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INTRUSION DETECTION SENSOR TESTING TOOLS

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Abstract

Intrusion detection sensors must be frequently tested to verify that they are operational, and they must be periodically tested to verify that they are functioning at required performance levels. Concerns involving this testing can include: the significant amount of manpower required, inconsistent results due to variability in methods and personnel, exposure of personnel to hazardous environments, and difficulty in obtaining access to the areas containing some of the intrusion sensors. To address these concerns, the Department of Energy directed Sandia National Laboratories to develop intrusion detection sensor testing tools. Over the past two years Sandia has developed several sensor testing tool prototypes. This paper describes the evolution of an exterior intrusion detection sensor tester and automatic data logger, and also describes various interior intrusion detection sensor test fixtures that can be remotely activated to simulate an intruder.

Introduction

Most sites with physical security systems have experienced the burden of verifying that these systems are properly operational. This verification must take place frequently to identify any security components that have failed, degraded, been damaged, or have been tampered with. Not only must the intrusion detection sensors be operationally verified, but all components of the system should be examined. The tests performed on intrusion detection sensors can be categorized into two basic types; Walk Tests and Performance Tests. Walk Tests are usually performed every week, and the Performance Tests are usually performed every year. Each of these tests have unique objectives and vary in the amount of effort required. This paper discusses these tests, and some of the potential difficulties involved with accomplishing them. Then, the tools being developed to aid in this testing are described. Finally, the present status of the testing tool's development will be discussed along with plans for the future. Both interior and exterior intrusion sensors have been addressed during this project. Initially, the objective of the project was to develop a testing tool for exterior sensors. The project expanded to include testing tools for interior sensors, and this is presently the focus of the project. The project began by addressing a "User Need Statement" submitted to DOE by a DOE site, and it mentioned both manpower and safety concerns associated with testing intrusion detection sensors.

Walk Test

The Walk Test must be frequently performed to verify that the intrusion detection sensors, and the entire alarm communication and display system is operational. A typical Walk Test consists of a person walking through the detection zone of the intrusion detection sensor and verifying that the proper alarm was displayed at the alarm console. A good Walk Test produces a stimulus, at the intrusion sensor's input, of the type that the sensor is designed to detect. In other words, it exercises the sensor's detection and processing electronics. The Walk Test only verifies that the intrusion sensor is indeed detecting and the alarm is being displayed properly. A Walk Test is usually a rapidly performed test that tells if the intrusion detection sensors are working, but **does not tell how well** they are working.

Performance Test

The purpose of the Performance Test is to determine that the performance of the intrusion detection sensor is at the required level and that the sensor is integrated into the system appropriately. This test is much more intensive. It usually consists of mapping detection zones, verifying proper detection overlap, and making sensitivity or other adjustments as needed to achieve the desired performance. Sometimes a

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human is used as the detection target; other times, an object that simulates some characteristic of a human is used as a detection target. Some sensors detect an action that the intruder takes rather than an inherent human characteristic. Nevertheless, Performance Testing is an intensive examination of the sensor's detection performance and this testing can be quite involved, requiring considerable time and manpower.

Exterior Intrusion Sensor Testing Tool

The Automated Sensor Testing project began by focusing on exterior intrusion detection sensor testing. Walk Testing exterior sensors is easily accomplished by simply gaining access to the Perimeter Intrusion Detection and Assessment System (PIDAS) and walking through each sensor's detection zone while coordinating with the alarm control center. Performance Testing can be very labor intensive because the detection sensitivity must be verified to be adequate along the sensor's entire length. This may require that a certain test be repeated a 1000 or more times to verify that the microwave sensors are operating at required levels along the entire PIDAS. Extensive manpower is expended, and as the day wears on, the testing may vary due to a change in personnel pulling the test target, or because the test target is being pulled at different speeds. Recording the data requires marking and measuring distances in the field and recording the results on paper. Testing a microwave can require three persons; two to handle the test target, and one to monitor the alarm.

The Exterior bi-static microwave intrusion detection sensor was selected as the first sensor for development of a testing tool. This sensor was selected because the test target (a 12 inch diameter aluminum sphere) was already developed and proven. This testing tool development had the following goals: reduce testing manpower, provide consistent test stimulus, automate data collection, and allow data analysis on a personal computer (PC).

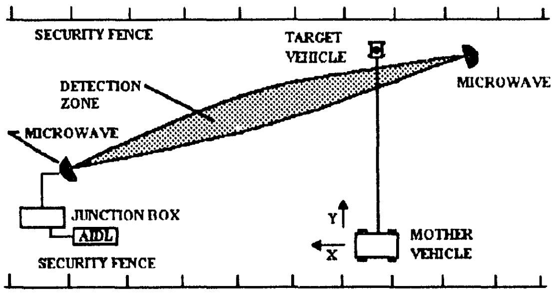

Figure 1. Exterior Intrusion Sensor Tester Concept

Figure 1 is a sketch showing the operation of the tester in a perimeter. The technician drives the tester into the PIDAS through one of the personnel gates, and aligns it parallel to one of the perimeter fences at the location where testing is to be performed. He attaches the Alarm Interface Data Logger (AIDL) to the sensor's alarm lines at the junction box and turns it on. He then enters the requested information via a touch screen menu at the Mother Vehicle. The Mother Vehicle transmits a test start message to the AIDL, and instructs the technician to launch the Target Vehicle. Position information is sent to the AIDL while the Target Vehicle crosses the PIDAS. When an alarm is detected, the AIDL records the next position as the detection location for that test. If no detection occurs before a test end message is received, a miss is recorded. After a period of time to allow the sensor to settle, the Target Vehicle is retrieved by sending another test start message and then reeling in the vehicle. The technician drives to the next location where he wishes to perform a test, and the cycle is repeated. Upon conclusion of the testing, the data is retrieved by ejecting the 3-1/2 inch disk from the AIDL. The data is recorded in a format for data analysis using common spreadsheet software and a PC.

Figure 2 shows a technician on the Mother Vehicle launching the Target Vehicle. The Mothe· Vehicle is based on a 4-wheel steered, gas powered lawn tractor. A touch screen is mounted in front of the operator and the STD bus computer and associated electronics are located under the touch screen. The computer system provides the user interface, controls motors and actuators, maintains position information via ultrasonics and odometry, and communicates to the AIDL using a spread spectrum RF modem that does not require FCC license. A ramp was designed to hold and launch the Target Vehicle.

Figure 2. Technician Operating Exterior Sensor Tester

Using the exterior sensor tester, a single technician can perform the testing that previously required up to three technicians. The data collection is automated and the data is recorded on a 3-1/2 inch disk not subject to errors typically made by individuals. The data can be printed out or graphed using a PC and common spreadsheet software.

Although the exterior tester addressed a written "User Need Statement" that was submitted to DOE, there also existed a more critical need for an interior sensor tester. The interior need was driven from different concerns than those for exterior sensor testing. These concerns and the fact that **most** DOE sites have interior sensors and only a **few** sites have large PIDAS's where the exterior sensor would be useful. These facts caused the priority to shift to developing tools to **remotely** test interior sensors.

Interior Intrusion Sensor Testing Tools

There are different concerns involved in testing interior sensors. As the name implies interior sensors are installed in a confined area, a room. The room may contain a high value asset and/or a very hazardous material. Many of the "rooms" that contain critical assets are actually vaults that are constructed to provide delay for an intruder attempting to gain access. Some of the problems encountered due to testing in these areas include the following:

1.) When access is gained by authorized personnel there is an increased insider threat. 2.) When the door to the vault is opened, there is a possible reduction in the physical security delay. 3.) In addition to physical security concerns, there are other factors that may impact the testing of sensors in vault type rooms. The frequency of inventory may be affected by the frequency of door openings. Access to these vaults is sometimes very difficult. It may involve scheduling people from security, health physics, material accountability, the vault manager, and technical security. This is expensive in manpower and can be a coordination headache. 4.) Personnel safety may be a concern in areas where hazardous material is kept.

In summary, difficulty testing interior intrusion detection sensors may exist due to security, manpower, access difficulty, or personnel safety concerns.

Interior sensors must also be Walk Tested weekly and must be Performance Tested yearly. In light of the concerns discussed above, the weekly Walk Test is most affected simply because of the frequency of testing. Therefore, the most benefit could be gained by developing a method of simulating a Walk Test that could be accomplished without needing access to the vault. The test tools being developed are remotely activated Walk Test simulators.

Balanced Magnet Switches

One of the most commonly used interior intrusion detection sensor is the Balanced Magnetic Switch (BMS). This sensor is mounted on the door and door frame and detects the door being opened. Therefore, a walk test is to open the door. To simulate a door opening, either the magnets must be moved away from the sensor, or the magnetic flux must be changed sufficiently to cause the sensor to alarm. One method of doing this is to mount the magnets on a motorized transport on the door. Pushing a button on the outside of the vault causes the motor to move the magnets one inch causing an alarm. Another method, developed by Pantex Plant personnel, is to combine an electromagnet with the BMS magnets to cause a change in magnetic flux when a button on the outside is pushed. Also, a microprocessor based door sensor with built-in self-test is being developed by a private company. These three testing methods will be evaluated at Sandia.

PIR/Microwave

Common volumetric interior intrusion detection sensors are Passive Infrared (PIR) and microwave or dual technology PIR/microwave types. The PIR sensors detect changes in infrared energy in the energy band emitted by warm bodies. Microwave sensors transmit microwave energy and detect changes in the microwave energy reflected back to the sensor. A single sensor combining both of these sensor types is very common. A method of testing a PIR sensor is to move a heated target across the detection zone of the sensor. A method of testing a microwave sensor is to move a microwave-reflective or a microwave-absorbing target across (or possibly in some cases toward) the sensor. A single test fixture has been developed to test microwave, PIR and dual

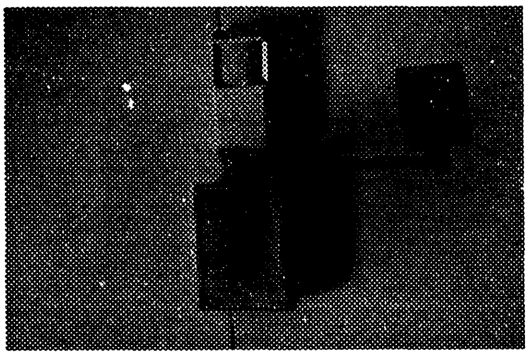

Figure 3. PIR/Microwave Test Fixture Mounted Under PIR/ Microwave Sensor

technology sensors. Figure 3 is a photo of the PIR/microwave test fixture mounted under a dual technology sensor. It contains a circuit board that receives the start command and generates the timing and motor control signals. When a button located outside the vault is pushed, the metallic target is heated for a period of time, usually to 2 degrees Centigrade or so above the ambient. This time period is adjustable, allowing the target presented to the PIR to be varied. Since the target is metallic and reflects microwave energy, it is also a suitable target for microwave sensors. After the target has heated, the motor is activated and moves the target across the detection zone of the sensor. The length of the target mounting arm can be any reasonable length, and the speed of movement is also adjustable. This allows the test fixture to be located next to or some distance away from the sensor.

The PIR/microwave test fixture addresses the concerns mentioned for Walk Testing intrusion sensors located inside vaults. In addition, the target configuration that allows installation flexibility. It can be installed to simulate a crawling intruder by sizing the target and adjusting the speed appropriately. It can be mounted across from the sensor to detect shadowing of the detection zone by items stored in the vault. It allows sensors to be individually tested. If a single alarm channel contains multiple intrusion sensors, a typical Walk Test only confirms that **at least one** of the sensors is operational, but **not** that **all** sensors in that alarm channel are operational. Finally, test fixtures present the same target to the sensor in a repeatable manner, providing consistent testing.

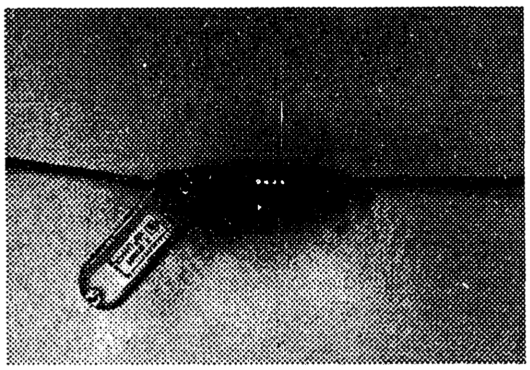

Figure 4. Wall Penetration Sensor Test Module

Wall Penetration

Another sensor type sometimes used in vault type rooms is wall penetration sensors. These sensors detect sound impulses caused by an intruder hammering on the wall in an attempt to penetrate the wall. Most of these sensors use frequency filtering and count logic in their processing. They are very similar to fence disturbance sensors used on chain link fences. The wall penetration test fixture module can be seen in Figure 4. It consists of a simple circuit board and a solenoid. This fixture was configured in modules, where each module produces a single noise impulse. The typical wall penetration sensor can be set to detect four impulses above a set amplitude within a certain time period, with each impulse separated in time by an determined amount. Therefore, the test fixture has to produce the correct number of noise impulses above the sensor's amplitude, within the counting time of the sensor. To do this, the wall penetration modules are connected together, and each module produces a noise impulse a period of time after it is triggered. The time delay is adjustable via component changes. In operation, a button, located outside the vault, is pushed to trigger the first module. When the first module fires, it triggers the next module, and so on, until they have all fired. Figure 5 shows a string of four modules. The modules are contained in condulet boxes and are connected together with a three conductor cable (power, ground, and trigger).

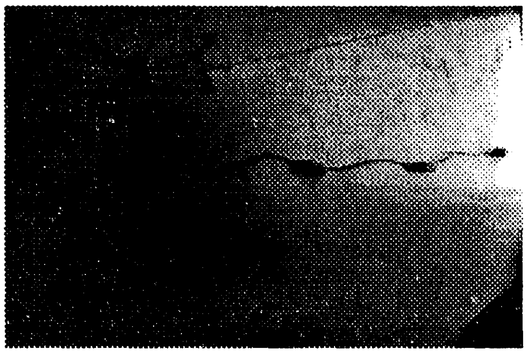

Figure 5. String of Four Wall Penetration Sensor Tester Modules

Designing the wall penetration tester in modules allows sensors with different count settings to be tested by simply installing the same number of modules as the count setting. Modules also allow the testing to be distributed along the length of the sensor, verifying the entire sensor's detection length. In addition, this tester can also be used to test fence disturbance sensors.

Present Status / Future Plans

Prototypes of all the testers have been built. Testing will be conducted on each of them to determine if they operate as expected. Some redesign or modification is expected, depending on the testing results. When satisfactory laboratory testing is achieved, they will be installed in actual sites and operated by end-users. From this feedback, we hope to learn what additional design changes are necessary prior to final release.

The exterior tester requires more software development before it is operational. There are also minor hardware items yet to be perfected. A canopy will be added to shade the operator and a carrier will be installed to carry the AIDL and some tools on the vehicle. After successful operational checkout of the subsystems, the Target Vehicle will be tested to determine if it produces an appropriate sensor response. The Target Vehicle will be modified if needed. In addition, a method to allow the Target Vehicle to also test a ported coax sensor will be investigated. End users will be asked to use or comment on the tester.

A motorized BMS tester prototype has been built. It, along with the Pantex tester method and the new microprocessor based door sensor will be evaluated by the Interior Intrusion Detection Sensor Group at Sandia. They will be evaluated for effectiveness and vulnerabilities. The results of this testing will determine what future direction BMS tester development will take.

The PIR/microwave prototype will be tested to identify any design problems. It will be used to test a commercially available dual technology sensor. The results of this testing will be compared with the results produced by a human target. Then, if warranted, various target size, shape and heating will be evaluated. It is expected that the prototype will undergo at least one more design iteration. After satisfactory laboratory testing, the tester will be placed in the field for beta testing by end users. Comments received may necessitate design changes.

The wall penetration tester will be laboratory tested to verify that the noise amplitude and delay are appropriate. It will also be evaluated to identify any other design deficiencies. The design will be changed as needed before being field tested. It will likely be tested both on wall penetration sensors and on fence disturbance sensors. Feedback from end users may indicate that several model types need to be produced.

Conclusion

The aim of this project is to develop low cost tools to reduce the manpower required for the testing and to address security and safety concerns associated with intrusion detection sensor testing. This goal will be achieved by further development of these intrusion sensor testing tools using direct feedback from the end users.

This work was supported by the United States Department of Energy under contract DE-AC04-94AL85000

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