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Title:
Identifying Cost-Effective Security Barrier Technologies for K-12 Schools: An Interdisciplinary Evaluation

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Project Summary

This project had three major objectives. The first was to conduct physical security surveys of K-12 schools in Arizona to compile a dataset of the physical security barrier technologies in use in those schools. The second was to survey parents and teachers to collect information about both groups' perceptions of security in their schools, this data was collected to compare parent and teacher perceptions of security with those of security experts who conducted physical security surveys of participating schools. The third objective of this research was to test commonly used door and window materials against ballistic and forced entry attack to determine the time necessary to penetrate each door and window material to establish delay times that security designers could refer to when using an emergency response time approach to school security design.

Each objective was designed to answer the following research questions:

- Question 1: What physical security barrier technologies are in use in K-12 schools and how secure, in the opinion of experienced security professionals, is each school?
- Question 2: How do parents and teachers perceive the level of security in their, or their children's, schools, and how do their perceptions compare to those of experienced security professionals?
- Question 3: How long will various doors and windows commonly used in K-12 schools withstand ballistic and force entry attacks?

The information obtained via this research is expected to provide school administrators, school security directors, and policy makers with data on what physical security barriers are in place in K-12 schools, the condition of those barrier technologies, and how stakeholders (parents and

teachers) perceive the level of security in their schools. In addition, the datasets collected during this research will provide school security data other researchers can use in future research related to physical security in schools and how stakeholder perceptions of school security influence the implementation of security measure in schools. Finally, the ballistic testing data gathered during this project should provide security designers with delay time data that will assist security designer's ability to develop physical security designs that will delay a school shooter's access to students and staff long enough for law enforcement to arrive on-scene and stop the attack.

To assess the physical security of participating schools, researchers visited 73 schools in 15 school districts and collected data on 3712 doors. The data collected includes door material, door condition, hinges, locks, door knobs, door closers, and any windows adjacent to, or in, each door. Board certified security professionals and a retired law enforcement officer then scored the security value of each type of physical security device on a scale of 0 to 5. The scores were then aggregated to arrive at an overall security score for each school that was compared to the survey responses of stakeholders.

Data on stakeholder perceptions were collected using a 43 item survey for parents and a 47 item survey for teachers delivered via SurveyMonkey. Data were collected from 614 parents and 398 teachers representing 43 K-12 schools in 8 or 9 school districts respectively. The data show that stakeholder perceptions of school security are not significantly different from those of security experts, suggesting that misinformed stakeholder influence is not a significant detriment to effective physical security in schools.

The final part of this research involved testing commonly used door and window materials in school against ballistic and forced entry attacks to establish baseline penetration times. The ballistic testing report is available in Appendix A of this report.

Research Design and Methodology

The researchers recruited public school districts throughout the State of Arizona to participate in this study. The researchers gave presentations on the study during regional emergency management meetings organized by The Arizona School Risk Retention Trust, Inc. (The Trust) a non-profit organization that provides property and liability insurance to all public schools in the state.[1] Interested meeting attendees then contacted the principal investigator to volunteer their school districts to participate in the research project.

School Physical Security Data Collection

Participants

Districts and Schools

Researchers visited and performed physical security surveys of 73 schools from 15 school districts throughout Arizona and collected data from 3,713 doors. The participating school districts consisted of large suburban, small cities, and rural school districts, three of which were located on the Navajo Reservation. No large city school districts volunteered to participate in this study.

Researchers visited each participating school and collected physical security data for every interior and exterior door (excluding storage rooms) and any windows in, or immediately adjacent to, each door. All door locks, handles, hinges, and door closers were visually inspected for damage and tested to determine functionality. The data was recorded in a standardized database using tablet computers. The database had an input form with pull-down lists of security devices for each field to ensure consistency in data collection. The locks, door knobs, dead latches, panic bars, and door closers of each door were tested and any problems were recorded in the database. Every inspection team was supervised by a board certified security professional.

After all of the data had been collected, it was cleaned, the school data anonymized, and then converted to a Microsoft Excel file so the data could be imported into SPSS. The data was then coded for statistical analysis. A scoring model was also developed by board certified security professionals and a retired law enforcement officer to rank the security value of each security item inspected during the physical security surveys. Each item was ranked on a scale of 0 to 5, with 5 indicating the highest security value. Data regarding the condition of each item were also ranked on a scale of 0 to 5 with 5 being the best condition and 0 indicating that an identified problem had a major impact on the security value of the item being assessed.

Ballistic Testing

The ballistics testing was conducted by a certified ballistics testing laboratory, NTS Chesapeake (NTS), in Belcamp, MD. Each door and window was tested against the three most commonly used calibers of ammunition – 9 mm, 5.56 mm, and 12 gauge shotgun. The number of shots used per caliber, per test were based on the standard magazine capacity for firearms of that caliber: 15 rounds for 9 mm handguns, 30 rounds for the AR-15 rifle, and five rounds for the 12 gauge shotgun. Three types of doors were tested: solid core wood, 18 gauge solid core steel, and 16 gauge solid core steel. For the window glazing tests three types of glass were tested: tempered, wired, and laminated. Each type of window was tested both with and without smash resistant film installed on the glass. Two types of smash resistant security films were used for testing: 3M 8 mil security film and 3M 8 mil Ultra+ C bond.

The following is the initial ballistics testing protocol developed by the research team and provided to NTS:

Penetration Test Protocols
for School Security Barrier Technologies

1. Scope

1.1. This document outlines test procedures for discovering the approximate time it would take an active shooter threat to breach the following, non-bullet resistant, barrier materials used in K-12 schools. Because each school shooting is unique and there are so many variables, for purposes of this study researchers are assuming the shooter will be a healthy male between the ages of 16 – 35 years old with an average build and little to no firearms training. In addition, since a school shooter will have a finite amount of ammunition and limited amount of time in which to shoot, the researchers assume that a shooter will only expend one magazine of ammunition trying to breach a security barrier.

1.1.1. Doors

- Solid Core Wood Doors
- Hollow Core Wood Doors
- Solid Steel Clad Doors
- Hollow Steel Doors

1.1.2. Gazing Materials

- Tempered Glass
- Wired Glass
- Laminated Glass
- Plate Glass
- Acrylic Window Glazing
- 8 Mil Smash Resistant Film applied to tempered, wired, laminated, and plate-glass window glazing
- 14 Mil Smash Resistant Film applied to tempered, wired, laminated, and plate-glass window glazing

2. Definitions

2.1. **Active Shooter** – An individual actively engaged in killing or attempting to kill people in a confined and populated area; in most cases, active shooters use firearms(s) and

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there is no pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly.

2.2. Blue Guns – Simulated weapons from Ring Manufacturing that are of the same weight and balance as the test weapons.

2.3. Brute Force Entry/Attack – The portion of this testing where a participant simulates an active shooter and uses physical force to enlarge a breach opening with the butt end of a rifle.

2.4. Critical Arc Area – The specified area on the door face or glazing face which will be the ballistic impact zone.

2.5. Designated Square – A 4-1/2" x 4-1/2" square to where the concentration of fire will be directed to within the *designated shooting area.*

2.6. Door Light/Narrow Lights – The small usually rectangular window placed within the door itself.

2.7. Mil – Unit of measurement equivalent to one-one-thousandth of an inch (1/1000").

2.8. Penetration Time – Researcher will use the following U.S. Army definition of penetration time: *the time it takes to make a 96-square-inch (man-sized) opening with the least dimension greater than 6 inches in a construction assembly using a given set of tools.*

2.9. Shot Zone – The area of a door or glazing material containing bullet holes as a result of ballistic testing.

2.10. Side Light – Is a window, usually with a vertical emphasis, that flanks a door or a larger window. Sidelights are narrow, usually stationary and found immediately adjacent doorways.

2.11. Smash Resistant Window Film (SRWF) – also known as anti-shatter film or security film, is a laminate used to improve post-failure performance of existing windows. Applied to the interior or exterior face of glass, SRWF holds the fragments of broken glass together in one sheet, thus reducing the projectile hazard of flying glass fragments.

2.12. Successful Penetration – When a 6-inch diameter hole has been made in the designated strike face. This size hole is large enough to fit an adult arm through the opening to unlock the door. This is considered a *penetration.*

2.13. Successful Breach – When a *man-sized* opening has been made by either material deterioration, or where a successful penetration was made and now the assailant can freely enter the door or window.

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3. Test Method Summary

3.1. Researchers will conduct ballistic and brute force penetration testing on common classroom doors (solid birch, 16-gauge and 18-gauge steel clad) using 5.56 mm, 9 mm, .357 Magnum, and 12-gauge 00 Buckshot ammunition. Every rifle and shotgun ballistic test on a door will be followed by a brute force entry attack to simulate an active shooter trying to force entry into a classroom. Every weapons test on glazing materials will be followed by a brute entry attack. Researchers will test twelve samples of each door and window glazing type against each caliber of ammunition.

3.2. Researchers will also test window glazing materials, both with and without smash resistant film applied to the glazing, to discover the penetration delay times of those materials. The research team will use two criteria for penetration time:

3.2.1. Because many classroom doors have sidelights or door lights that an attacker could breach then reach inside the classroom and unlock the door during an attack, the first criteria will measure how long it would take an attacker to create a hole large enough for an adult arm to pass through.

3.2.2. The second penetration time criteria will be the same U.S. Army criteria used for the door testing: the time necessary to create a 96 square inch hole in the material.

3.3. Time will be recorded for all testing and will be recorded on each sample. Video of all penetration tests will be recorded from two angles for later review and analysis.

4. Significance and Use

4.1. These tests are not testing for bullet resistance. The research is designed to test the resilience of these barrier technologies against ballistic and brute force to determine how long each technology will keep an intruder out of a protected area. The Sandy Hook shooting took six minutes from the time the attacker began breaching the front window of the school until killing himself in a classroom. If it would have taken him longer to enter the school, and subsequently each classroom, the delay may have resulted in fewer casualties. This research is focused on testing the delay time created by common door and window materials and is not intended to test the ballistic and brute force resistance of locking mechanisms, which is outside the scope of this project.

5. Firearms and Ammunition

5.1. **Firearms** – The following caliber firearms and ammunition will be used to conduct the ballistic portion of the testing:

- 9mm Handgun, 124 grain, full metal jacket, muzzle velocity of 1250 fps (± 50 fps).
- .357 Magnum Handgun, 158 grain, full metal jacket, muzzle velocity of 1280 fps (± 50 fps).

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- 5.56 mm AR-15 Rifle, 62 grain, full metal jacket, muzzle velocity of 3250 fps (± 50 fps).

- 12 Ga. Shotgun, 00 Buckshot, 2 3/4 in., 9 pellets, muzzle velocity 1315 fps. (± 50 fps).

5.2. Ammunition

5.2.1. All ammunition used for this testing will be manufactured in compliance with United States Military Specifications (MILSPEC), or Sporting Arms and Ammunition Manufacturer's Institute (SAAMI).

6. Test Stands

6.1. Test stand – Door The construction of the test stand will allow the stand to hold a common standard steel frame pre-hung school door with dimensions of 40 inches wide by 86 inches tall. The stand must allow the door to operate and swing normally. All doors will be mounted as outward swinging doors since that is the most common classroom configuration in K-12 schools. The stand must allow for easy mounting and removal of test doors and shall be adjustable to accommodate any variations in door framing.

6.2. Test Stand – Window Glazing All glazing test samples will be unframed in a standard size of 24 inches wide by 24 inches tall. Neoprene shims will hold the glazing material in place on the test stand. For smash resistant film tests, glazing tape or caulk will be used to mount the smash resistant film to the test stand. Test samples will be mounted in such a manner as to simulate a sidelight or narrow light mounted in a door or doorframe. When mounted to the test stand, the bottoms of the test samples will be at a height of 48 inches from the ground. The stand must allow for easy mounting and removal of glazing samples and shall be adjustable to accommodate any variations in glazing sample sizes.

6.3. Test Sample Mounting

6.3.1. The test samples shall be rigidly mounted to the test stand, simulating how a door or window would be mounted to a school building.

6.3.2. The test weapon shall be mounted at a distance of **1 foot** from the strike face, simulating an active shooter attempting to gain entry into a school door or sidelight.

6.4. Shot Placement: The placement of shots shall follow the shot placement requirements of UL Test Standard 752 to ensure consistency among samples. Since the shot pattern of an active shooter will be random and vary among shooters, this test will use a 4-½ inches x 4-½ inches designated square as an area of concentration for shot placement on both doors and window glazing materials.

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6.4.1. Shot Placement, Door: Shot placement will be on the face of the door and within the designated shooting area of the door specified below.

6.4.1.1. Beginning at a point in the center of the door knob, measuring lines 24 inches vertically and horizontally at 90 degree angles toward the top and hinge edges of the door. These two points will be connected by an arc, .3.2maintaining a 24-inch radius from the center of the door knob.

6.4.1.1.1. Shots may be placed anywhere within this area provided no shot may be more than 4-½ inches apart from the center of impact from any other shot placed on target. All shots must fit within a 4-½ inch x 4-½ inch square within the valid test area of the door.

6.4.1.1.2. The order of shots is not critical as long as they are within the parameters of the size of the designated testing square, and within the critical arc area.

6.4.1.1.3. Since each caliber tested will have a magazine capacity of at least 5 rounds or greater, after the first 5 rounds are placed according to standard, the remaining rounds may be placed anywhere in that designated square.

6.4.1.1.4. The sample is considered successfully breached when a 96 square inch hole has been made in the designated strike face. This size hole is large enough to fit an adult arm through the opening to unlock the door. This is considered a penetration.

6.4.1.1.5. The test time will pause when either the weapon magazine has been exhausted and there is no successful breach, or a successful breach has been accomplished prior to the magazine being exhausted.

6.4.2. Shot Placement – Glazing: Shot placement will be in the center of the glazing sample strike face and the first 5 shots will follow Section 17.5 of the UL 752 Testing Standard for order of specific shot placement. Since each caliber of test weapon will have a magazine capacity of at least 5 rounds or greater, subsequent shots may be placed anywhere in the designated square.

6.4.2.1. For the first five shots, shot one will be in the upper left-hand corner of the target square, the second shot will be in the upper right-hand corner, the third shot will be in the lower right-hand corner, the fourth shot will be placed in the lower left-hand corner, and the fifth shot will be in the center of the square.

6.4.2.2. The test timer will stop if the sample disintegrates or a 96 square inch hole is created in the designated strike face before firing all of the first 5 rounds.

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6.4.2.3. If the 5 shot placement has been accomplished to standard, and the glazing remains in place as an unsuccessful penetration, the remaining unexpended rounds shall be fired at the square until either a successful breach has been accomplished, or the weapon's magazine has been exhausted. The time and testing will stop at this point and the brute force attack phase of the testing will begin.

7. **Witness Material:** Witness material will be placed at 1 foot intervals on the protected side up to 4 feet away from the sample. This material is to capture the spalling of the sample's fragmentation. These witness panels will also detect any yawing or flight path change of the bullets post penetration of the sample. This data will be collected and studied for a separate portion of the test from each caliber.

8. **Apparatus (Brute Force Attack)**

8.1. This portion of the test is to record the penetration delay time of a simulated active shooter who has damaged a door or window glazing with the bullets from a firearm, and is now attempting to expand that opening to a 96 square inch opening using brute force, primarily with the butt end of the weapon. This portion of the test will be conducted by a participant simulating the active shooter.

8.1.1. Many classroom doors are solid core doors with no side lights or narrow lights. In this instance once a successful ballistic breach has been made, the sample will be subjected to the physical attack portion of the test. This will hold the same for the glazing material with smash resistant film on it.

8.1.2. Researchers will test two methods of installing smash resistant film. The first is the "daylight" method in which the film is applied only to the glass and not anchored to the window frame. The second, "wet" method will attach the film to the window frame using a specialized adhesive caulk.

8.2. Simulated Weapon

8.2.1. For safety purposes test personnel will use either unloaded weapons with chamber flags install to clearly indicate the weapon is unloaded, or weapons that have be rendered inert by removing the firing pin.

8.3. Brute Force Physical Attack, Door:

8.3.1. Elapsed time has already been recorded to each door which has been moved to this portion of the testing.

8.3.2. The participant will need to assume a firing position to simulate that he has just finished shooting the door. When the participant is ready he will reposition the blunt object as to use the butt end of his weapon and begin to strike the area of the door in which shots were placed during the ballistic test.

8.3.3. Time will resume being recorded when the participant moves from the shooting position to the attack position. The person conducting the test will forcibly and repeatedly strike the shot zone of the test surface with a simulated or inert weapon for five minutes or until a 96 square inch hole is created in the test material. If after five minutes, a 96 square inch hole has not been created, two test personnel will repeatedly strike the shot zone with sledge hammers until either a 96 square inch hole is created or five additional minutes have elapsed.

8.4. Physical Attack, Glazing:

8.4.1. Glazing samples with smash resistant window film, or others which have not disintegrated from the ballistic attack portion of this test will be subjected to the "Physical Attack" portion of this test.

8.4.2. Chronographic time has already been recorded to each glazing sample which has been moved to this portion of the testing.

8.4.3. The participant will assume a firing position to simulate transitioning from shooting to brute force attack. When the participant is ready he will reposition the blunt object as to use the butt end of his weapon and begin to strike the glazing shot zone.

8.4.4. Researchers will start the timer when the participant moves from the shooting position to the attack position. The participant will forcibly strike the shot zone until a 96 square inch opening is reached or 5 minutes have elapsed, whichever comes first.

8.5. Acceptable Criteria:

8.5.1. A successful breach will occur on any door or window glazing sample, once a 96 square inch hole is created in the test surface.

8.5.2. Each sample will be recorded as a successful or unsuccessful breach.

9. Testing Environment

9.1. The testing shall be conducted in a protected environment which can maintain room temperature conditions of 72° ±5°F.

10. Reporting:

10.1. After all tests have been completed, the testing facility will prepare a comprehensive report of all recorded data. This report will include the intent of the test, the results, all data, photographs and appendices.

11. Reference Documents

ASTM Standard F1233, *Standard Test Method for Security Glazing Materials and Systems (2013).*

ANSI/UL Standard 752, *Underwriters Laboratories Inc. Standard for Safety, Bullet Resisting Equipment (2010).*

AAMA/WDMA/CSA, 101/I.S.2/A440-11, NAFS – North American Fenestration Standard/Specification for windows, doors, and skylights (2008)

TEES, Tactical Energetic Entry Systems, *Mechanical, Thermal, Power tool, & Ballistic Breaching Couse (2018).*

The American Institute of Architects, *Security Planning and Design: A Guide for Architects and Building Design Professionals*, 84.

The above protocols were developed early in the project for the purpose of obtaining price quotations from test labs. The ballistic testing was not conducted until the end of the research period and after the physical security surveys were completed. Several changes were made to the original test protocols based on data gathered during physical security surveys of schools, budgetary concerns, and issues that arose during the ballistics testing. The following are the changes made to the test protocols.

1. Hollow core wood and steel doors were eliminated from the test protocols after data gathered during the physical security surveys revealed that neither type of door was used in schools.

2. Plate glass and acrylic window glazing were also eliminated based on physical security survey data.

3. The number of tests was reduced from 12 per test item, per caliber was lowered to 3 because of budgetary concerns.

4. The .357 magnum caliber testing was eliminated for budgetary reasons because the caliber isn't commonly used during school shootings.

5. Using each weapon as a battering ram on the doors was abandoned after the butts of the AR-15 rifle and twelve gauge shotgun broke during the first test of each caliber and the use of a 9 mm handgun was scrapped after the technician conducting the test suffered a minor hand injury during the first test of that caliber. The weapons were still used as battering rams against the window glazing materials.

6. The 14 mil smash resistant film was not testing because a newer and stronger 8 mil product, 3M 8 mil Ultra +, became available prior to testing and was used instead of the 14 mil film.

The principal investigator (PI) and research safety officer (RSO) were present during all of the door tests and the first 27 window tests. Because of COVID related supply-chain issues 54 of glass samples had not yet arrived while the PI and RSO were at NTS in August 2021. The remaining test samples did not become available until December 2021. The second round of testing would be conducted by the same technicians who conducted the first round of testing and knew how to conduct the tests according to the test protocols used during the August tests. A fixed test barrel was used to fire all test shots, and after each shot the test barrel was repositioned and aimed at another point within the target test area before firing a subsequent round. All door and window tests were video recorded from three different angles, but visibility of the target areas of the doors was partially obstructed by the test barrel in the front and the test bed structure and witness materials in the back. The complete NTS test report can be found in Appendix A of this report.

Stakeholder Perceptions Survey

Participants

Districts and Schools

Overall, the physical safety data represents 15 participating school districts and 73 participating schools from across Arizona. The school districts consist of large suburban, small cities, and rural school districts, three of which were located on reservations. No large city school districts volunteered to participate in this study. The teacher and parent data represents 43 schools within 8 or 9 school districts, respectively (see below).

Parents

Participants included 614 parents or guardians who had a least one child attending one of 43 schools (i.e., elementary, middle, or high school), within one of nine school districts in the State of Arizona. Four hundred and one (n = 401) self-identified as females and 119 self-identified as males (94 missing data points). The participants' average age was 43.64 (SD = 8.70), with an age range from 23 to 78 years old. Participants self-identified as white, non-Hispanic (66%), Hispanic (10.3%), black or African American (.5%), American Indian (4.6%), Asian (.7%), and Native Hawaiian or Pacific Islander (.2%; 110 missing data points).

Teachers

Participants included 384 teachers who taught at one of 43 schools (i.e., elementary, middle, or high school), within one of eight school districts in the State of Arizona. Two hundred and ninety-two (n = 292) self-identified as females and 86 self-identified as males (six missing data points). The participants' average age was 45.38 (SD = 12.77), with an age range from 22 to 100 years old. Participants self-identified as white, non-Hispanic (84.4%), Hispanic (7.8%), black or African American (.5%), American Indian (1%), Asian (.3%), and Native Hawaiian or

Pacific Islander (.3%; 18 missing data points). The participants' reported an average job tenure of 7.12 years (SD = 6.65), with a range from .17 to 40 years at their school (26 missing data points).

Measures and Recruitment of Parents and Teachers

Two members of the research team with expertise in item and assessment tool development created a parent and teacher survey, both of which were designed to assess parent and teacher perceptions, respectively, of their school's safety. Both survey instruments also assessed demographics, some of which are set forth above (see Appendices B and C for a full list of demographics assessed). The parent survey consisted of 43 items, which are attached in full to this report as Appendix B. The teacher survey consisted of 47 items, which are also attached in full to this report as Appendix C. There was an English and Spanish version of each survey. The English version was first translated into Spanish, then back translated into English to identify mistranslations. No mistranslations were identified. This two-step process was conducted by two different individuals fluent in both languages.

Once developed, all survey items were inputted into SurveyMonkey, an online survey platform, for administration. Members of the research team asked all participating districts to forward the survey links (English and Spanish versions) via their parent and teacher email distribution lists. A letter preceded entry into each survey that informed participants of the nature of and eligibility for the study and that participation was completely voluntary and confidential.

Analytical Approach

Once data collection was complete, data were cleaned, and missing values were identified and coded -99 (missing) or -33 (not applicable or "I don't know"). All analyses were conducted via IBM SPSS, version 27.

Results

Physical Security Survey

Door Construction

Data were collected from 3713 doors, 3146 of which were classroom doors. The most common type of classroom door was solid core wood doors, which comprised 49.8% of the classroom doors surveyed. The second most common type of classroom door was solid core steel at 42.2% (Figure 1).

Door Material

		N	%
Aluminum Solid Core		12	0.3%
Aluminum - Hollow		9	0.2%
Aluminum - Solid		6	0.2%
Corrugated - Metal		4	0.1%
Fiberglass - Hollow		2	0.1%
Fiberglass - Solid		35	0.9%
Glass		3	0.1%
Steel - Hollow Core		152	4.1%
Steel - Solid Core		1567	42.2%
Wood - Hollow Core		42	1.1%
Wood - Panel		22	0.6%
Wood - Solid Core		1847	49.8%
Wood - Solid Core Dutch		1	0.0%
Missing	-99	9	0.2%
	-33	1	0.0%
Total		3712	100.0%

Figure 1: Classroom Doors by Door Material

Lockable from Inside the Classroom

In the event of an active shooter event, the ability to lock classroom doors is critical. In 2015, the Sandy Hook Advisory Commission recommended that every classroom be equipped with a lock that could be locked from inside the classroom, finding that, “There has never been an event in

which an active shooter breached a locked classroom door".[2] Of the classrooms surveyed 22% could not be locked from inside the classroom, which would require teachers to expose themselves outside the classroom in the event of an active shooter at the school. A few schools (6.4%) mitigated this problem by using devices to block the door latch so the door knob could be kept locked at all times while still allowing free ingress and egress to the room. In the event of an active shooter, teachers can remove these latch blockers from inside the classroom allowing the door latch to extend into the door frame and locking the door.

Door Latches

A door latch extends into the door frame to hold a door closed and retracts into the door when the door lever or door knob is turned. The most commonly used latch in classroom is the deadlatch, which is used on 85.6% of classroom doors (Figure 2). A deadlatch is a more secure type of latch because, unlike an ordinary door latch, has a mechanism that makes it difficult to force the open by sliding something thin, such as a credit card, between the door and door frame to unlock the door.

Latch Type

		N	%
Spring Latch		176	5.6%
Dead Latch		2695	85.6%
Dead Bolt		253	8.0%
Barrel Bolt		2	0.1%
Rod and Stay		2	0.1%
Vertical Rod		2	0.1%
Slide Latch		3	0.1%
77		2	0.1%
Missing	-99	7	0.2%
	-33	5	0.2%
Total		3147	100.0%

Figure 2: Classroom Latches by Type

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Door Lites and Side Lites

To allow visibility into classrooms, most classrooms (90.5%) have either a door lite (60.4%) or side lite (30.1%). Door lites and side lites are widows that are either installed in a door or immediately adjacent to a door. The advantage of these windows is that the inside of a classroom can be observed at any time. The disadvantages are that during an active shooting a shooter can see into classrooms and locate potential victims, and the lites can be broken out – allowing an attacker to reach inside the classroom and open the door from the inside. The most common glazing material for these windows is tempered glass, which shatters into many small fragments that fall out of the window when broken.(Figure 3)

Figure 3: Broken Tempered Glass

Because tempered glass shatters and collapses out of the window frame, it presents a vulnerability to classrooms as an attacker can easily shoot out the glass to gain entry. The photo in Figure 3 was taken after a test sample of tempered glass had been shot twice with 9mm ammunition.

Wired glass was the second most common lite glazing material. Wired glass is weaker than standard float glass and it breaks easily, it can't be tempered because of the wires running through the glass and when broken, breaks into long sharp jagged shards that can cause serious injury.[3]

Laminated glass was the glazing material that was most resistant to forced entry during the ballistic testing phase of this research (See Appendix A). Unfortunately, it was only used in 3% of door lites (Figure 4) and 2.6% of side lites (Figure 5) surveyed.

Door Lite Glazing

		N	%
Tempered		966	30.7%
Wired		754	24.0%
Acrylic/Polycarbonate		32	1.0%
Laminated		93	3.0%
Plate		26	0.8%
Obscured Tempered		17	0.5%
Obscured Wired		1	0.0%
Opaque Glass		2	0.1%
Missing	-99	17	0.5%
	-33	1239	39.4%
Total		3147	100.0%

Figure 4: Door Lite Glazing Material

Side Lite Glazing

		N	%
Tempered		431	13.7%
Wired		205	6.5%
Acrylic/Polycarbonate		10	0.3%
Laminated		83	2.6%
Plate		222	7.1%
77		1	0.0%
Missing	-99	6	0.2%
	-33	2189	69.6%
Total		3147	100.0%

Figure 5: Side Lite Glazing Material

Door Lite and Side Lite Coverings

Some schools used window coverings to block visibility into classrooms through door lites and side lites. Most of the window coverings were improvised, using paper taped to the window glazing to block visibility from outside the classroom. In some cases, the schools used

red and green construction paper that was taped together so that one side was red and the other green. In the event of an active shooting, teachers could use the colored paper to signal to first responders whether there were injured persons inside the classroom – red indicating injuries and green indicating no one being injured.

Door Lite Covering

		N	%
Shades		7	0.2%
Blinds		4	0.1%
Curtains		63	2.0%
Obstructive Film		69	2.2%
Tape		1	0.0%
Other - Nonspecific		6	0.2%
Opaque Glass		5	0.2%
Paint		8	0.3%
Paper - Other		653	20.7%
Paper - Red/Green		53	1.7%
None		1000	31.8%
Missing	-99	22	0.7%
	-33	1256	39.9%
Total		3147	100.0%

Figure 6: Door Lite Coverings

Side Lite Covering

		N	%
Shades		4	0.1%
Blinds		345	11.0%
Curtains		163	5.2%
Obstructive Film		14	0.4%
Paint		3	0.1%
Paper - Other		155	4.9%
Paper - Red/Green		1	0.0%
No Covering		259	8.2%
Missing	-99	10	0.3%
	-33	2193	69.7%
Total		3147	100.0%

Figure 7: Side Lite Covering

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The paper window coverings were improvised by schools to obstruct visibility into the classroom during an active shooter event. This was just one of several improvised security "fixes" observed during the physical security surveys. For example, in some of the schools with classroom doors that could not be locked from the outside the schools used straps, magnets, and tape to block the latches from entering the door frame (Figure 8). These latch blockers allow teachers to keep the door handle in the locked state at all times, but allows free ingress and egress during the school day. If an active shooter event were to occur, the teachers can remove the latch blockers from inside the classroom to lock the door closed without having to go outside the classroom to lock the door and possibly exposing themselves to the shooter.

Latch Blocker

		N	%
Magnet		120	3.2%
Strap		82	2.2%
Tape		14	0.4%
Missing	-99	15	0.4%
	-33	3481	93.8%
Total		3712	100.0%

Figure 8: Number of Latch Blockers by Type

Latch blocker and paper window covering were not the only improvisation observed in schools. In some cases in which there was a problem with a lock or door latch, school maintenance or custodial personnel would jury-rig a solution rather than fixing the problem correctly by replacing the broken or missing part. This could be due, in part, to limited maintenance budgets, but in some cases the jury-rigging appeared to be the result of a lack of knowledge or training. For example, in one school, researchers found a double-door fire exit that was locked using two brackets, one mounted on each door, with a U-shaped bar that dropped into both brackets and spanned across the center mullion to prevent the doors from being opened – creating a safety hazard and fire code violation (Figure 9, Frames 1 & 2). Upon closer inspection, the researchers

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discovered that one of the latch strikes on the center mullion was missing a screw, which prevented the door from being held shut when locked (Figure 9, Frame 3). The strike could have been repaired correctly by simply replacing the missing screw (Figure 9, Frame 4).

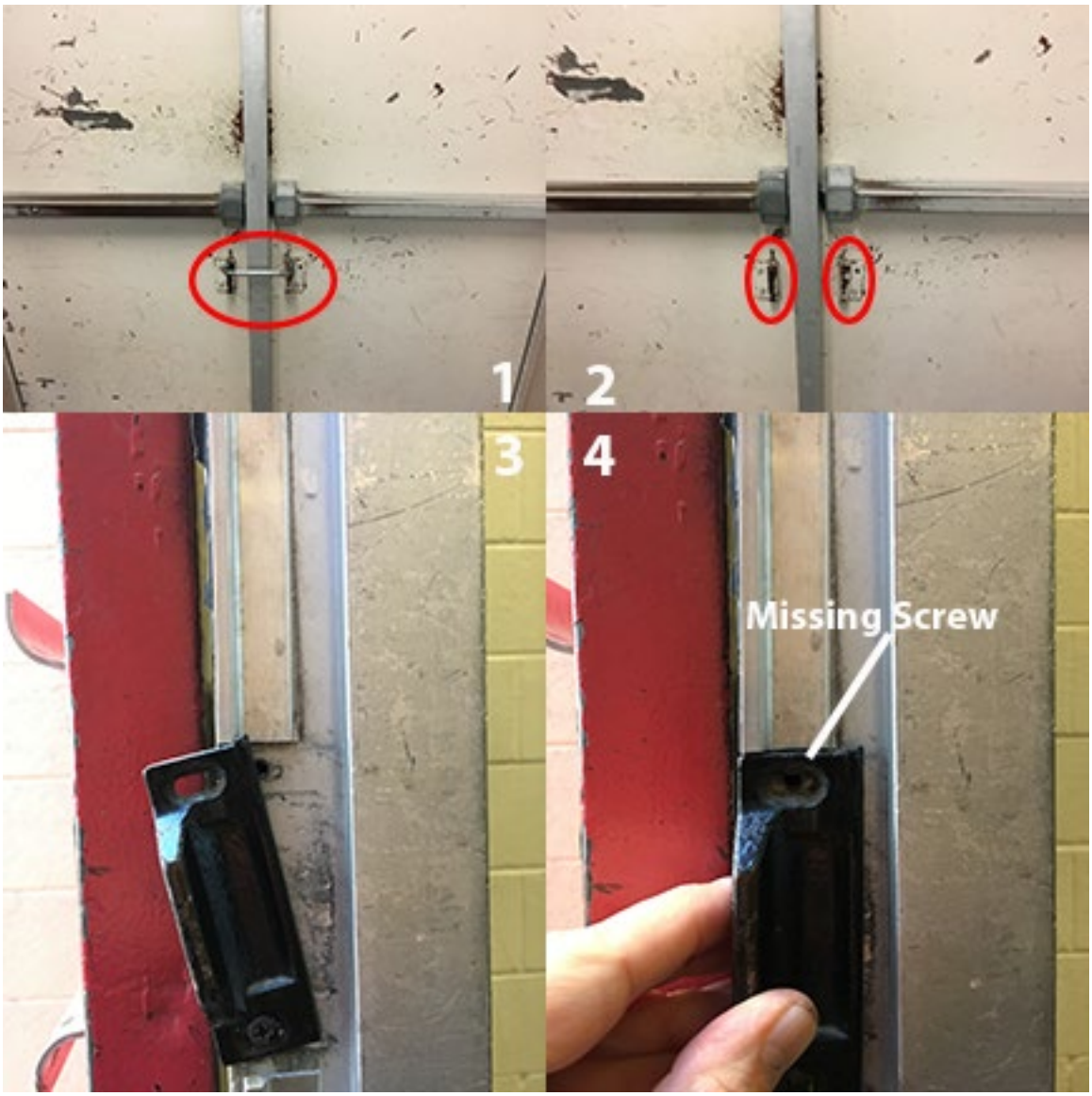

Figure 9: Jury-Rigged Door Lock

Based on observations like these, an overlooked component of a sound school security program is the maintenance and repair of doors and door locking devices. Improper maintenance of doors and door hardware can create security vulnerabilities and safety issues. Allocating funding for security maintenance and ensuring maintenance personnel are trained to properly

repair doors and door hardware is a relatively cost-effective way to improve security in schools. Policy makers looking to fund security improvements in schools should allocate funding to replace classroom door locks that cannot be locked from inside classrooms, provide window coverings to obstruct door and side lights, and repair or replace broken door hardware.

Stakeholder Perceptions Survey

Participating Districts and Schools

Overall, the physical safety data represents 15 participating school districts and 73 participating schools from across Arizona. The school districts consist of large suburban, small cities, and rural school districts, three of which were located on reservations. No large city school districts volunteered to participate in this study. The teacher and parent data represents 43 schools within 8 or 9 school districts, respectively (see below).

Parents

Participants included 614 parents or guardians who had a least one child attending one of 43 schools (i.e., elementary, middle, or high school), within one of nine school districts in the State of Arizona. Four hundred and one (n = 401) self-identified as females and 119 self-identified as males (94 missing data points). The participants' average age was 43.64 (SD = 8.70), with an age range from 23 to 78 years old. Participants self-identified as white, non-Hispanic (66%), Hispanic (10.3%), black or African American (.5%), American Indian (4.6%), Asian (.7%), and Native Hawaiian or Pacific Islander (.2%; 110 missing data points).

Teachers

Participants included 384 teachers who taught at one of 43 schools (i.e., elementary, middle, or high school), within one of eight school districts in the State of Arizona. Two hundred and ninety-two (n = 292) self-identified as females and 86 self-identified as males (six missing

data points). The participants' average age was 45.38 (SD = 12.77), with an age range from 22 to 100 years old. Participants self-identified as white, non-Hispanic (84.4%), Hispanic (7.8%), black or African American (.5%), American Indian (1%), Asian (.3%), and Native Hawaiian or Pacific Islander (.3%; 18 missing data points). The participants' reported an average job tenure of 7.12 years (SD = 6.65), with a range from .17 to 40 years at their school (26 missing data points).

Measures and Recruitment of Parents and Teachers

Two members of the research team with expertise in item and assessment tool development created a parent and teacher survey, both of which were designed to assess parent and teacher perceptions, respectively, of their school's safety. Both survey instruments also assessed demographics, some of which are set forth above (see Appendices B and C) for a full list of demographics assessed). The parent survey consisted of 43 items, which are attached in full to this report as Appendix B. The teacher survey consisted of 47 items, which are also attached in full to this report as Appendix C. There was an English and Spanish version of each survey. The English version was first translated into Spanish, then back translated into English to identify mistranslations. No mistranslations were identified. This two-step process was conducted by two different individuals fluent in both languages.

Once developed, all survey items were inputted into SurveyMonkey, an online survey platform, for administration. Members of the research team asked all participating districts to forward the survey links (English and Spanish versions) via their parent and teacher email distribution lists. A letter preceded entry into each survey that informed participants of the nature of and eligibility for the study and that participation was completely voluntary and confidential.

Analytical Approach

Once data collection was complete, data were cleaned, and missing values were identified and coded -99 (missing) or -33 (not applicable or "I don't know"). All analyses reported herein were conducted via IBM SPSS, version 27.

Results

Parent Survey – Aggregated Across All Schools

How safe **would you feel** in the presence of the following security features at your school?	Not At All Safe	A little Safe	Moderately Safe	Quite a Bit Safe	Extremely Safe
1. Locked or monitored **School Building** doors	10 (1.6)	39 (6.4)	135 (22)	235 (38)	111 (18.1)
2. Locked or monitored gates around **School Grounds**	18 (2.9)	36 (5.9)	137 (22.3)	206 (33.6)	135 (22)
3. Pretend security cameras	249 (40.6)	134 (21.8)	91 (14.8)	39 (6.4)	18 (2.9)
4. Working security cameras	26 (4.2)	63 (10.3)	141 (23)	161 (26.2)	139 (22.6)
5. Unarmed security guards	81 (13.2)	144 (23.5)	165 (26.9)	109 (17.8)	29 (4.7)
6. Armed security guards	46 (7.5)	34 (5.5)	112 (18.2)	159 (25.9)	177 (28.8)
7. Law enforcement officers	14 (2.3)	15 (2.4)	67 (10.9)	143 (23.3)	291 (47.4)
8. Metal detectors	63 (10.3)	103 (16.8)	144 (23.5)	129 (21)	88 (14.3)
9. Visitors' check-in policies	25 (4.1)	90 (14.7)	137 (22.3)	156 (25.4)	117 (19.1)
10. Badges identifying authorized school personnel	21 (3.4)	93 (15.1)	158 (25.7)	147 (23.9)	110 (17.9)
11. Anonymous threat reporting system	26 (4.2)	92 (15)	157 (25.6)	144 (23.5)	108 (17.6)
12. Lockable classroom doors	9 (1.5)	33 (5.4)	113 (18.4)	207 (33.7)	166 (27)

Figure 10: Parent Survey Results Aggregated Across Schools

NOTE: Columns contain the number of respondents who endorsed the safe category; numbers contained in parentheses are the percentages of the total participants who responded to each item. Missing values ranged from 82 to 89 for each item.

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Teacher Survey – Aggregated Across All Schools

How safe **would you feel** in the presence of the following security features at your school?	Not At All Safe	A little Safe	Moderately Safe	Quite a Bit Safe	Extremely Safe
1. Locked or monitored **School Building** doors	3 (.8)	24 (6.3)	87 (22.7)	182 (47.4)	85 (22.1)
2. Locked or monitored gates around **School Grounds**	8 (2.1)	28 (7.3)	90 (23.4)	154 (40.1)	102 (26.6)
3. Pretend security cameras	176 (45.8)	103 (26.8)	69 (18.0)	26 (6.8)	7 (1.8)
4. Working security cameras	11 (29)	40 (10.4)	90 (23.4)	140 (36.5)	100 (26.0)
5. Unarmed security guards	30 (7.8)	80 (20.8)	153 (39.8)	92 (24.0)	26 (6.8)
6. Armed security guards	30 (7.8)	36 (9.4)	75 (19.5)	118 (30.7)	121 (31.5)
7. Law enforcement officers	6 (1.6)	19 (4.9)	51 (13.3)	110 (28.6)	196 (51.0)
8. Metal detectors	46 (12.0)	91 (23.7)	93 (24.4)	86 (22.4)	65 (16.9)
9. Visitors' check-in policies	11 (2.9)	53 (13.8)	110 (28.6)	128 (33.3)	79 (20.6)
10. Badges identifying authorized school personnel	21 (5.5)	64 (16.7)	117 (30.5)	115 (29.9)	64 (16.7)
11. Anonymous threat reporting system	16 (4.2)	75 (19.5)	122 (31.8)	115 (29.9)	53 (13.8)
12. Lockable classroom doors	1 (.3)	16 (4.2)	92 (24.0)	145 (37.8)	127 (33.1)

Figure 11: Teacher Survey Aggregated Across All Schools

NOTE: Columns contain the number of respondents who endorsed the safe category; numbers contained in parentheses are the percentages of the total participants who responded to each item. Missing values ranged from 2-4 for each item.

Aggregate Safety Scores

For each participating school, door features were scored separately (e.g., material, latch type and condition, presence of door and side lites, etc.) on a scale of 0 to 5, with higher scores indicating that the feature is safer than the lower scores (for a full list of door features assessed, see Appendix D). For each school door, feature scores were aggregated to the door level, then door level scores were aggregated to the school and district levels. This process created two

global physical safety scores, one by school and one by district. For both parents and teachers, item scores were separately aggregated to the school and district levels (see Appendices B and C for item score ranges), with higher scores indicating stronger safety perceptions.

Case Summaries

Aggregate of Variables 33 to 41

District	Mean	Std. Deviation	Minimum	Maximum	% of Total N
100	4.2979	.35385	3.16	4.74	8.1%
102	4.3764	.20828	3.07	4.81	9.6%
105	4.0868	.34792	2.68	4.85	11.9%
106	4.0568	.27833	3.50	4.69	2.3%
107	3.9324	.28563	3.39	4.58	3.6%
108	4.2264	.34188	2.83	4.80	12.8%
109	4.2306	.45416	3.29	4.61	0.3%
110	4.2860	.29618	3.54	4.67	1.1%
111	3.8978	.61677	2.97	4.56	0.4%
112	4.3169	.23791	3.72	4.69	2.3%
113	4.2710	.27190	3.66	4.72	5.5%
114	4.1498	.50849	2.82	4.83	6.0%
115	4.2956	.21888	3.44	4.72	7.2%
116	4.3413	.24821	3.09	4.85	23.0%
117	4.2519	.40071	2.02	4.72	6.0%
Total	4.2476	.33445	2.02	4.85	100.0%

Figure 12: Physical Safety Score by District

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Average Physical Safety Score by District	4.25	0.11	--																	
2. Average Physical Safety Score by School	4.25	0.16	.705**	--																
3. Teacher Peceptions of Safety_Buildings by District	3.88	0.38	.477**	.372**	--															
4. Teacher Peceptions of Safety_ Grounds by District	3.53	0.33	.181**	.142**	.894**	--														
5. Teacher Perceptions of Safety_Classrooms by District	4.02	0.38	.700**	.548**	.763**	.553**	--													
6. Teacher Perceptions of Overall Safety by District	4.17	0.35	.430**	.334**	.962**	.841**	.615**	--												
7. Teacher Peceptions of Safety_Buildings by School	3.74	1.03	.132**	.275**	.393**	.368**	.336**	.343**	--											
8. Teacher Peceptions of Safety_ Grounds by School	3.38	1.00	.079**	.284**	.431**	.479**	.328**	.368**	.942**	--										
9. Teacher Perceptions of Safety_Classrooms by School	3.89	0.91	.391**	.325**	.447**	.371**	.604**	.340**	.640**	.623**	--									
10. Teacher Perceptions of Overall Safety by School	4.03	0.84	.180**	.230**	.467**	.420**	.369**	.443**	.813**	.781**	.763**	--								
11. Parent Peceptions of Safety_Buildings by District	4.21	0.63	.241**	.179**	.215**	.237**	-.124**	.395**	.012	0.014	-.092**	.121**	--							
12. Parent Peceptions of Safety_ Grounds by District	4.19	0.84	.407**	.304**	.495**	.467**	.197**	.625**	.138**	.156**	.091**	.252**	.973**	--						
13. Parent Perceptions of Safety_Classrooms by District	4.31	0.74	.450**	.336**	.324**	.194**	.278**	.436**	.070**	.039	.123**	.182**	.955**	.983**	--					
14. Parent Perceptions of Overall Safety by District	4.65	0.75	.550**	.411**	.659**	.440**	.518**	.748**	.204**	.172**	.244**	.325**	.922**	.977**	.979**	--				
15. Parent Peceptions of Safety_Buildings by School	3.64	1.16	.039	.322**	.406**	.340**	.218**	.451**	.344**	.451**	.110**	.339**	.338**	.387**	.305**	.387**	--			
16. Parent Peceptions of Safety_ Grounds by School	3.59	1.22	.116**	.372**	.482**	.436**	.249**	.521**	.410**	.534**	.201**	.417**	.427**	.507**	.408**	.502**	.963**	--		
17. Parent Perceptions of Safety_Classrooms by School	3.79	1.03	.160**	.344**	.398**	.341**	.292**	.416**	.185**	.336**	.052*	.172**	.337**	.424**	.361**	.438**	.901**	.896**	--	
18. Parent Perceptions of Overall Safety by School	3.98	1.10	.243**	.430**	.435**	.294**	.360**	.458**	.385**	.475**	.161**	.377**	.383**	.497**	.457**	.566**	.903**	.905**	.879**	--

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Figure 13: Descriptive Statistics for and Correlations among Average District and School Level Physical Safety Scores and Teacher and Parent Safety Perceptions

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Artifacts

This study generated four datasets. The first dataset consists of all physical security, parent, and teacher survey data collected during this project. This data set contains all parent and teacher survey response data as well as all of the physical security data collected during the physical security surveys of participating schools and it contains 3712 samples and 60 variables. The second dataset contains the physical security data collected during the physical security surveys of participating schools. This dataset contains 3712 samples and 26 variables. The third dataset contains the parent survey response data. This dataset contains 614 samples and 46 variables. The fourth dataset contains the teacher survey response data. This dataset contains 384 samples and 46 variables. All four datasets have been uploaded to the National Archive of Criminal Justice Data (NACJD) for dissemination to other researchers. The ballistics testing report from NTS was also uploaded to NACJD as an appendix to this final report. Nearly two terabytes of recorded data will be submitted to the NIJ JEFS system. Artifacts will also be made available via the Scholarly Commons website.

This research is expected to generate multiple published articles in both scholarly journals and professional publications as well as conference papers and presentations.

Notes

1 (The Trust 2022)

2 (Sandy Hook Advisory Commission 2015)

3 (CBS News 2010)

References

CBS News. 2010. *Dangers of Wired Glass.* Accessed 4 14, 2022. https://vimeo.com/13217720.

Sandy Hook Advisory Commission. 2015. "Final Report of the Sandy Hook Advisory Commission."

The Trust. 2022. *About Us: The Trust Alliance.* Accessed 4 14, 2022. https://www.svc.the-trust.org/Home/AboutU.

Appendix A: NTS Ballistic Testing Report

31 December 2021

Embry-Riddle Aero Univ
1 Aerospace Boulevard
Daytona Beach, FL 32114

Attention: Mr. Tom Foley

Subject: Penetration Testing of School Security Barriers – NTS Chesapeake PR141546, tested 3 August 2021 through 31 December 2021.

Dear Mr. Foley:

Please find enclosed a report documenting the subject test series conducted by NTS-Chesapeake Testing from 3 August 2021 through 31 December 2021.

If you have any questions related to this test, please call Mr. Kyle North at 410-297-8154 or contact him via e-mail at kyle.north@nts.com.

Sincerely,

Chris Schueler
General Manager, NTS-Chesapeake Testing

kcn

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TEST REPORT

Embry-Riddle Aeronautical University

Penetration Testing of School Barrier Systems

Prepared by:

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NTS-Chesapeake Testing

4603B Compass Point Road
Belcamp, MD 21017

31 December 2021

Further dissemination only as directed by
Embry-Riddle Aeronautical University, December 2021.

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1 Introduction

Embry-Riddle Aeronautical University (ERAU) contracted NTS-Chesapeake Testing (NTS) to conduct testing in support of ERAU's program for Penetration Testing for School Barrier Technologies. All testing was conducted at NTS Chesapeake located at 4603B Compass Point Road, Belcamp MD 21017, from 3 August 2021 through 31 December 2021.

The goal of this test program was to conduct ballistic and forced entry testing of various commercially available window and door make-ups that are used in K-12 schools, to aid in determining the approximate time it would take an active shooter to breach the system.

2 Test Articles

All test articles were provided by ERAU. For samples in which an aftermarket film was applied, all film application was performed by the manufacturer (D&L Window Tinting) and per ERAU instructions. A description of each test article provided is detailed in Table 1.

Table 1 - Test Articles

Sample ID	Manufacturer	Description	Dimensions
Clear Laminated Glass No Film	Pella Windows & Doors Inc.	1/4” Clear Laminated 0.30” AB	24” x 24”
	Global Security Glazing	1/4” Clear Laminated 0.30” PVB	24” x 24”
Clear Laminated Glass 8mm Film	Pella Windows & Doors Inc.	1/4” Clear Laminated 0.30” AB w/ 8mm D&L Film	24” x 24”
	Global Security Glazing	1/4” Clear Laminated 0.30” PVB w/ 8mm D&L Film	24” x 24”
Clear Laminated Glass 8mm Ultra Film + C Bond	Pella Windows & Doors Inc.	1/4” Clear Laminated 0.30” AB w/ 8mm D&L Ultra Film + C Bond	24” x 24”
	Global Security Glazing	1/4” Clear Laminated 0.30” PVB w/ 8mm D&L Ultra Film + C Bond	24” x 24”
Clear Tempered Glass No Film	Pella Windows & Doors Inc.	1/4” Clear Tempered	24” x 24”
	Global Security Glazing	1/4” Clear Tempered	24” x 24”
Clear Tempered Glass 8mm Film	Pella Windows & Doors Inc.	1/4” Clear Tempered w/ 8mm D&L Film	24” x 24”
	Global Security Glazing	1/4” Clear Monolithic Tempered w/ 8mm D&L Film	24” x 24”
Clear Tempered Glass 8mm Ultra Film + C Bond	Pella Windows & Doors Inc.	1/4” Clear Tempered w/ 8mm D&L Ultra Film + C Bond	24” x 24”
	Global Security Glazing	1/4” Clear Monolithic Tempered w/ 8mm D&L Ultra Film + C Bond	24” x 24”
Clear Wire Glass No Film	WireLite	1/4” WireLite	24” x 24”
	Global Security Glazing	1/4” Misco (Diamond) Wire	24” x 24”
Clear Wire Glass 8mm Film	WireLite	1/4” WireLite w/ 8mm D&L Film	24” x 24”
	Global Security Glazing	1/4” Misco (Diamond) Wire w/ 8mm D&L Film	24” x 24”
Clear Wire Glass 8mm Ultra Film + C Bond	WireLite	1/4” WireLite w/ 8mm D&L Ultra Film + C Bond	24” x 24”
	Global Security Glazing	1/4” Misco (Diamond) Wire w/ 8mm D&L Ultra Film + C Bond	24” x 24”
18-gauge Hollow Metal Door w/ Galvannealed Finish	Tell	18-gauge steel door, 36” x 80”. Galvannealed finish. Metal door frame, with metal commercial hinges, and ALX53PD entrance lock.	36” x 80”
16-gauge Hollow Metal Door w/ Cold Rolled Steel Finish	Tell	16-gauge steel door, 36” x 80”. Cold Rolled Steel finish. Metal door frame, with metal commercial hinges, and ALX53PD entrance lock.	36” x 80”
Solid Core Wood Door	USA Wood Doors	36” x 80”. Cendura-Flush Mineral Core, Hardwood Edge. Metal door frame, with metal commercial hinges, and ALX53PD entrance lock.	36” x 80”

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All test articles were installed per manufacturers installation recommendations, when available, and per customer request.

For all window testing, the window sample was rigidly clamped in a steel frame with 1.5” bite around the perimeter of the front/back face of the window. Uniformly spaced toggle clamps on the front face of the sample were used to ensure a uniform clamping load on the strike face of the sample. Figure 1 shows an image of the typical mounting conditions used for all window ballistic and forced entry testing.

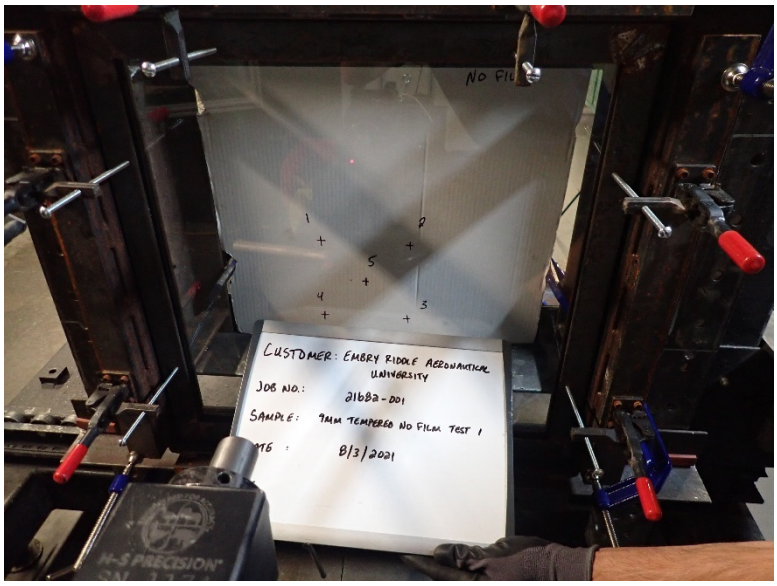

Figure 1 – Window Mounting Conditions

For window samples in which aftermarket film was applied prior to testing, an aluminum frame with neoprene shims was used to replicate real-world installation constraints.

For all door testing, the door and frame were installed into simulated wall structure constructed from wood and drywall materials. The door frame and door insert were then installed and plumbed per manufacturer instructions and customer request. Figures 2 – 3 show images of the typical mounting conditions used for all door ballistic and forced entry testing. The simulated wall was rigidly mounted to NTS’s target fixture for all tests.

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Figure 2 – Simulated Wall Structure for Door Installation

Figure 3 – Simulated Wall Structure – Side Profile View

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3 Test Equipment and Resources

All test equipment needed to conduct the ballistic and forced entry testing was provided by NTS.

3.1 Test Equipment – Ballistic Testing

Actual firearms were utilized for the live-fire portion of testing in which the average time to expend a full magazine from each weapon was determined. Details of the firearms used for this testing are in Table 2.

Table 2 - Firearms

Firearm Caliber	Manufacturer	Model / Description
5.56mm	Anderson Manufacturing	AM-15
9mm	Glock	G19
12-gauge	Remington	870 12-ga

To ensure safety during testing, all shots made on the door and window samples were conducted using an appropriately chambered test barrel which was fixtured in a universal receiver which was mounted to a NTS gun mount. Details of the test barrels used for testing are in Table 3.

Table 3 – Test Barrels

Caliber	Barrel Length (in.)	Barrel Twist
5.56mm	29	1:7
9mm	10	1:10
12-gauge	30	Smooth Bore

Commercially available ammunition was used for all ballistic testing. The shotshell ammunition used was commercial off the shelf (COTS), while the 9mm and 5.56mm ammunition used was handloaded by NTS personnel to ensure the appropriate velocity was achieved per customer request. Details of the ammunition used for testing is in Table 4. The average velocity reported in Table 4 is a result of firing 10 rounds with each test threat, and measuring the velocity at a distance of approximately 12-inches from the muzzle of the test barrel, to simulate the placement of the sample for the door/window penetration testing. The propellant load used to achieve this average velocity was used for all follow-on penetration testing of the door and window samples, where velocity measurement wasn't possible due to close proximity of the sample to the test barrel.

Table 4 – Test Ammunition

	Ammunition Description	Ammunition Identity	Bullet Weight (grain)	Average Velocity (ft/s)	Manufacturer & ID/Lot #	COTS or Hand Load
1	9mm 124gr FMJ	9mm	124 gr	1252	Remington, Lot 23558	4.5-grain of Accurate No. 2
2	5.56mm 62gr M855	M855	62 gr	3234	Military, Lot Unknown	19.8-grain of N110
3	12ga 2-3/4" 00 Buckshot, 9 Pellets	12ga	NA	1244	Federal, Lot F133U41-F133U05	COTS

3.2 Test Equipment – Forced Entry Testing

The forced entry testing of all window samples was conducted with attacks from the firearms identified in Table 2 of Section 3.1 of this report.

The forced entry testing of the door samples was conducted with attacks from the firearms identified in Table 2 of Section 3.1 of this report, and with 10-lb commercially available sledgehammers.

The NTS personnel who conducted the forced entry testing were meant to represent school shooter that was a healthy male, between the ages of 16-35 years old. Details of the forced entry attackers used during this program are provided in Table 5.

Table 5 – Forced Entry Attackers

Attacker	Age (yrs)	Height (ft, in)	Weight (lbs)
Cody S.	24	6-ft, 0-in	165
Lance E.	26	5-ft, 10-in	180

3.3 Test Equipment – Documentation

Three (3) digital video cameras were used to document all ballistic and forced entry testing. The cameras provided a front overall, rear overall, and top-down view of the testing. Digital photographs were also taken to document all testing. Due to file-size limitations, only notable photos are included in this report. All photos and videos were provided to the customer separate from this report.

4 Live Fire Testing

4.1 Live Fire Testing - Objective

Live fire testing was conducted to measure the time required for a shooter to expend firearm with fully loaded magazine. This was accomplished by shoulder firing the weapons identified in Table 2 of Section 3.1 of this report. For the live firing, each firearm was equipped with a single full capacity magazine.

4.2 Live Fire Testing - Results

Table 6 provides an overview of the results obtained from this sub-test.

Table 6 – Live Fire Test Results

Test ID	Firearm ID	No. of Shots	Duration (mm:ss)	Notes
Live Fire 1	9mm	15	00:20	Shots fired at an approximate rate of 2-s per shot
Live Fire 2	9mm	15	00:10	Shots fired at an approximate rate of 1-s per shot
Live Fire 3	9mm	15	00:03	Shots fired as fast as possible
Live Fire 4	5.56mm	30	01:02	Shots fired at an approximate rate of 2-s per shot
Live Fire 5	5.56mm	30	00:29	Shots fired at an approximate rate of 1-s per shot
Live Fire 6	5.56mm	30	00:08	Shots fired as fast as possible
Live Fire 7	12-ga	5	00:07	Shots fired at an approximate rate of 2-s per shot
Live Fire 8	12-ga	5	00:03	Shots fired at an approximate rate of 1-s per shot
Live Fire 9	12-ga	5	00:02	Shots fired as fast as possible

5 Penetration Testing

5.1 Penetration Testing - Objective

The objective of the penetration sub-test was to subject the window and door samples to ballistic impacts followed by a forced entry physical attack of the area damaged by the ballistic impacts. The data generated by this sub-test, coupled with the firing duration information presented in Table 6 of Section 4.2 of this report, will allow ERAU to estimate an approximate total time for an active shooter to breach the item being tested.

5.2 Penetration Testing – Setup and Test Method - Ballistics

Each sample that underwent penetration testing was first subjected to ballistic impacts and was then subjected to a forced entry physical attack.

For the ballistic testing, the sample was mounted approximately 1-ft from the end of the test barrel and in the manner described in Section 2 of this report. All firings were made with the ammunition and test barrels identified in Tables 3 and 4 of this report.

For each threat, shots 1-5 were placed in accordance with the 5-shot pattern of UL 752. 4 shots were placed on the corners of a 4.5” square and the 5th shot was placed in the center of the pattern. The remaining shots were placed randomly within the 4.5” x 4.5” square constrained by shots 1-4. For the window samples, the 4.5” square was centrally located on the sample. For the door samples, the 4.5” square was placed within a 24” radius of the center of the doorknob, towards the central area of the sample.

The cumulative number of shots impacted on the sample for each threat, is consistent with the number of shots evaluated during the live fire sub-test detailed in Section 4 of this report, and are meant to simulate an active shooter fully expending one full magazine of ammunition into the sample. The cumulative number of shots for each threat are listed below, for reference:

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- 9mm – 15 total shots
- 5.56mm – 30 total shots
- 12-ga – 5 total shots.

For all ballistic testing, 1/8-in thick corrugated cardboard indicators were placed at distances of 12-in, 24-in, 36-in, and 48-in behind the strike face of the sample so that penetrations and spall from each shot could be analyzed by ERAU. New cardboard indicators were used for each sample.

All ballistic testing was conducted at ambient range conditions (70 ± 5 °F and 50 ± 20 % RH).

5.3 Penetration Testing – Setup and Test Method – Forced Entry Testing

Following ballistic testing, the same sample underwent forced entry sample in which an attacker attempted to further exploit the 4.5" area previously damaged during ballistic testing.

For the follow-on forced entry testing, the sample remained mounted in the same mount used for ballistic testing.

Each window sample that underwent ballistic testing was subsequently subjected to a forced entry attack in which the attacker used the butt end of a weapon to attack the sample. Prior to starting the forced entry testing, the attacker assumed a firing position to simulate transitioning from shooting to a brute force attack. When the attacker was ready, they repositioned the firearm to use the butt end of the weapon to strike the shot sample. The attack continued for a period of 5-mintues or until an opening large enough for the attacker to reach their entire arm through occurred, whichever occurred first.

Similarly, each door sample that underwent ballistic testing was subsequently subjected to a forced entry attack in which the attacker used the butt end of a weapon and/or 10-lb sledgehammers to attack the sample. Prior to starting the forced entry testing, the attacker assumed a firing position to simulate transitioning from shooting to a brute force attack. When the attacker was ready, they repositioned the firearm to use the butt end of the weapon to strike the shot sample. The attack continued for a period of 5-mintues or until an opening large enough for the attacker to reach their entire arm through occurred, whichever occurred first. If after 5-minutes the sample was not breached, two attackers utilized 10-lb sledgehammers to continue attacking the sample for an additional period of 5-minutes or until an opening large enough for the attacker to reach their entire arm through occurred, whichever occurred first.

The firearm used for attacking each sample correlated with the ammunition type that used to ballistically test the sample in the previous step. All firearms used for this portion of the testing are identified in Table 2 of the Section 3.1 of this report.

All forced entry testing was conducted at ambient range conditions (70 ± 5 °F and 50 ± 20 % RH).

5.3 Penetration Testing – Test Results

Table 7 provides the test data collected during the window penetration testing and Table 8 provides the test data collected during the door penetration testing.

Table 7 – Window Penetration Testing Results

Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
9mm Tempered No Film 1	¼" Clear Tempered Glass, No Film	Pella	24 x 24	11.52	0.220	9mm	3	Testing terminated after 3 shots due to damage of sample. Approximate through hole = 6" x 9.5"	NA	NA	NA
9mm Tempered No Film 2	¼" Clear Tempered Glass, No Film	Pella	24 x 24	11.50	0.220	9mm	3	Testing terminated after 3 shots due to damage of sample. Approximate through hole = 6" x 7.5"	NA	NA	NA
9mm Tempered No Film 3	¼" Clear Tempered Glass, No Film	Pella	24 x 24	11.53	0.220	9mm	4	Testing terminated after 4 shots due to damage of sample. Approximate through hole = 7" x 9.25"	NA	NA	NA
9mm Laminate No Film 1	¼" Clear Laminate, No Film	Pella	24 x 24	11.41	0.232	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.0" x 8.25".	00:13
9mm Laminate No Film 2	¼" Clear Laminate, No Film	Pella	24 x 24	11.57	0.235	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 6.5" x 8.75".	00:15
9mm Laminate No Film 3	¼" Clear Laminate, No Film	Pella	24 x 24	14.38	0.280	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 5.0" x 7.0".	00:19
9mm Wired No Film 1	¼" Wired Glass, No Film	Pella	24 x 24	14.10	0.266	9mm	15	15 cumulative shots, penetration occurred on all shots. Only wire mesh was left intact within the 4.5-inch shooting square prior to FE testing.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 5.75" x 11.0".	00:04
9mm Wired No Film 2	¼" Wired Glass, No Film	Pella	24 x 24	14.09	0.266	9mm	15	15 cumulative shots, penetration occurred on all shots. Only wire mesh was left intact within the 4.5-inch shooting square prior to FE testing.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 11.50" x 8.25".	00:07
9mm Wired No Film 3	¼" Wired Glass, No Film	Pella	24 x 24	13.99	0.263	9mm	15	15 cumulative shots, penetration occurred on all shots. Only wire mesh was left intact within the 4.5-inch shooting square prior to FE testing.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 10.0 x 12.0".	00:10
9mm Laminate 8mm Film 1	¼" Clear Laminate, 8mm Film	Pella	24 x 24	12.18	0.261	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 6.50" x 7.25".	00:28

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
9mm Laminate 8mm Film 2	¼" Clear Laminate, 8mm Film	Pella	24 x 24	12.31	0.243	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 9.25" x 8.25".	00:22
9mm Laminate 8mm Film 3	¼" Clear Laminate, 8mm Film	Pella	24 x 24	12.08	0.248	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.50" x 7.25".	00:16
9mm Tempered 8mm Film 1	¼" Clear Tempered Glass, 8mm Film	Pella	24 x 24	12.68	0.234	9mm	15	Testing terminated after 15 shots due to damage of sample. Approximate through hole = 6.25" x 7.0"	NA	NA	NA
9mm Tempered 8mm Film 2	¼" Clear Tempered Glass, 8mm Film	Pella	24 x 24	12.42	0.234	9mm	12	Testing terminated after 12 shots due to damage of sample. Approximate through hole = 6.50" x 6.25"	NA	NA	NA
9mm Tempered 8mm Film 3	¼" Clear Tempered Glass, 8mm Film	Pella	24 x 24	12.07	0.234	9mm	13	Testing terminated after 13 shots due to damage of sample. Approximate through hole = 6.25" x 5.75"	NA	NA	NA
9mm Wired 8mm Film 1	¼" Wired Glass, 8mm Film	Pella	24 x 24	15.24	0.277	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.25" x 6.00".	00:09
9mm Wired 8mm Film 2	¼" Wired Glass, 8mm Film	Pella	24 x 24	15.26	0.277	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 8.75" x 9.25".	00:08
9mm Wired 8mm Film 3	¼" Wired Glass, 8mm Film	Pella	24 x 24	15.24	0.277	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 6.25" x 8.00".	00:08
9mm Tempered 8mm Ultra + C Bond 1	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	13.22	0.234	9mm	13	Testing terminated after 13 shots due to damage of sample. Approximate through hole = 6.50" x 6.75"	NA	NA	NA
9mm Tempered 8mm Ultra + C Bond 2	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	13.26	0.232	9mm	10	Testing terminated after 10 shots due to damage of sample. Approximate through hole = 5.75" x 6.50"	NA	NA	NA
9mm Tempered 8mm Ultra + C Bond 3	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	13.30	0.233	9mm	10	Testing terminated after 10 shots due to damage of sample. Approximate through hole = 6.00" x 6.00"	NA	NA	NA
9mm Clear Laminate 8mm Ultra + C Bond 1	¼" Clear Laminate, 8mm Ultra Film + C Bond	Pella	24 x 24	13.01	0.244	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 6.25" x 7.25".	00:16

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
9mm Clear Laminate 8mm Ultra + C Bond 2	¼" Clear Laminate, 8mm Ultra Film + C Bond	Pella	24 x 24	13.32	0.245	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 6.25" x 6.25".	00:13
9mm Clear Laminate 8mm Ultra + C Bond 3	¼" Clear Laminate, 8mm Ultra Film + C Bond	Pella	24 x 24	13.22	0.246	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.0" x 6.0".	00:10
9mm Wired 8mm Ultra + C Bond 1	¼" Wired Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	15.79	0.277	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.25" x 8.0".	00:11
9mm Wired 8mm Ultra + C Bond 2	¼" Wired Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	15.75	0.275	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.5" x 6.5".	00:06
9mm Wired 8mm Ultra + C Bond 3	¼" Wired Glass, 8mm Ultra Film + C Bond	Pella	24 x 24	15.68	0.275	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with handgun until breach occurred. Approximate through hole = 7.25" x 6.0".	00:07
5.56mm Tempered No Film 1	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.66	0.223	5.56mm	2	Testing terminated after 2 shots due to damage of sample. Approximate through hole = 5.50" x 6.00"	NA	NA	NA
5.56mm Tempered No Film 2	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.71	0.222	5.56mm	2	Testing terminated after 2 shots due to damage of sample. Approximate through hole = 7.50" x 7.50"	NA	NA	NA
5.56mm Tempered No Film 3	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.61	0.222	5.56mm	2	Testing terminated after 2 shots due to damage of sample. Approximate through hole = 8.00" x 9.00"	NA	NA	NA
5.56mm Laminate No Film 1	¼" Clear Laminate, No Film	Global	24 x 24	13.37	0.272	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 7.0" x 6.50".	00:08
5.56mm Laminate No Film 2	¼" Clear Laminate, No Film	Global	24 x 24	13.34	0.269	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 7.5" x 6.0".	00:07
5.56mm Laminate No Film 3	¼" Clear Laminate, No Film	Global	24 x 24	13.38	0.272	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.0" x 6.0".	00:04
5.56mm Wired No Film 1	¼" Wired Glass, No Film	Global	24 x 24	14.92	0.282	5.56mm	16	Testing terminated after 16 shots due to damage of sample. Only wiring was left inside shot square perimeter. Approximate through hole = 6.00" x 6.00"	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 7.5" x 6.0".	00:03

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
5.56mm Wired No Film 2	¼" Wired Glass, No Film	Global	24 x 24	14.84	0.280	5.56mm	14	Testing terminated after 14 shots due to damage of sample. Only wiring was left inside shot square perimeter. Approximate through hole = 5.50" x 6.00"	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.5" x 7.5".	00:02
5.56mm Wired No Film 3	¼" Wired Glass, No Film	Global	24 x 24	14.28	0.268	5.56mm	15	Testing terminated after 15 shots due to damage of sample. Only wiring was left inside shot square perimeter. Approximate through hole = 5.00" x 6.00"	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:02
5.56mm Laminate 8mm Film 1	¼" Clear Laminate, 8mm Film	Global	24 x 24	14.76	0.281	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 7.0" x 7.5".	00:10
5.56mm Laminate 8mm Film 2	¼" Clear Laminate, 8mm Film	Global	24 x 24	14.88	0.280	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:09
5.56mm Laminate 8mm Film 3	¼" Clear Laminate, 8mm Film	Global	24 x 24	14.83	0.280	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.0" x 10.0".	00:15
5.56mm Tempered 8mm Film 1	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	13.09	0.231	5.56mm	13	Testing terminated after 13 shots due to damage of sample. Approximate through hole = 5.00" x 6.00"	NA	NA	NA
5.56mm Tempered 8mm Film 2	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	13.11	0.233	5.56mm	12	Testing terminated after 12 shots due to damage of sample. Approximate through hole = 5.00" x 6.00"	NA	NA	NA
5.56mm Tempered 8mm Film 3	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	13.07	0.231	5.56mm	11	Testing terminated after 11 shots due to damage of sample. Approximate through hole = 5.00" x 6.00"	NA	NA	NA
5.56mm Wired 8mm Film 1	¼" Wired Glass, 8mm Film	Global	24 x 24	16.39	0.294	5.56mm	15	Ballistic testing terminated after shot 15 due to damage of sample. Only the wiring was left inside the shot perimeter. Approximate hole size= 5.50" x 6.00".	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.5" x 6.0".	00:02
5.56mm Wired 8mm Film 2	¼" Wired Glass, 8mm Film	Global	24 x 24	16.39	0.292	5.56mm	14	Ballistic testing terminated after shot 14 due to damage of sample. Only the wiring was left inside the shot perimeter. Approximate hole size= 6.00" x 6.00".	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:02

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
5.56mm Wired 8mm Film 3	¼" Wired Glass, 8mm Film	Global	24 x 24	16.39	0.289	5.56mm	15	Ballistic testing terminated after shot 15 due to damage of sample. Only the wiring was left inside the shot perimeter. Approximate hole size= 6.00" x 6.00".	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:02
5.56mm Tempered 8mm Ultra + C Bond 1	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	13.36	0.236	5.56mm	12	Testing terminated after shot 12 due to damage of sample. Approximate hole size= 6.50" x 6.50".	NA	NA	NA
5.56mm Tempered 8mm Ultra + C Bond 2	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	13.36	0.235	5.56mm	14	Testing terminated after shot 14 due to damage of sample. Approximate hole size= 6.00" x 6.00".	NA	NA	NA
5.56mm Tempered 8mm Ultra + C Bond 3	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	13.51	0.241	5.56mm	14	Testing terminated after shot 12 due to damage of sample. Approximate hole size= 6.00" x 6.00".	NA	NA	NA
5.56mm Laminate 8mm Ultra + C Bond 1	¼" Clear Laminate, 8mm Ultra Film + C Bond	Global	24 x 24	15.18	0.284	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.5" x 6.0".	00:04
5.56mm Laminate 8mm Ultra + C Bond 2	¼" Clear Laminate, 8mm Ultra Film + C Bond	Global	24 x 24	15.12	0.288	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.5" x 7.0".	00:08
5.56mm Laminate 8mm Ultra + C Bond 3	¼" Clear Laminate, 8mm Ultra Film + C Bond	Global	24 x 24	15.11	0.284	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.5" x 5.0".	00:08
5.56mm Wired 8mm Ultra + C Bond 1	¼" Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	16.46	0.292	5.56mm	14	Ballistic testing terminated after shot 14 due to damage of sample. Only the wiring was left inside the shot perimeter. Approximate hole size= 6.00" x 6.00".	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:03
5.56mm Wired 8mm Ultra + C Bond 2	¼" Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	16.61	0.293	5.56mm	14	Ballistic testing terminated after shot 14 due to damage of sample. Only the wiring was left inside the shot perimeter. Approximate hole size= 5.50" x 7.50".	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 6.0" x 6.0".	00:03
5.56mm Wired 8mm	¼" Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	16.40	0.293	5.56mm	13	Ballistic testing terminated after shot 13 due to damage of sample. Only the wiring was	Cody S.	Attacked with rifle until breach occurred. Approximate through hole = 5.0" x 6.0".	00:01

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
Ultra + C Bond 3								left inside the shot perimeter. Approximate hole size= 5.00" x 6.00".			
12ga Tempered No Film 1	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.67	0.221	12ga	2	Testing terminated after shot 2 due to damage of sample. Approximate hole size= 10.00" x 6.00".	NA	NA	NA
12ga Tempered No Film 2	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.62	0.220	12ga	2	Testing terminated after shot 2 due to damage of sample. Approximate hole size= 10.00" x 5.00".	NA	NA	NA
12ga Tempered No Film 3	¼" Clear Tempered Glass, No Film	Global	24 x 24	11.67	0.221	12ga	2	Testing terminated after shot 2 due to damage of sample. Approximate hole size= 9.00" x 5.00".	NA	NA	NA
12ga Laminate No Film 1	¼" Clear Laminate, No Film	Global	24 x 24	13.43	0.270	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 9 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 5.0" x 7.0".	00:09
12ga Laminate No Film 2	¼" Clear Laminate, No Film	Global	24 x 24	13.42	0.270	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 6 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.0" x 7.0".	00:06
12ga Laminate No Film 3	¼" Clear Laminate, No Film	Global	24 x 24	13.52	0.271	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 5 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 8.0" x 8.0".	00:05
12ga Wired No Film 1	¼" Wired Glass, No Film	Global	24 x 24	14.98	0.282	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 3 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 8.5" x 8.0".	00:03
12ga Wired No Film 2	¼" Wired Glass, No Film	Global	24 x 24	14.90	0.280	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 1 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.0" x 7.5".	00:01

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
12ga Wired No Film 3	¼" Wired Glass, No Film	Global	24 x 24	14.95	0.281	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 2 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.0" x 11.0".	00:02
12ga Laminate 8mm Film 1	¼" Clear Laminate, 8mm Film	Global	24 x 24	13.71	0.231	12ga	5	5 cumulative shots, penetration occurred on all shots. Testing terminated due to damage of sample. Approximate hole size = 6.00" x 7.50".	NA	NA	NA
12ga Laminate 8mm Film 2	¼" Clear Laminate, 8mm Film	Global	24 x 24	13.68	0.230	12ga	4	Testing terminated after shot 4 due to damage of sample. Approximate hole size= 6.50" x 6.00".	NA	NA	NA
12ga Laminate 8mm Film 3	¼" Clear Laminate, 8mm Film	Global	24 x 24	13.72	0.231	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 1 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.5" x 8.5".	00:01
12ga Tempered 8mm Film 1	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	14.87	0.279	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 7 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.5" x 8.5".	00:07
12ga Tempered 8mm Film 2	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	14.74	0.278	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 5 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 9.0" x 6.0".	00:05
12ga Tempered 8mm Film 3	¼" Clear Tempered Glass, 8mm Film	Global	24 x 24	14.82	0.278	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 8 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 9.0" x 9.0".	00:08
12ga Wired 8mm Film 1	¼" Wired Glass, 8mm Film	Global	24 x 24	16.95	0.286	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 2 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.0" x 11.0".	00:02

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
12ga Wired 8mm Film 2	¼" Wired Glass, 8mm Film	Global	24 x 24	16.93	0.286	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 3 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.5" x 11.0".	00:03
12ga Wired 8mm Film 3	¼" Wired Glass, 8mm Film	Global	24 x 24	16.91	0.286	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 3 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 8.0" x 6.0".	00:03
12ga Tempered 8mm Ultra + C Bond 1	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	13.86	0.240	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 2 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.0" x 8.0".	00:02
12ga Tempered 8mm Ultra + C Bond 2	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	13.96	0.246	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 2 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.0" x 7.0".	00:02
12ga Tempered 8mm Ultra + C Bond 3	¼" Clear Tempered Glass, 8mm Ultra Film + C Bond	Global	24 x 24	14.07	0.240	12ga	5	5 cumulative shots, penetration occurred on all shots. Testing terminated after shot 5 due to damage of sample. Approximate hole size= 5.00" x 6.00".	NA	NA	NA
12ga Laminate 8mm Ultra + C Bond 1	¼" Clear Laminate, 8mm Ultra Film + C Bond	Global	24 x 24	15.80	0.288	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 14 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.0" x 7.0".	00:14
12ga Laminate 8mm Ultra + C Bond 2	¼" Clear Laminate, 8mm Ultra Film + C Bond	Global	24 x 24	15.66	0.289	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 20 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 5.5" x 6.0".	00:20
12ga Laminate	¼" Clear Laminate, 8mm	Global	24 x 24	15.72	0.287	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 10 seconds. Testing was terminated	00:10

Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
8mm Ultra + C Bond 3	Ultra Film + C Bond									due to damage of sample. Approximate through-hole size = 5.5” x 6.0”.	
12ga Wired 8mm Ultra + C Bond 1	¼” Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	17.28	0.295	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 4 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 7.0” x 7.5”.	00:04
12ga Wired 8mm Ultra + C Bond 2	¼” Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	17.25	0.295	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 6 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.5” x 6.5”.	00:06
12ga Wired 8mm Ultra + C Bond 3	¼” Wired Glass, 8mm Ultra Film + C Bond	Global	24 x 24	17.12	0.294	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S.	Attacked with blunt force using butt of 12 gauge shotgun for 3 seconds. Testing was terminated due to damage of sample. Approximate through-hole size = 6.5” x 7.5”.	00:03

Table 8 – Door Penetration Testing Results

Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
9mm 18 Gauge Door 1	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked with blunt force via 9mm handgun for 5 minutes causing little to no damage. Was then attacked using sledgehammers for 4 seconds. Testing was terminated due to sample framing failing. Door body was not breached. This sample was tested in a steel framing system. All other samples were tested in a wood/drywall wall simulant.	05:04
9mm 18 Gauge Door 2	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Did not attack with handgun per customer request. Attack began with sledgehammers and continued until breach of sample. The door body was not breached, however the door became unlatched allowing it to be opened.	00:34
9mm 18 Gauge Door 3	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Did not attack with handgun per customer request. Attack began with sledgehammers and continued until breach of sample. The door body was breached allowing the attacker to reach through and access the protected side door handle. The protected side door handle was broken and the door was unable to be unlocked by the attackers.	00:55
5.56mm 18 Gauge Door 1	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Did not attack with rifle per customer request. Attack began with sledgehammers and continued until breach of sample. The door body was not breached, however the door frame failed allowing the door to be bent in allowing it to be pushed inward. Approximate hole size on front skin of door = 8.0" x 5.75". No through hole.	01:34
5.56mm 18 Gauge Door 2	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked using butt of AR-15 rifle for 2 minutes and 40 seconds causing little to no damage. Testing terminated per customer request. Was then attacked using sledge hammers for 41 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 8.0" x 9.0".	03:21
5.56mm 18 Gauge Door 3	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No rifle attack per customer request. Attacked using sledge hammers for 1 minute and 2 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 6.0" x 5.5"	01:02
12-ga 18 Gauge Door 1	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration	Cody S., Lance E.	Attacked using butt of shotgun for 33 seconds causing little to no damage. Testing terminated due to the stock of the firearm breaking. The sample was then attacked using sledgehammers for 41 seconds. Testing was terminated	01:14

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
								occurred on all shots.		due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.5" x 5.0".	
12-ga 18 Gauge Door 2	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledge hammers for 34 seconds. Testing was terminated due to breach of sample and customer request. Door began coming apart at the surface but was not fully penetrated. The door became unlatched allowing it to be opened.	00:34
12-ga 18 Gauge Door 3	18 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledge hammers for 48 seconds. Testing was terminated due to breach of sample and customer request. Door began coming apart at the surface and was fully penetrated but not to the point where attacker could reach an arm inside. The door became unlatched allowing it to be opened. Approximate damage are on front of sample = 5.5" x 2.5", no through hole.	00:48
9mm 16 Gauge Door 1	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No handgun attack per customer request. Attacked using sledge hammers for 2 minutes and 10 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.5" x 4.5".	02:10
9mm 16 Gauge Door 2	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No handgun attack per customer request. Attacked using sledge hammers for 2 minutes and 8 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.0" x 4.5".	02:08
9mm 16 Gauge Door 3	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No handgun attack per customer request. Attacked using sledge hammers for 1 minute and 43 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 7.0" x 2.0".	01:43
5.56mm 16 Gauge Door 1	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No rifle attack per customer request. Attacked using sledge hammers for 3 minutes and 16 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.0" x 5.5".	03:16
5.56mm 16 Gauge Door 2	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration	Cody S., Lance E.	No rifle attack per customer request. Attacked using sledge hammers for 4 minutes and 1 second. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach	04:01

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
								occurred on all shots.		through the hole to unlock and open the door. Approximate through hole size = 5.0" x 5.75".	
5.56mm 16 Gauge Door 3	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No rifle attack per customer request. Attacked using sledge hammers for 2 minutes and 5 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.0" x 6.0".	02:05
12-ga 16 Gauge Door 1	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledge hammers for 38 seconds. Testing was terminated due to breach of sample and customer request. Door began coming apart at the surface but was not fully penetrated. The door became unlatched allowing it to be opened.	00:38
12-ga 16 Gauge Door 2	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledge hammers for 3 minutes and 48 seconds (at 2:30 mark, attackers became very tired). Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate hole size = 6.0" x 6.25".	03:48
12-ga 16 Gauge Door 3	16 Gauge Solid Core Steel Dore 1.75" thick	Tell	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledgehammers for 2 minutes and 59 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate hole size = 5.5" x 6.0".	02:59
9mm Wood Door 1	Solid Core Wood Door 1.75" thick	USA Wood Door	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No handgun attack was conducted on this test. Attacked using sledgehammers for 9 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.5" x 7.0".	00:09
9mm Wood Door 2	Solid Core Wood Door 1.75" thick	USA Wood Door	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked with blunt forced via 9mm handgun for 56 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.5" x 5.0".	00:56
9mm Wood Door 3	Solid Core Wood Door 1.75" thick	USA Wood Door	35.75 x 79	NA	NA	9mm	15	15 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked with blunt forced via 9mm handgun for 1 minute and 5 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 4.5" x 4.5".	01:05

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Test ID	Test Sample Information					Ballistic Testing			FE Testing		
	Description	Mfr.	Dimensions (in. x in)	Weight (lbs)	Avg. Thickness (in.)	Ballistic Threat ID	No. of Ballistic Impacts	Post Ballistic Testing Notes	FE Attacker ID	Post FE Attack Notes	FE Attack Duration (mm:ss)
5.56mm Wood Door 1	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked using butt of AR-15 rifle for 18 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.25” x 9.0”.	00:18
5.56mm Wood Door 2	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked using butt of AR-15 rifle for 14 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 8.0” x 5.0”.	00:14
5.56mm Wood Door 3	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	5.56mm	30	30 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked using butt of AR-15 rifle for 20 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.25” x 6.0”.	00:20
12ga Wood Door 1	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	Attacked using butt of 12 gauge shotgun for 11 seconds causing little to no damage. Testing was terminated due to the stock breaking on the shotgun. Was then attacked using sledgehammers for 6 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.5” x 4.25”.	00:17
12ga Wood Door 2	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledgehammers for 5 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 5.5” x 6.0”.	00:05
12ga Wood Door 3	Solid Core Wood Door 1.75” thick	USA Wood Door	35.75 x 79	NA	NA	12ga	5	5 cumulative shots, penetration occurred on all shots.	Cody S., Lance E.	No shotgun attack per customer request. Attacked using sledgehammers for 11 seconds. Testing was terminated due to breach of sample and customer request. Door was fully penetrated to where attacker was able reach through the hole to unlock and open the door. Approximate through hole size = 7.5” x 10.0”.	00:11

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APPENDIX 1 – Calibration Data

Job Number: PR141546

Customer: Embry-Riddle Aeronautical University **Date:** 8/3 – 12/31/2021

Range: 1 **Range Lead:** KN

Equipment	Serial Number	NTS I.D. #	Cal. Date	Due Date	Range Lead Initials
Chronograph 1	104	WC027149	9/29/2021	9/29/2022	KN
Chronograph 2	108	WC067007	9/29/2021	9/29/2022	KN
Powder Scale	A20319477	WC075109	3/12/2021	3/12/2022	KN
Floor Scale	25359073	WC060708	12/9/2021	12/9/2022	KN
100 ft. Tape Measure	906	WC064334	3/10/2021	3/10/2022	KN
25 ft. Tape Measure	WC074988	WC074988	10/19/2020	10/19/2022	KN
Thermometer	210185096	WC075125	3/9/2021	3/9/2023	KN
Angle Block	845	WC027023	1/22/2021	1/22/2023	KN
Temp/Humidity/BP Sensor	M21050295	WC075112	3/23/2021	3/23/2022	KN

END OF REPORT

Appendix B: Parent Survey Questions

Definitions:

School: This term generally refers to the place at which your child attends school.

School Buildings: Buildings in which classes are held during school hours.

School Grounds: School-owned property surrounding the School Buildings, including playgrounds and athletic fields but **EXCLUDING parking lots**.

Using the definitions above… Please select your level of agreement with each of the following statements.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know
1. On most days, this school controls access to **School Buildings** during school hours (for example, locked or monitored doors).	1	2	3	4	5	6	7
2. On most days, this school controls access to **School Grounds** during school hours (for example, locked or monitored gates).	1	2	3	4	5	6	7
3. This school has at least one **unarmed** security guard (not law enforcement) on **School Grounds** during all school hours.	1	2	3	4	5	6	7
This school has at least one **armed** security guard (not law enforcement) on **School Grounds** during all school hours.	1	2	3	4	5	6	7
4. This school has least one law enforcement officer on **School Grounds** during all school hours.	1	2	3	4	5	6	7
5. An anonymous threat reporting system is always available (for example, online submission, telephone hotline, or written submission via drop box).	1	2	3	4	5	6	7
6. The **exterior** of the **School Buildings** is regularly maintained (for example, outside window and door locks work, cracked or broken windows repaired quickly).	1	2	3	4	5	6	7
7. The **interior** of the **School Buildings** is regularly maintained (for example, classroom door, office, and gym locks work).	1	2	3	4	5	6	7
8. The fences around the **School Grounds** are in good condition (for example, no holes or gaps in fencing).	1	2	3	4	5	6	7

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Definitions:

School: This term generally refers to the place at which your child attends school.

School Buildings: Buildings in which classes are held during school hours.

School Grounds: School-owned property surrounding the School Buildings, including playgrounds and athletic fields but **EXCLUDING parking lots**.

Using the definitions above… Please select your level of agreement with each of the following statements.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know
9. During school hours, visitors are always prevented from accessing **School Grounds** until they check-in with school personnel.	1	2	3	4	5	6	7
10. Once access to **School Grounds** is granted during school hours, visitors are always required to wear clearly visible visitor badges.	1	2	3	4	5	6	7
11. During school hours, visitors are always prevented from accessing **School Buildings** until they check in with school personnel.	1	2	3	4	5	6	7
12. Once access to **School Buildings** is granted, visitors are always required to wear clearly visible visitor badges.	1	2	3	4	5	6	7
13. The security features within the **School Buildings** make me feel safe.	1	2	3	4	5	6	7
14. The security features on the **School Grounds** make me feel safe.	1	2	3	4	5	6	7
15. The security features inside the classroom make me feel safe.	1	2	3	4	5	6	7
16. Overall, I feel that this school is a safe school.	1	2	3	4	5	6	7
17. Children at this school have been trained on what to do in the event of an emergency at school (for example, lockout or lockdown).	1	2	3	4	5	6	7
18. The **School Buildings** have safety features that would slow down someone who should not be there from trying to get in during school hours.	1	2	3	4	5	6	7
19. The **School Grounds** have security features that would slow down someone who should not be there from trying to get in during school hours.	1	2	3	4	5	6	7

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20. My school has security cameras. ☐ Yes ☐ No ☐ I Don't Know

Using the definitions above…	No Metal Detectors in Use	Only Visitors	Only Students	Only Students & Visitors	All Persons	I do not know
21. My school requires all persons entering **School Buildings** to pass through metal detectors.						

Using the definitions above… Please select the frequency that you believe the following behavior occurs.	Never	Rarely	Sometimes	Usually	Always	I do not know
22. School personnel monitor the **School Buildings**.	1	2	3	4	5	6
23. School personnel monitor the **School Grounds**.	1	2	3	4	5	6

Using the definitions above… How safe **would you feel** in the presence of the following security features at your school?	Not At All Safe	A little Safe	Moderately Safe	Quite a Bit Safe	Extremely Safe
24. Locked or monitored **School Building** doors	1	2	3	4	5
25. Locked or monitored gates around **School Grounds**	1	2	3	4	5
26. Pretend security cameras	1	2	3	4	5
27. Working security cameras	1	2	3	4	5
28. Unarmed security guards	1	2	3	4	5
29. Armed security guards	1	2	3	4	5
30. Law enforcement officers	1	2	3	4	5
31. Metal detectors	1	2	3	4	5
32. Visitors' check-in policies	1	2	3	4	5
33. Badges identifying authorized school personnel	1	2	3	4	5
34. Anonymous threat reporting system	1	2	3	4	5
35. Lockable classroom doors	1	2	3	4	5

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36. Name of School: _____

37. How many of your children currently attend this school? _____

38. What is the age of your oldest child attending this school? _____

39. What is the grade of your oldest child attending this school? _____

40. How are you related to your oldest child attending this school?

- ☐ Mother
- ☐ Father
- ☐ Step-mother
- ☐ Step-father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Other: _____

41. How long has your oldest child attended this school?

- ☐ This is my child's first year
- ☐ This is my child's second year
- ☐ This is my child's third year
- ☐ My child has been at this school four or more years

42. With which gender do you identify?

- ☐ Female
- ☐ Male
- ☐ Other: _____

43. What is your race/ethnicity?

- ☐ White Non-Hispanic
- ☐ Hispanic
- ☐ Black or African American
- ☐ American Indian
  - Tribal Affiliation: _____
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Other: _____

44. How old are you, in years? _____

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Appendix C: Teacher Survey Questions

Definitions:

School: This term generally refers to the place at which you work.

School Buildings: Buildings in which classes are held during school hours.

School Grounds: School-owned property surrounding the School Buildings, including playgrounds and athletic fields but **EXCLUDING parking lots**.

Using the definitions above… Please select your level of agreement with each of the following statements.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know
1. On most days, my school controls access to **School Buildings** during school hours (for example, locked or monitored doors).	1	2	3	4	5	6	7
2. On most days, my school controls access to **School Grounds** during school hours (for example, locked or monitored gates).	1	2	3	4	5	6	7
3. My school has at least one **unarmed** security guard (not law enforcement) on **School Grounds** during all school hours.	1	2	3	4	5	6	7
4. My school has at least one **armed** security guard (not law enforcement) on **School Grounds** during all school hours.	1	2	3	4	5	6	7
5. My school has least one law enforcement officer on **School Grounds** during all school hours.	1	2	3	4	5	6	7
6. An anonymous threat reporting system is always available (for example, online submission, telephone hotline, or written submission via drop box).	1	2	3	4	5	6	7
7. The **exterior** of the **School Buildings** is regularly maintained (for example, outside window and door locks work, cracked or broken windows are repaired quickly).	1	2	3	4	5	6	7
8. The **interior** of the **School Buildings** is regularly maintained (for example, classroom door, office, and gym locks work).	1	2	3	4	5	6	7
9. The fences around the **School Grounds** are in good condition (for example, no holes or gaps in fencing).	1	2	3	4	5	6	7
10. I have been trained on what to do in the event of an emergency at school (for example, lockout or lockdown).	1	2	3	4	5	6	7

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Definitions:

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School Grounds: School-owned property surrounding the School Buildings, including playgrounds and athletic fields but **EXCLUDING parking lots**.

Using the definitions above… Please select your level of agreement with each of the following statements.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know
11. During school hours, visitors are always prevented from accessing **School Grounds** until they check-in with school personnel.	1	2	3	4	5	6	7
12. Once access to **School Grounds** is granted during school hours, visitors are always required to wear clearly visible visitor badges.	1	2	3	4	5	6	7
13. During school hours, visitors are always prevented from accessing **School Buildings** until they check in with school personnel.	1	2	3	4	5	6	7
14. Once access to **School Buildings** is granted, visitors are always required to wear clearly visible visitor badges.	1	2	3	4	5	6	7
15. The security features within the **School Buildings** make me feel safe.	1	2	3	4	5	6	7
16. The security features on **School Grounds** make me feel safe.	1	2	3	4	5	6	7
17. The security features inside the classroom make me feel safe.	1	2	3	4	5	6	7
18. Overall, I feel that this school is a safe school.	1	2	3	4	5	6	7
19. Children at this school have been trained on what to do in the event of an emergency at school (for example, lockout or lockdown).	1	2	3	4	5	6	7
20. The **School Buildings** have security features that would slow down someone who should not be there from trying to get in during school hours.	1	2	3	4	5	6	7
21. The **School Grounds** have security features that would slow down someone who should not be there from trying to get in during school hours.	1	2	3	4	5	6	7

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22. My school has security cameras. ☐ Yes ☐ No ☐ I don't know

If YES … please select your level of agreement with item no. 23.

If NO or I DON'T KNOW … move on to item no. 24.

23. The security cameras in place at my school are always functional.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know

24. Those who work at my school are issued identification badges. ☐ Yes ☐ No

If YES … please select your level of agreement with item no. 25.

If NO … move on to item no. 26.

25. Those who work at my school always wear their identification badges during school hours.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know

Using the definitions above… 26. My school requires all persons entering **School Buildings** to pass through metal detectors.	No Metal Detectors in Use	Only Visitors	Only Students	Only Students & Visitors	All Persons	I do not know

If Metal Detectors are present at your school, then select the level of agreement with the following statement: 27. Metal detectors at my school are generally functional.	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree	I do not know

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School Buildings: Buildings in which classes are held during school hours.

School Grounds: School-owned property surrounding the School Buildings, including playgrounds and athletic fields but **EXCLUDING parking lots**.

Using the definitions above… Please select the frequency that you believe the following behavior occurs.	Never	Rarely	Sometimes	Usually	Always
28. School personnel monitor the **School Buildings**.	1	2	3	4	5
29. School personnel monitor the **School Grounds**.	1	2	3	4	5

Using the definitions above… How safe **would you feel** in the presence of the following security features at your school?	Not At All Safe	A little Safe	Moderately Safe	Quite a Bit Safe	Extremely Safe
30. Locked or monitored **School Building** doors	1	2	3	4	5
31. Locked or monitored gates around **School Grounds**	1	2	3	4	5
32. Pretend security cameras	1	2	3	4	5
33. Working security cameras	1	2	3	4	5
34. Unarmed security guards	1	2	3	4	5
35. Armed security guards	1	2	3	4	5
36. Law enforcement officers	1	2	3	4	5
37. Metal detectors	1	2	3	4	5
38. Visitors' check-in policies	1	2	3	4	5
39. Badges identifying authorized school personnel	1	2	3	4	5
40. Anonymous threat reporting system	1	2	3	4	5
41. Lockable classroom doors	1	2	3	4	5

42. Name of School: _____
43. What grade(s) do you teach at your school? _____
44. How long have you worked at this school (**years/months**)?
45. With which gender do you identify?

☐ Female

☐ Male

☐ Other: _____

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46. What is your race/ethnicity?

- ☐ White Non-Hispanic
- ☐ Hispanic
- ☐ Black or African American
- ☐ American Indian

    Tribal Affiliation: _____

- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Other: _____

47. How old are you, in years? _____

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