Testing of Person-Passable Openings that Intersect a Security Boundary

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The Physical Security Pathway performs research and development (R&D) to develop and enhance methods, tools, and technologies that advance the technical basis needed to optimize and modernize a nuclear facility's security posture. One research area, being performed in conjunction with the Nuclear Energy Institute and Light Water Reactor Sustainability (LWRS) Program researchers at Sandia National Laboratories (SNL), is testing to reevaluate and redefine the minimum passible opening size through which a person can effectively pass and navigate. These tests are on both simple two-dimensional (up to 36-inch in depth) and more complex three-dimensional (longer lengths and changes in direction) configurations. The primary impact of this effort is to define the scenarios in which an adversary could successfully pass through a potentially complex opening, as well as define the scenarios in which an adversary would not be expected to successfully traverse a complex opening. This systematically tested data can then be used to support risk-informed decision-making. At its inception, the project intended to investigate openings that could be found to intersect security boundary layers (e.g., drainage culvert), but through careful experimental design, the testing seeks to further understand the delay characteristics of engineered openings (e.g., piping systems), as well as potential breach points (e.g., cutting through a wall or door).

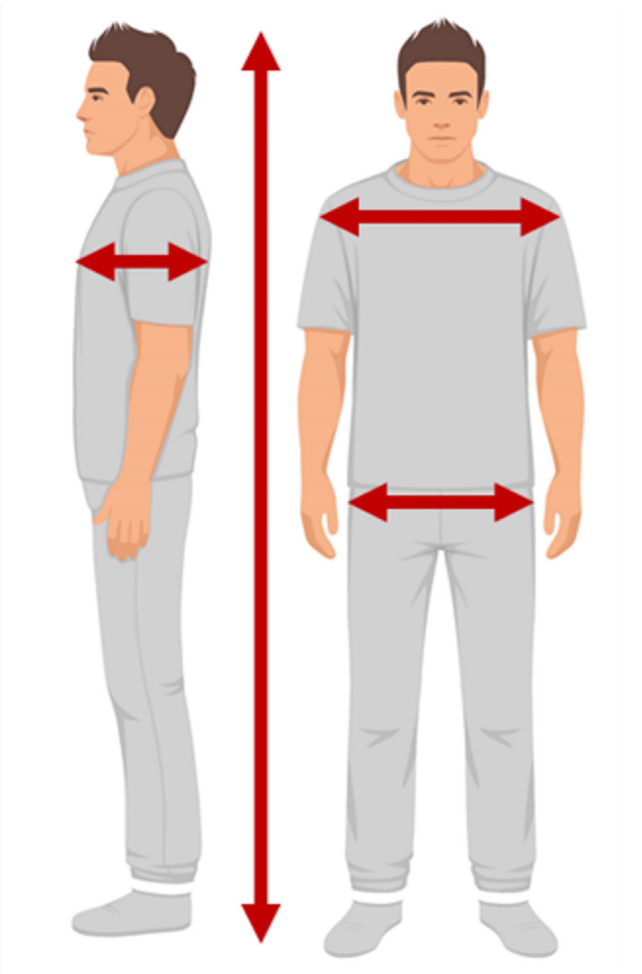
In determining the minimum passable opening size that an adversary could exploit, the following questions should also be asked: (1) Does this opening increase risk or provide an opportunity to an adversary? (2) If so, how can this opening be exploited? (3) How much time does it take for the opening configuration to be exploited in various scenarios? (4) What are the limitations of this exploitation?

The industry has an established minimum passable opening size, and while these dimensions have been the accepted standard for decades, there is little information to their origin, correlation to the adversary size that could exploit the minimum passible openings, or how much delay is generated by openings of different sizes. This study seeks to not only determine the smallest area in which an adversary can pass, but also to correlate passable apertures with statistical person size data for various U.S. military populations, and how fast they can successfully navigate different configurations.

As one can imagine, a plethora of variables or factors exist that can influence both the minimum passable opening size, as well as the time or rate at which an adversary can successfully traverse a barrier. The size of the person attempting to breach the opening will be a primary influence on how small a hole they can squeeze through. As shown in Figure 4, there are critical dimensions of the human body that cannot be easily manipulated, such as hip width, chest depth, and head diameter. Conversely, there are other adversary factors that are less fixed, such as choice of clothing, body armor, or equipment and weapons being carried that could be dragged behind during the passthrough in order to successfully traverse the opening. The time and rate that it takes to successfully navigate a longer opening, such as a pipe, will depend on variables such as person size, pipe diameter, internal surface friction, and the ability to navigate corners.

Personality variables like claustrophobia, mental fortitude, determination, etc., are not being considered as it is

Figure 4. Human hip and chest depth are data of interest.



assumed a determined adversary will mentally prepare and allow themselves to be placed in uncomfortable and stressed positions in order to achieve their goal.

Our test team is seeking to include both male and female test participants that represent a number of human factors databases with large sample size populations. While it is expected that a low percentile of subjects will likely determine the minimum passible opening in this study, participants in the 50th and 75th percentiles may have different performance characteristics for traversal rates and differences in the ability to drag a bag of equipment behind them in a longer and more complex pipe.

All testing is to take place at the SNL's Sandia Access Delay lab and will be broken into two distinct activities: (1) two-dimensional testing; and (2) three-dimensional testing. An example of two- and three-dimensional testing configurations are shown in Figure 5 and Figure 6, respectively. For our two-dimensional tests, participants will navigate through a rectangular opening that can be varied incrementally in both horizontal and vertical major dimensions, where a circular aperture will be used to simulate a round hole. The depth of the two-dimensional fixture is approximately 3.5-inches, which approximates a thin wall section. In addition to the rectangular opening, each participant will attempt to traverse a series of pipe sections of varied diameters, which are each 36-inches long.

The three-dimensional testing will utilize modular circular pipe and square conduit sections with predetermined internal dimensions. These tests can be configured to provide a long 24-foot straight section, an "L" with a single 90° elbow, or a jog section with two 90° elbows.

Safety of our participants is of utmost importance and consideration. Each will be chosen from a pool of volunteers who will be recruited from SNL and fully informed as to the test objectives, the safety precautions in place, and screened for risk factors such as claustrophobia. Because this testing is primarily a test of a person's ability to conduct a given task, our test team is working with the Sandia Human Studies Board to fully vet the processes, procedures, test fixtures, data collection, and participant safety. The test fixtures designed for this test series are designed to be quickly opened or disassembled to allow a test participant to be freed from the apparatus if they happen to become stuck.

SNL's Access Delay Department has a long history of conducting these types of access delay tests and employs a range of experienced engineers and technologists who each bring unique skillsets, including experienced breachers, computer modelers, explosive experts, and security professionals. Together, there is broad expertise in all aspects of physical security systems R&D, as well as integrated, engineered systems design and implementation.

Figure 5. Proposed two-dimensional opening test setup.

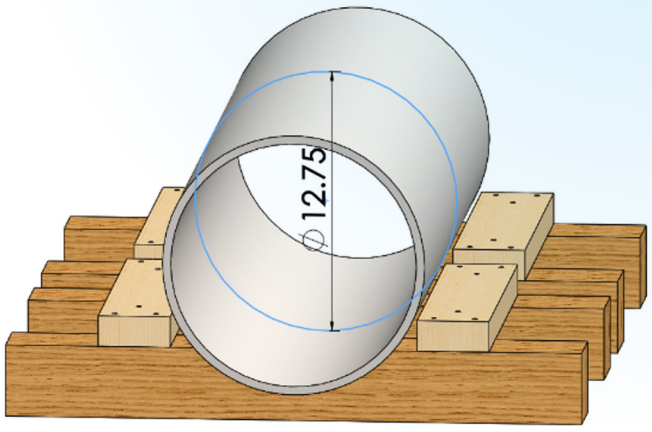


Figure 6. Proposed three-dimensional opening test setups.