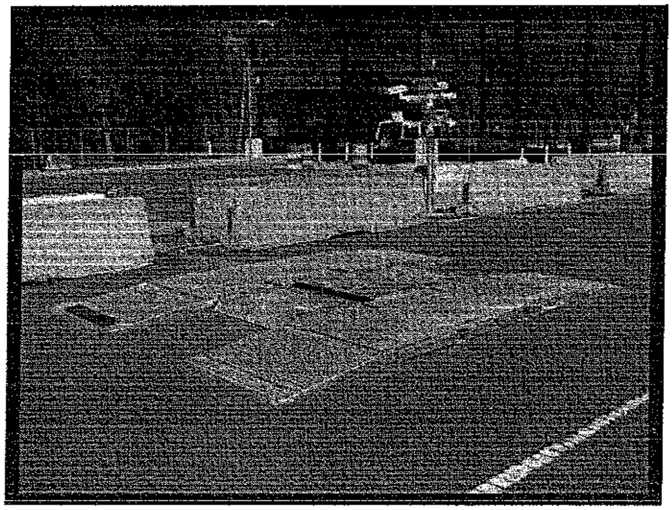

Figure 11. Lane 5 Large Vehicle Sensor with License Plate Reader and Vehicle ID Camera

Due to the size and length of some of the vehicles, the units were installed approximately 20 feet from the edge of the gate structure's overhang.

The power and communications are routed through above-ground conduit, between the two rows of concrete Jersey Barriers seen in the figure above. The communication lines are routed to one of the two guard stations on either side of the gate, which each house a system Processing Terminal.

4. METHODOLOGY

4.1 Site and Schedule

The system was installed in August 2008 at IAD [redacted] Installation, networking, training, and programming were conducted between August and November 2008.

Safe Skies OT&E was conducted December 1 – 5, 2008. Lanes 3 and 5 were used for operational testing.

4.2 Test Subjects

Operational test scenarios were conducted using 8 different passenger vehicles:

[redacted]

[redacted]

[redacted]

[redacted]

Since the reference library was being populated for testing purposes and there was only one model of each test vehicle, no information on the test vehicle model year was recorded.

4.3 Critical Issues

The CIs are the primary objectives of this evaluation. Procedures and data collection processes are based on Measures of Effectiveness (MOE) and Measure of Performance (MOP) to generate qualitative and quantitative data that can be used to address the identified CIs. Missions and Tasks are used to develop methods for collecting quantitative and/or qualitative information that does not lend itself to statistical analysis.

- **CI 1: What is the current perimeter security infrastructure at [redacted]**
- **CI 2: Does the Gatekeeper system meet IAD security expectations and/or enhance security operations at [redacted]**

CI 1: What is the current perimeter security infrastructure at the IAD traffic entry gate?		
Mission	**Task**	
1 Identify the perimeter security infrastructure of [redacted]	**1A**	Document the security features of the [redacted] site and current security technology/equipment.
	1B	Describe the operational use of present security technology/equipment.
	1C	Describe any security processes and procedures.
	1D	Determine the estimated time required to screen a vehicle using the existing method[10].
	1E	Determine an approximate throughput of traffic with respect to vehicle size[11] and screening lanes[12].

[10] The existing method of screening involves onsite security personnel manually investigating the undercarriage of a vehicle using a parabolic mirror and arm extension.

[11] Vehicle Size was limited to four varieties: (1) Small Personal (2) Large Personal (3) Commercial and (4) Heavy Industrial.

[12] There are six screening lanes: three Escort lanes, two Oversized Lanes, and one Lane for badged personnel that are not excorting another vehicle..

[redacted]

CI 2: Does the Gatekeeper system meet IAD security expectations and/or enhance security operations at [redacted]			
MOE		**MOP**	
1	Does the Gatekeeper successfully identify a vehicle's make and model?	**1A**	Determine the rate at which the Gatekeeper successfully identifies the make and model of screened vehicles.
		1B	Determine the approximate time required to perform a complete screening process.
		1C	Determine the approximate time required to manually input a new template into the Gatekeeper image database.
2	Does the Gatekeeper successfully identify foreign objects[13] on a vehicle's undercarriage?	**2A**	Determine the rate at which the Gatekeeper successfully identifies a foreign object that is mounted to the undercarriage of a vehicle.
		2B	Are there any additional time constraints associated with the screening process when a foreign object is present?
3	Is the Gatekeeper's rate of detection impacted by environmental conditions?	**3A**	Determine if the Gatekeeper retains effective identification of undercarriages, vehicle types, and placement of foreign objects during (1) rain conditions (2) night time vs. daytime.
4	Maintenance and Use Issues	**4A**	How do inspection personnel respond to the alarm signal from the Gatekeeper?
		4B	Are there features of the Gatekeeper that the gate security personnel felt improved or hindered the vehicle screening process?
		4C	Does the system generate nuisance alarms? If so, attempt to identify the rate and conditions of the alarm.
		4D	Does the system generate false alarms? If so, attempt to identify the rate and conditions of the alarm.
		4E	Are there any maintenance requirements of the system? If so, identify them.

[redacted]

5. RESULTS

5.1 CI 1

CI 1 addresses the documentation of [redacted] which includes a site description, a record of present technology, and a description of security-specific operations and procedures. The purpose of recording this information is to provide a basis of comparison for changes caused by the installation of the GateKeeper system. The details of this CI were provided in Sections 3.1 – 3.3 of this report.

5.2 CI 2

CI 2 addresses the overall performance of the GateKeeper system and is designed to determine whether the system meets the airport's security expectations. All time records were collected by hand, PDA, or taken from the reference log of the GateKeeper software.

5.2.1 MOE 2.1

The GateKeeper was designed to determine the make and model of a vehicle by comparing it against a reference image database. This MOE was designed to determine how successful the GateKeeper was in making a correct determination of vehicle make and model, and the time constraints associated with the process.

[redacted]

---

[14] These images were reviewed by Gatekeeper personnel and deemed acceptable for use as reference images.

5.2.1.1 MOPs 2.1A, 2.1B, and 2.1C

The GateKeeper system can identify a vehicle that is being screened either through correct identification of the vehicle tag or through a comparison of the undercarriage to reference images in the system's reference database.

If a vehicle has previously been screened by the GateKeeper, a reference image would have been entered into the system database, and would have been indexed by its license plate number. In this way, the specific vehicle reference image would be accessed via the license plate index marker. If the license plate reader fails, the end user may manually search for the index by typing the plate number into the main screen of the software.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

5.2.2 MOE 2.2

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

5.2.2.2 MOP 2.2B

[redacted]

[redacted]

[redacted]

5.2.4 MOE 2.4

This MOE is designed to verify the maintenance requirements and operational use, including alarm resolution procedures, of the Gatekeeper system.

5.2.4.1 MOP 2.4A

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

The following charts show the rates at which nuisance/false alarms were generated as the [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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[redacted]

[redacted]

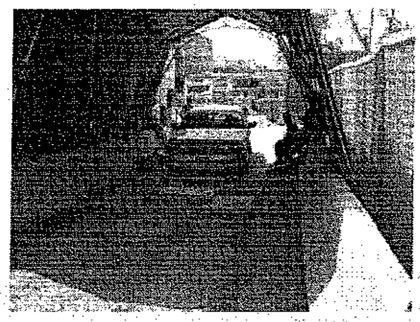
APPENDIX A – GATEKEEPER SYSTEM DESCRIPTION

[redacted]

[redacted]

GATEKEEPER SECURITY
YOUR FIRST LINE OF DEFENSE

Gatekeeper Entry Point Control System



1. Gatekeeper ECPS

Uses a single camera and a mirror system to take multiple frames from two angles as the vehicle passes over the camera to create two, clear, comprehensive, 2-D views of the vehicle's undercarriage. This system provides two views; one looking forward at 65 degrees (front view) and one looking back at 63 degrees (back view), enabling the system to automatically view the areas up and over axils, cross beams and in pockets under a vehicle. This allows the operator to switch back and forth between the two images and view the underside of the vehicle from two angles.

The camera operates under its present configuration at a frame rate of 200 fps. The camera has the capability of operating at 1000 fps however as its view has been split to provide simultaneously, both a front and back undercarriage view, the camera is operating at the lower speed.

Vehicles can cross the system at speeds up to 15 mph (24 kph). There is no minimum speed over the system except stopping (dead stop) for longer than six seconds. The system's software algorithms that monitor the camera's frame capture will continue to "stitch" new frames into an image that contains new pixels. Once the system continues to receive the same frame/pixels for six seconds it times out and stops creating the image at that point. This preserves buffer space (that relates to speed of image delivery etc). As part of the artificial intelligence (AI) features of the system, the camera is always working and it is looking for movement of a certain description. Once movement is again identified, the system will commence to record and compile/stitch the balance of the image of the stopped vehicle.

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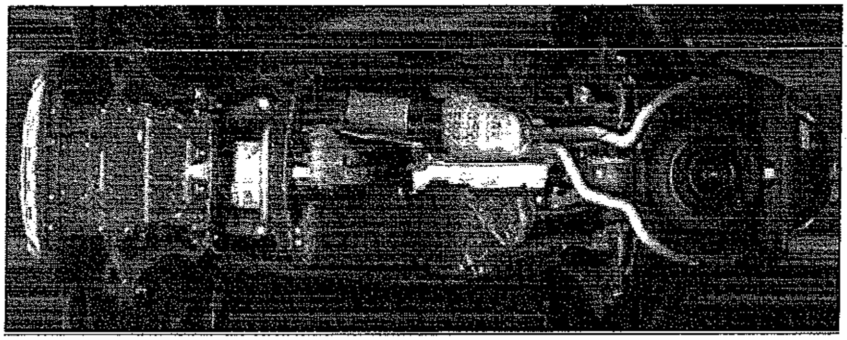
2. Images are stored in a database



Front View Image

Back View Image

The Gatekeeper ECPS automatically records, matches, and compares both the front and back views of the vehicle's undercarriage. The system has two databases:

An **Archive** database that contains all images (front and back undercarriage views and front image of vehicle as it approaches the ramp) of all vehicles crossing the system.

A **Reference Image** database that contains one set of front and back undercarriage images (the vehicle standard undercarriage image, "VSUI") of all makes and models (types) of vehicles that have been compiled. These front & back undercarriage images – the VSUI - are equivalent to a vehicle type "fingerprint".

When scanning vehicles, the computer will automatically compare the newly scanned image with the VSUI in the Reference Image database using foreign object detection software. If no VSUI of the vehicle is found, and the new image is complete (has spare tire, etc) and clear of foreign objects, the operator can then save that image as the VSUI of that vehicle type in the Reference Image database. Because the system captures and compares both forward and backward looking images, the foreign object detection software also detects foreign object in both image views.

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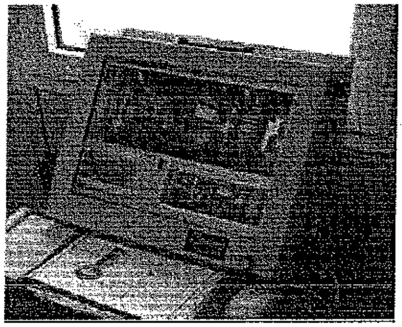
All scanned images of vehicles crossing the system are saved in the Archive database. When the FOD software notes a discrepancy between the new image and the VSUI, an indicator (a red circle) is shown on that area of the image and an audible alarm is sounded to notify the operator of the possible threat from the detected foreign object.

3. <u>Images can be manipulated using a touch screen monitor or with a mouse.</u>



System Monitor

A unique capability of the Gatekeeper system is its specially designed and ruggedized monitor. It is 15.5 in. x 17.75 in. x 4 in., and weighs 17 lb (7.71 kg). The monitor has a fold-over cover to protect the screen during transportation and the cover doubles as an adjustable stand for the monitor when it is open. The monitor is comprised of a single board computer, touch screen and controller, hard drive and power supply, plus auxiliaries. The touch screen is an 18.5" Hi-Resolution, color LCD screen (1280 x 1024) that has had several protective and performance laminations. The screen is the same as those used on a number of aircraft carrier decks by the flight officers and have been specifically environmentally hardened. The components are shock resistant with the hard drive having a manufacture's rating of 200 Gs operating and 1,000 Gs non-operating. The type of screen used is a Near Field Imaging Capacitive screen. This technology allows the operator to use the tap screen capabilities with either his bare finger or while wearing gloves (up to a wielder's glove thickness). The benefit of this type of screen is that security personnel do not have to take gloves off in hot or cold weather to operate the screen.

Additional enhancements to the screen provide a large format display capable of operating in bright sunlight (system also comes with daylight shield that can be affixed to the top of the monitor), and also includes an Enhanced Specula Reflector (ESR). ESR is a thin, mirror-like, non-metallic film applied to the screen during the manufacturing process that offers greater than 98% specula reflectivity across the entire visible spectrum. This ESR is designed to increase the cavity efficiency of backlight sub-assemblies, and reflects 5% of the ambient light back through the LCD and low heat generating back lighting.

Other benefits of this screen are that surface contaminants do not affect the screen surface and it is the only touch screen to pass UL ball drop tests. The normal temperature operating range of the screen is from 32-151°F (0-66°C). Humidity rating 0 - 98% relative humidity, non-condensing.

All images can be easily manipulated (zoom in/out and self-centering, and moved around) by the operator using a mouse or by gently tapping on the monitor's screen using the operator's finger (bare or wearing a glove). The monitor allows for 6X zoom in both partial and full screen viewing. There are two images that are being compared on the screen; a reference image (VSUI), and the

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current image (image being reviewed). As either image is tapped at any point or clicked on using the mouse, both image/s will zoom in and self-center on the same area. Touching or clicking on the full screen button opens a new view, displaying the vehicle in full screen mode, thus allowing the operator to see the image in greater detail. The images can continue to be manipulated in this view.

The on-screen sensitivity selection bar allows the operator to increase or decrease the foreign object detection (FOD) capability. The front image of the vehicle depicting the vehicle number plate etc also operates in a zoom mode. The on screen history button allows past images to be recalled via viewing or the search function. Once recalled the selected image is sent back through the system for analysis and comparison. The areas of interest circled in red remain on the enlarged image.

The system takes both front and back views of the undercarriage, and the operator can toggle between them by touching the appropriate button on the screen generating an almost "3D view" of the vehicle's underside. All viewing options and their features operate in both front and back views.

4. Electronic requirements and description of the electronics.

The Gatekeeper mobile system uses two computers: one for the scanner and the other as a part of the monitor. They both have auto ranging (90 VAC to 264 VAC & 47 Hz to 63 Hz) power supplies. The traffic light is powered (12 volts) and controlled from the scanner via a single cable.

The standard monitor power cable is 100 ft (30.48 m) of 18-gage wire, and the scanner power cable is 100 ft (30.48 m) of 12-gage wire. The Ethernet cable is 300 ft (91.44 m) of fully shielded CAT5E cable that contains a Kevlar center and UV resistant outer coating. The Ethernet is a 1000 Base T that enables the system to communicate at a very high speed - i.e. it takes less than a millisecond from the time the scan is complete (vehicle leaves platform) to the time the images are at the monitor (based on 300 ft (91.44 m) of Ethernet cable). All cables are fitted with MIL-C-26482 connectors (military bayonet connectors). All cables and connectors are "commercial-off-the-shelf" (COTS) components.

The scanner is 41 in. x 24.75 in. x 5 in. (1.04 m X 0.63 m X 0.127 m) and has two lighting rails running on each side of the scanner that are 2 in. x 60 in. (0.051 m X 1.524 m). The scanner weighs approximately 55 lb (24.95 kg), and is constructed of 1/8 in. aluminum with a dual skin on the top for heat ventilation. The system is sealed around the two glass viewing windows and the removable lid. The scanner contains a single board computer, DIO controller (Digital Input/Output ports - these ports (connections) can be used to accept input signals from other equipment such as sensors, sniffers, etc as a part of a complete security checkpoint system or be used in an output mode to send control signals to other equipment such as gates, bollards, alarms, etc), power supplies, main commercial camera (under carriage image capture) and front view camera (camera that takes the image of the front and if required the back of the vehicle via an additional embedded camera) and mirrors etc. Once the scanner is put in the platform, three inches of the scanner plus the armor plate sit above the platform height, and is protected by guide rails that are graduated in height from 3 in. at the point of entry to the platform, up to 4 in. by the scanner. This configuration protects the scanner and makes it rugged. The system can operate in ambient heat temperatures from 14-170°F (10-76.67°C).

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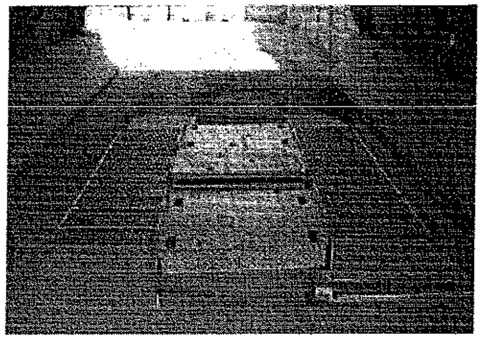
5. Gatekeeper system has sturdy, durable ramps/platform.



Heavy Gage Galvanized Steel Platform

The mobile system's platform consists of 5 pieces plus the scanner. It has two ramps that are 2 ft x 12 ft x 2 in. (0.61 m x 3.66 m x 5.08 cm) and each weighs 345 lb (156.49 kg), the ramps also contain wheel guides on the inside of each ramp that range in height from 3-4 in. (7.62-10.16 cm); the ramps are locked together by three protective armor plates; two at 70 lb (31.75 kg) and one at 105 lb (47.63 kg). The total weight of the platform is 935 lb (424.11 kg). The system is made of hot dipped galvanized steel with all parts interlocking (i.e. no bolts or nuts). The platform is extremely rugged and can handle small cars to large trucks. The grated ramps allow the system to sit on gravel roads etc., and allow rain to drain away from the system and not puddle on the platform. The overall size of the platform is 12 ft x 7.5 ft (3.66 m x 2.29 m).

6. System Maintenance Requirements.

The regular care and maintenance is not difficult but proper attention must be given to the systems in order for the electronics to continue performing properly.

Daily Maintenance: Check calibration of scanner by activating self-test calibration function on monitor screen. Regular wiping of the viewing glass on the scanner (depends on environment but at least once an hour) with a dry cloth. Keep all trash (paper etc) away from scanner. Clean the touch screen with rubbing alcohol or similar to remove finger marks etc.

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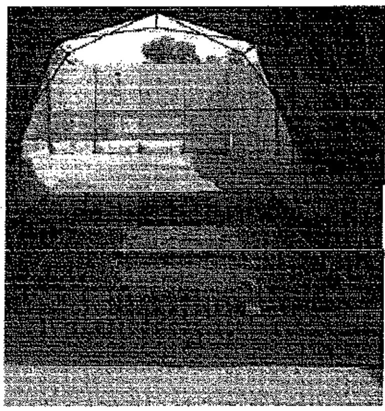
Monthly Maintenance: Remove the scanner from the platform and take it to a clean area. Once there remove the lid off the scanner (10 screws) and vacuum the interior of the scanner. Check all connectors. Clean all mirrors and the inside of the viewing glass and camera lenses. Replace the lid of the scanner and place scanner back in the platform. Check all cables and areas where the cables may rub against the platform or other areas, and make sure that they are not caught on or rubbing against anything.

7. Mobility.

The mobile platform can be set up, cables run and monitor and scanner operating in less than 15 minutes using four people. If the expandable shelter (tent) is used it will add a further 5 - 7 minutes to the set up time.

8. Standoff / remote operation.



CAT-5E
Ethernet Cable

Guards monitoring system

in bunker 300 feet away

Un-manned Check Point

The standard system can be remotely operated from 100 yd (91.44 m). It takes about 4-5 seconds for the image to appear on screen (from vehicle leaving platform) in a processed state i.e. compile images at scanner < 1 second, images transmitted from scanner to monitor < millisecond and 3–4 seconds to search the Reference Image database for a UVSI and present the resultant scan and images on screen.

Recent enhancements resulting from the employment of a ruggedized flash drive memory in conjunction with the ruggedized hard drive has increased performance times significantly i.e. made them faster - delivering fully processed and foreign object detection matched images on the monitor screen in less than 1 second after the vehicle leaves the platform. This option is available on all models going forward.

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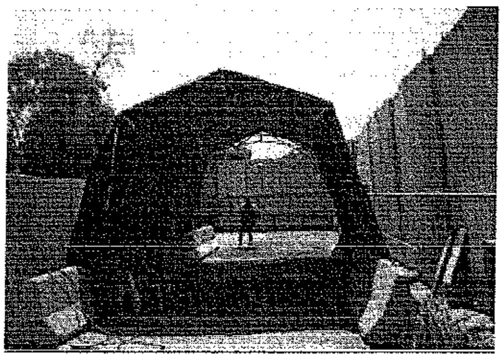
9. Training.

The troops who have trained on the systems have all stated that the basic features are easy to learn and use. To adequately learn and become thoroughly familiar with the systems, Gatekeeper recommend that the classroom style training of one hour (max) is conducted first in an area where the trainees can put their attention towards learning the system without distractions, and then follow that with in-field practice. Once the basic operation is understood and internalized, the routine operation is simple & direct.

A set of laminated *Quick Start Instructions* is provided to operators to help lead them step by step in using the equipment and to serve as a quick reference guide for the Gatekeeper system. See Appendix B for a copy of the instructions.

10. Use of a tent.



GKH-1091 Enclosure

Gatekeeper recommends that a shelter/tent be used with the system for optimum performance. Using a shelter/tent of some description at all times will keep sunlight from interfering with the camera optics and ensure the highest level of automated system performance. In addition, the effect of adverse weather conditions are reduced as the shelter keeps rain and snow off the scanner's viewing glass. The viewing glass also has various treatments that by themselves help to preserve the systems performance in adverse weather conditions. The viewing glass has anti-glare and a reflective coating along with a hydrophobic coating that repels water. Even with the shelter and the various protective glass coatings the system's viewing glass will require more frequent cleaning in adverse weather conditions however, less than if the system was used without a shelter. The tent used in Iraq is available from DOD stock.

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