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Transportation Security Administration

Office of Security Technology

Airport Perimeter Security Projects for FY08-09

FINAL REPORT

Yuma Marine Corps Air Station/Yuma International Airport (NYL)

Virtual Perimeter Monitoring System-Airport (VPMS-A)

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

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OVERVIEW

INTRODUCTION

In fiscal year (FY) 2006, the Transportation Security Administration (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 Airport Perimeter Security (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

Yuma Marine Corps Air Station/Yuma International Airport (NYL) was selected to pilot the Virtual Perimeter Monitoring System-Airport (VPMS-A), a central command and control system developed by the Naval Surface Warfare Center – Panama City Division (NSWC-PCD). The deployment and operation of the new system would test different breach scenarios in order to generate information that would reflect the impact of the system on operational security (OpSec) awareness at NYL, as compared to that of the legacy system.

The VPMS-A surveillance system was designed to enhance OpSec awareness at NYL by interfacing with multiple technologies (sensor information or data streams) and displaying the information on a single Common Operating Picture (COP). The TSA, in cooperation with the

[redacted]

NSWC-PCD, piloted the system at several airports across the United States to evaluate its capabilities.

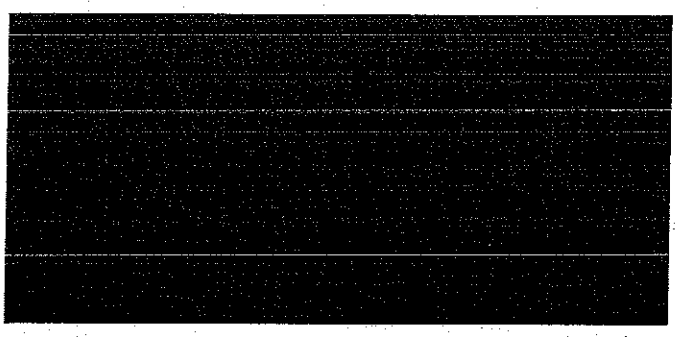
National Safe Skies Alliance (Safe Skies) provided independent verification and validation (IV&V) services and operated along with airport authorities to verify that the mobile perimeter tower enhancements met the airport's security expectations. The IV&V was concluded November 06, 2009.

The VPMS-A equipment consisted of, new video camera equipment (11 fixed cameras and 1 PTZ camera), wireless communication systems, video analytic software, video archiving subsystems, and a Common Operating Picture (COP). All equipment and systems were installed and operational in October of 2009.

NYL differed from the other VPMS-A sites in that the system was equipped with additional fixed cameras and video analytic processing hardware. Unlike the other sites, the NYL installation supported primarily fixed cameras instead of PTZ's.

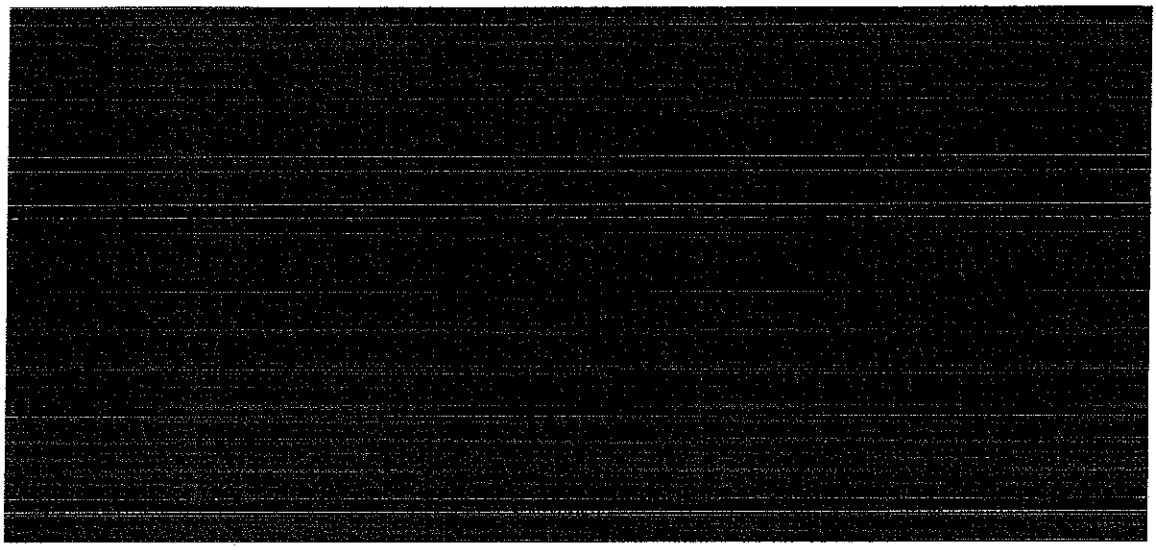
Testing sites were limited to locations where existing video analytic rule sets had been implemented with earlier systems. These legacy systems had limited capabilities and storage capacity.

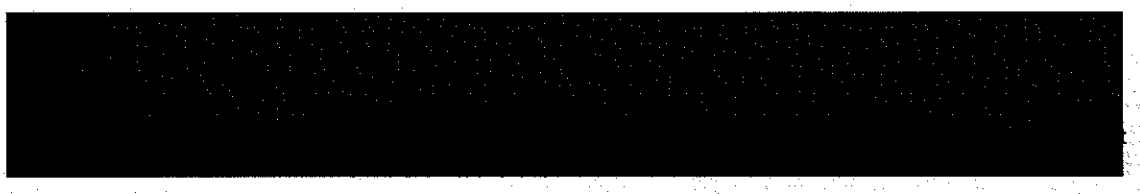
These locations were:



The Safe Skies Lead Test Engineer (LTE) generated a site survey document based on a preliminary survey of the locations prior to the deployment of the security technology improvements. The LTE developed operational testing procedures used as the basis for determining if the system met the security requirements of NYL airport authorities. Representatives of TSA, Safe Skies, and NYL convened to discuss and verify the system 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





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DHS/TSA 2600.02.01.10-016	**Virtual Perimeter Monitoring System-Airport (VPMS-A) NYL Operational Test and Evaluation Report** 	
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	Project Performed for: U.S. Dept. of Homeland Security Transportation Security Administration 601 S. 12th Street Mail Stop TSA-16 Arlington, VA 22209	TSA Technical Review Team Charles Kelley John Nestor David Taylor
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16. Supplementary Notes

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

17. Abstract

This report presents the evaluation results of the Virtual Perimeter Monitoring System – Airport (VPMS-A) as it was installed at NYL. The VPMS-A was developed by the Naval Surface Warfare Center – Panama City Division to provide an adaptive system capable of enhancing operational security (OpSec) awareness at an airport perimeter. National Safe Skies Alliance, on behalf of the Transportation Security Administration, implemented a series of Operational Test and Evaluation scenarios in order to generate information that would reflect the impact of the system on OpSec awareness at NYL, as compared to that of the legacy system.

Testing was conducted October 26 – November 6, 2009, under mostly covert conditions, in order to test the system's performance capabilities in detecting intruders, suspicious behavior, and security protocol violations.

18. Key Words

Arizona, Common Operating Picture, Naval Surface Warfare Center – Panama City Division, NYL, Virtual Perimeter Monitoring System, VPMS, Yuma

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EXECUTIVE SUMMARY

The Transportation Security Administration (TSA) selected Yuma Marine Corps Air Station/Yuma International Airport (NYL) to pilot the Virtual Perimeter Monitoring System-Airport (VPMS-A), developed by the Naval Surface Warfare Center – Panama City Division. National Safe Skies Alliance (Safe Skies) implemented a series of Operational Test and Evaluation (OT&E) scenarios in order to determine the usefulness of the system to NYL security.

Legacy System Description

NYL's legacy security system had consisted of a closed-circuit television (CCTV) network, limited video archiving system, and some activity-reporting technologies. The video archiving system was several years old and had a storage capacity limit of approximately 15 days. NYL reported that the foremost issue was that [redacted]

Mounting poles from the legacy system were used to support the VPMS-A installation.

VPMS-A System and Installation

The VPMS-A equipment—new video camera equipment (11 fixed cameras and 1 PTZ camera), wireless communication systems, video analytic software, video archiving subsystems, and a Common Operating Picture (COP)—were installed and operational in October of 2009. In addition to the outdoor components, five IP cameras were installed in the terminal and integrated into the CCTV network.

The COP console and CCTV monitor were installed in the security operations center, located in the airport terminal; the core server was installed in a separate storage area. Camera and communication equipment were installed at areas around the facility as listed in Table 1.

Table 1. Technologies and Locations

Camera Type	Locations							
	[redacted]							
Fixed	1	2	1	2	1	2	1	1
PTZ				1				

Live feeds from the 11 fixed cameras were processed through the VPMS-A video analytic component, ObjectVideo. Customized rule sets provided automated detection of violations. Figure 1 illustrates the flow of information within the system.

[redacted]

[redacted]

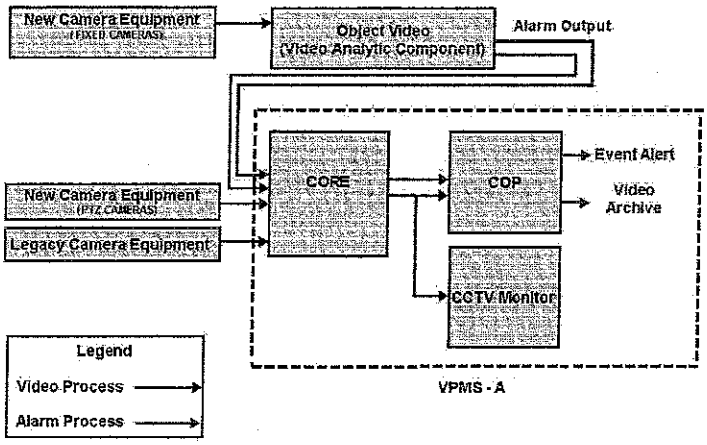

Figure 1. Flow of Information within VPMS-A

The COP console interface that was accessible to security personnel was powered by VideoNEXT. Through this software, security personnel could monitor alerts issued through the video analytic component and control the integrated PTZ cameras.

User Surveys and Comments

[redacted] Some issues have been reported and have been brought to the attention of the vendor. Resolutions to existing issues are currently being resolved. In general, NYL personnel felt that the VPMS-A provided substantial amounts of information and was relatively simple to operate.

Evaluation Results

The Safe Skies team posed as unauthorized personnel at each of the sites monitored by the VPMS-A. Evaluation test scenarios were performed October 26 – November 6, 2009. Team members [redacted] test results are summarized below.

[redacted] Table 2 shows the results of these tests.

[redacted]

[redacted]

ACRONYMS

AOA	Air Operations Area
CCTV	Closed-Circuit Television
CI	Confidence Interval
COI	Critical Operational Issue
COP	Common Operational Picture
FAA	Federal Aviation Administration
GA	General Aviation
MOE	Measure of Effectiveness
MOP	Measure of Performance
NSWC - PCD	Naval Surface Warfare Center – Panama City Division
NYL	Yuma Marine Corps Air Station/Yuma International Airport – FAA designation
OpSec	Operational Security
OT&E	Operational Test and Evaluation
TSA	Transportation Security Administration
VPMS-A	Virtual Perimeter Monitoring System - Airport

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1. INTRODUCTION

The Transportation Security Administration (TSA) selected Yuma Marine Corps Air Station/Yuma International Airport (NYL) to pilot the Virtual Perimeter Monitoring System-Airport (VPMS-A), a central command and control system developed by the Naval Surface Warfare Center – Panama City Division (NSWC-PCD). National Safe Skies Alliance (Safe Skies) implemented a series of Operational Test and Evaluation (OT&E) scenarios in order to generate information that would reflect the impact of the system on operational security (OpSec) awareness at NYL, as compared to that of the legacy system[1].

1.1 Background

The VPMS-A surveillance system was designed to enhance OpSec awareness at an airport by interfacing with multiple technologies (sensor information or data streams) and displaying the information on a single Common Operating Picture (COP). The TSA, in cooperation with the NSWC-PCD, piloted the system at several airports across the United States to evaluate its capabilities. Safe Skies was designated as the third-party evaluator to perform Baseline testing and OT&E.

1.2 Purpose of Document

This report details the scenarios and procedures that Safe Skies implemented in order to document the impact of the VPMS-A on OpSec awareness at NYL. The following sections describe the operational testing, and compare and contrast the operational evaluation data with results that were reported for the project Baseline (*DHS/TSA 2600.02.01.09-160*, September 2009).

2. SCOPE

Safe Skies evaluated the VPMS-A system at NYL in accordance with the Critical Operational Issue (COI) that was defined and approved in the project's Final Test Plan (*DHS/TSA 2600.02.01.09-182,* October 2009).

2.1 Limitations/Risks/Assumptions

The OT&E procedures and data collection activities were only performed at locations where VPMS-A equipment had been installed. This document does not reflect a security assessment for the entire facility.

[1] The *legacy system* was the perimeter security technology that was present prior to the installation of the VPMS-A.

[redacted]

[redacted]

The OT&E procedures were considered covert (i.e., general personnel on site were not to be aware of Safe Skies' agenda). There is no evidence to support that Safe Skies' agenda had been compromised; thus, there is a reasonable assurance that the results accurately reflect the OpSec at NYL within and around the sites that were evaluated.

This document reports ObjectVideo performance and COP response. Because ObjectVideo is the detection component of the VPMS-A system, the tables that summarize the scenario detections were calculated using responses from the ObjectVideo system only. ObjectVideo results have been compared to Baseline results. Similar to OT&E testing, the Baseline tests were conducted covertly. Safe Skies assumes that the Baseline results represent the OpSec response prior to the installation of VPMS-A.

The following data analysis illustrates the VPMS-A's current OpSec capabilities as determined through the COP's response to alerts and the ObjectVideo detection software. [redacted]

NYL had a small security staff, so a very limited number of user surveys were returned to Safe Skies. The comments are recorded, but could not be analyzed for trends.

New monitoring equipment was installed at [redacted] However, due to a mechanical failure of the gate operation equipment, testing could not be performed in this area. The area underwent a Baseline survey, but no OT&E tests were conducted.

3. SYSTEM DESCRIPTION

3.1 Legacy System

NYL's legacy security system had consisted of a closed-circuit television (CCTV) network, limited video archiving system, and some activity-reporting technologies. The operational CCTV network expanded only to cameras that were mounted in and around the terminal area. Twenty (20) cameras covered the inside of the terminal and the public parking areas. Eight (8) to 12 more cameras were mounted at locations [redacted]

[redacted]

[redacted]

The video archiving system that was in use by NYL was several years old, and had a storage capacity limit of approximately 15 days. Existing video equipment could record continuously on

[redacted]

The remaining elements of the legacy system were the personnel from the NYL Department of Public Safety, FAA Control Tower, General Aviation (GA), and Marine Corps Base, as well as civilians, who provided operational security awareness along the perimeter regions of the facility. These personnel were relied upon to support the areas of the perimeter that were not monitored by security technologies.

3.2 Virtual Perimeter Monitoring System-Airport (VPMS-A)

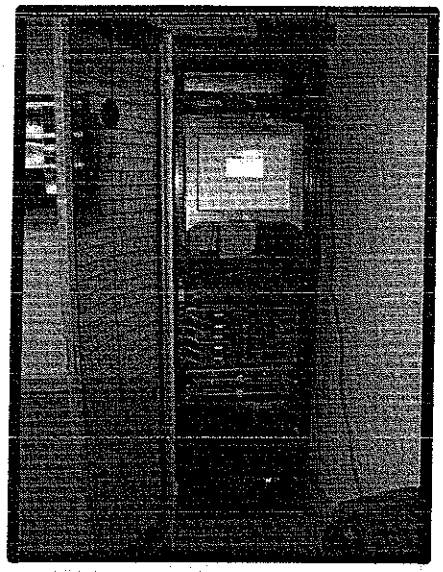


Figure 2. VPMS Core

The VPMS-A system included high-quality video camera equipment, wireless communication systems, video analytic software, video archiving subsystems, and a Common Operating Picture (COP). Designed to be an adaptive security tool, the VPMS-A's open architecture configuration allowed for the integration of multiple sensors or additional security equipment. Additional details of the VPMS-A configuration and system specifications can be found in the following NSWC-PCD documents:

- *Draft System Segment Specification for the Yuma Marine Corps Air Station/Yuma International Airport Virtual Perimeter Monitoring System*
- *Yuma Marine Corps Air Station/Yuma International Airport Virtual Perimeter Monitoring System Operational Verification Test*
- *Yuma Marine Corps Air Station/Yuma International Airport Virtual Perimeter Monitoring System Test Description*

The core of the VPMS-A (Figure 2) was installed and maintained in the NYL terminal building. The core included the sensor interfacing, communications networking, sensor processing, the computer control and display equipment, and archive retrieval for the whole of the VPMS-A. Information was then streamed to the end-user interface in the control center. Here, a single PC

[redacted]

[redacted]

and set of peripheral devices drove the interaction between the end user and the surveillance network. This COP provided the end user with a means to view all of the integrated camera surveillance equipment, retrieve and display video archives, and review alarm alerts. Figure 3 shows the COP.

Figure 3. COP Operators Station Used by NYL Personnel

The following diagram shows the flow of information within the VPMS-A, from the sensor input to the user interface components.

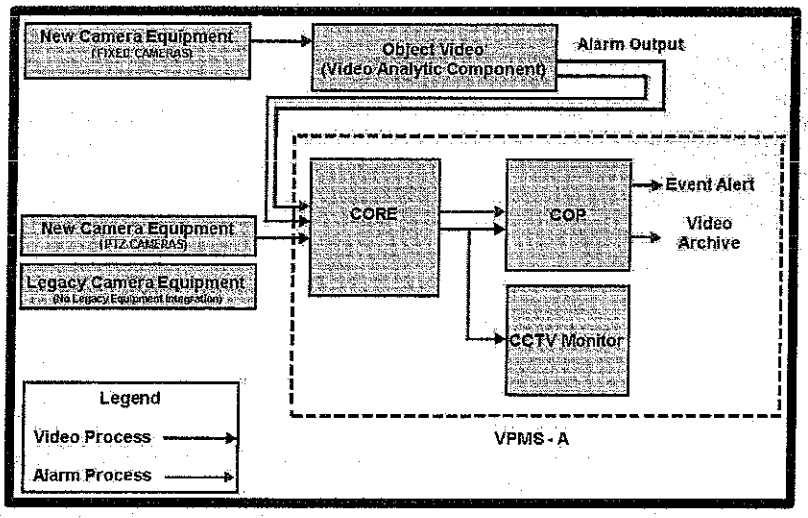


Figure 4. Flow of Information within VPMS-A

[redacted]

[redacted]

As shown in the diagram, no legacy security equipment was integrated into the VPMS-A. Alarm events observed within the view of the cameras were analyzed by ObjectVideo, which was the video analytic software. If ObjectVideo determined that the event constituted a violation of its rule-set configurations, it would issue alarms to VideoNEXT. This software was the primary component of the COP, which was the user interface through which the ObjectVideo alarms were reported as "events" that security personnel could review and acknowledge as clear or requiring investigation. VideoNEXT also provided the controls for the PTZ cameras. Figure 5 illustrates the large CCTV monitors that NYL staff used to monitor activity from multiple cameras.

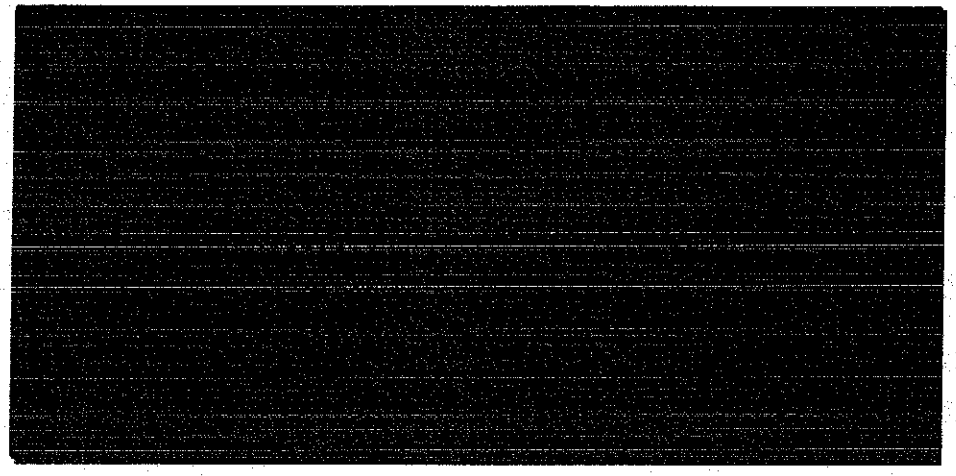


Figure 5. CCTV Monitors

The VPMS-A equipment—new video camera equipment (11 fixed cameras and 1 PTZ camera), wireless communication systems, video analytic software, video archiving subsystems, and a Common Operating Picture (COP) — were installed and operational in October of 2009. NYL differed from the other VPMS-A sites in that the system was equipped with additional fixed cameras and video analytic processing hardware. Unlike the other sites, the NYL installation supported primarily fixed cameras instead of PTZ. Table 4 lists the camera types, quantities, and locations for all VPMS-A camera equipment.

Table 4. Camera Node Technologies and Locations

Camera Type	Locations							
Fixed	1	2	1	2	1	2	1	1
PTZ				1				

[redacted]

[redacted]

The COP terminal and CCTV monitor were installed in the command center, located in the airport terminal; the core server was installed in a separate storage area. Camera and communications equipment were installed at the following areas around the facility, illustrated in Figure 6:

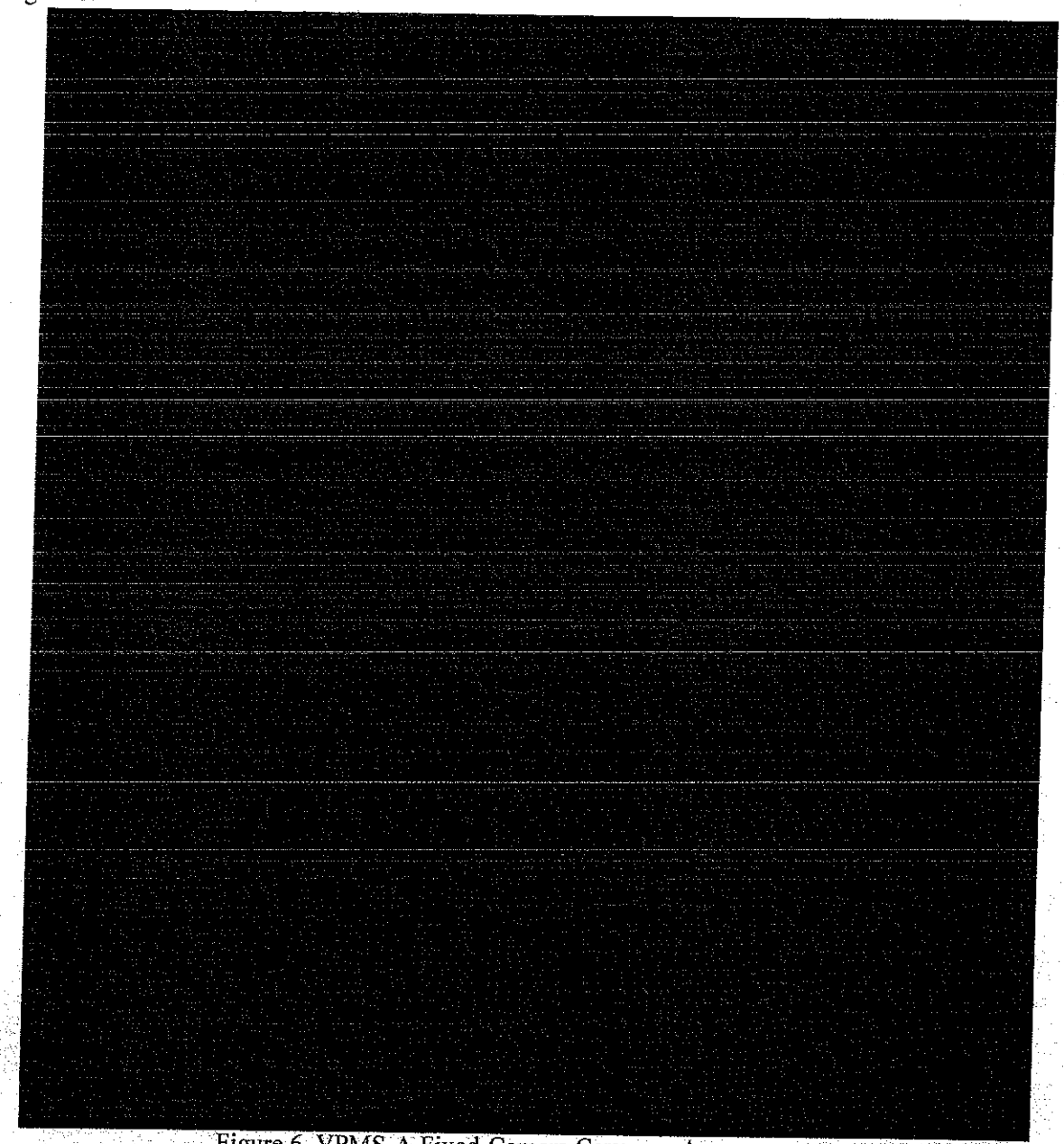
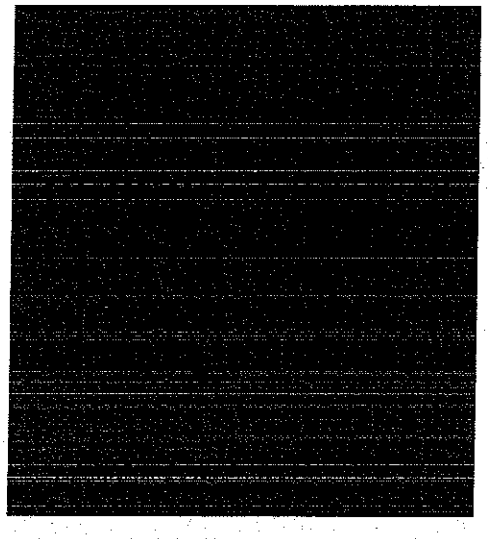


Figure 6. VPMS-A Fixed-Camera Coverage Areas

[redacted]

[redacted]

Camera nodes were typically composed of one or two cameras and the wireless communication equipment. Figure 7 shows an example of a typical camera node.



Node components were selected based on the surrounding infrastructure, line-of-sight, and potential security risks. The directional antennas that were incorporated into each node communicated to a central hub that was mounted to the roof of the main Terminal building.

Live feeds from 11 camera sources were processed through the following video analytic component: VEW™, developed by DRS Technologies, Inc., and powered by ObjectVideo. Through ObjectVideo, airport personnel were able to set up customized rule sets that provided automated detection of violations. The system configuration at NYL allowed for unattended monitoring of 11 different cameras. NYL was the only site to receive the upgrade to allow for a total of 16 cameras. Without the upgrade, only eight cameras can be integrated into the system. Appendix A illustrates a series of screen shots from the perimeter areas that are currently being monitored by the new system.

The user interface software, Security Knowledge Manager™ by VideoNEXT Network Solutions, Inc., was designed to be intuitive for personnel with varying levels of computer proficiency. This interface was displayed on the COP. A 46-inch CCTV monitor was mounted to the wall adjacent to the COP to allow other personnel who were not sitting in front of the COP to watch for activity on the surveillance network.

[redacted]

[redacted]

4. METHODOLOGY

4.1 Sites

Safe Skies personnel performed a series of covert evaluation scenarios throughout the new surveillance infrastructure. Testing locations were limited to locations where video analytic rule sets had been implemented: [redacted]

4.2 Schedule

Evaluation test scenarios were performed October 26 – November 6, 2009.

4.3 Test Personnel

[redacted]

4.4 Test Equipment

[redacted]

4.5 Critical Operational Issues

The primary objective of conducting system tests and data collection is to address Critical Operational Issues (COI), which are the primary issues of interest. In order to address the COIs, corresponding Missions and Tasks were established, which were used to develop the methods for collecting quantitative and/or qualitative information. The Measures of Effectiveness (MOE) and Measures of Performance (MOP) were used to develop the methodologies for gathering quantitative detection rate data. See Table 5.

[redacted]

[redacted]

Table 5. Critical Operational Issues

COI 1: How effective is the VPMS-A COP at enabling situational awareness?		
Mission	**Task**	
1 Is the system effective at improving incident response?	**A**	Determine the operators' perception of the system's capability to improve situational awareness.
	B	Determine the operators' perception of the system's data collection capabilities.
	C	Determine the operators' perception of the system's ability to facilitate coordination of incident responses.
	D	Determine the operators' perception of whether the system improves airport security.
	E	Determine the operators' perception of the system's access to stored data.
	F	Determine the operators' perception of the value of the system's stored data.
2 Is the system optimized for operation?	**A**	Determine any changes to the system employees would recommend.
	B	Determine what the employees think the system's strengths are.
	C	Determine any changes to the system's installation that employees would recommend.
	D	Determine if employees had any difficulty operating the system.
	E	Determine if employees would recommend the system for airport-wide use.
	F	Determine how this system compares with other similar systems they are familiar with.
COI 2: Within key location areas, how effective is the VPMS-A at NYL?		
MOE	**MOP**	
[redacted]		

[redacted]

[redacted]

COI 1: How effective is the VPMS-A COP at enabling situational awareness?	
Mission	**Task**
[redacted]	

5. RESULTS

To account for situations when a limited amount of data is collected, Safe Skies has established general guidelines for reporting confidence intervals (CI):

- For sample sizes of less than *15*, only the percent detected will be reported.
- For sample sizes of at least *15,* the percent detected and the associated CI will be reported.

All statistical tests are evaluated to an $\alpha = .05$ level of significance.

5.1 Evaluation Scenarios

[redacted]

Table 6. Site and Scenario Matrix

Camera Type	Locations
[redacted]	

[redacted]

[redacted]

Due to a mechanical failure of the gate operation equipment, testing could not be performed in the [redacted]

5.2 ObjectVideo Alarm Results

Events that took place within the view of the VPMS-A fixed camera equipment were processed by the ObjectVideo analytic component. If ObjectVideo determined that the event constituted a violation, it issued an alarm to VideoNEXT, the software that generated the user interface at the COP.

The following sections report results of alarms issued by the ObjectVideo component of the VPMS-A, which was responsible for the automated detection of violations within the areas covered by the video camera network. ObjectVideo performance data was compared to the OpSec results of the Baseline. It should be made clear, however, that the ObjectVideo software was an integrated component of the VPMS-A and was *not* generally used or viewed by the security personnel to resolve alarms. Access to views as seen in the following screenshots was only available by accessing software on the core server.

5.2.1 [redacted]

[redacted]

[redacted]

[redacted]

[redacted] In the event of an alarm, ObjectVideo would register an alert and highlight the threat by surrounding it with a red box, as shown in Figure 8. Table 7 details results from the [redacted] testing.

[redacted]

Table 7. [redacted]

	OT & E				Baseline			
Location	# Alarms	# Tests	% Detected	95% CI	# Alarms	# Tests	% Detected	*p*-value
[redacted]								

CIs for rate statistics, including those in Table 8 above, are calculated using the Clopper-Pearson method of calculating CIs (Fleiss, 2003, 26). The CIs can be considered a range of values with a stated percentage (in this case, 95%) representing the proportion of CIs that could be expected to contain the true value. For example, if the true percentage detected by the [redacted] camera location during OT&E testing were, in fact, [redacted] we would expect 95% of all CIs for samples of data taken to contain this percentage. The width of a CI is indicative of the amount of uncertainty in an estimate (i.e., a wider CI indicates a high level of uncertainty; a narrower CI indicates a lower level of uncertainty). The width between the bounds of the CI for the [redacted] camera location during OT&E testing, [redacted], is indicative of the amount of uncertainty in this estimate.

Comparison tests were used to determine if there were significant differences in detection rates between OT&E and Baseline for all locations where [redacted] was performed (Simonoff, 2003, 9.1). [redacted] *p*-values are listed in the table above.

5.2.2 [redacted]

[redacted]

[redacted]

[redacted]

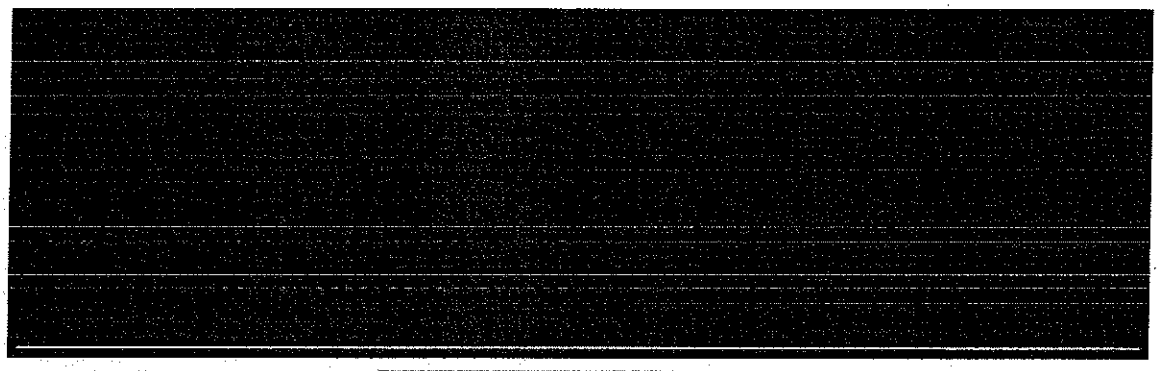
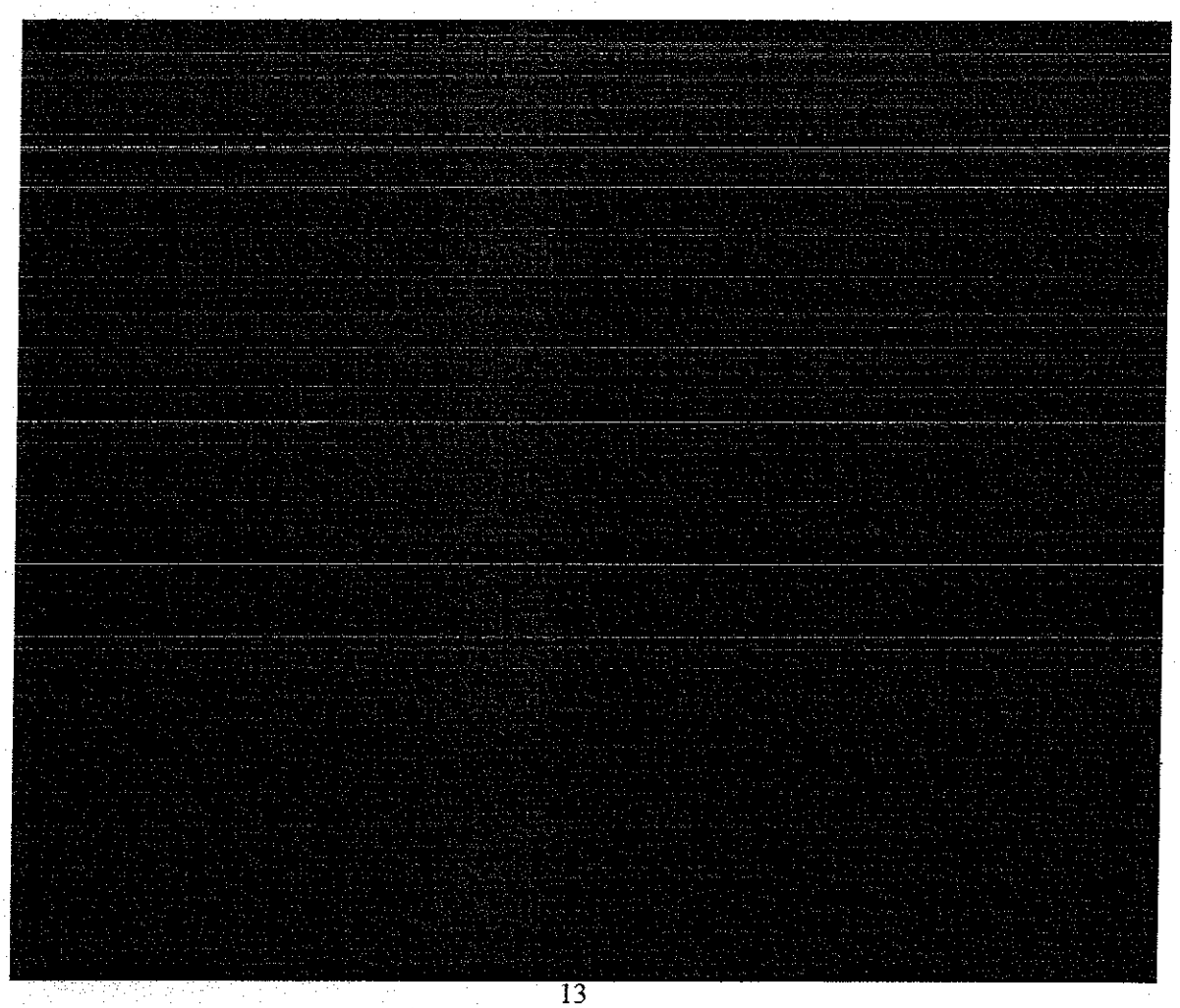


Figure 9. [redacted]



[redacted]

[redacted]

Table 8. [redacted]

	OT&E				Baseline			
Location	# Alarms	# Tests	% Detected	95% CI	# Alarms	# Tests	% Detected	*p*-value
[redacted]								

Comparison tests were used to determine if there were significant differences in detection rates between OT&E and Baseline for all locations where Baseline testing was also performed (Simonoff, 2003, 9.1). [redacted] *p*-values are listed in the table above. A statistical comparison was not performed for the [redacted] location because no Baseline testing was performed at this location.

5.3 VideoNEXT Results

VideoNEXT, the user interface portion of the VPMS-A, aggregated the alarms issued by ObjectVideo and reported them to the end user.

In comparing the ObjectVideo alert logs to the VideoNEXT event logs, Safe Skies can confirm that [redacted] of the ObjectVideo alerts were transmitted to the COP to be reviewed by the security personnel.

5.4 User Surveys

Surveys were distributed to security personnel in order to assess the users' opinions regarding the VPMS-A as compared to the legacy security system. Five surveys were returned. Table 9 summarizes the users' responses.

[redacted]

[redacted]

Table 9. Survey Summary

When performing security responsibilities or responding to emergencies:		Never	Seldom	Some-times	Usually	Always	N/A or Don't Know
1	The incident alert provided by the system immediately attracts my attention	Legacy	[redacted]				
		New					
2	The system makes it easy to identify where an incident is located	Legacy					
		New					
3	The system quickly provides information needed to initiate an effective response to the incident	Legacy					
		New					
4	The system provides sufficient documentation of an incident	Legacy					
		New					
5	The system continues to provide monitoring/alerting of other covered areas during an incident	Legacy					
		New					
6	The system readily provides the information needed to respond to multiple incidents	Legacy					
		New					
7	The system readily provides the information needed to track multiple incidents	Legacy					
		New					
8	The system provides sufficient methods to document multiple incidents	Legacy					
		New					
9	Responses are effectively coordinated	Legacy					
		New					
10	Responses are effectively implemented	Legacy					
		New					
11	The system provides easy access to stored information from the *cameras*	Legacy					
		New					

[redacted]

[redacted]

When performing security responsibilities or responding to emergencies:		Never	Seldom	Some-times	Usually	Always	N/A or Don't Know
12 The system provides easy access to stored information from the *sensors*	Legacy	[redacted]					
	New						
13 The system captures information that is useful for generating reports to the oversight	Legacy						
	New						

[redacted]

Several interviewees indicated that they would like a more comprehensive training and Standard Operating Procedures documentation for system maintenance. This would allow NYL personnel more control of the system and reduce reliance on the vendor's response time.

During conversations with Safe Skies team members, NYL personnel were positive about the VPMS-A, expressed gratitude for the new system, and were pleased with its performance.

[redacted]

[redacted]

6. SUMMARY & OBSERVATIONS

[redacted]

7. REFERENCES

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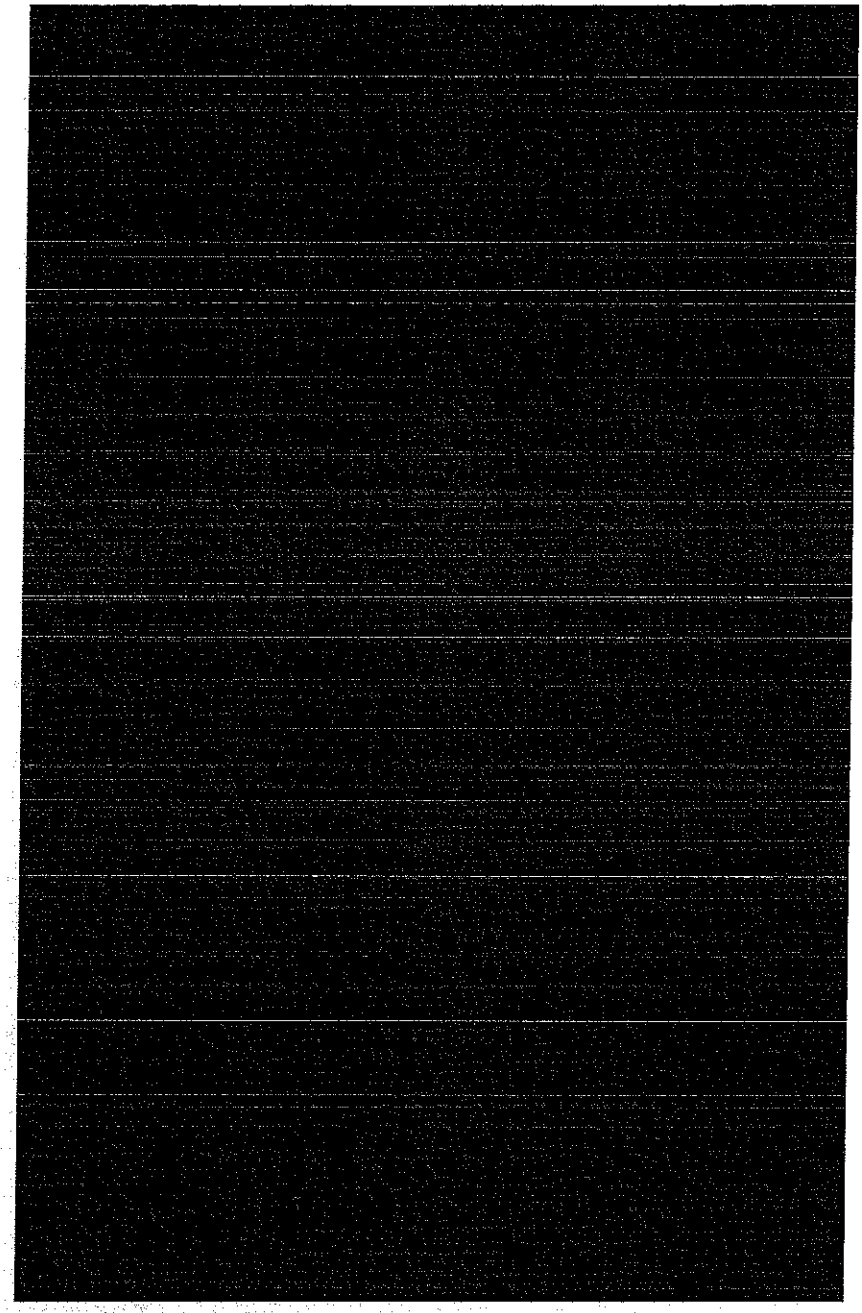
APPENDIX A – CAMERA SCREENSHOTS

[redacted]

[redacted]



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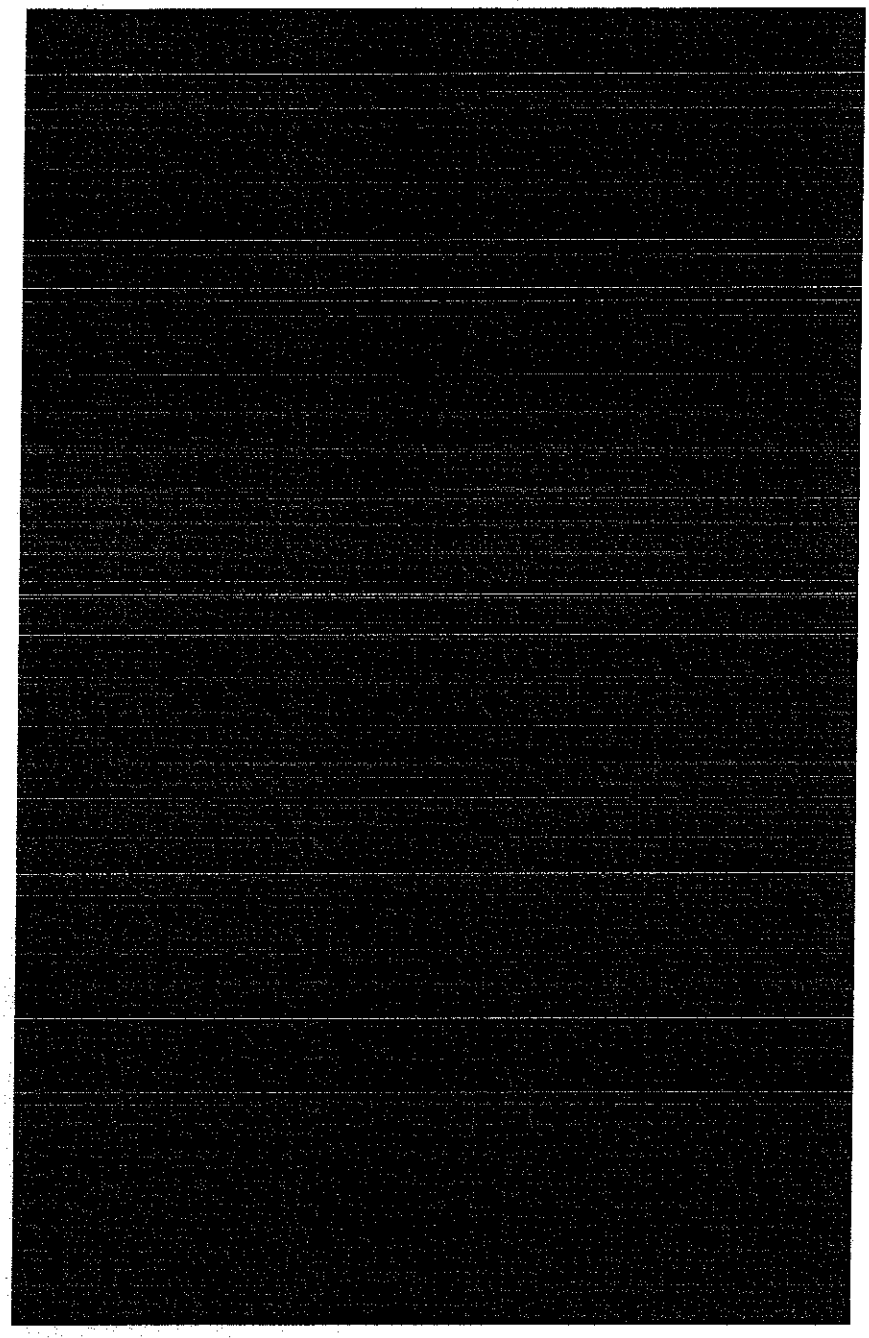

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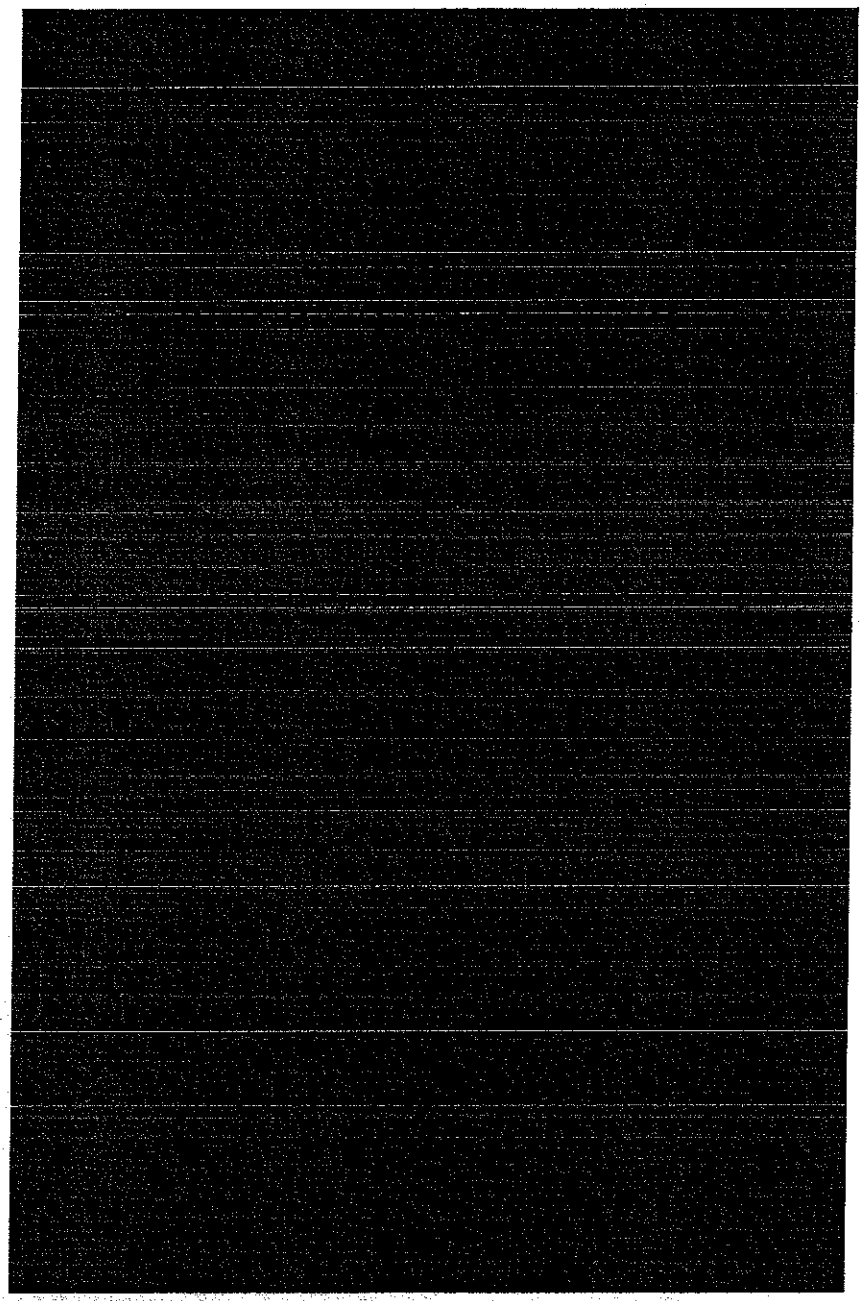

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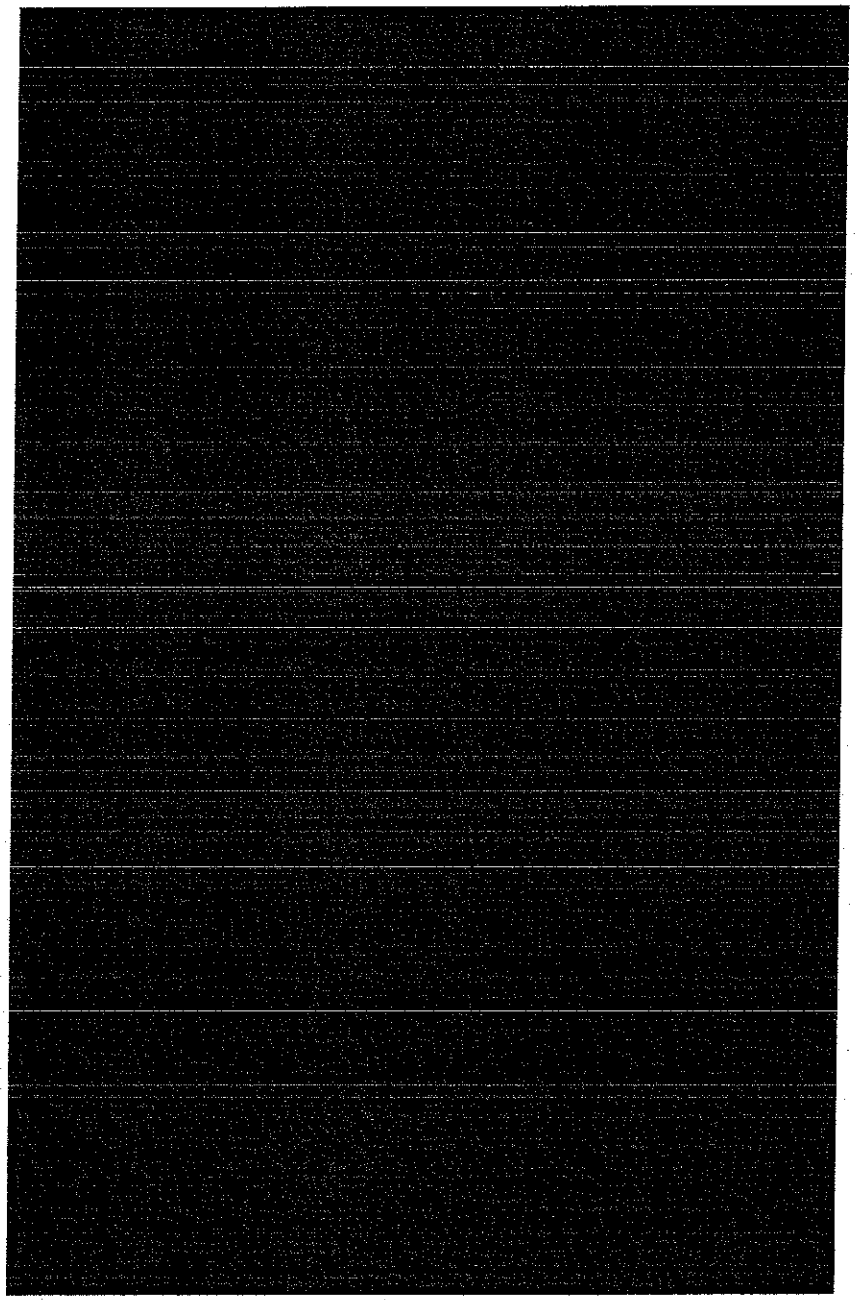

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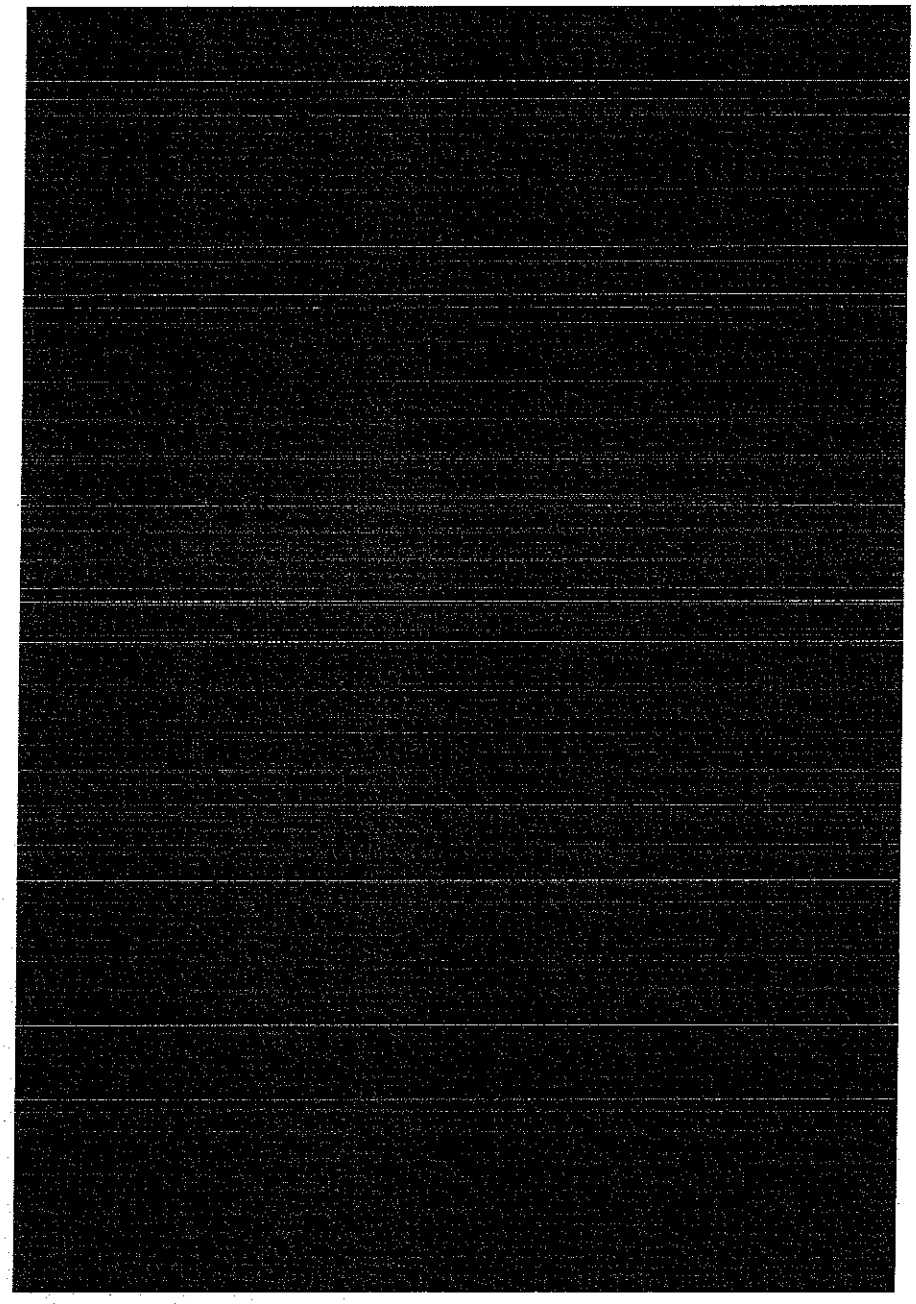

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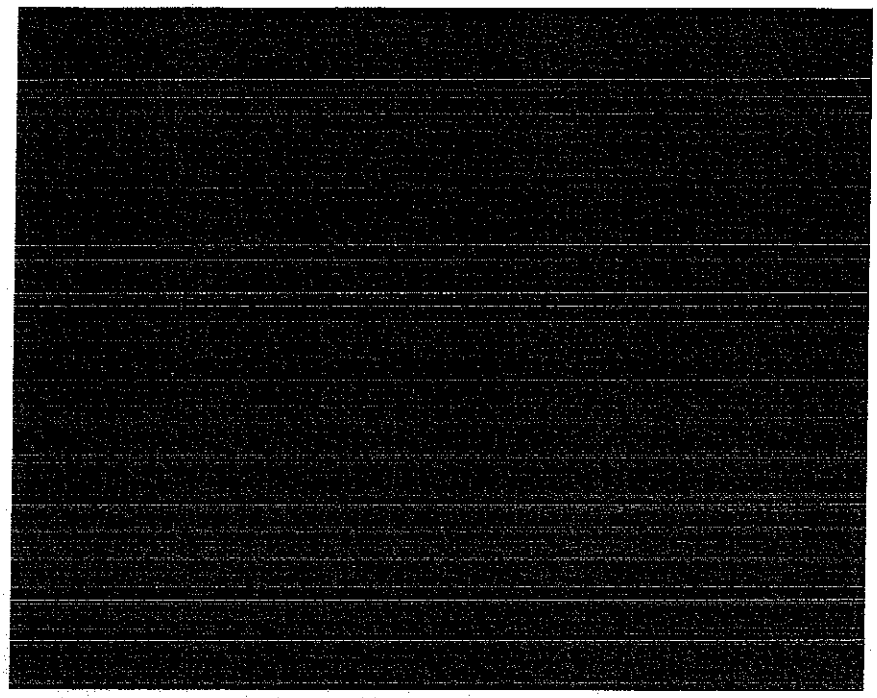

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