



Partner Alliance for Safer Schools

WHITE PAPER: What Is Weapons Detection?

The volunteers who make up the Partner Alliance for Safer Schools (PASS) bring together their research and expertise from the education, public safety, and industry communities to develop and support a coordinated approach to make effective use of proven security practices for schools. The PASS team is also dedicated to developing white papers on specific, school-safety topics.

The content in these white papers may point to specific products, brands, or organizations as illustrations of how certain safety and security measures are implemented. PASS does not endorse any products or brands and only endorses those organizations listed on the partner page on the passk12.org web site. Together, the volunteers and partners of PASS share a single vision: Making all schools safer is both achievable and urgently needed.

AUTHORS

Main Author: Weapons Detection Roundtable Group

KEY TOPIC

Understanding Weapons Detection Technology

PROBLEM SOLVED

The advancement of metal detection, coupled with Artificial Intelligence (AI) and integration with other security systems, is a new technology source that schools are investigating. Unfortunately, with any cutting-edge technology, many misconceptions of what the technology is capable of are present. PASS, with the assistance of top experts, has provided a road map of weapons detection and the best practices for the use of this technology.

RELEVANT PASS GUIDELINES SECTION/S

Enhanced Technologies

MOST RELEVANT FOR

- School administrators and safety officers
- Government safety administrators
- Public safety personnel
- School board members and other governance stakeholders
- Systems integrators and consultants
- School stakeholder organizations (e.g., PTA, PTO, PTSA)

TIME TO READ

22 minutes

Introduction

Advancement in the ability to detect objects that can cause mass casualties and the rise of mass casualty events have caused schools and districts to investigate the use of this technology to further enhance the safety and security of students, staff, and visitors; however, there are many misconceptions as to what weapons detection technology can and cannot do as well as whether it is the right technology for a particular school or district. Top technology experts worked with PASS to provide an educational tool for schools and districts to better understand and implement this technology. This white paper will provide insights in the following areas:

- Definition of weapons detection technology
- How the technology fits into the Deter, Detect, Delay, Response approach to safety and security
- What expectations and process requirements are needed to implement weapons detection

The white paper focuses on metallic and firearm detection technology as these are the most relevant for schools today. While there are technologies that can address explosive devices, this paper is more focused on firearms and large mass casualty metallic objects.

Technology Definitions

“Weapons detection” as defined by Merriam Webster is “weapon: something (such as a club, knife, or gun) used to injure, defeat, or destroy” and “detect(ion): to discover or determine the existence, presence, or fact of.” This appears simple at first, but the issue is what is considered a “weapon” for each school. Is that a knife, pair of scissors, pocketknife, handgun, or semiautomatic rifle? To assist, PASS has provided some definitions for the types of technology that is present in the market today.

The technology can be categorized as physical (walkthrough detectors), audio (gunshot detection), and visual (video surveillance analytics). As with any security system, each of these systems has different advantages and disadvantages. This paper will dissect and explore how and where these systems can be implemented.

Metal Detectors:

Metal detectors are the devices that we all see at the airports and courthouses around the country. There are two types of metal detectors, passive and active. Passive metal detectors are magnetometers or “mags,” as they are commonly called. They detect only ferrous metals – metals that can be magnetized. Active metal detectors can detect ferrous and nonferrous metals. Metal detectors can be tuned to detect for a certain amount of metal from very small to very large. Originally, metal detectors would not differentiate from whether the metal was a set of car keys or pocket knife, a metal baseball bat or firearm with a long barrel; it simply detected the presence of metal. The ability to differentiate between metallic objects advanced slowly over the decades and is what we now know as a physical

weapons detection system. The NIJ 0601.1 was established 1974 to ensure that depending on how little or how much metal was to be detected, the device would meet those parameters. Metal detection has been used successfully since 1979 (Paulter Jr., 2000).

Metal detection devices are two physical types: a walk-through detector and a hand wand detector (add images). Traditionally, a walk-through metal detector is the primary means of detecting metal objects, and wand detectors are used for secondary screening for metal objects.

PASS recommends that wand detection devices are ONLY used for secondary screening for weapons.

Physical Weapons Detection:

Physical weapon detection systems use metal detection and analytics to provide more detail on the metallic object being detected. For example, many objects have enough metallic parts to set off a metal detector. Physical weapons detection systems frequently understand that many objects have a certain size, shape, and density that can be classified as a non-threat rather than a weapon and therefore does not alert a threat. The advantage to this technology is that nuisance alarms are reduced and the ability to have more people enter through the detection device (called throughput) is increased. While the ability to discriminate/differentiate between innocuous metal objects and threat objects has significantly improved compared to traditional metal detectors, weapons detectors will still alert on innocuous metal objects that are similar in metal type and/or mass to the threat items the school/district want to detect. A heavily ruggedized Chromebook may have enough metallic content to either alert a weapons detector or potentially mask an actual threat, thereby requiring the system to alert on such an object to instigate a manual search to confirm the absence of an actual threat.

Brandished Weapon Detection:

This technology is based on the use of images from security cameras to accurately identify an object as a weapon or not. Through the use of machine learning and artificial intelligence, brandished weapons detection uses key characteristics to identify whether a weapon such as a handgun, rifle, or large bladed knife is being “seen” by the video camera. Again, the use of size, shape, and even movement of the object assists in determining whether there is a weapon present. The advantage to this technology is that the ability to recognize a weapon happens in a matter of seconds without the need of people passing through a physical device. The disadvantage is that a weapon can be concealed (under clothing, in a bag, etc.) and will not be detected.

Gunshot Detection:

This technology uses sound and infrared analysis to determine that a gun has been fired. Through a comprehensive set of analytics, the technology is able to determine a gun has been fired, and in some cases, is able to provide an approximate direction of where the shot was fired. The advantage to this technology is that it is very stable and has very few false positives. The disadvantage to this technology is that a gun must be fired for the technology to respond.

X-ray Detection:

X-ray detection is commonly used to detect many different mass casualty threats including liquid, letter, shoe, and radiation bombs as well as metallic weapons.

Weapons Detection – Deter, Detect, Delay, and Response

The different types of weapons detection technology fit in various areas of the Deter, Detect, Delay, and Response matrix. The industry experts of weapons detection conclude that the different technologies fit the matrix in this manner:

Deter:

Physical weapons detection provides the best deterrent as it can detect concealed objects in addition to the deterrent effect provided by the presence and clear visibility of the physical weapon detection devices when they are deployed.

Detect:

- Physical Weapons Detection
 - Detects a firearm or other threat when concealed by a student or visitor upon entry into a school building or sporting event
- Brandished Weapons Detection
 - Detects a brandished (open-carried) firearm in the field of view of video surveillance cameras. The detection of brandished weapons is dependent on the field of view factors of the video surveillance camera.
- Gunshot Detection
 - Detects and localizes a gunshot either indoors or outdoors

Delay:

All weapons technology provides the ability to interface to other technologies to delay a threat. These integrations can include:

- Access control – locking of doors automatically

Response:

All weapons technologies provide the ability to interface to other technologies to initiate response protocols. These integrations include:

- Communication –
 - Initiating automated alerts to the building occupants to invoke a procedural response
 - Initiating alerts to the local law enforcement and first responders

Expectations for Weapons Technology

Setting appropriate expectations for weapons technology is absolutely critical for any school and/or district. The one expectation that is to be clear is that ***no weapons technology in and of itself is capable of detecting all threats***. In addition, there is no one technology or process that will eliminate weapons

from the school environment. Limiting weapons being introduced in the school is a multistep process. Weapons detection technology is only as effective as the process and procedures developed around the use of the technology. In order to properly evaluate what technology or technologies might be most beneficial to the school or district, a proper baseline of expectations and threat assessment of the specific building are required.

Baseline Expectations:

Schools and districts should begin by creating the baseline expectation that the school/district requires from the technology. PASS recommends that schools should reasonably expect that firearms and larger, tactical knives are going to be detected and not allowed in the building.

Physical weapon detection systems are now better able to discriminate the metallic signature of a weapon from the signature of an innocuous object. For example, a metal water bottle will be detected by a traditional metal detector. Physical weapons detection systems are able to “know” that a metal water bottle is a metal water bottle and not a potential weapon. These systems tend to have a lower nuisance alarm rate, which means the staff sees fewer alerts indicative of a detected threat to investigate. Users of these systems have the ability to set the detection level to identify specific weapon signatures. The basic levels are:

- Firearms with long barrels
- Handguns that contain a magazine clip
- Tactical metal knives - larger knives (larger than a Swiss Army Knife)

Brandished weapons detection systems provide highly accurate brandished weapons detection with IP cameras that have a minimum of 720p resolution. At minimum, brandished weapons technology requires the following:

- Weapon is within 1% of the total view of the camera.
- Minimum 720p resolution and the preference is 1080p or greater. Higher resolution cameras can provide more accurate detection of weapons.
- Appropriate lighting conditions as recommended by the detection system manufacturer.

Understanding and Identifying the Threat Landscape:

What is the environment that the school building resides in? Is the landscape more of an urban area that may have potential for more active shooter threats around the school perimeter, or is the landscape more suburban where the potential for active shooter threats around the school are not as prevalent? For rural landscapes, is the threat more for guns or for large bladed knives? Understanding what the major threats are; assists in deciding what to detect and how to implement weapons detection.

Physical Weapons Detection:

- Schools/Districts should identify the smallest metallic objects in a school that can be considered a weapon. These metallic objects can include, but are not limited to, scissors, paper cutters,

X-ACTO knives, and power equipment. It is important to understand that attempting to have the technology detect similar items, such as pocket knives and box cutters, may not be the appropriate solution for the specific school building.

- While the desire is to “detect everything that is a threat,” it is important that the school/district clearly decide what type of weapons to detect are the greatest priority to the school/district. The prioritization of threats should be made with the following factors in mind:
 - Policy and Procedures
 - Policies that include appropriate training and handling of confiscated weapons
 - Personnel Requirements
 - Ideally law enforcement, SROs, or properly trained security staff should be the staff using weapons detection systems.
 - Student Experience
 - How will drop off and pickup of students be affected?
 - Situational (Special Use Situational) – Ball games, theater productions, etc.
 - Questions to ask to help prioritize:
 - Portability – Does your system need to be portable? If so, how easy is it to move the system?
 - What is the minimal standard required for this school building? (Pick one.)
 - Firearms with long barrels
 - Handguns that contain a magazine clip
 - Tactical metal knives - larger knives (larger than a Swiss Army Knife)
- Schools/districts should look at the current procedures on how students, staff, and visitors enter the building. When a school is looking to find “all weapon threats,” this generally conflicts with the procedure to get students into the building. Physical weapons detection tends to reduce the throughput (the number of people that can enter the building at a time). The size of the finer or smaller weapons that are to be detected significantly increases the time for students and staff to enter the building. This could cause an issue in itself by having lines of students.

Brandished Weapons Detection:

- Evaluate FBI data for weapons violence that provides a holistic dataset to determine whether brandished weapons technology is the best fit for the district/school environment.
- Determine whether current camera locations and cameras are adequate for weapons detection.

Evaluating Weapons Detection Systems

When evaluating weapon detection systems, there are some testing criteria that schools should be aware of. These testing examples can assist in a proper evaluation of the systems.

1. Testing should be conducted for the threats that are determined to be the highest priority. As weapons detection systems have the capability to detect a wide variety of potential threats, it is important that the test be conducted for the threats identified in the threat landscape assessment. The system should be set to identify those threats before testing begins.
2. For physical weapons detection systems, testing with real firearms is the preferred way to test as long as the testing is conducted utilizing the appropriate safety precautions and ideally with a law enforcement officer present. Validation testing can also be completed using the test pieces provided and recognized by the standards put forth by the U.S. Department of Justice (DOJ) and Department of Homeland Security (DHS). It is important to test weapons of different sizes. The weapons that the school/district wants to detect are items that must be tested.
3. For brandished weapons detection systems, the preferred method is using replicas that mimic the firearms often used in gun violence. These can include airsoft weapons and other types of replicas that have the look and shape of actual firearms.
4. For physical weapons detection systems, test the orientation and placement of the weapon in different ways. Where the weapon is on a person's body and which way the weapon is pointing (e.g., up, down, sideways) are important factors when testing a system. The system should be tested with the weapon on different parts of the body, different sides of the body, and at different heights (e.g., low, middle, and upper part of the body) so that the effective "detection range" can be identified.
5. For visual (brandished) weapons detection systems, it is important to test in various locations and distances from the cameras to determine the effectiveness of the detection system. In addition, lighting is an important factor in visual weapons detection. The test should be conducted in different types of lighting conditions.
6. Test for nuisance alerts. Nuisance alarm items are items that will frequently cause a physical weapons detection system to provide an alert. It is important to test common items that would enter the school to see what items may cause nuisance alerts. The testing should be conducted using the baseline expectation of the district that is established as the result of the threat landscape assessment. Common nuisance alarm items can include laptops, umbrellas, telescoping handles on rolling bags, thick-spined binders, hard eyeglass cases, and tin crayon/pencil cases. Testing is beneficial to better understand the process and personnel that will be required to operate the systems effectively. This will help establish additional needs, such as bag checks, using handheld wands for additional screening, or other concepts to prevent nuisance alarm items from passing through the detection system.
7. Test alarm response and resolution. When an alarm is activated, certain processes need to be implemented. The processes can include separating the person from items like a backpack or briefcase and having them walk through the system a second time or wanding the person to identify what caused the alert. This is important to note as the response and resolution of an alert is an important step in identifying the standard operating practice for when a weapon is detected.
8. Test the time for screening. It is important to assess how long it will take for persons to go through the physical detection system.

9. Ideally, the testing should be conducted at the locations where the detection systems will be implemented or similar locations and environments. This will assist in ensuring that the detection system will fit the space and conditions in which it will be installed. The placement of the physical weapons detection system should also be in compliance with fire code and local AHJ standard for minimum distance from exit doors, and the devices must not block the path of egress.
10. If the school or district plans to use the physical weapons detection system, and the system will need to be moved and/or set up temporarily (i.e. basketball game, randomized screening), testing should be conducted in those locations as well.

Operational and Maintenance Considerations

Weapons detection technology does require some modifications to existing processes, procedures, and dedication of staff resources more than other technologies. The districts and schools should be aware of some of the changes and be ready to adapt procedures and staffing to ensure a successful implementation and ongoing use of the systems.

A critical factor in a successful implementation is the proper training of the personnel who will be conducting the process and utilizing the weapons screening technology. While the technology may appear easy to use, there are key factors that each person needs to know in order to make the process efficient and effective. Districts and schools should consider at least a day or more of training on the weapons detection system and conduct exercises on how the system will be utilized as well as the routine aspects of maintenance of the technology. Without the proper training at the beginning of the process, the technology may not provide the desired results.

In addition, all weapons detection technology implementations should have the support of the manufacturer for the “go live” or first few days of implementation in a “live” or normal environment. Not only do the manufacturers have personnel specific to assist with implementation, but these experts also have the knowledge of multiple implementations and are a valued resource in providing ways to best utilize the technology specific to your school or district.

With physical weapons detection systems, the process and personnel are the most important components in the success of the technology. This panel of experts recommends completing modifications of the process for entry into the buildings and/or events before implementation.

Physical weapons detection operational considerations include:

- Each entrance in which the physical detection system is implemented should consist of a minimum of one weapons detection device for each primary entry point. The baseline expectation set in this white paper for weapons detection will allow between 2400-3600 persons to enter the building for an event (e.g., concert, basketball game, theater performance) per hour in this recommended configuration. For a normal school day, districts should expect and plan that the average for persons entering the building is 300 persons per detection system for every 15 minutes. If the district and/or school desires a more detailed detection (e.g., smaller weapons

than a large knife or firearm), this will reduce the number of persons that can enter through the detection systems.

One effective method of bypassing a stationary weapon screening system is simply to avoid it. If you have multiple entrances but only screen persons entering the building at two locations each day, districts should ensure that the other entrances are secure, monitored, and/or staffed during times of the day that the majority of people are entering the building.

- Schools/Districts should consider utilizing the physical weapons technology for random screening for weapons. Establishing a method for conducting randomized physical screenings for weapons using metal detectors, wands, or bag inspections. The goal is not to profile individuals but to create an unpredictable deterrent and enhance overall safety.
- Each primary entry point with a weapons detection system deployed should have a minimum of two trained staff. When multiple weapons detection systems (lanes) are used at a single entrance, they require a minimum of two trained staff per lane/system. Ideally, the staff will be law enforcement, school resource officers (SRO), or trained district security staff. One of the staff will actively ensure that all persons enter through the detection device, and the second will be conducting bag checks and possible secondary screening of individuals.
- Preparation of the persons entering the building will assist in more accurate results and reduce the time needed for persons to pass through the systems. The use of stanchion belts and other physical and/or natural barriers that direct persons entering appropriately is encouraged. Additionally, have nuisance items such as laptops, Chromebooks, tablets out of bags/backpacks, umbrellas, and mobility devices ready to be handed to the second staff person so that these items do not alert when persons are passing through the detection system.

Prior to implementation of a physical weapons detection system, PASS recommends that the process and intent of the weapons detection system is clearly communicated to staff, students, and parents. Email, social media posts, and possibly quick videos could be used to inform the community of why the system is in place as well as what to expect when entering the school. Consider providing information such as what not to bring to the school, how the process will work, and what the process will look like. Communication of this information before implementation, repeatedly, has provided smooth implementations of weapons detection technology for districts.

Brandished weapons detection operational considerations include:

- Consider IT policies for restricting access to internal networks and remote access to the network for third party services.
- Consider the space requirements for server, data equipment.
- Understand that cameras with brandished weapons technology work ideally in a well-lit environment with unobstructed views from the camera lens. Ideally, the camera should be placed in a way that the lighting conditions are constant. As stated previously, the better the image quality of the camera view, the more accurate the weapon detection.

- Ensure that a minimum of two (2) trained staff are viewing the weapons detection camera view during the time in which high foot traffic is in view of the camera(s). Ideally, the use of a service that specializes in monitoring, reviewing, and responding to brandished weapons alerts is the most effective and accurate way to utilize the technology.
- Understand that as the brandished weapons technology is monitoring the camera image 24/7, it is important to have a primary and secondary person to receive alerts from the system at any time. This can be accomplished through a service that specializes in brandished weapons detection as well.

Process for Response to Alerts:

A new process that may need to be developed by the district is the response process and procedure, as well as recording the alerts from the weapons detection technology.

For physical weapons detection, this group recommends a process and procedure similar to the following:

- On alert, move the individual to a secondary screening area that should be 10 or more feet away from the weapons detection system area.
- Remove any bags or backpacks from the individual and conduct a search of the bag.
- Have the individual pass back through the system.
- If alerted again, move the individual to the secondary screening area and use a wand device to check for metal on the person.
- Establish a process for alerting law enforcement if a weapon is found. DHS has some best practices that can assist with this process.

For brandished weapons and gunshot detection systems, this group recommends a process and procedure similar to the following:

- On alert, a staff member verifies that the camera image(s) does contain a weapon.
- Staff member immediately notifies the appropriate personnel and/or law enforcement.
- When possible, isolate the individual from the general populace.

Reporting of alerts from the weapons technology should include the time and date of the occurrence, person (staff, student, visitor, etc.) who caused the alert to happen, and what steps were taken to respond to the alert. Ideally this information is stored in a secured digital database.

PASS recommends that the school and/or district work with the manufacturer of the technology to further develop and train the appropriate staff on the alert process to ensure optimized results.

Maintenance Considerations:

Weapons detection systems should be routinely (at minimum every year) maintained for accurate and efficient performance. The maintenance that districts should consider are:

- Server/appliance maintenance: software and firmware updates, keeping devices free of dust, etc.

- Camera maintenance: cleaning cameras, updating the firmware, ensuring that image quality is the same
- Maintaining network infrastructure to ensure optimal uptime of all equipment
- ***Testing of the systems*** should be conducted once a month with the approved manufacturer's test device(s).
- Training on the system should also be conducted once a month. As people and roles change, it is important that the personnel operating the systems are trained in the process and proper use of the technology.

Unification of Weapon Detection Technologies

All technology implementations should further build upon the unification of security and safety components and related systems by school districts. Unified systems address the difficulties of integrating technologies across different platforms and within the connected environment in which they reside. Properly implemented, a unified system eases integration of new components and allows a district to continue to evolve and expand. It is important for a school district to work with its integrator to ensure facility infrastructure can support any new technology as part of a unified system.

Schools and districts should evaluate the process and technologies in place and investigate how the weapons and gunshot detection technologies can unify with these systems to create a more secure and efficient environment for safety of students and staff.

Summary

The threat of a mass casualty incident in a school is a great cause for concern, and implementing weapons and gunshot detection technology needs to be a strategic, layered approach. The keys to evaluating and implementing the technology include setting the appropriate expectations for the process and technology, understanding and determining the threats specific to the school and/or district, and implementing proper operational procedures.

The school and/or district should set the reasonable expectation of the technologies as described in the baseline expectation in this white paper. This expectation should be clearly communicated to staff, students, parents, and the community. The threat landscape of the school or district should be thoroughly evaluated to ensure that the technology implemented will mitigate the threat.

Finally, the process and procedures for weapons detection are vital to the success of mass casualty mitigation. Schools and districts should make sure that the procedures work specific to the school environment.

The most important asset of any weapons detection implementations is the people who will be responsible for the utilization and implementation of the processes and technology. These individuals need to have the appropriate training in order to facilitate a successful implementation and reduce the risks to the school.

By focusing on a layered and tiered approach to mitigate the risk of mass casualty weapons entering the school campus and/or building, setting appropriate expectations, and investing time to train the personnel on the processes and technology, schools can successfully provide a safe and secure environment.

References

Paulter Jr., N. J. (2000). *Walk-Through Metal Detectors for Use in Concealed Weapon and Contraband Detection*. Gaithersburg: National Institute of Standards and Technology.

ASTM, New York (2010). ASTM F1468-04a Standard Practice For Evaluation Of Metallic Weapons Detectors For Controlled Access Search and Screening.

DHS, New York (2024). Walk-Through Weapons Screening Systems for Mass Casualty Threats Market Survey Report.

The School District of Lee County (2024).

https://www.leeschools.net/our_district/departments/operations/school_safety/opengate

<https://m.youtube.com/watch?v=VfliyxbaA0>

https://www.worldeyecam.com/security-cameras-lens-chart.html?srsId=AfmBOoogeFB4h9OHP6RbaGx0aN6WVtM7bPDvNAf1LW8le5Gwt_n4kbhh

<https://ipcamtalk.com/threads/motion-detection-and-distance.68392/>