The author(s) shown below used Federal funds provided by the U.S. Department of Justice and prepared the following final report:

Document Title: Draft Technical Report For SECURES Demonstration in Hampton and Newport News, Virginia

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Document No.:   233342

Date Received: January 2011

Award Number: 2003-IJ-CX-K029

This report has not been published by the U.S. Department of Justice. To provide better customer service, NCJRS has made this Federally-funded grant final report available electronically in addition to traditional paper copies.

DRAFT Technical Report

For

SECURES Demonstration in Hampton and Newport News, Virginia

Configuration Item Number: 13xxx-1xx

Category: III
Cage Code: 1K736

Revision - 1

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National Institute of Justice

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Revision Change Page

Revision	Date	Change	Initials
0	xx/xx/06	Initial Release	ML
1	01/30/08	Edited with CSLJ Assessment Report	GO

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QinetiQ
North America

PSI
Planning Systems Inc.

Executive Summary

On March 21, 2005 Planning Systems Inc. (PSI) teamed with the Center for Society Law and Justice (CSLJ) and the Department of Justice / Office of Justice Programs entered into a cooperative agreement 2003-IJ-CX-K029 for the deployment, operation and analysis of an acoustic gunshot detection system in Newport News and Hampton Virginia. The National Institute of Justice (NIJ) – Office of Science and Technology, oversaw the project. Chris Miles, Senior Program Manager, Sensors, Surveillance, and Biometrics provided oversight and direction on behalf of NIJ. The SECURES® acoustic gunshot detection system deployed in Newport News and Hampton, Virginia represented the third generation of hardware electronics since its original inception.

This report is presented in two basics sections. The first section represents the findings by CSLJ as an independent third party assessor with scientifically founded conclusions based on research and statistical data collected during the operation of the system including independent Live-Fire tests conducted in Newport News and Hampton, Virginia. The second section of this report is the overview of deployment and operational initiatives as reported by PSI personnel.

The conclusions drawn by CSLJ are impressive. Some of the most notable include:
  o The Live-Fire tests conducted in Newport News and Hampton, though differing in actual results, suggest that the detection of handguns by the SECURES® system, particularly in calibers of 9 mm and greater, is very accurate.
  o The ability of the SECURES® system to locate gunshots was very accurate often localizing the actual test shot location within a 10-foot radius.
  o Trade-offs between detecting true positives and false positives was noted wherein false positives can be reduced to near zero with relative small loss in true positives.
  o Indications exist that public awareness of the SECURES® system may serve to decrease the number of gunshot relate 911 calls.
  o Eleven (11) arrests were made as a result of SECURES® related dispatches that can conservatively attributed solely to the SECURES® system deployment.
  o In Newport News there were four gunshot victims found on SECURES related dispatches of which 1 would not have been found otherwise. The other three gunshot victims found were incidents where associated 911 calls also existed.

The deployment and operations of the SECURES systems in Newport News and Hampton were completed under best practices as known at the time deployed. These initiatives, as with most projects, were met with challenges that have been overcomed. The information gained in these efforts, though beyond the scope of these demonstrations, have subsequently been used in other deployments to further stream line deployments and operations.

1   CSLJ Assessment Report

Implementing SECURES® Gunshot Detection Technology in Newport News and Hampton, VA: an empirical assessment

Presented by Dr. Peter Scharf

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ACKNOWLDEGEMENTS:

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I. **Abstract:**

There is great enthusiasm among policing entities regarding the crime control and operational impact of sensor technologies. But what do we really know about the accuracy, effectiveness and efficiency of these solutions? Preliminary assessments of the SECURES® system were conducted in Dallas and Austin, TX. The Center for Society, Law and Justice (CSLJ) was contracted through NIJ to conduct more intensive validation and assessment of the SECURES® system as installed and implemented in Newport News, VA and Hampton, VA. In undertaking this assessment, as described in this report, CSLJ sought to answer two fundamental research questions related to sensor technologies:

1. How effective is the SECURES® system as deployed in Newport News and Hampton police departments in detecting "shots fired" incidents in the areas in which it is installed and implemented?

2. What is the impact of the SECURES® system on police operations, the police agency and the community as a whole?

This report is focused upon an empirical validation of suggesting the effectiveness of claims and perceptions regarding the usefulness of the SECURES® technology in Newport News and Hampton police departments. Results attained suggest the complexity of deploying new technologies in urban settings, specifically:

1) The project support in both Newport News and Hampton was outstanding and modeled the type of partnership needed for NIJ operational tests of new technologies;

2) PSI's technical implementation of the systems conformed to the intent defined in the NIJ proposals that were submitted. Training of both police officers and dispatch personnel was rating as effective;

3) The "live fire" tests differed in the two cities with Hampton achieving a high rate of true positive identification of shots fired along with a low rate of false positive activation for extraneous noises. Newport News results were less successful;

4) The Hampton results for handguns 9mm in caliber and greater, suggest that the SECURES® the system is very accurate;

5) SECURES as measured by the Hampton live fire test was very accurate in its ability to locate gunshots-often within a 10 ft radius of the actual test shot location;

6) There was a noted tradeoff between true positive errors in the Hampton live fire experiment. If the sensor bar were set higher, false positives would be reduced but so would true positives;

7) There is some indication that public awareness of the gunshot detection system may serve to decrease gunshot-related 911 calls. This trend is clear in Hampton measured, however, the reduced drop in" gun calls" in Newport News may be related to the much lower accuracy of the system there.

8) Eleven (11) arrests made as a result of SECURES®, in both cities can be conservatively attributed solely to the deployment of the SECURES® system.

9) In the field assessment, the problem of unnecessary responses (false positive error) was an issue. In Hampton, 18% of SECURES®-related dispatches had associated 911 calls. This means that 82% of dispatches would not have occurred but for the gunshot detection system.

10) In Newport News, there were four gunshot victims found on SECURES® related dispatches during the 11 month period reviewed. However, all but one of these incidents also resulted in 911 calls.

11) There was little evidence that clearance rates were affected in either Hampton or Newport News by deployment of SECURES®.

12) Weapons related dispatches tended to increase following deployment of the systems. About 79% of all weapons-related calls were SECURES® alerts in that period. In Hampton the introduction of SECURES® however, more than doubled the number and percentage of weapons-related dispatches in the SECURES® coverage area.

The conclusions of this report suggest that many of the most optimistic notions of how the system would perform and how the system might impact police operations lacked empirical support by the assessment efforts of the investigators. Issues that policy makers might consider are how

experiments such as the assessment of SECURES® are significant in creating a research environment to facilitate clinical assessment of emerging It is also important to recognize that it is important to address the "gap" between technology "potential and what might accomplish in the field in terms of cases cleared or crime reduction Further the assumption of the technology, that rapid police response to an acoustic "problem event" as well other assumptions underlying technologies being considered may not be founded in reality. The focus upon the technology as the core area of NIJ emphasis should be questioned as operational factors as to how the police use the information generated by a technology may be more important than the technology itself. The cost of the high number of false positives represented a significant problem for both Newport News and Hampton Police Departments. Also funds spent on one technology might be invested on other technologies, or on more officers, better salaries, or on community programs. Determination of these "cost-benefit" tradeoffs is essential in any serious assessment of a new technology. This assessment created high standard of scrutiny for the SECURES® product. It may be unfair to compare SECURES® with other similar technologies unless those technologies have been scrutinized with the same precision. There were many positive results derived from the Newport News and Hampton implementations. The police "*accepted*" the experiment and training, search protocol management and dispatcher decision-making were exceptional. Also the 97% "hit rate" in the Hampton "live fire" experiment was encouraging. Problems in the effort were noted and included high rates of response to non-confirmed gunshots, the failure to initiate more "valid" arrests, assist in clearances or to reduce crime.

II. **Introduction:**

SECURES® is an acoustic gun shot detection system that seeks to identify source points of
gunshots in neighborhoods in which it is implemented. With the SECURES® system in place,
police dispatchers will receive alerts of a gun shot and will dispatch police officers to those places
where gun shots have been identified. The SECURES® gun shot detection system is intended to
be a valuable tool for law enforcement agencies in reliably identifying the exact location of
gunshots fired. SECURES® aims to achieve, according to material presented by its developer the
following services for both law enforcement agency personnel and the citizens of the
community[1]:

1) Creation of a validated and immediate alert for dispatchers regarding possible
   "shots fired" incidents;

2) Availability of data providing more precise "shots fired" locations for response and
   field investigation efforts;

3) Precise definition of incidents of gun shots in crime hot spots among cities who
   deploy the SECURES® technology;

4) Rapid response to gunfire independent of 911 calls reporting gunfire;

5) Corroborates 911 calls for reports of gunfire;

6) Provides true incidence and location of outdoor gunshots known;

7) A means to assure citizens that "shots fired" incidents are being aggressively and
   promptly addressed; and

8) Development of a problem-solving tool for law enforcement to use in analyzing
   "shots fired" incidents along with other police data.

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[1] PSI SPIE,

Planning Systems, Incorporated (PSI) was awarded a Cooperative Agreement Grant entitled,
"SECURES® Urban Gunshot Detection System Demonstration Hampton, Virginia", and (Grant
#2003- IJ-CX-K029. This grant was "split" between Hampton Virginia and Newport News
Virginia. Senor grids covered two "hot spot" areas of the city plagued by gunfire and utilize one
receiver. Newport News began operation of the SECURES® system on 27 July 2005 and
continued the experiment for 11 months. In Hampton, a similar deployment was followed several
months later over a duration of 6 months. A certain amount of publicity accompanied the
introduction of the systems: For example the following TV news report commented:

> Newport News' new gunshot detector system is helping police protect the people
> living in the East End.
>
> 100 sensors on utility poles are activated when shots are fired, sending a signal to
> the police 911 dispatchers so they can send investigators to the scene.
>
> They also can tell the officer exactly where the gunman was standing at the time.
>
> "It goes off on every single computer, whoever has SECURES® on theirs. And as
> we hear the shots, we all bring it up and there it is flashing in front of us," said
> Carol Render. "I can tell them 17 feet from the building from Jefferson Avenue to
> the building is where you'll find it and it could be a casing."
>
> Police say the system has even led them to the shooter.
>
> "We actually found the person who is discharging the firearm and was still armed.
> But, then there's been a couple of other cases that because we responded to that
> exact locations on a SECURES® activation, we actually found other criminal
> activity going on and were able to make arrests on those cases," Assistant Police
> Chief Joe Moore noted.
>
> The detectors have been in use since July 2005 and are part of a SECURES® test
> by the National Institute of Justice.

Comments by police officers in both agencies suggested that system was a useful tool and many
suggested that they relied upon information provided by the system. This report is focused upon
an empirical validation of these claims and perceptions. Questions to be address seek evidence to
support the claims of gunshot detection advocates. While this report deals with SECURES®, the
questions below might apply to other gunshot technologies as well:

> i. Is the system accurate in identifying gunshots?

ii.   Can it distinguish gunshots from other acoustic events?

iii. Will it help the police "clear" cases;

iv.   Will it result in reduced crime in areas in which it is deployed?

v.   Is the technology an efficient response to gun events in urban communities?

III. Research Strategy:

To answer these questions, the following strategy was deployed. The objective assessment of the SECURES® detection system involves answering two basic and difficult questions. One question focuses on whether the system works, that is, whether it accurately detects and locates gunshots and only gunshots. Another question focuses on the system's impact on law enforcement operations and the community. The approach adopted in the assessment has focused upon the following strategy in assessing outcomes in Newport News and Hampton, VA. This research report describes the procedures deployed for the collection, analysis and interpretation of observations and data related to the validity, reliability and impact of the SECURES® gun shot detection system. CSLJ established the following goals for this report:

Goal One: To assess the ability of SECURES® technology to determine the locations of "shots fired" incidents within the area in which it is implemented;

Goal Two: To assess the effectiveness of the SECURES® technology in operationally identifying discharge of gun shots;

Goal Three: To assess the impact of SECURES® on law enforcement problem solving and response efforts within the identified area;

Goal Four: To assess the impact of SECURES® on Newport News and Hampton Police efforts to control gun crimes and overall crime in targeted areas.

To meet these goals, CSLJ defined a research design and assessment strategy that was aimed at capturing and analyzing key police data in a way that is of minimum burden to each agency. Coordination with the agencies was undertaken to prepare the agency for proper use of the SECURES® system and to create a positive atmosphere for all those involved in the

implementation: Newport News PD and Hampton PD (users of the system), CSLJ (assessors of the system), and Planning Systems Inc. (creators of the system.) Data collection procedures were undertaken to assure that "searches" were undertaken by officers to determine as carefully as possible the source of the "SECURES® activation. It should be noted that executive and line participation by both Newport News and Hampton was outstanding in their coordination with PSI and assessors and included such efforts as:

- Assuring responses to activation
- Data analysis
- Training support
- Supervision of field searches
- Meetings to assure experimental quality
- Orientation of command, etc.

CSLJ collected and analyzed the following information with this support:

- The natural history of the SECURES® installation, implementation and assessment in each of the four sites;
- Description of the process of implementation within each agency;
- Live fire data in Newport News and Hampton;
- Findings related to the analysis of "shots fired" incidents within each agency during the experimental period.

In this effort CSLJ sought to:

- To present findings related to the impact of the implementation of SECURES® on police operations; and
- To draw reasonable conclusions from evidence collected from the assessment in terms of future adoption potential and extensions of the SECURES® system.

The data collection efforts for the SECURES® assessment centered on determining:

1) The gross effectiveness of the SECURES® system in detecting gun shots; and
2) The impact of the implementation and technology on significant police outcomes.

Determining the effectiveness of SECURES® in determining gunshot events:

In terms of determining the ability of the SECURES® system to identify correctly gun shot events with other acoustic events (fire crackers, back-fires, etc.). Newport News and Hampton officers departments provided weapons, fireworks, and bullet traps and supervised for safety the live fire experiments. Officers fired live rounds from the weapons and discharged the fireworks, banged pots and initiated other urban noises and CSLJ researchers recorded times, GPS coordinates, and initial results as radioed by the dispatcher. System activation results were later confirmed by examination of appropriate data records. It should be noted that cooperation in objectively conducting these live fire events was outstanding in both agencies. Research principles involved in conducting these *live-fire* field experiments included:

1. Articulation of clear operational definition rules and outcomes
   The protocols and procedures for the experimental test of the SECURES® system were articulated in advance of the actual test. All test rules were specified and followed. Finally, the categories of measurement of performance of the system were defined prior to the test.

2. Communicating public results
   The findings of the test were immediately made available to PSI, NIJ and the Newport News and Hampton Police Departments. All parties were invited to be present during the actual test experiment.

3. Defining clear experimental intervals
   The time period of the test was be clearly specified. Both start and end times were announced and during these times only assessors and selected members of the police department actively participated in the experiment.

4. Initiating random treatments

The controlled field test included random shots of different types of firearms and other selected noises at randomly selected times and locations in which the SECURES® system was deployed. The assessor had the ability to manipulate the weapon types, locations of shots, number of shots fired and time of shots fired for the experimental test.

5. Conducting "clinical" and independent and objective data collection
The experimental assessment constituted an independent and objective test of the performance of the SECURES® system.

6. Objective assessment of false positive and false negative errors

The results the field test provided an objective "error assessment" of the SECURES® system.   The assessment demonstrated how much error is present in the deployment of the SECURES® system as indicated by the results of the test as suggested in the table below:

In terms of assessing the following typology was used:

Relationship between Event Occurrence and SECURES® Activation

		Event Occurrence	
		Present	Absent
Secures Activation	Positive	True Positive (TP)	False Positive (FP)
	Negative	False Negative (FN)	True Negative (TN)

Sensitivity and Specificity were assessed in the following cells:

- Sensitivity: TP/TP + FN
- Specificity: TN/TN + FP

For example sensitivity was measured by:

- The proportion of events that SECURES® detects
- How good is SECURES® at detecting events
- A sensitive SECURES® will rarely miss detecting events (false negative)

Specificity was assessed as follows:

- The proportion of non-gun events that do not trigger an activation of SECURES®
- How good is SECURES® at discriminating between gun shots and other noises
- A specific SECURES® will rarely misclassify non-gun noise as a gun shot event (few false positives)

Assessing Field Response to Introduction of SECURES® technology in Newport News and Hampton

The assessment of SECURES® also required the use of baseline and control data. Baseline data will be necessary to determine the impact that SECURES® has on a targeted location by comparing data collected prior to the implementation of SECURES® to data collected after the implementation of SECURES®. Control data was necessary to conduct simultaneous comparisons between police districts or crime "hot spots" in which SECURES® is being used and those districts or hot spots in which it is not.

Using this approach all activations in the field were collected and categorized in terms of whether the activation was a confirmed gunshot (determined by casing, witness, observation, an officer observation, etc. Similarly non-gunshot activations were noted by physical evidence (firecracker burn, witness or officer observation. Events that were unconfirmed were noted. In peak police demand situations it was often difficult to make a definitive determination despite the best efforts of the officers at the scene. Types of data that were collected included:

Type	Description
Baseline	NN/HPD Historical data from police district in which SECURES® will be implemented
Experimental	NN/HPD Data collected from police district during and after the implementation of SECURES®
Control/Baseline	NN/HPD Historical data collected from police district in which SECURES® will not be implemented
Control	NN/HPD Data collected from police district that does not have the SECURES® system in place

In selecting SECURES® experimental and control groups for the assessment, every effort was made to ensure that each of the groups are of similar population density and crime rate.[2] Historical baseline data was collected for a six month period prior to the introduction of SECURES® including:

General Category	Indicator
Gun Shots	• Number of gun shot incidents

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[2]

	• Number of gun shot incidents occurring outside • Number of gun shot incidents occurring inside • Number of gun shot incidents corresponding to 911 • Number of gun shot incidents corresponding to SECURES®
Crime Data	• UCR statistics • NIBRS statistics • Drug crime statistics • Victimization survey data
Calls for Service	• 911 calls for service
SECURES®	• Number of SECURES® events registered • Number of SECURES® events leading to evidence of actual gun discharge • Number of confirmed outdoor gun shot incidents detected by SECURES®
Time	• Average police response time • Time interval between gun shot incident (defined by 911 call time) and police appearance on scene • Time interval between gun shot incident (defined by SECURES® report) and police appearance on scene • Time interval between incident and arrest
Investigative Data	• Evidence collected from gun shot scene (from both SECURES® and non-SECURES® reported events) • Case closures • Warrants issued
Survey Data	• Interviews with dispatch operators • Interviews with patrol • Interviews with supervisors

Key in the analysis of data was the comparison between SECURES®-generated and 911-generated gun shot incidents. The comparison between SECURES® and 911 events will be made

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both between the control and experimental groups and within the experimental group using both baseline and post-implementation data. All incidents collected from 911 and SECURES® will be identified by a Crime Report Number (CRN). CRN's will be analyzed according to both time and location. CRN time data will provide the ability to assess police response time to SECURES®-generated incidents as compared to 911-generated incidents. CRN place data will provide the ability to assess the accuracy of SECURES® localization as compared to localization data from 911-generated incidents. The comparison of CRN's generated by 911 and SECURES® will provide time and location validation for the SECURES® system as implemented in the four test sites. The comparison of these data will provide the foundation for assessing how SECURES® improves police response time, evidence collection, warrant issuance, etc.

The methodology employed for this field assessment was aimed at establishing a foundation upon which the reliability, validity and impact of SECURES® may be determined. The assessment methodology analyzing the data is offered to provide information on the SECURES® system in the following areas:

- Sensitivity and Specificity
- Effectiveness
- Efficiency
- Crime Impact
- Operational Impact

Principles utilized in conducting the study included:

- Clear operational definition of outcomes (i.e., what is a "hit")
- Public "results" (principle of co-observation)
- Clear experimental interval (i.e., when the experiment was "live")
- Intensive search to determine "ground truth" of acoustic event;
- Design articulated prior to the experiment; and
- Objective analysis of false positive and false negative error rates.

Shots fired were validated   in terms of the SECURES® ability to detect and localize gun shot incidents by measuring the rate of false positive and false negative errors.

SECURES® Experimental Field Assessment Result Types	
False Negative Error	A gun shot incident occurs, but the SECURES® system does not detect this incident: bullet/injury no activation
False Positive Error	The SECURES® system is activated, but it is determined that no gun shot incident has occurred. (fire-cracker, etc. found)
True Negative Response	The SECURES® system remains neutral when random urban noise occurs: does not activate to back-fire, etc.
True Positive Response	The SECURES® system is activated when a gun shot incident occurs: Gun shot fired, system activates

In this effort it was sought to determine that when used in the field in Newport News and Hampton:

1. The rate of false positive error of the SECURES® system?
2. The rate of false negative error of the SECURES® system?
3. The rate of true negative response of the SECURES® system?
4. The rate of true positive response of the SECURES® system?

In considering the results from the field CSLJ determined the effectiveness, efficiency and operational and crime control impact of the system as deployed in Newport News and Hampton police departments:

Effectiveness:

Effectiveness is the efficacy of the SECURES® system in enhancing police related outcomes. To assess the effectiveness of the SECURES® systems on the operations and outcomes of the four

test site police agencies, CSLJ analyze the following policing outcomes in Newport News and Hampton

- The number of SECURES® events which generate evidence from on-scene investigations
- The number of SECURES® events leading to multiple evidentiary findings
- The number of SECURES® events leading to arrest warrants
- The number of SECURES® events leading to convictions

Efficiency:

Did police respond on the scene to a reported incident faster? Did collecting more useful evidence regarding an incident as a result of the implementation of SECURES®? Were more cases closed? To obtain these important measures of performance and impact, the following types of information were assessed.

- Time interval between the 911 or SECURES® event and appearance on the scene by police[3]
- Time interval between appearance on scene and collection of initial confirmatory evidence, including witnesses, victim, forensic and physical findings
- Time interval between appearance on scene and collection of additional evidence
- Time interval between appearance on scene and investigative follow-up
- Time and data intervals between event and issuance of warrant and/or arrest of suspect
- Rate at which arrests based on SECURES®-generated data yield convictions

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[3] Uncontrollable circumstances such as the location of an officer when dispatched after incident occurrence (whether generated from SECURES® or 911 data) will be handled as a random occurrence in this assessment and will thus are a non-confounding variable.

2   Impact:

Identifying impact in the criminal justice field can be difficult. Establishing causal links between
justice programs or interventions and crime rates is a challenge due to the many potential external
variables that can also influence crime rates. Essential to assessing the impact of SECURES® is
articulating the theoretical framework and hypotheses of the expected chain of causes and effects
that will lead to improved police operational effectiveness and improved societal outcomes.
Many assessments of new technologies such as SECURES® are conducted without any
theoretical foundation or explanation of the anticipated effects and impact. These studies often
produce assessments that fail to point to evidence that the results are within the technology's
locus of control. Specifically, the impact assessment methodology focused upon the following
areas:

1.   SECURES® Impact on Police Operations
2.   SECURES® Impact on Police Organizations

Organizational theories (see Simon 1990) suggest that technology may not only affect the outputs
of an organization but also affect its core business practices. COMSTAT police technology, for
example, has been argued to have changed not only how well police work, but how they work.
Thus, assessment of police organizational impact differs from the previously discussed
operational impact in that it measures changes in the way police work, not just changes in their
levels of effectiveness. Key questions for this assessment included how SECURES® changed, if
at all the way that Newport News and Hampton deployed policing resources.

**IV.   Research Results: Did SECURES® system as deployed in Newport News and
Hampton Work? Did it have an impact upon crime and policing operations?**

The accuracy of the system as assessed in Newport News and Hampton had at least three
assessment dimensions:
1)   Detection of gunshots (true positive vs. false negative results)

2) Identification of the location of a gunshot ("localization")

3) Ability to distinguish gunshots from similar acoustic events: the false positive problem.

Ideally the system should detect and accurately locate all gunshots in the coverage area. In addition it should fail to activate when non-gunshot acoustic events (fireworks, thunder, etc.) occur or, at least, provide results that can be used to distinguish non-gunshot activations from gunshot activations.

The SECURES® system is designed to detect and provide the location of gunshots that occur within the coverage area bounded by its sensors, which are typically mounted on utility poles or on the exterior walls of buildings. These sensors, when activated, send a signal to a receiver that communicates with a server. The data reports of the activated sensors are used to locate the acoustic event in three-dimensional space, so that the system communicates both map coordinates and whether the event is "ground" or "aerial". Linked to a law enforcement dispatching system (CAD), an alert will provide a police dispatcher both the nearest address and an aerial photo of the shot location. That aerial shot can be used to establish distances from landmarks or other locations to help a responding officer locate the precise location of the event.

The design of the SECURES® system allows for the detection of all outdoor gunshots in the coverage area. It will not typically activate in response to indoor gunshots. In addition, the sensitivity of the system to explosive discharge-type sounds must be set to minimize alerts on non-gunshot sounds such as fireworks. Therefore low caliber weapons (below 9mm) might not consistently result in activations and some non-gunshot discharges will result in activations for typical system settings. The false positive/false negative tradeoffs are in part determined by setting how many sensors will be required for event activation and by the density of their placement in the coverage area. In addition, a police department can choose not to respond to "aerial" activations if airburst fireworks may represent a problem.

Assessment of false positive, false negative, and localization error might be accomplished using either test data or operational data. In this study the SECURES® system began operations in two areas of the Newport News Police Department's South District on August 1, 2005 and in

Hampton on January 1, 2006. In both locations police dispatchers received SECURES® alerts at their workstations and dispatched officers to the identified locations. Police in both departments who responded to the SECURES® alerts had a dual function. They were, of course, to deal with any public order, medical, or criminal situation encountered, just as if responding to a normal citizen call for service. In addition, the officers were to make a special effort to identify the source of the event by looking for physical evidence (such as bullet casings) and searching out and interviewing witnesses.

Data from the operational test period – dispatching system records and filed officer reports – can be used to answer a variety of questions about the usefulness of automated gunshot detection for law enforcement. Such data cannot, however, be used for assessing the accuracy of the system for detecting or localizing actual gunshots. Making such an assessment requires knowledge of when and where gunshots actually occurred. By responding to and investigating SECURES® alerts the officers might, theoretically, determine which alerts corresponded to actual shots (though, as discussed below, this is often not possible in practice). But even if such determinations could be consistently made, there is no realistic way of determining how many actual gunshots were not detected by the system. Analysis of operational data from both Newport News and Hampton provides strong evidence that actual gunshots do not always result in 911 calls for service. In Newport News only 24% of SECURES® alerts had associated 911 calls (43% of gunshot events confirmed on the scene by officers). The figure for Hampton was 18% (39% of confirmed events).[4] Since there is no other practical way of measuring undetected shots, a key measure of system accuracy – the percentage of actual gunshots detected by the system – is not possible with operational data, but can only be determined through a live fire test in the operational area.

Similarly, operational data is only of limited use in assessing the ability of the system to locate shots. Information for locating a gunshot event in space is potentially available through the position of bullet casings or bullet holes, location of a shooting victim, or reports of witnesses, but none of these are wholly reliable: bullet casings/holes might be related to a different gunshot

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[4] The low reporting rate results are consistent with results reported in Dallas (10.6%). See Mazerolle et.al (1999A).

event, victims can move or be moved; witnesses can lie or be mistaken. Just as with detection accuracy, only a live fire test can accurately assess the system's localization ability.

The third dimension of accuracy, the avoidance of false positive error, presents even greater measurement difficulties. It is easy to define false positive error in this case: a SECURES® alert indicates a gunshot where there has been no gunshot. One can theoretically count such events. From the operational data, we can find SECURES® alerts where the responding officer found evidence of fireworks, or witnesses reported an acoustic event such as fireworks, thunder, an exploding air container (basketballs, balloons, plastic bottles, etc.), an exploding transformer, a vehicle backfire, or other possible explanations of the SECURES® alert. But the occurrence of such reported events coupled with the lack of physical or witness gunshot evidence only suggests that the alert might be a false positive: a gunshot may still have occurred. Indeed, some witnesses may have an interest in concealing certain gunshot events and are happy to offer alternative interpretations when suggested by the officer.

Even was it possible to accurately count the percentage of SECURES® alerts that were false positives, how would one interpret such a number? The SECURES® system may have successfully avoided activating on almost all non-gunshot acoustic events, yet if those events are large in number relative to actual gunshots, false positives might represent a significant percentage of police dispatches. It is, of course, impossible to determine from operational data the percentage of non-gunshot acoustic events that resulted in a false alarm. Only controlled live fire tests can assess the percentage of non-gunshot events that result in a false positive, but the limited range of such events that can reasonably be experimentally produced limits those tests. One can shoot fireworks, pop balloons and bang metal objects, but these are only a small percentage of possible noise sources that might fool the system.

V. System Accuracy: Live Fire Test Results

Estimating SECURES® system detection and localization accuracy requires a field experiment where it was possible to control the source, timing and location of acoustic events – both gunshots

and non-gunshot events that the system might interpret as gunshots – and record the response of the system to those events. Two such experiments were conducted by CSLJ researchers with the assistance of local police officials and, to a limited extent, SECURES® engineers. The first was carried out in Newport News on October 3, 2006 and the second in Hampton on November 29, 2006.

In both locations the procedures were the same. CSLJ researchers pre-selected firing locations within the SECURES® coverage areas (11 firing locations in Newport News, 6 in Hampton) and conducted the test firings at those locations in close cooperation with the respective police departments. The firing locations were chosen to maximize variation in conditions within the SECURES® coverage grids, such as distance from sensors, edge versus center of grid, and distance from buildings and other structures. SECURES® staff was not informed of the firing locations before the tests. In a few cases the originally selected locations were modified slightly at the request of supervising officers for public safety reasons.

The respective police departments provided weapons, fireworks, and mobile bullet traps. Officers fired live rounds[5] from the weapons and discharged the fireworks, and UNO researchers recorded times, GPS coordinates, and initial results as radioed by the dispatcher. System activation results were later confirmed by examination of appropriate data records.

In Newport News, 9mm and .45 caliber handguns were discharged, bottle rockets and firecrackers were set off, and a metal folding chair was banged with a hammer. In Hampton .22, 9mm, .38, and .45 caliber handguns were fired, bottle rockets and firecrackers were set off, and balloons were popped. The results were as follows:

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[5] Unlike the Redwood City Field trial for the Shotspotter technology (Mazerolle, etc. Al., 1999B), police officials both in Newport News and Hampton allowed use of live rounds rather than blanks. Since the amplitude wave for blanks differs from that of live ammunition, these tests might offer a somewhat closer approximation of real life results.

2.2.1.1 Live-fire Test Results

Newport News				
SOURCE	Number of Shots Fired	Percent Ground Activations	Percent Aerial Activations	Percent No Activation
9mm	33	18	6	76
.45	33	18	6	76
All Handguns	66	18	6	76
Firecrackers	22	0	0	100
Bottle Rockets	22	18	32	50
Metal Noise	11	0	0	100

Hampton				
SOURCE	Number of Shots Fired	Percent Ground Activations	Percent Aerial Activations	Percent No Activation
9mm	18	100	-	0
.38	18	88	12	0
.45	18	100	-	0
All Handguns > .22	54	97	3	0
.22	18	33	0	67
Firecrackers	14	35	-	65
Bottle Rockets	12	25	50	25
Balloons	12	0	0	100

The Newport News and Hampton tests yielded radically different results. In Newport News, only 18% of the gunshots yielded SECURES® ground activations, in Hampton 97% (excluding .22's) yielded the appropriate response, an almost flawless performance. Bottle rockets yielded a significant system response in both locations, and were about twice as likely to activate as an aerial rather than a ground event. In Hampton, 35% of the firecrackers showed ground activation. Firecrackers produced no alerts in Newport News.

What accounts for the poor results in Newport News? SECURES® engineers initially suggested two possible explanations. The first was the test methodology. It was suggested that the barrel of the guns being fired were located too close to the bullet trap, which might absorb too much of the

shock wave and result in fewer activations. This idea was tested during the Hampton series. The Newport News bullet trap was used in a separate test with the weapon fired at different distances. All firings resulted in appropriate system activations. This explanation was therefore rejected both by SECURES® engineers and CSLJ researchers.

The second explanation proposed was that radio frequency interference (RFI) was interrupting communication between the sensors and the receiver. The RFI problem was, in fact, recognized as a potential issue by PSI engineers during the installation and testing period-and a solution was proposed, however, not implemented prior to the live fire assessment. A spectrum analysis study conducted after the Newport News test discovered a strong pulsing RFI signal near the SECURES® transmitting frequency at the receiver site (City Hall). The pulse was both periodic (once every 1.64 seconds) with occasional random transmission bursts. Another indication of the RFI problem is the records of reception of sensor status messages by the system. Sensors transmit these messages every 8 hours. During the early part of the installation of the system (April 16-24, 2005) 83.2% of these messages were received. By May reception had dropped to about 50% and stayed at about the level throughout the operational period, including the period of the live-fire test. (Hampton, in contrast, had a reception rate of 96.5 % in Feb 2006.) The new source of RFI that began in May 2005 apparently originated in the nearby Newport News shipyard. A detailed analysis of the Newport News live-fire test results (see appendix) provides strong evidence that this RFI interference was the cause of the poor test results.

The RFI interference problem in Newport News is an indication that the effectiveness of the technology is hostage to the way it is implemented, and that difficulties in implementation will vary from location to location. At the time of this report the problem has not yet been solved in Newport News. This experience also indicates that once installed these systems must be continuously tested and checked, since new technical problems can emerge without warning and may be invisible to local personnel. Newport News officials, for example, were unaware of the scope and importance of the RFI problem until the live-fire test. Since local officials have no consistently good way to assess the number of actual gunshots in an area, it will not be possible in some cases (such as an intermittent RFI problem) to tell whether an observed reduction in gunshot activity is an actual drop in activity or a drop in the system's effectiveness at measuring it.

The Hampton test, then, is the better indicator of the system's accuracy potential. The Hampton results tell us that for handguns 9mm in caliber and greater, the system is very accurate in detecting gunshots taking place outdoors and very accurate in identifying them as ground shots. The ability to detect lower calibers is not as impressive, as SECURES® officials have always recognized. Only about 1/3 of .22 caliber gunshots showed an appropriate system response in the Hampton test.

The system also appears quite accurate in its ability to locate gunshots. Comparison of the map coordinates of the SECURES® activations with the actual location of the tests places the identified location in most cases within a 10 ft radius of the actual test shot location.

35% of the firecrackers resulted in ground activations, and were indistinguishable from gunshots in the system. Bottle rockets resulted in activations 75% of the time, a third of these registering as ground activations. In Newport News a higher percentage of bottle rockets activated the system than did handguns.

There will in any gunshot detection system be an almost inevitable tradeoff between false positive and false negative error. To some extent the nature of that tradeoff is under the control of the police agency. This control can be exercised in two ways: by setting the sensor count required for a confirmed activation and by deciding whether to response to an aerial activation.

Table 2 shows an example of these the false positive – false negative tradeoffs in detail, based on the Hampton live-fire results. In normal operations and during the test, at least 4 sensors must activate and a location resolved for an alert to be forwarded to the police dispatcher by the system. It is possible to set the system so that a higher number of sensor activations are required for an alert. In the Hampton test, the 4-sensor criterion resulted in an 84% true positive result for gunshots (when .22 firings are included) and a 54% false positive rate for fireworks, when both ground and aerial activations are included. That is, police would respond to 84% of gunshots (97% if .22 shots are not considered) but would also respond to 54% of firework events.

If the bar were set higher, false positives would be reduced but so would true positives. Using a 6-sensor minimum criterion, police would respond to only 19% of the firework events but would miss an additional 15% of the actual gunshots. At the 10-sensor level, police would respond to none of the fireworks but would respond to only 27% of

TABLE 2:
Hampton Sensor Results (Ground & Aerial)

HAMPTON – Ground and Aerial									
	Sensor Minimum for Activation								
Source	4 (act)	5	6	7	8	9	10	11	12	TOTAL
0.45	18	18	17	14	12	10	8	4	3	18
0.38	18	18	16	14	12	6	3	0	0	18
9mm	23	23	20	18	16	13	10	5	2	23
0.22	6	3	0	0	0	0	0	0	0	18
All Handguns	65	62	53	46	40	29	21	9	5	77
True Pos %	84%	81%	69%	60%	52%	38%	27%	12%	6%	
FireCracker	5	2	1	1	1	0	0	0	0	14
Bottle Rkt	9	6	4	2	1	1	0	0	0	12
All Fireworks	14	8	5	3	2	1	0	0	0	26
False Pos %	54%	31%	19%	12%	8%	4%	0%	0%	0%	

Police might also fine-tune the tradeoff by responding only to ground activations. Table 3 shows sensor level results for ground activations only. Comparison of tables 2 and 3 indicate that responding only to ground activations would reduce false positives (at the 4 sensor level) from 54% to 38%. True positives would be cut only from 84% to 79%.

TABLE 3:
Hampton Sensor Results (Ground Only)

HAMPTON - Ground Only									
	Sensor Minimum for Activation								
Source	4 (act)	5	6	7	8	9	10	11	12	TOTAL
0.45	18	18	17	14	12	10	8	4	3	18
0.38	16	16	14	12	10	5	3	0	0	18
9mm	23	23	20	18	16	13	10	5	2	23

0.22	4	2	0	0	0	0	0	0	0	18
All Handguns	61	59	51	44	38	28	21	9	5	77
True Pos %	79%	77%	66%	57%	49%	36%	27%	12%	6%	
FireCracker	5	2	1	1	1	0	0	0	0	14
Bottle Rkt	5	4	3	2	1	1	0	0	0	12
All Fireworks	10	6	4	3	2	1	0	0	0	26
False Pos %	38%	23%	15%	12%	8%	4%	0%	0%	0%	

These results, of course, are for the Hampton SECURES® area only. Newport News results are different. A law enforcement agency must determine the parameters of these tradeoffs themselves through careful testing in each of its coverage areas, and make decisions based on those results and on available patrol manpower, current workload, policing philosophy, community relationship, and other factors.

VI. <u>Operational Impact</u>: Analysis Of Newport News and Hampton Field Assessment Data

The ultimate criterion on which the value of this technology should be judged is its value as a tool in carrying out the law enforcement agency's mission. The analyses provided here can offer useful information to address the question of operational value in a policing context, but not final policy answers.

Impact on agency operations and effectiveness:

System accuracy affects but does not determine whether its use can enable the police agency to better accomplish its mission. One problem with assessing the usefulness of the system to law

enforcement is that it can be used in a wide variety of ways in a wide variety of community environments. How an agency uses any tool, including SECURES®, often determines whether it enhances the agency's performance of its job or is a waste of resources. A gunshot detection system may enhance the law enforcement mission in a variety of ways:

1) It can enhance the quality of patrol officer response to gunshot events by:
   a) Ensuring response even to events not reported via citizen calls for service or officer observation
   b) Reduce the response time of patrol officers to gunshot events even when they are reported to citizen calls for service,
   c) Provide responding officers information on the exact location of events enabling them to respond to the appropriate site

2) The enhanced patrol officer response can speed medical help to gunshot victims

3) The enhance patrol officer response can increase the likelihood of capturing perpetrators still on or near the scene

4) Investigation of gunshot crimes can be enhanced because:
   a) The enhanced patrol officer response can lead to improved identification and/or securing of potential witnesses, vehicles, and evidence (esp. guns, drugs, money) before they can move or be moved from the scene
   b) Investigators can use the improved localization of gunshots to locate physical evidence, potential witnesses, and work out bullet paths and the locations of victims and perpetrators. Also, the exacting timing of the gunshots can be correlated with other time-stamped records (telephone, cell phone, radio, etc.) to link perpetrators, victims, and witnesses to the event in time as well as space

5) Statistics and mapping of gunshot system data can be used in crime analysis to:
   a) Determine manpower disbursement
   b) Design special enforcement tactics

c) Use for performance measurement (COMPSTAT)

d) Use in community policing applications

6) The community's awareness of the system can enhance its feeling of safety by improving its opinion of police effectiveness

7) Criminals' awareness of the system may deter gunshot-related criminal activity

The operation of a gunshot detection system can also negatively affect law enforcement operations, particularly through the generation of false alarms that cause patrol officers to be unnecessarily dispatched to calls. Unnecessary dispatches can place a burden on manpower resources and lengthen response time to actual emergency calls.

Tradeoffs between positive and negative effects of the system on operations are in part a function of the relative sizes of these effects (how many additional crimes detected? how many wasted trips?). They are also a function of value placed on different outcomes (how much additional time and trouble is worth each additional arrest? each saved victim?). Such calculations can be complex. For example, a "wasted" dispatch might not be of much moment in a patrol area where there are not many calls for service and officers spend most of their time in random patrol, but might have significant operational impact in busy areas.

These possible impacts imply that areas covered by the SECURES® system should show changes in:

1) Police response time to gunshot events
2) Gunshot-related incident arrests on/near scene by responding officers
3) Percentage of gunshot-related crimes cleared
4) Reported violent crimes
5) Survival rates of gunshot victims
6) Citizen satisfaction with police services

There is of course much complexity in both securing and interpreting data for such variables.
Some of these, such as citizen satisfaction, are not reliably measurable given the resources
available for this assessment study. Others face problems of data availability, reliability, and
interpretation.

Even if most of these problems are addressed, the research results will not indicate the potential of
the SECURES® system to have these effects (except in the case of response time – see below)
but will only indicate the effects it had in Newport News and Hampton, Virginia during the test
period for this new technology. There are a variety of reasons why our results might understate
the potential of the system:

1) As with the implementation of any new technology, it takes time, sometimes
   substantial time, for the organization to become comfortable with the technology and
   discover from experience how best to use it. These systems are not yet widely in use
   and there is thus no industry wisdom available that can be tapped for such purposes. A
   long trial and error period, therefore, is likely.

2) Both operational experience and the live-fire tests pointed to technical issues with the
   system that do not appear to be inherent in the technology but are related either to
   radio frequency interference from outside sources or coordination problems between
   SECURES® personnel and local technical staff. Since the system was not fully
   functional because of these problems during the operational period (primarily in
   Newport News) the data are not indicative of the technology's potential.

3) Even with experience, the way the system is eventually used in these two police
   departments does not exhaust its potential for its use. Other departments may develop
   more effective strategies, especially when combined with other technologies.

4) The Newport News and Hampton neighborhoods where SECURES® was
   implemented are similar. There are a wide variety of other types of urban
   environments in other cities in which the technology may be more (or less) effective.

5) The gunshot detection technology may be most effective when combined with other
technologies, especially street surveillance cameras and patrol car mobile computers.
No such combinations were in use in either location during the test periods.

6) Patrol officers in Hampton and Newport News had a dual responsibility in regard to
SECURES®. Their time on scene included effort spent tracking down witnesses and
searching for evidence in part to evaluate the effectiveness of the system. These
efforts were probably in excess of what would normally occur when dispatched to the
scene of a potential gunshot call. In addition, officers were asked to prepare formal
reports in response to each SECURES® dispatch, a requirement that was followed
religiously in Hampton. Therefore, CAD records and other indicators of use of police
manpower resources cannot be used to directly measure the impact of SECURES® on
use of resources, though, some useful indirect measures can be developed.

3   *Police Response to Gunshot Events:*

A gunshot detection system can improve police response to gunshot events in two ways: it can
alert police to gunshots when there is no other notification (citizen calls for service or patrol
officer observation), and it can shorten response time when there is notification, particularly
through a 911 call or other citizen call for service. Tables 4 and 5 summarize SECURES® related
CAD system records for Hampton and Newport News. Some dispatch records[6] indicate in their
notes that a related 911 call was received, in some cases there is a 911- based CAD record coded
in such a way as to indicate it duplicates an earlier SECURES® alert dispatch record.

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[6] In general the CAD records used for our analyses are sometimes problematic for research purposes. The primary
purpose of a CAD system is the management of police officer location, safety, and response to calls for service, as
well as serving as a communications hub and "help desk" for officers on patrol. Very busy dispatchers give top
priority to officer protection and assistance. Therefore data entry of certain times, such as officer arrival time, time
cleared the scene, and of other information, such as details of associated 911 calls and the linking of dispatch records
for the same incident, is understandably imperfect. In some cases, we have had to make "best guess" decisions when
coding this data for analysis.

In Hampton, 18% of SECURES®-related dispatches had associated 911 calls. This means that 82% of dispatches would not have occurred but for the gunshot detection system. How many of these were "legitimate"? The issue of false alarms is discussed in more detail below. But if we focus on only dispatches where physical or witness evidence was found to confirm an actual gunshot, only 39% of these "confirmed" dispatches had associated 911 calls for service. This means that 61% of the SECURES®-initiated dispatches for actual gunshot events would not have otherwise occurred. Ground activations (less likely to be fireworks) were slightly more likely to be associated with 911 calls than aerial activities.

TABLE 4
SECURES® Alerts & Calls for Service: Hampton

	SECURES Alert Dispatches							
	All Alerts		Gunshot Conf-Phys/Wit		Ground Alerts		Aerial Alerts	
Month	With CFS	total	With CFS	Total	With CFS	total	With CFS	total
2006Apr	5	14	3	6	4	12	1	2
2006May	6	17	4	8	5	15	1	2
2006Jun	1	7	0	2	1	4	0	3
2006Jul	1	25	0	0	0	13	1	12
2006Aug	2	12	2	4	1	8	1	4
2006Sept	0	9	0	3	0	4	0	5
TOTAL	15	84	9	23	11	56	4	28
Percent with CFS	18%		39%		20%		14%	

The percentages for Newport News[7] are very similar, 24% of SECURES®-initiated dispatches had associated 911 calls, and 43% of "confirmed" gunshot dispatches. In both Newport News and Hampton ground activations were more than twice as likely to be associated with 911 calls as aerial activations

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[7] Though data was available for the 12-month period August 2005-July 2006, July has been excluded from all analyses because of the firework-related alert problem in that month. See discussion below.

TABLE 5
SECURES Alerts & Calls for Service: Newport News

	Dispatches							
	All Alerts		Gunshot Conf-Phys/Wit		Ground Alerts		Aerial Alerts	
Month	With CFS	total	With CFS	total	With CFS	total	With CFS	total
2005 Aug	8	37	0	3	7	22	1	15
2005 Sept	8	17	5	6	7	12	1	5
2005 Oct	9	28	3	7	8	22	1	6
2005 Nov	10	29	0	4	7	23	3	6
2005 Dec	7	28	1	6	6	21	1	7
2006 Jan	1	14	0	2	1	12	0	2
2006 Feb	4	16	0	2	4	14	0	2
2006 Mar	4	13	2	3	4	12	0	1
2006 Apr	3	13	1	1	2	9	1	4
2006 May	3	20	1	3	2	17	0	3
2006 Jun	14	76	6	7	13	53	1	23
TOTAL	71	291	19	44	61	217	9	74
Percent with CFS	24%		43%		28%		12%	

Clearly, the operational evidence indicates that gunshot detection systems will alert police to real gunshot events of which they would otherwise be unaware. Is this information valuable? Does it lead to valuable outcomes that are attributable to the system, i.e., that would not have occurred "but for" the system?

One way to approach the question is to ask what happened on the patrol officer dispatches without associated 911 calls. In Newport News, there were four gunshot victims found on SECURES® related dispatches during the 11 month period reviewed. However, all but one of these incidents also resulted in 911 calls. 10 arrests were made on SECURES® calls (in 7 incidents), 2 were associated with 911 calls. In Hampton there were no victims indicated on SECURES®-initiated dispatches. Of 4 arrests made on SECURES® calls, only 1 had a corresponding call for service. Both a located victim and 11 arrests, then, can be attributed solely to the system.

There is some indication that public awareness of the gunshot detection system may serve to decrease gunshot-related 911 calls. This trend is clear in Hampton over time. The trend is not as clear in Newport News, but even there, after the system was announced publicly and there was associated press coverage in January 2006, the association of SECURES® alerts with 911 calls dropped from 30% (in 2005) to 19% (in 2006). The somewhat less dramatic drop in Newport News may be related to the much lower accuracy of the system there. The live-fire tests indicated fewer than 1 in 4 gunshots were probably detected during the Newport News operational period.[8]

4   Crime Reduction

One ultimate aim of a crime detection and investigation tool is a reduction in crime. Measuring SECURES® system impact on crime and solving crime offers some challenges. The only measure of criminal activity available is crimes reported to police and, as we have seen, the presence of SECURES® may affect citizen crime reporting. In addition, the SECURES® system itself may lead to the discovery and reporting of additional offenses, especially weapons offenses. Finally, it is unlikely that the full impacts of the system will be felt in these initial periods of operation, both because the respective police departments need time to learn how best to use the

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[8] Note that we cannot assume that only one in four gunshot *events* were detected, since many events might involve multiple shots, and only one shot need be detected for a dispatch to be made. The live-fire tests showed that for a series of shots less than 10 seconds apart in the same location, some shots would result in alerts and others would not.

system and because deterrent effects may increase as public awareness of the system and its capabilities grows.

The initial investigation into potential crime reduction effects in Newport News and Hampton focused on crimes reported to police in SECURES® and non-SECURES® covered areas both before and after implementation of the system. In both cases the "before" period chosen was the same monthly period one year earlier to control for possible seasonal variations. For example, the Hampton test period (April-August 2006) is compared to the same period in 2005 (April-August). In this and in other analyses below, we use a basic research design comparing before and after treatment changes in variables of interest between the experimental area (where SECURES is operational) and a control area.

The meaning of such a comparison may be interpreted as outlined in the table below. If Set 1 -> Set 2 change significantly exceeds Set 3 -> Set 4 change, this would be interpreted as a possible SECURES® effect. (Of course the SECURES® effect may be desirable or undesirable.) Otherwise, no SECURES effect is indicated.

	Time 1: Before Secures Implementation	Time 2: After SECURES Implementation
SECURES® Area	Set 1	Set 2
Control (Similar non-SECURES Area)	Set 3	Set 4

The analyses are complicated by a number of factors:

1) Since the police department had selected those areas for SECURES® coverage where it was believed gun activity was the most serious problem, even a similar control area might differ in some ways from the experimental area.

2) In Newport News incident-based reporting statistics were available only by "reporting areas" which are not coterminous with SECURES® coverage areas.

3) SECURES activated on gunshots outside the SECURES® sensor grid, and officers were dispatched to those calls.

4) In Newport News the SECURES® system was announced to the public in January 2006, so that there is a non-public (August-December, 2005) and a public (January-July, 2006) test period which might be expected to affect public and police behavior in different ways. In Hampton, the presence of the system was not, to our knowledge, officially announced.

5) Since the sensor grid is limited in coverage area (the area in Hampton is even smaller) the existence of the system may simply serve to displace criminal activity to a nearby area. It is not possible to test for displacement effects with the data available.

These issues make defining the precise boundary between SECURES®-affected and unaffected periods and areas problematic. Nevertheless it is worth approximating these times and physical boundaries for purposes of analysis. The reporting areas in the Newport News South District, which includes the two SECURES® sensor grids and the surrounding areas, were divided into two groups for analysis by their relation to the SECURES® coverage areas: those reporting areas at least partially overlapped by one of the SECURES® grids and those not overlapped by either.

Table 6 shows the offenses reported to police, and percent cleared in each area group in each year beginning in 2002. 2005 is separated into months before and after SECURES® operations began. 2006 is the period of public operation. The data show no pattern of deterrent effect for offenses reported to police. Offenses in all three categories – violent, weapons, and other – increased in SECURES® areas from the pre- to post-implementation periods. In comparison areas the change from pre to post periods was less than that in the SECURES ® areas, sometimes dramatically so. It is not clear if these patterns are meaningful or related to SECURES ® implementation. SECURES® areas were selected by the respective police departments based on greatest law enforcement need. It is possible that need was at least in part determined by the prospect of a worsening crime problem. It is also possible that increased police visibility in the area because of SECURES® dispatches affected crime reporting patterns.

TABLE 6: SECURES® Crime Effects

CITY of HAMPTON								
	SECURES® AREA				NON-SECURES AREAS			
OFFENSES	TOTAL Apr-Aug 2005	TOTAL Apr-Aug 2006	Increase/ Decrease	% Increase/ Decrease	TOTAL Apr-Aug 2005	TOTAL Apr-Aug 2006	Increase/ Decrease	% Increase/ Decrease
Violent	39	42	3	8	1040	1141	101	10
Weapons	7	60	53	757	164	201	37	23
All Other	92	144	52	57	4155	4108	-47	-1
TOTAL	145	246	101	70	5209	5309	100	2
Excluding Weapons	138	186	48	35	5045	5108	63	1
NEWPORT NEWS SOUTH DISTRICT: NON-PUBLIC PERIOD								
	4.2.1.1.1 SECURES® OVERLAP AREA				*4.2.1.1.2 NON-OVERLAP AREAS*			
OFFENSES	TOTAL Aug-Dec 2004	TOTAL Aug-Dec 2005	Increase/ Decrease	% Increase/ Decrease	TOTAL Aug-Dec 2004	TOTAL Aug-Dec 2005	Increase/ Decrease	% Increase/ Decrease
Violent	235	278	43	18	577	596	19	3
Weapons	42	125	83	198	155	172	17	11
All Other	674	898	224	33	2976	2651	-325	-11
TOTAL	951	1301	350	37	3708	3419	-289	-8
Excluding Weapons	716	1023	307	43	3131	2823	-308	-10
NEWPORT NEWS SOUTH DISTRICT: PUBLIC PERIOD								
	SECURES® OVERLAP AREA				*4.2.1.1.3 NON-OVERLAP AREAS*			
OFFENSES	TOTAL Jan-July 2005	TOTAL Jan-July 2006	Increase/ Decrease	% Increase/ Decrease	TOTAL Jan-July 2005	TOTAL Jan-July 2006	Increase/ Decrease	% Increase/ Decrease
Violent	326	398	72	22	852	886	34	4
Weapons	77	99	22	29	190	203	13	7
All Other	1056	1143	87	8	3322	3286	-36	-1
TOTAL	1459	1640	181	12	4364	4375	11	0

Excluding Weapons	1133	1242	109	10	3512	3489	-23	-1

Since citizen calls for service are a very unreliable and inconsistent source of information, gunshot detection systems should increase the number of weapons-related offenses recorded by police. Indeed, Table 6 provides strong evidence that this is the case. Such systems should also enable police to clear (by arrest or other means) both weapons offenses (random gunfire offenses, firearms possession, etc.) and violent offenses where a weapon is used, since the system should allow patrol officers to arrive at the scene more rapidly and enable patrol officers and investigators to better determine the timing and location of the shots.

Analysis of crime clearance statistics for Newport News (see Table 7) does not show clear evidence of these effects. SECURES® dispatch results indicate 7 incidents in which arrests were made. But these have little impact on the larger pattern of clearance results for violent and weapons crimes. Weapons offenses do show clearance improvements during the initial implementation period in comparison to the pre-implementation period, and this improvement occurs only in the SECURES® overlapped areas. But weapons offense clearance rates in the SECURES® areas actually declines (both in comparison to the earlier SECURES® implementation period and to its pre-SECURES® comparison period) in the second, public, operational period. The level of decline during this period is very similar to what occurs in the non-SECURES® areas. The change in violent offense clearances is either worse that comparison areas (in the non-public period) or about the same (in the public period.) These results provide little evidence of SECURES®-related improvement in the ability to solve gun-related crimes for most such crimes.

TABLE 7: SECURES® Crime Clearance Effects

NEWPORT NEWS SOUTH DISTRICT: NON-PUBLIC PERIOD

Percent Cleared	SECURES OVERLAP AREA			4.2.1.1.4 NON-OVERLAP AREAS		
	TOTAL Aug-Dec 2004	TOTAL Aug-Dec 2005	Increase/ Decrease	TOTAL Aug-Dec 2004	TOTAL Aug-Dec 2005	Increase/ Decrease
Violent	58	57	-1	57	60	3
Weapons	43	46	3	54	49	-5
All Other	36	43	7	33	36	3
NEWPORT NEWS SOUTH DISTRICT: PUBLIC PERIOD						
Percent Cleared	SECURES OVERLAP AREA			4.2.1.1.5 NON-OVERLAP AREAS		
	TOTAL Jan-July 2005	TOTAL Jan-July 2006	Increase/ Decrease	TOTAL Jan-July 2005	TOTAL Jan-July 2006	Increase/ Decrease
Violent	65	59	-6	62	56	-6
Weapons	51	42	-9	56	46	-10
All Other	40	45	5	34	34	0

Impact on Law Enforcement Resources

Since during the operational period both in Hampton and Newport News officers dispatched as a result of SECURES® alerts were responsible for attempting to evaluate the accuracy of the system we cannot use time the officers spent on site in any calculation of the manpower impact of the system. However we can measure the number of dispatches that occurred solely because of the system and attempt to determine the value of those dispatches.

Table 8 outlines the outcomes of dispatches caused by the SECURES® system. Dispatch outcomes are determined through the recorded results of the dispatch, typically recorded in the dispatchers' comments based on the officer's radio reports in Newport News, and in dispatcher notes or written officer reports in Hampton. Officers were asked to determine the cause of the SECURES activation through a search for physical evidence or witness interviews. In many cases (especially in Newport News) a cause could not be determined.

The issue of how to define a "false alarm" is complex, for example including dispatches where either 1) there was no corresponding call for service, and 2) there was no evidence found of an actual gunshot. A much better estimate, however, would include all non-CFS/non-gunshot-confirmed dispatches as false alarm, including even those where no cause was determined. This is reasonable because these unknown-cause dispatches are those in which the officer found evidence of nothing: no gunshot evidence, no fireworks, no witnesses (at least any who had useful information.) If these dispatches are counted, the results are very similar in the two test sites (probably because Newport News officers had a much higher rate of unknown-cause outcomes).

TABLE 8
"False alarm" Dispatches Caused by SECURES® system

Activation Type[9]	Total	gunshot or CFS	Other cause, no CFS	unknown, no CFS	Percent "False alarm"	Percent "False alarm" (incl. Unk.)
Hampton						
Ground	56	26	25	5	49	54
Aerial	28	5	17	7	77	82
Total	84	31	42	12	58	63
Newport News						
Ground	217	85	30	102	26	61
Aerial	74	13	19	43	59	82
Total	291	98	49	145	33	66

Of course, many police officer dispatches are "false alarm" in the sense that, upon arrival, there is no complainant and no evidence of any situation or event that requires the officer's attention. Silent burglar false alarms are the best example of such dispatches. Table 8 is one way to count what contribution the SECURES® system would make to that problem. Table 9 looks at how the existence of the SECURES® system contributes to overall patrol officer workload.

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[9] "Ground" activation dispatches include those where a combination of ground and aerial activations occurred. "aerial" dispatches are those where only aerial activations occurred.

TABLE 9

SECURES® and Weapons Dispatches vs All Dispatches

Newport News

Period	Monthly Dispatches by Type				SECURES % of Total	SECURES % of All Weapons	All Weapons % of Total
	Gunshot - Shooting	SECURES ALERT	Other	Total			
SECURES Overlap > 50%							
PreSECURES	10	<1	200	210	0.08	1.61	4.92
Non-Public	9	14	216	239	5.80	61.94	9.36
Public	5	20	182	207	9.51	78.86	12.06
SECURES Overlap < 50%							
PreSECURES	14	<1	565	580	0.03	1.15	2.50
Non-Public	20	7	637	664	1.08	26.71	4.04
Public	14	14	620	648	2.09	48.47	4.32
Adjacent							
PreSECURES	21	0	1167	1188	0.00	0.00	1.80
Non-Public	26	1	1225	1252	0.08	3.68	2.17
Public	22	1	1150	1174	0.09	4.27	2.00
Non-Adjacent							
PreSECURES	28	0	1476	1504	0.00	0.00	1.83
Non-Public	32	<1	1474	1505	0.01	0.52	2.11
Public	34	0	1379	1413	0.00	0.00	2.42

Hampton

Period	Dispatches by Type				SECURES % of Total	SECURES % of All Weaponl	Weapons % of Total
	Gunshot-Shooting	SECURES alert	Other	Total			
SECURES® Coverage Area							
Pre-SECURES (Apr-Sept 2005)	31	0	2089	2120	0.00	0.00	1.46

SECURES (Apr-Sept 2006)	17	64	2224	2305	2.78	79.01	3.51
	Hampton Non-SECURES® Areas						
Pre-SECURES (Apr-Sept 2005)	739	0	69327	70066	0.00	0.00	1.05
SECURES (Apr-Sept 2006)	712	15	69451	70178	0.02	2.06	1.04

In Newport News, SECURES®-related dispatches account for a significant percentage of all dispatches in the areas overlapped by the SECURES® grids. If we focus on those reporting areas most impacted by the system (more than 50% overlap with a SECURES® grid), almost 10% of all dispatches in the second, public test period (2006) were SECURES® related dispatches. The percentage of weapons-related dispatches (CFS calls coded "weapon" or "shooting" plus SECURES) of the total dispatches[10] increased from about 5% of all calls before SECURES® to 12% in the second operational period. About 79% of all weapons-related calls were SECURES® alerts in that period. Since in Newport News the SECURES® system probably activated only for one in four gunshots within the grids (based on the live fire tests), these results probably understate the potential SECURES® impact on patrol dispatch workload by a least a half.

In Hampton, weapons-related dispatches are in general a lower percentage of all dispatches. SECURES®, however, more than doubled the number and percentage of weapons-related dispatches in the SECURES® coverage area.

5   Interpretation re: Operational Value of the SECURES® System

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[10] The CAD records used for analysis included two types of calls excluded from this analysis. The first were "DUPNCAN" records and any other record where a dispatch time and date were not recorded, as well as records indicating an officer initiated event, such as a vehicle stop. The record counted here include only those where, as best as we could determine, an officer was dispatched to a scene as a result of a citizen call for service or SECURES alert.

The decision to install a gunshot detection system such as SECURES® in a law enforcement agency's jurisdiction will in most cases be based on an assessment of the system's usefulness as a law enforcement tool and its cost. Money spent on one technology might alternately be spent on other technologies, or on more officers, better salaries, or on other community needs. Determination of these "cost-benefit" tradeoffs will vary according to local values and conditions and the financial situation of the agency and governing authorities, and is outside the scope of this evaluation. This evaluation has focused on the accuracy of the system in detecting and locating gunshots and on how responding to those activations might impact other police patrol/dispatch activities and crime.

The question of accuracy turns out to be complex. It is clear that when the system is working properly – as in Hampton – it does an excellent job in detecting and locating outdoor gunshots in calibers of at least 9mm. But it will also activate on fireworks, perhaps 1/3 the time for firecrackers and 75% of bottle rockets fired. How big of a problem "false positives" are for a department depends on the normal patrol workload and on how often fireworks are discharged.

Experience both in Hampton and Newport News indicates that during periods such as New Years Eve and early July the system is essentially useless to law enforcement, unless the agency is concerned with vigorous enforcement of fireworks ordinances. But even at other times, fireworks-related alerts seem to represent a significant portion of SECURES® dispatches. The potential exists for mischievous juveniles or serious criminals to intentionally set off fireworks to run police around in circles. Police officials can address the false positive problem to some extent by increasing the number of sensors required for activation or by responding only to "ground" activations, but these adjustments mean that a larger percentage of actual gunshots will also be missed.

The Newport News tests revealed a serious problem with radio frequency interference resulting in 75% of the test shots being missed by the system. This is a problem, of course, that PSI and Newport News officials have to solve in that jurisdiction. But it also points to the vulnerability of the system to RFI (and other interference issues) and the need for constant testing and monitoring of the system to insure it is working properly. Such testing procedures need to be developed and

the necessary testing equipment deployed to each SECURES® operational site so that testing becomes a routine part of system maintenance, ideally by local technical staff.

This evaluation used data gathered during the initial operational test periods both in Newport News (11 months) and Hampton (6 months). It is highly unlikely that in these short periods the law enforcement agencies involved would work out the best way to use the technology in their jurisdictions. Results on crime deterrence and other community benefits should be regarded as preliminary.

SECURES® and CAD records indicate that almost 400 SECURES® activation dispatches in the two locations resulted in one additional gunshot victim discovered and 11 additional arrests.[11] There appears to be no impact of the technology on crime or clearance rates in either jurisdiction but analyses are complicated by the fact that only crimes reported to police can be counted. (There is some evidence that the presence of the system affects citizen reporting of crime.) SECURES® certainly leads to the recording of additional weapons offenses, since only 1/5 to 2/5 of gunshots result in citizen calls to police. This suggests that the system will dramatically increase the number of times patrol officers are dispatched on weapons-related call.

Are these results applicable to other jurisdictions that might adopt the system? Certainly the Hampton tests show that the system can quite accurately detect and locate most outdoor gunshots, but will also be fooled frequently by other explosive sounds, especially fireworks.

There is no doubt that the system will speed response to gunshots in any jurisdiction if the system activations are dispatched with at least the same priority as a citizen call for service. In many cases, there would be no officer dispatched without the system. The system will therefore result in more rapid assistance to some gunshot victims and, over time, might result in lives saved. It will also result in additional weapons-related arrests.

Such effects might be improved if the system is implemented in combination with other technologies. For example, if alerts are sent directly to patrol officers' vehicle laptops – with

nearest addresses and aerial photograph images – response time might be shortened significantly. Analysis of Hampton SECURES ® dispatch records indicates that about half the gunshot event to officer arrival time is taken up by the dispatch process. Median event to arrival time might be reduced from 4 minutes to 2 if officers were informed of the event directly by the SECURES® system. There is also a growing trend in large cities such as Chicago combining acoustic detection technologies with cameras in high crime areas. These integrated security sensor webs involving a number of integrated technologies might produce results quite different from those observed in Newport News and Hampton.

VII. Conclusions:

The following are the conclusions reach by the investigators regarding the deployment of SECURES® in Newport News and Hampton Police Departments:

"Live Fire" Conclusions:

a. The project support in both Newport News and Hampton was outstanding and modeled the type of partnership needed for NIJ operational tests of new technologies;

b. The technical implementation of the systems conformed to the intent defined in the NIJ proposals submitted. Police-vendor relationships in site selection, management of the equipment was judged as very effective;

c. Training of both police officers and dispatch personnel was rating as effective by almost all respondents in both Hampton and Newport News;

d. The "live fire" test results differed in the two cities. In Hampton a high rate of true positive identification of shots fired was attained along with a low rate of false positive activation for extraneous noises. In Hampton 97% (excluding .22's) yielded were matched by correct activation. In Newport News the "lives fire" was marred by low rates of true positive identification with high rates of false positive identification of other noises. More than 70% of gunshot events were missed. The

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[11] Information on the outcome of these cases was not available.

hypothesis that Radio Frequency Interference from ships in a near by shipping yard caused the problem received strong support from PSI engineering analysis.

e. The Hampton "live fire" results for handguns 9mm in caliber and greater, suggest that the SECURES® the system is very accurate in detecting gunshots taking place outdoors and in identifying them as ground shots.

f. SECURES® as measured by the Hampton "live fire" test was very accurate in its ability to locate gunshots. Analysis of activations with the actual location of the tests places the identified location in most cases within a 10 ft radius of the actual test shot location;

g. There was a noted *tradeoff* between true positive error/ and false positive error in the Hampton live fire experiment. In normal operations and during the test, at least four (4) sensors must activate and a location resolved for an alert to be forwarded to the police dispatcher by the system. It is possible to set the system so that a higher number of sensor activations are required for activation. In the Hampton test, the 4-sensor criterion resulted in an 84% true positive result for gunshots (when .22 firings are included) and a 54% false positive rate for fireworks, when both ground and aerial activations are included;

"Field Assessment" conclusions in Newport News and Hampton Police Departments:

h. There is some indication that public awareness of the gunshot detection system may serve to decrease gunshot-related 911 calls. This trend is clear in Hampton measured over time, but not evident in Newport News, In Newport News when the system was announced publicly and there was associated press coverage in January 2006, the association of SECURES® alerts with 911 calls dropped from 30% (in 2005) to 19% (in 2006). The reduced drop in" gun calls" in Newport News may be related to the much lower accuracy of the system there.

i. In Newport News with several hundred activations 10 arrests were made responding SECURES® calls (in 7 incidents), 2 were associated with 911 calls. Of 4 arrests made in Hampton on SECURES® calls, 1 had a corresponding call for

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service. Both a located victim and 11 arrests, then, can be attributed solely to the
deployment of the SECURES® system.

j. In the field assessment, the problem of unnecessary responses (false positive error)
was an important policing issue as perceived by the police executives involved in
the experiment. For example, in Hampton, 18% of SECURES®-related dispatches
had associated 911 calls. This means that 82% of dispatches would not have
occurred but for the gunshot detection system.

k. In terms of the field assessment, the findings suggest that there was an increase the
number of times patrol officers were dispatched on weapons-related calls, and
many of these calls will not be productive. In both operational test jurisdictions,
about 2/3 of SECURES®-related dispatches were "but-for false alarms" – both not
a confirmed gunshot and no call corresponding call for service. 58% of dispatches
in Hampton and 33% in Newport News were for in this category.

l. The problem of the absence of direct indicators of operational value of the system
raised the question as to the value police place upon use information delivered to
the field through the SECURES® system. For example, in Newport News, there
were four gunshot victims found on SECURES® related dispatches during the 11
month period reviewed. However, all but one of these incidents also resulted in
911 calls;

m. There was little evidence that offense "clearance" rates were affected in either
Hampton or Newport News by deployment of SECURES®. Weapons offenses do
show clearance improvements during the initial implementation period in
comparison to the pre-implementation period, and this improvement occurs only in
the SECURES® overlapped areas. But weapons offense clearance rates in the
SECURES® areas actually declines in the second, public, operational period.-after
system is announced. The level of decline during this period is very similar to
what occurs in the non-SECURES® areas;

Weapons related dispatches tended to increase following deployment of the systems. The
percentage of weapons-related dispatches (CFS calls coded "weapon" or "shooting" plus

SECURES®) of the total dispatches[12] increased in Newport News from about 5% of all calls before SECURES® to 12% in the second operational period. About 79% of all weapons-related calls were SECURES® alerts in that period. In Hampton, weapons-related dispatches are in general a lower percentage of all dispatches. SECURES®, however, more than doubled the number and percentage of weapons-related dispatches in the SECURES® coverage area.

VIII. Policy Recommendations:

What is it that might be concluded regarding policy and the promise of "gunshot technologies" as a tool for communities to manage gun violence and crime risks, based upon the assessment of SECURES® in Hampton and Newport News?

1. Clinical Testing Environments for Criminal Justice Technologies: Experiments such as the assessment of SECURES® are significant not only in terms of specific results, but rather in terms of creating a research environment to facilitate clinical assessment of emerging technologies for public knowledge and to improve these technologies. The partnership between Newport News Police, PSI and CSLJ represented a model of cooperative co-inquiry essential to developing advanced understanding of the operational uses of new technologies. In these field labs the impact of new technologies upon crime trends and policing operations are possible. These types of field partnerships are essential if NIJ is to have an impact upon improving emerging criminal justice technologies.

2. Between promise and reality: The assessors believe that it is important to address the "gap" between technology "potential" as they are articulated by vendors and what they actually might accomplish in the field in terms of cases cleared or crime

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[12] The CAD records used for analysis included two types of calls excluded from this analysis. The first were "DUPNCAN" records and any other record where a dispatch time and date were not recorded, as well as records indicating an officer initiated event, such as a vehicle stop. The record counted here include only those where, as best as we could determine, an officer was dispatched to a scene as a result of a citizen call for service or SECURES alert.

reduction. The reasons for doing this are not to eliminate particular technologies, but rather to identify faulty assumptions in order to improve the technologies and the art of criminal justice implementation. The study of SECURES® in Hampton and Newport News for examples forces one to question the importance of rapid response in reducing crime, a critical assumption, not only in this technologies, but other technologies as well. The untested assumption of the technology, that rapid police response to an acoustic "problem event" may not be founded in reality. Median event to arrival time might be reduced from 4 minutes to 2 minutes if officers were informed of the event directly by the SECURES® system, but probably not have an impact upon the resolution of the event.

3. <u>Technology or Operational Fit</u>: The focus upon the technology as the core area of NIJ emphasis should be questioned as operational factors as to how the police use the information generated by a technology may be more important than the particular technology itself. As we noted the critical gap in the Hampton and Newport News studies may not be in any deficiency in the SECURES® technology, but rather the doctrine which police use and the ways they use information. One of the ironies of the Newport News experiment was that this was the location in which Herman Goldstein[13] implemented problem oriented policing with then Chief, Daryl Stephens. Even though two of the project site commanders were involved in the problem-oriented policing experiment, there was no systematic use of SECURES® information to add to the knowledge of crime in the area, but rather the doctrine deployed was the time tested, but questionable rapid response to incidents.

4. <u>The paradoxes of crime fighting technologies</u>-Effectiveness: There are many technologies that represent themselves as "Crime Fighting "tools. The early iteration of SECURES® was positioned in the Dallas experiment[14] in l995 as an urban noise management tool, in effect addressing urban gunshot nuisances. The migration to SECURES® as a crime control device have created a standard, difficult to meet. Measuring SECURES® system impact on crime and solving

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[13] Problem-Oriented Policing NY; McGraw Hill, l979
[14] 1995 NIJ -Green

crime offers severe challenges. The only measure of criminal activity available is crimes reported to police and, as we have seen, the presence of SECURES® may affect citizen crime reporting. In addition, the SECURES® system itself may lead to the discovery and reporting of additional offenses, especially weapons offenses. Despite these methodological concerns, the question of whether SECURES® or any other gunshot technology, even in a new and improved form, can have a strong impact upon violent crime remains an open question.

5. <u>The cost of false positive alerts and unwarranted pursuits</u>: The cost of the high number of false positives represented a significant problem for the policing agencies involved, Newport News and Hampton. During a "ride along" the principal investigator went on three firecracker chases, much to the chagrin and frustration of the officers involved. As noted the research described in this report suggested that the SECURES® system will dramatically increase the number of times patrol officers are dispatched on weapons-related calls, and many of these calls will not be productive. In both operational test jurisdictions, about 2/3 of SECURES®-related dispatches were "but-for false alarms." From the police agencies involved, these pursuits involved liability and injury risks and a diversion of resources from other duties. Easing this will require reduction of false positive error rates and decisions not to pursue during celebration periods, e.g. Fourth of July. Unnecessary dispatches can stretch available manpower resources and lengthen response time to actual emergencies. Police officials can partially reduce the false positive problem by increasing the number of sensors required for activation or by responding only to "ground" activations, but these adjustments may mean that a larger percentage of actual gunshots will also be missed.

6. <u>Efficiency matters-the ROI of Acoustic Technologies</u>: There is an important issue in the experiment as to whether it is rational for a police department. One Hampton PD police executive asked speculatively if "assuming that all policing is about resource allocation, "was the use of the technologies and the obvious false pursuits, a "rational investment in police resources." Money spent on one technology might be invested on other technologies, or on more officers, better salaries, or on community prevention programs. Determination of these "cost-

benefit" tradeoffs is essential to making a determination as to whether SECURES® in its present form offers policing agencies a reasonable return on its criminal justice investment in technology, officers, lost opportunities for other activities and risk. Value questions such as the value of "an arrest", an averted violent offense and the risks and costs of "unnecessary" responses and a line of inquiry required making this assessment.

7. <u>Equity and Assessment</u>: The assessment of SECURES® in Newport News and Hampton created a high standard of scrutiny for the product. It may be unfair to compare SECURES® with other similar technologies unless those rival technologies have been subjected to similar scrutiny. As SECURES® marketing statements may be qualified by the research reported in this report, so too other vendors have made similar statements and have not verified these statements through a comparable research initiative. A "*side by side*" comparative study should be undertaken by NIJ where there is competition in terms of documented features and benefits. Where technologies face differing standards of research it places policing agencies in a role comparable to an investor deciding to invest in either a company with audited results or one with un-audited financial results.

8. <u>What went right</u>? There was much that"went right" during the Newport News and Hampton experiment. The police "*bought into*" the experiment and training, search protocol management and dispatcher decision-making were exceptional. PSI developed a strong trust relationship with executives in both Newport News and Hampton. Also many officers as judged by surveys administered, believed (questioned by later research) that SECURES® offered useful and objective information useful for patrol officers. The letdown in response enthusiasm (unwillingness to respond to SECURES® activations), evident in other gunshot experiments, did not occur in either Newport News or Hampton. The "*live fire*" results in Hampton were" a plus for the technology. In Hampton 97% (excluding .22's) yielded the appropriate response, an almost flawless performance. Also, there is no doubt that the system might speed response to gunshots, if activations are dispatched with at least the same priority as a citizen call for

service. In many cases, there would be no officer dispatched without the system being activated.

9. <u>What could have gone better?</u> Obviously, the results in terms of some of results raised a number of problematic concerns. Key among these concerns are the "system meltdown"-Newport News, high false positive error rates in both cities, the failure to initiate more "valid" arrests, assist in clearances or to reduce crime. The key question is why? While a definitive answer is problematic, there several hypotheses that need to be ruled out:

- The technology as it exists may not be readily able to optimize the trade-off between false positive and false negative error. Tuning the system "up" or " down" may exchange but not eliminate "error"-either you will find fire crackers or miss gun shots;

- The theory that "getting to a gunshot location faster is better "may be flawed. The savings of a few seconds may not alter the inevitability of the "shooter" fleeing the scene. The technology may work but not matter to police given their crime reduction mission.

- Related is the question suggested by our project mentor, Dr. Stanley Erickson that "we may know enough" (i.e. have the right theory) to develop an effective technology. This calls for an integration of crime theory and technology, a frontier beyond our present scope of problem definition.

- A PSI executive, George Orrison, suggested that a broader integrated sensor net (video, acoustic, motion, etc.) may be required if policing operations are to be affected and crime patterns altered.

- The notion (suggested by one of our project managers, Dr. Steven Edwards) that the "failure" has nothing to do with the technology, but that experiment failed to change the operational reality of the policing agencies. If true this would have a major impact upon how NIJ seeks to implement new technologies.

10. <u>Is it wise for the Public to Invest in Gunshot Technologies</u>? The history of technology suggests that many technologies that face initial difficulties may in the long run yield enormous benefits and lead to the development of new improved

and integrated technologies. Viewed in this light the assessment presented in this report may be seen as a means of leveraging the anomalies between promise and observed result to point towards engineering solutions of a" next generation" engineering solution, perhaps an integration of video, motion and acoustic technologies. Critical in the decision to invest in early stage technologies, is the question of the Public (NIJ) investment horizon. How long is it reasonable to wait for a technology to mature into a viable and operationally useful technology? It is the hope that this report is read in the spirit of uncovering uncomfortable facts as a means of propelling the field from an early stage and problematic tool, to a more effective one. When integrated into a change strategy by the agencies, better assessment approaches and new theory the generation sensor technology may have a far stronger impact upon crime control and policing, than the technology iteration used in Newport News and Hampton.

2   Deployment and Operation of SECURES®

2.1   Introduction to SECURES®

SECURES® is the civilian version of a family of acoustic gunshot detection and localization systems being developed by PSI. The technology is based on military weapons fire localization systems originally funded by Defense Advanced Research Projects Agency (DARPA) and currently owned by PSI. Military versions of the system include man portable sniper and mobile artillery detection and localization.

The system consists of a grid of acoustic sensors mounted to utility poles or buildings in the area plagued by gunfire, a radio receiver housed in a building within a mile of the sensor grid and a display terminal located at the police communications center. The sensors are completely self-contained; battery operated; and need no external connections. The sensors detect the explosive muzzle blast of a gunshot, while rejecting background noise and transmit a message to the receiver. A data communications link from the receiver to the police communications center carries the detection message. See Figure 1: System Overview.
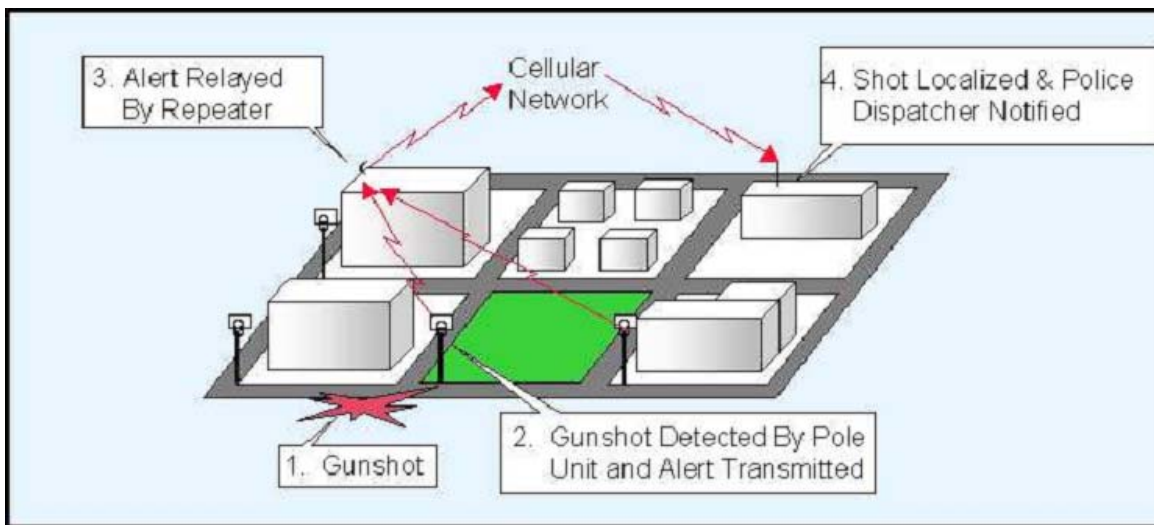
Figure 1: System Overview

Within seconds of a shot being fired, police dispatchers view the precise location on a computer display in the 911 communications center. The location and time of the gunshot is displayed on an aerial photograph of the instrumented urban area. The street network, building "footprints" as well as the closest address to the gunshot are visible on the display. A gunshot detection system has several benefits such as:

- Precise position and time of outdoor gunfire localized and recorded
- Rapid response to gunfire independent of 911 calls reporting gunfire
- Corroborates 911 calls for reports of gunfire
- More accurate incidence and location of outdoor gunshots will be known
- Assist in locating physical evidence, provides corroborating evidence
- Enhanced officer safety
- Integrated with police Standard Operating Procedures (SOPs)
- Direction of vehicle travel of drive by shootings can be determined
- Easy interface to CAD, CCTV, Mobile Computer systems

CSLJ serves as the research assessment partner with PSI and the Department of Justice National Institute for Justice (NIJ) in implementing and assessing the SECURES® gunshot detection system.   PSI arranged a joint executive staff meeting to include both Hampton and Newport News Chiefs, department heads and other staff members as well as NIJ and CSLJ. At this meeting an overview of the system was provided and the role of all parties involved from installation through implementation and assessment was defined.

2.2   SECURES Deployment in Newport News, Virginia

2.2.1 Technical Support to Deploy SECURES®

PSI coordinated with NNPD Planning Division to incorporate the SECURES® technology into the NNPD 911 Communications Center. Crime analysis techniques were utilized to identify two deployment areas with a high incidence of gunfire. Gunshot crime data was fused with Geographical Information Systems (GIS) data to determine the area where SECURES® would be deployed (Figure 2). The candidate areas were validated with NNPD command and patrol personnel as the most effective area to deploy the system.

Acoustic modeling and radio frequency propagation models were used to select sensor locations and a receiver station site. Consideration was given to the area's terrain, structure heights and utility poles, which would provide the most suitable placement of sensors for ideal coverage. The structures within the site boundaries are typically one and two story buildings of both multi and single-family dwellings. The area is largely residential with light commercial and community structures (churches, schools, etc.) within the boundaries.   The cities own Geographical Information System data was integrated into the SECURES® Display application
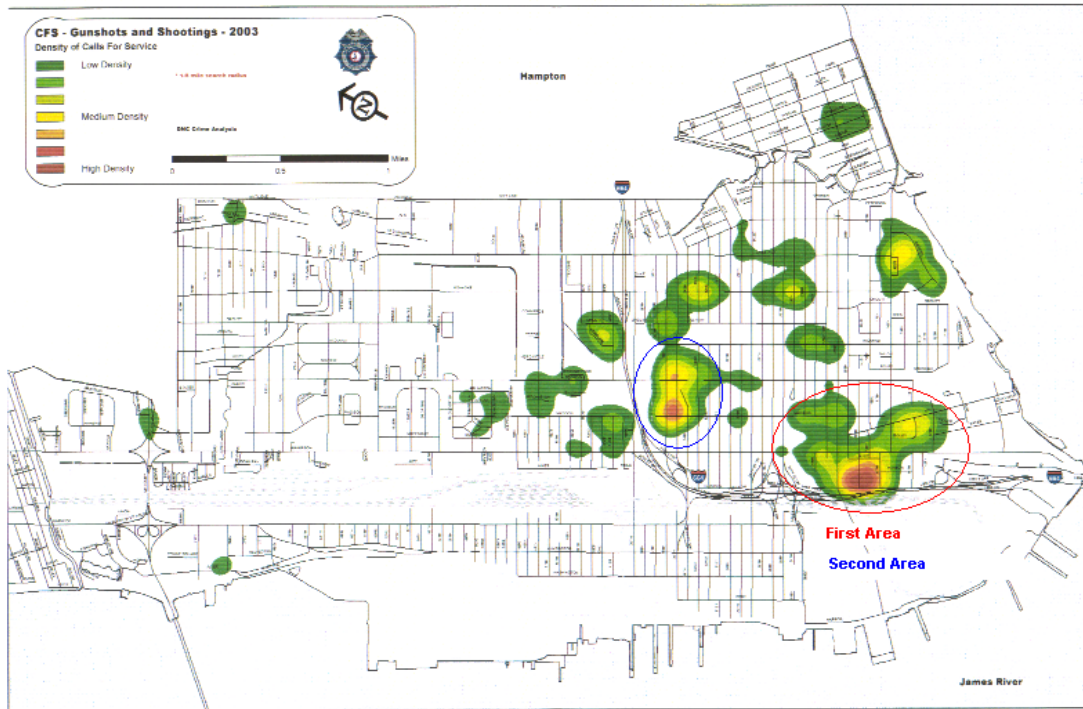
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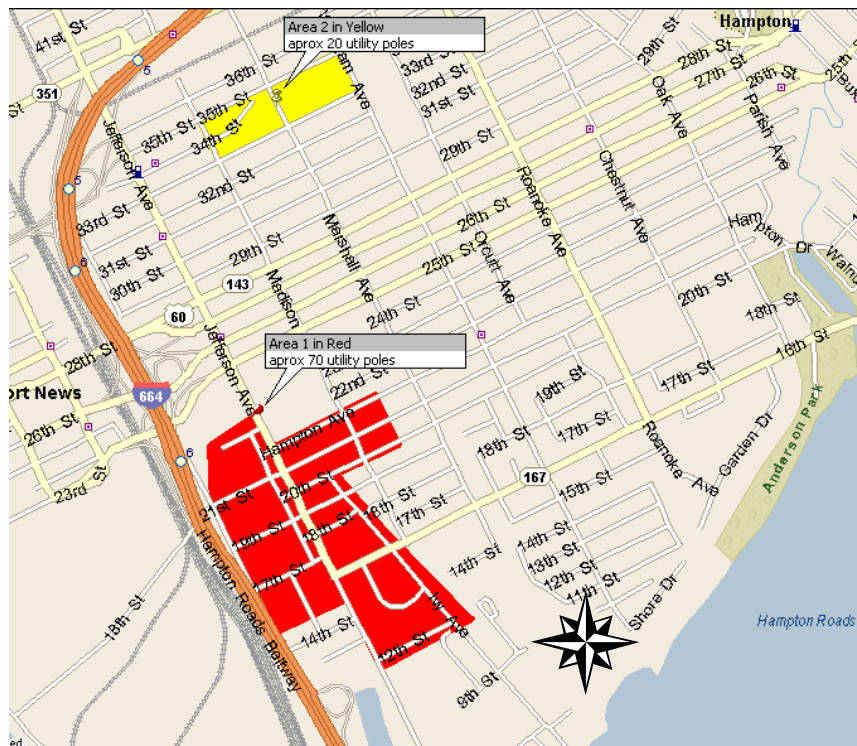**Figure 2: Gunshot Crime Density Map showing areas where SECURES was deployed in Newport News**

Figure 3: Boundaries of SECURES sensor coverage in Newport News

2.2.2 Pole Use Agreement for Sensor Mounting

By far the most time consuming step in implementation was to obtain a Pole Use Agreement. Negotiations directly between Dominion Virginia Power and PSI produced no results. Eventually negotiations were entered into between NNPD and Dominion Virginia Power as a municipal public safety measure. It was necessary for the NNPD chief of police to actively advocate that the city attorney sign the agreement. Once in place PSI found the utility pole owners – Dominion Virginia Power quite cooperative. Approval for mounting position was accomplished by onsite survey of each pole with the PSI project manager and a representative of DVP.

Figure 4: Sensor Installation in Newport News

2.2.3 Sensor Installation

With one month of the date of the agreement the system was installed and a period of quiet operations began for sensor monitoring. Services to install sensors were provided by the city of Newport News Engineering Department. All sensors were installed over a two-day period.
Figure 5 depicts the sensor grid covering two areas in Newport News. Sensors were mounted exclusively to utility poles.
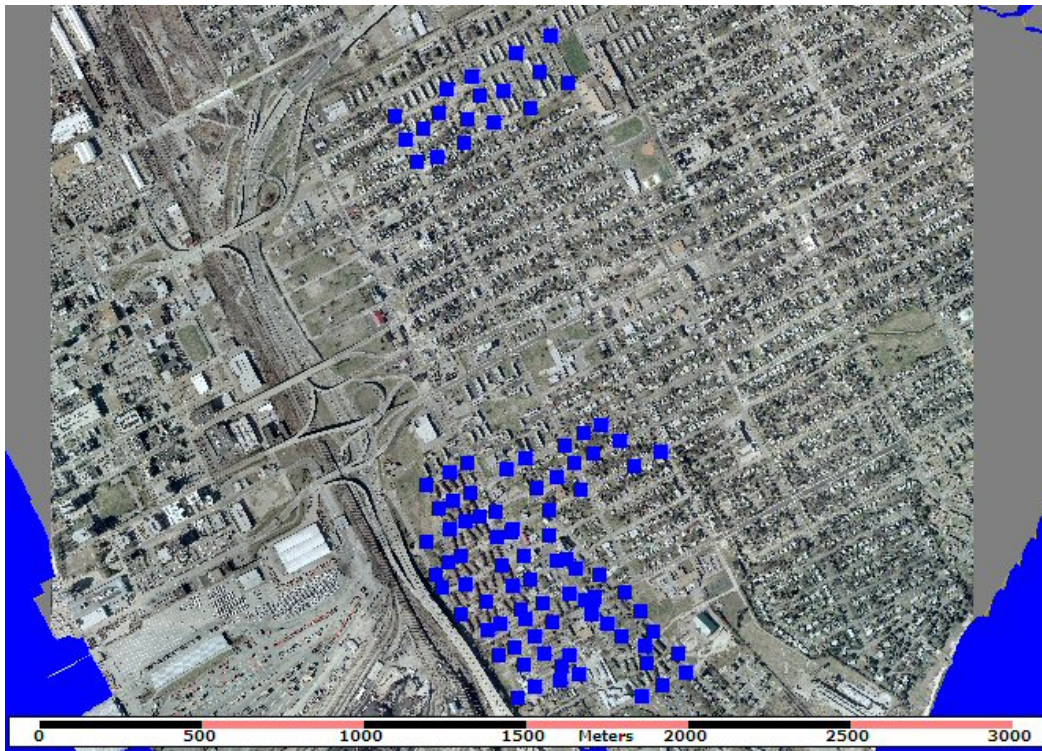
Figure 5: Sensor lay-down in Newport News

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2.2.4 Receiver Station

The SECURES Receiver Station is installed on the 10th floor radio room of the Newport News City Hall. The Receiver Station is connected to the Display Application residing on the 911 center CAD workstations by the Newport News Local Area Network (LAN)

Figure 6: NNPD SECURES Receiver Antenna

Figure 7: NNPD SECURES Receiver Station

2.2.5 Training

Training was developed and provided by UNO/CSLJ offered assistance and direct input to both PSI and the NNPD. With input from PSI and CSLJ, the NNPD developed an SOP (Standard Operating Procedure) for dispatch and patrol officers specific to a SECURES® gunshot activation which was included in all training materials and

Figure 8: CSLJ providing SECURES training

field guides. As a component of the training, PSI developed and provided a gunshot simulation program that simulates three gunshot incidents. Materials and field guides were also prepared. A critical component of the training was to standardize search procedures to allow CSLJ to determine the source of the acoustic event. The value of all information in the Newport News Assessment was dependent upon the effort NNPD officers expended in determining the source of each acoustic event through finding shell casings, fireworks residue, witness interviews etc.
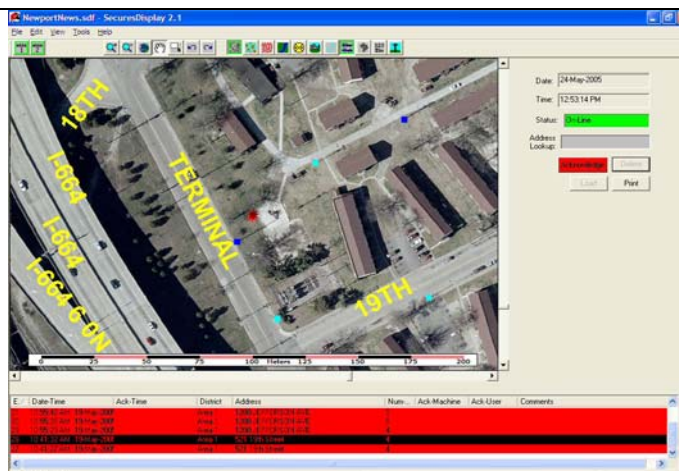
2.2.6 In Situ Live Fire Test

An in situ live fire test was planned and executed 19 May 2005 just prior to the initiation of full operational use of the system by NNPD. The purpose of this test was to validate the sensor settings and functionality of the SECURES system with live fire. Three shooting locations were chosen by the NNNPD. One was in a relatively open area with few acoustic obstructions. A second firing location was in a moderately congested area with moderate acoustic obstructions. A third firing position was selected with a high amount of acoustic obstructions.

In Situ Live Fire Test Data and Analysis

| **Firing Position 1: Open Area – Least Acoustic Obstructions** |
| --- |
| |
| Analysis – three shots:
   • Localized 2 of 3 shots (4 sensors reporting) 3rd missed shot - 2 sensors reported. High background noise was noted from adjacent freeway
   • Localization accuracy within 3.5 meters
   • Localization consistency within 1.27 meters
Consistent address resolution |

Firing Position 2: Moderate Acoustic Obstructions
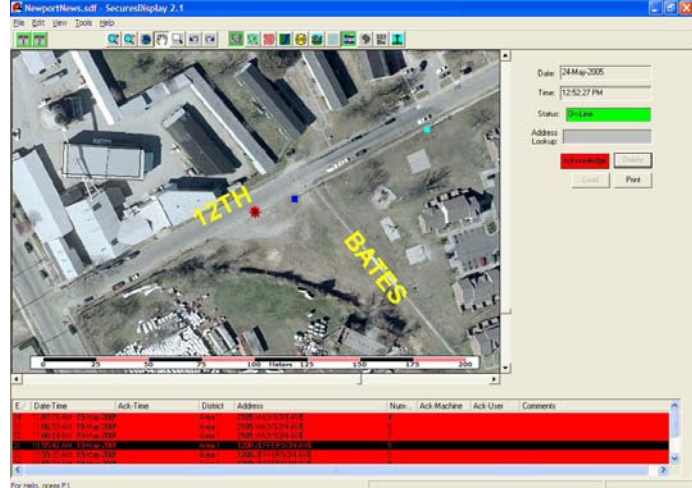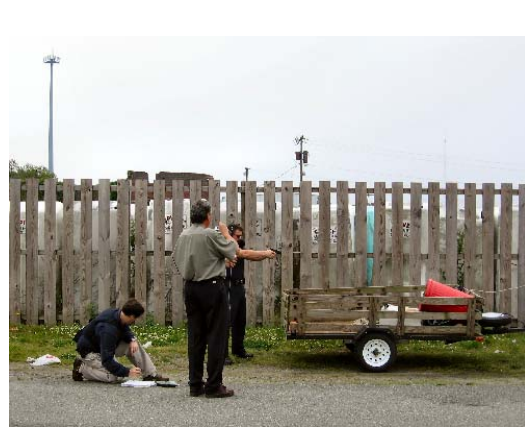
Analysis – three shots:
- Localized 3 of 3 shots (2 shots 5 sensors, 1 shot 4 sensors)
- Localization accuracy within 1.88 meters
- Localization consistency within 1.6 meters
- Consistent address resolution

Firing Point 3: Most Acoustically Obstructed
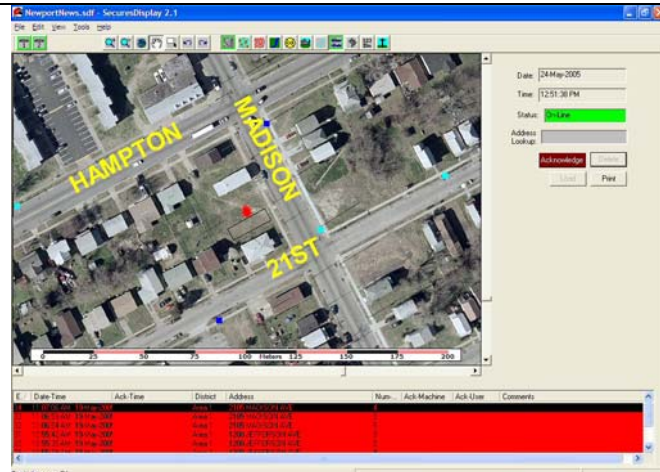
Analysis – three shots:
- Localized 3 of 3 shots
- Localization accuracy within 1 meter
- Localization consistency within 1.84 meters
- Consistent address resolution

In Situ Live Fire Test Summary

- 8 of 9 shots localized.
- All shots were correctly classified as "ground events" vs. "aerial events".
- All shot localizations accurate to within 3.5 meters, average of 2.13 meters.
- All shot localized consistently to within 1.84 meters, average 1.57 meters
- All shots consistently resolved to the correct address
- The number of acoustic obstructions (buildings) between the weapon muzzle and the sensors had no apparent effect on the systems ability to detect and correctly localize the shots.

NNPD was unable to coordinate providing weapons of different calibers for the test. Coordination with the NNFD necessary for launching aerial fireworks was not possible at the time of the test and therefore planed nuisance noise sources were unable to be tested. It is worthwhile to note that during the test there were many potential environmental nuisance noise sources which theoretically could create a false positive detection such as slamming car doors, freeway truck noise and firing position number two was adjacent to an active lumber yard. No nuisance activations i.e. False Positives were detected during the test interval; however, true system specificity could not be measured due to the inability to setoff fire works.

2.2.7 Operational Use of SECURES® by the Newport News Police Department

The NNPD SECURES® system quiet operations began in June of 2005 followed by full activation on July 27, 2005. NNPD chose that its use of the SECURES® system be "covert." For the first six months of operation the public was not aware of the presence and capabilities of the system. Upon receipt of a SECURES activation, dispatchers assigned two patrol cars priority one to the incident. Responding officers were tr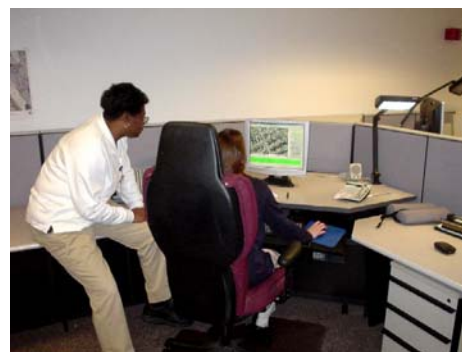ained to exit their vehicles, canvas the area for suspects, witnesses and evidence of either gunfire or some other source for the activation. Upon completion of the call, officers closed the call based on proper

Figure 9: NNPD Dispatchers using SECURES

selection of case closing reasons created for this demonstration. If evidence or bullet damage was located or a suspect arrested, an Incident Based Report (IBR) was competed. Any associated evidence was tagged and processed according to NNPD SOPs.

In January 2006, the department made a public announcement moving the experiment to an overt (open) status. The presence and capabilities of the system were publicized in at least three local television news stories and one newspaper article. The differences between outcomes during the overt and covert periods were studied by CSLJ at the conclusion of the demonstration.

2.3 SECURES® Deployment in Hampton Virginia

2.3.1 Technical Support to deploy SECURES®

PSI coordinated with HPD Plans, Analysis and Emergency Operations Branch to incorporate the SECURES® technology into the HPD 911 Communications Center. Crime analysis techniques were utilized to identify two deployment areas with a high incidence of gunfire. Gunshot crime data was plotted geographically using the cities GIS data to determine the area where SECURES® would be deployed. The candidate areas were validated with HPD command and patrol personnel as the most effective area to deploy the system.
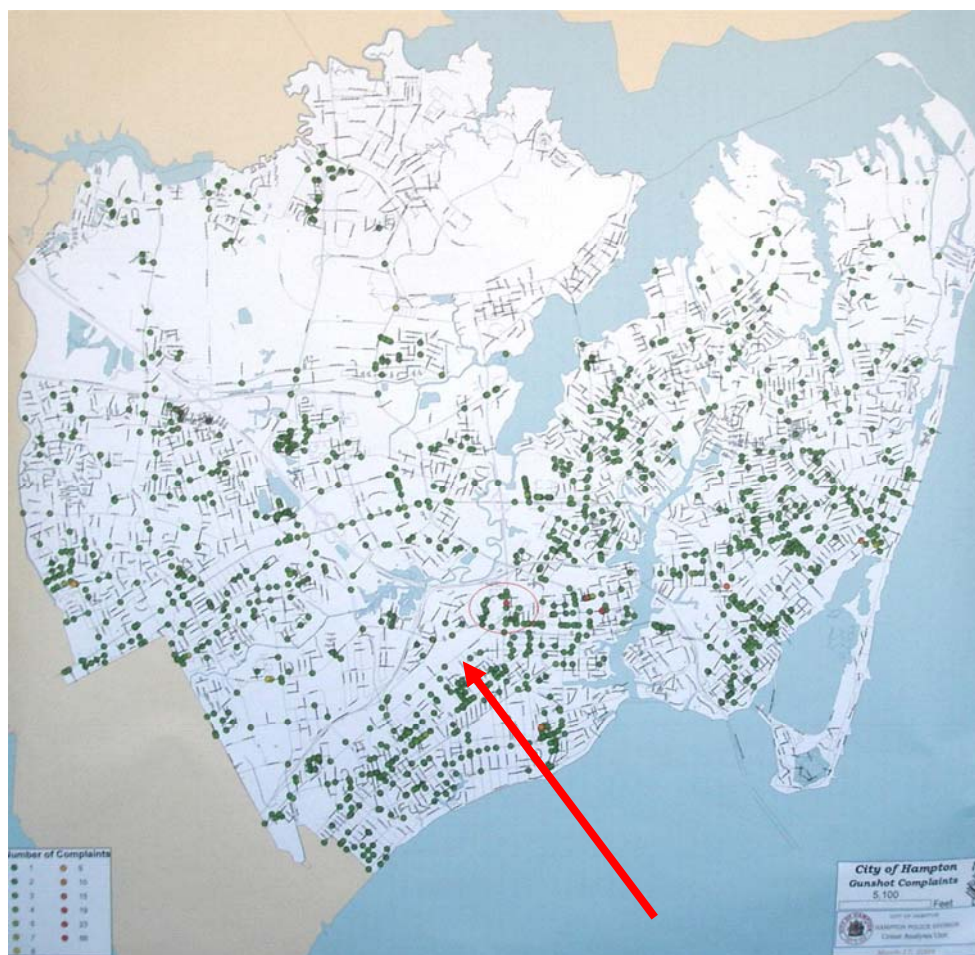

Figure 10: Gunshot point data map showing area where SECURES® is deployed in Hampton

The variety of structure heights and low utility pole density in the area to be instrumented was unlike previous SECURES® deployments. The area chosen for deployment is mainly residential with apartment communities in the central, north and west portions of the area with single-family homes and retail shops along the east and south portions of

the area. There is a single 10-story apartment building in roughly the center of the area. Railroad tracks cut through the southeast portion of the area.

SECURES® sensors proved very adaptable to this environment. Acoustic modeling and radio frequency propagation models were used to select sensor locations and a receiver station site. Consideration was given to the area's terrain, structure heights and low density of utility poles. Mounting of sensors on the roof edge of multiple apartment buildings within the sensor area more than made up for the low density of utility poles.

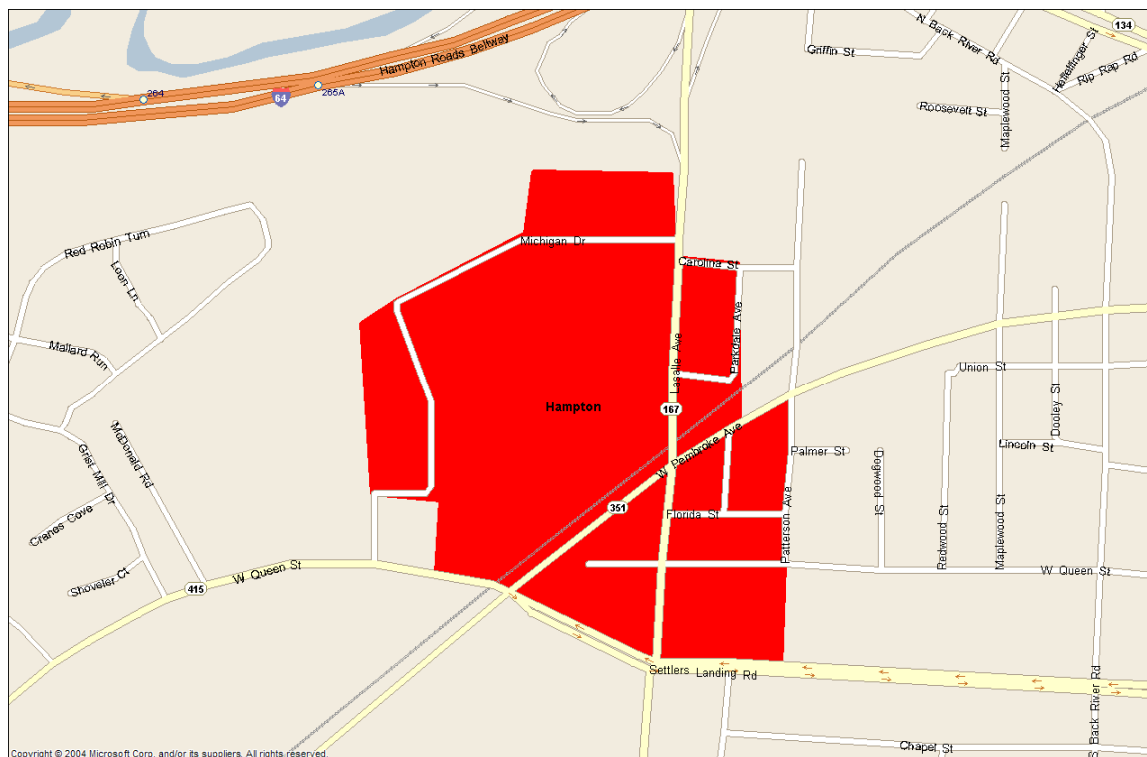The cities own Geographical Information System data was integrated into the SECURES® Display application.

Figure 11: Boundaries of SECURES® sensor coverage in Hampton VA

2.3.2 Pole Use Agreement for Sensor Mounting

Like in Newport News, securing a Pole Use Agreement represented the longest interval in implementing the system. Approval for mounting position was accomplished by utilizing the same set of rules for sensor placement as established by DVP during the NNPD sensor installation planning site survey.

2.3.3 Sensor Installation

With two weeks of the date of the execution of the pole use agreement, the system was installed and a period of quiet operations began for sensor monitoring. A bucket truck crew to assist in installing sensors was provided by the city of Hampton Parks Department. All sensors were installed over a one-day period.

Figure 15 depicts the sensor grid covering two areas in Hampton. While the majority of the sensors were mounted to utility poles and light poles, low density of poles in the apartment building areas of the grid necessitated mounting of sensors to roofs of buildings. This represents the first deployment of SECURES® sensors in this fashion. Performance of these sensors has shown to be very effective. Figures 12, 13, and 14 depict three examples of sensors deployed in this fashion. In figure 12, the sensors were affixed to the wooden facade of the building with lag screws.

In figures 13 and 14, the building manager did not want permanent mounting to the building or damage to the expensive rubber roofing membrane. Non-destructive ballast mounts were utilized. These mounts are extremely robust and can withstand very high wind gusts while being non-damaging to the roof.

Figure 12 SECURES® Sensor mounted to roof facade

Figure 13: SECURES® Sensor Installed On 11th story roof – with ballast mount at roof line

Figure 14: SECURES® Sensor Installed On 11th story roof top with ballast mount

Figure 15: Sensor lay-down in Hampton

2.3.4 Receiver Station

The SECURES Receiver Station was placed in the elevator penthouse of the 10-story, Lincoln Park Tower high-rise a HRHA site with wireless Ethernet link to police department dispatch.

Figure 16: HPD SECURES® Receiver Antenna

Figure 17: HPD SECURES® Receiver Station

2.3.5 Training

**Figure 18: CSLJ & PSI provided SECURES®
training at HPD 911 Center**

Training was developed and provided by UNO/CSLJ offered assistance and direct input to both PSI and the HPD. With input from PSI and CSLJ, the HPD developed an SOP (Standard Operating Procedure) for dispatch and patrol officers specific to a SECURES® gunshot activation which was included in all training materials and field guides. As a component of the training, PSI developed and provided a gunshot simulation program that simulates three gunshot incidents. Materials and field guides were also prepared. A critical component of the training was to standardize search procedures to allow

CSLJ to determine the source of the acoustic event. The value of all information in the Hampton Assessment was dependent upon the effort HPD officers expended in determining the source of each acoustic event through finding shell casings, fireworks residue, witness interviews etc.

2.3.6 Operational Use of SECURES by the Hampton Police Division

The HPD SECURES® system quiet operations began in March 2006 followed by full

activation on 1 April 2006. HPD chose that its use of the SECURES® system be "covert" with the public not aware of the presence and capabilities of the system. Upon receipt of a SECURES® activation, dispatchers assigned two patrol cars and one supervisor priority one to the incident. Responding officers were trained to exit their vehicles, canvas the area for suspects, witnesses and evidence of either gunfire or some other source for the activation. Upon completion of the call, officers closed the call based on proper selection of case closing reasons created for this demonstration. If evidence or bullet damage was located or a

Figure 19: HPD Dispatchers Using SECURES

suspect arrested, an Incident Based Report (IBR) was competed. Any associated evidence was tagged and processed according to HPD SOPs.