



The Tested and Proven Performance* of Security Grade Chain Link Fencing Systems

Deterring • Delaying • Protecting

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Executive Summary

By using ASTM F2781 testing standards, which compared security grade chain link's performance against that of a major competitive product, the security and fence industries now have data to verify the effectiveness of security grade chain link fence products in deterring and delaying intruders in high security applications. The tests showed select security grades of chain link significantly outperformed their potential competitors in resisting low and medium force entry efforts, and one grade was comparable in High Aggressive Threat Levels involving powerful gasoline powered equipment.

In addition, impact testing (a 4000 lb. vehicle traveling 20 mph) has shown security grade chain link to be effective in absorbing the impact of a vehicle, which establishes it as an effective safety barrier for parks, schools, and other public places. The testing was conducted by one of the nation's most respected independent testing organizations, the Southwest Research Institute in San Antonio, Texas, and the empirical test data and finding of the testing shows:

- Security grade chain link fence can be effective in deterring and delaying intruders and providing protection from vehicular impact in high security applications when properly specified and installed (design engineers should also adhere to ASTM guidelines for appropriate framework and fittings).
- Properly specified and installed security grade chain link fence provides superior resistance to both low and medium grade forced-entry threats and significantly outperformed a competing expanded metal [1/2"-13R (.188)] panel fence system in both categories
- Security grade chain link offers different products, fabrics, and gauges for different levels of threats when establishing perimeters and measuring performance in vehicular impact resistance
- Security grade, small mesh chain link fence is designed to preclude toeholds and finger penetration, serves as an effective barrier to the passage of weapons, and provides good visibility for the detection of breaching attempts
- Subjecting security grade chain link fence to ASTM testing standards through an independent testing organization provides the security and fence industries with data and test results needed for good, defensible decision-making

According to "Security Planning and Design: A Guide for Architects and Building Design," a wide variety of tactics and techniques can be used to defend against a forced-entry attack ranging from high level to relatively low-level protection, but the main purpose of the perimeter is to detect and delay aggressors attempting to penetrate a facility.

The writer, Joseph A. Demkin, American Institute of Architects, went on to say, "It is not practical to harden a commercial facility to prevent penetration; therefore, it is imperative to coordinate the level of protection for these properties with the time of law enforcement response." Thus concluding that the level of protection (i.e., the specified time to penetrate) chosen for a property is often coordinated with the time required for appropriate response.

With this data, gathered through ASTM approved testing procedures, security and fence professionals can specify and select fence systems based on both the penetration delay time required for an appropriate response by security personnel, and on security grade chain link's vehicular impact resistance capabilities.

While claims have been made by the producers of competing fence systems about the performance of their products against chain link fence systems (often comparing it to residential or light commercial chain link products, rather than the security grade chain link used in these tests), these testing results provide the data needed by security and fence professionals to make a well informed, logical decision – **security grade chain link**.

Quantitative Testing Systems

The ASTM F2781 testing and rating system, *Standard Practice for Testing Forced-entry, Ballistic, and Low Impact Resistance of Security Fence Systems*, has allowed security chain link fence systems to be tested and evaluated against these standards, as well as against competing products. The testing system rates the penetration resistance characteristics of fence systems used in commercial, government and military installations and results in a rating reflecting the severity. (see Table 1).

The methodology measures the actual time delays for specific fence systems at three different threat levels by evaluating the time necessary for vandals and unsophisticated criminals to forcefully penetrate security fence systems by creating a four sq. ft. opening.

The threat levels are defined by the number of people involved in the entry attempt and the tools available to them (see page 6 for details), which are classified as low, medium, and aggressive. Under the quantitative testing guidelines, the time to effectively penetrate the fence system using simple hand tools (low), sophisticated hand tools (medium), and power tools (aggressive) are measured in tenths of a minute.

Thus, the forced-entry resistant rating system uses L, M, and A and signifies the time elapsed to penetrate such as 4.3 or four minutes and 18 seconds. With this rating system, ratings will read, for example, L8.3, M6.7, and A3.2 noting both the threat level and the time required for penetration.



Low threat consists of two men using hand tools to penetrate the barrier.

Penetration Findings

Various grades of chain link fence have long been the primary tool in establishing security perimeters, although in recent years, competing product manufacturers have challenged the effectiveness of chain link fence as a resistant deterrent (often comparing residential chain link, rather than security grade chain link, to their products).

Security and fence professionals needed quantitative results from an objective testing methodology which would allow them to use credible measurements to compare security grade chain link's performance in forced-entry resistance situations against expanded metal panel fence and other competing fence products. ASTM's guidelines provided those measurements.



The 1/2" mesh by 9 GA met a Medium Aggression threat level of M10.9 and outperformed a major competing expanded metal panel product.

A broad range of chain link fence products and a competitive product were tested using the ASTM testing and rating system. The Southwest Research Institute's Mechanical and Materials Engineering Division conducted the testing which was expanded to include impact testing, tunneling penetration, and the ability to unravel chain link fence as a means of forced-entry. Evaluation of the quantitative test results has led to definitive findings/recommendations on specifying security grade chain link fence based on threat level and safety standards. Through the testing and rating system, it was concluded that:

1. Mesh sizes smaller than 1" significantly increase penetration resistance times.
2. 1/2" mesh x 9 GA provides greater penetration resistance than 3/8" mesh x 11 GA.
3. 3/8" mesh x 11 GA and 1/2" mesh x 9 GA provide more penetration resistance than expanded metal panel fencing at Low Threat Levels.
4. 1/2" mesh x 9 GA provides more penetration resistance at a Low and Medium Threat Level than expanded metal panel fencing.

5. Unraveling of security grade chain link wire pickets with the fence under tension was deemed “not a practical means of penetration” during testing due to the excessive time required to pull and pry a wire for 2" x 6 GA fabric and 1" x 9 GA fabric. Unraveling was considered “not doable” for wire sizes of at least 11 GA with mesh sizes less than 1 inch.
6. Tunneling resistance increases significantly (11 minutes to 26 minutes) when burying security grade chain link fabric below ground and backfilling with stone and soil.

These findings are conclusive and can be used in the specification of security fencing based on anticipated threat levels and security personnel response times. For more information about security grade chain link fence, visit chainlinkinfo.org and see Security Fencing Guidelines.

Safety Barrier Test

This test simulated a 4000 lb. moving vehicle impacting two different security grade chain link fence systems, and a competing expanded metal panel fence system, at 20 mph. It was determined that security grade chain link systems absorbed tremendous amounts of energy by stretching during impact. The 3/8" MESH x 11 GA fence system stopped the impact vehicle in 7.5 feet and the 1/2" MESH x 9 GA fence system stopped the impact vehicle in just four feet, **while the expanded metal panel fence completely failed to stop the penetration.**



Engineers designing safety and security systems for parks and other public works projects can use this research information to specify the correct security grade chain link fence system to meet these vehicle impact safety standards and eliminate adding a costly, unsightly barrier system.

*One properly designed security grade chain link fence can thereby meet the two important safety criteria required by ASTM – perimeter **safety** and vehicular impact **protection.***

Test vehicle penetration at 20 mph.

ASTM Threat Levels

The success or failure of any attempt to forcefully penetrate a fence system is dependent upon three primary factors of the cumulative effect of the threat: the tools and implements used; the elapsed time; and the sophistication and motivation of the personnel affecting the forced-entry.

For testing and rating purposes, the threat levels were defined as:

Low Threat Level (L) - Specifically exempted from the inventory of available tools for the low (L) threat level category are power tools (gasoline, electric or hydraulic), and devices requiring more than one person to transport and operate.

Medium Threat Level (M) - Specifically exempted from the inventory of available tools for the medium (M) threat level category are power tools requiring an outside power source or self contained gasoline or battery driven tools and devices requiring more than two persons to transport and operate.

Aggressive Threat Level (A) - Specifically exempted from the inventory of available tools for the aggressive (A) threat level category are devices requiring more than two persons to transport and operate.

The procedures of this test method are intended to evaluate the time necessary for vandals and unsophisticated criminals to forcefully penetrate security fence systems by using manually operated tools – defined as a low, medium, or aggressive forced-entry threat. Aggressor groups range from unsophisticated criminals and vandals to organized criminals.

The tools specified for testing at each threat level are known to have a maximum destructive effect on structures and their sub-assemblies and are readily available to aggressors posing the defined level of threat.

Testing Guidelines

These test requirements and subsequent rating system have been established for use in evaluating the penetration resistance characteristics of standard fence systems to be used in commercial, government and military installations.

In the testing procedures, each rating is based on a Structured portion and a Discretionary portion of the testing as described below:

- Structured portion of the test provides for a zero to five-minute test with specific tools selected as the most debilitating from the tool list.
- Discretionary portion of the test provides up to 55 minutes of testing, optimizing forced-entry efforts by selecting any (or all) tools from the applicable category of the list (low (L), medium (M), or aggressive (A)).

Testing of security fence systems in accordance with the requirements of this test method results in a rating reflecting the severity of the threat and the cumulative resistance time. The times used to establish the protection ratings range from a minimum of 0 minutes to a maximum of 60 minutes and are intended to reflect the elapsed time of forced-entry resistance.



As security and fence professionals, you need to know how long it takes aggressors to penetrate a perimeter under different conditions. The ASTM testing procedures and this study offer those guidelines.

It is important to recognize that the lowest threat level time will establish the maximum time limit for a greater threat level.

Test Results: Fence System Penetration

The forced-entry testing of all samples begins with the Structured portion of testing and continues through the Discretionary portion of testing or until forced-entry has been achieved. For the purposes of the test, the Forced-entry Criteria is defined as creating an opening of four square feet in the fence system.

Penetration Test: 4 ft. Square	3/8" MESH x 11 GA	1/2" MESH x 9 GA
Low: 2 men, hand tools	L12.5 minutes.	L10.9 minutes.
Medium: 2 men, battery operated power tools	M1.8 minutes.	M10.9 minutes.
Aggressive: 2 men, gas powered tools	A0.7 minutes.	A1.2 minutes.

Further Testing

Additional tests were conducted to determine the resiliency of the fence systems against specific methods of breaching. Some of the tests were not used to determine the security rating of the fence systems but were used solely to establish the efficiency of certain tools and methods of penetrating the fence system. These tests consisted of Unraveling Test, Impact Test, and Tunneling Test.

Unraveling Test

This test was conducted as a special test and was not used to determine the security rating of the fence systems. Only three fence systems were subjected to this testing: 2" MESH x 6 GA, 1" MESH x 9 GA, and 3/8" MESH x 11 GA.

The objective during this test was to unravel a link from the fence fabric and creating a void or separation in the mesh to allow for a penetration of the fence system. Optimum tools selected by actual use were as follows:

- 12" Bolt Cutters
- 3 lb. Hammer
- Fence Pliers
- Crowbar
- Cable Ratchet (Come-Along)

The 2" mesh chain link system was penetrated after 10 minutes. Unraveling was deemed ineffective as a means of penetration on the 1" and 3/8" mesh chain link.



Test Results: Unraveling

Size of Fence System	2" MESH x 6 GA	1" MESH x 9 GA & 3/8" MESH x 11 GA
Time to unravel	10 minutes	unraveling ineffective as a means of penetration

Results

- 2" MESH X 6 GA fence system was breached at 10.0 minutes
- 3/8" MESH X 11 GA fence system was not penetrated. The aggressors failed to release the tension in the fabric by using Cable-ratchet.

Tunneling Test

Only the 2" MESH x 6 GA fence system and the 1/2" MESH X 9 GA fence system were subjected to this testing. The 2" MESH X 6 GA fence system simulated an unburied fence system. The 1/2" MESH X 9 GA fence system was buried below the grade. The objective during this test was to achieve a forced-entry by digging under the fence. The hole had to be sufficiently large for an adult male to slip under. Optimum tools selected by actual use were as follows:

- Shovels • Pick • Digging Bar

Test Results: Tunneling/Penetration

Test Condition	No Buried Fence	Buried Fence
Time to tunnel below grade installation	11.1 minutes	25.8 minutes

Results

- The fence system that was not buried was breached at 11.1 minutes.
- The buried fence system was breached in 25.8 minutes.



Two men with hand tools can dig under a typical unburied fence in 11.1 minutes.



It took 25 minutes for two men with hand tools to dig under a typical buried fence.

Impact Test Methodology

Only the 3/8" MESH X 11 GA fence system, the 1/2" MESH X 9 GA fence system, and the expanded metal panel fence system were subjected to this testing. Using ASTM F2781 standards, the tests simulated a 4000 lb. moving vehicle impacting a fence system at 20 mph using a bogey test vehicle. The intended point of impact was in the middle of the thirty-foot section with 4" OD posts spaced 10 feet on center.

Test Results: Impact

Size of Fence System	3/8" MESH x 11 GA	1/2" MESH x 9 GA	Expanded Metal Panel Fence
Simulated auto weighing 4,000 lbs. @ 20 mph	7.5 feet	4 feet	FAILED (full penetration of fence by test vehicle)

The impact vehicle was accelerated to the desired speed using a pulley system and tow vehicle. The vehicle was released and freewheeling prior to the impact with the test article once the desired speed was attained.

After the impact a detailed inspection of the fence system was performed. The static deflection of the fence system was measured 24" above grade. The conditions of the fence system's main components were documented. High-speed video was used to determine the dynamic deflection of the fence during the impact.



Bogey vehicle weighing 4,000 lbs. and moving 20 mph was stopped in just 4 feet by 1/2" Mesh x 9 GA chain link fence.

Example of an alternate fence system



The test vehicle totally penetrated an expanded metal panel fence system.

Results

Testing shows that properly designed and installed chain link fence systems produced the following results:

- 3/8" MESH X 11 GA fence system stopped the impact vehicle and the maximum dynamic penetration of the fence system was 7.5 feet.
- 1/2" MESH X 9 GA fence system stopped the impact vehicle with a maximum dynamic penetration of the fence system was 4 feet.

In further test results, the test vehicle totally penetrated an expanded metal panel fence system.

Conclusions

For security and fence professionals, there are certain conclusions that can be drawn from the data produced by using these ASTM testing procedures. First and foremost, security grade chain link fence systems, when properly specified and installed, can provide proven levels of resistance to various threat levels – outperforming select expanded metal panel fence products. In addition, cost surveys show security grade chain link systems are *consistently less expensive* to install than expanded metal panel fence systems.

Testing security grade chain link fence systems using approved ASTM standard practices also shows that security grade chain link can provide appropriate safety barriers capable of absorbing the impact of an automobile, and *protecting schools, parks, and other public areas from low impact vehicular*

threats. It performs well in tunneling tests and can be hardened to create further delays in penetration. Finally, testing reveals that unraveling security grade chain link fence is an almost completely ineffective method of forced entry.

Security grade chain link remains the leading, most cost effective perimeter fence system on the market today and, when properly specified and installed, can provide a higher standard of resistance to low and medium threats than competing products. With these ASTM testing procedures, the security and fence industries can also measure and compare fence systems on vehicular impact, and accompanying safety standards.

These tests affirm security grade chain link's ability to deter, delay, and protect.

SUMMARY OF TEST DELAY TIMES

Fence Type	Impact Penetration <small>(4,000 lb test vehicle @ 20 mph)</small>	Low Threat Breach	Medium Threat Breach	Agressive Threat Breach	Unravel Test
		<small>Breach is defined as creating a 2' x 2' entry point</small>			
2" x 6 ga chain link	N/A	1.47 min	N/A	1.30 min	10.0 min
1" x 9 ga chain link	N/A	1.17 min	N/A	.78 min	Unraveling ineffective as a means of penetration
3/8" x 11 ga chain link	7 ft To 8 ft.	12.51 min	1.82 min	.75 min	Unraveling ineffective as a means of penetration
1/2" x 9 ga chain link	4 ft.	10.90 min	10.90 min	1.18 min	Unraveling ineffective as a means of penetration
<i>Expanded Metal</i> 1/2"-13 (.188)	FAILED <small>(full penetration of fence by test vehicle)</small>	5.35 min	5.35 min	1.30 min	N/A

Note: All penetration and breach tests done in accordance with ASTM F2781

N/A indicates product not tested in this configuration

NOTE TO SPECIFIERS and ENGINEERS

To properly evaluate the design for the selection of the best security fence system, specifiers and design engineers should request documentation that testing was done in compliance with ASTM F2781 and other appropriate standards.