GLOBAL GRAB TECHNOLOGIES

YOUR COMPLETE SECURITY SOLUTIONS PARTNER

Testing Results for 50ft

277 Mallory Station Road, Suite 112 Franklin, Tennessee 37067-8251
615-224-0400 • 877-260-4722 toll free • 615-224-0411 fax • www.grabglobal.com

TEST REPORT FOR:

Smith & Wesson Security Solutions

M50 Post and Cable System - 50 ft

TESTED TO:

ASTM F 2656-07

Standard Test Method for Vehicle Crash Testing of Perimeter Barriers

Test M50

PREPARED FOR:

Smith & Wesson Security Solutions

277 Mallory Station Road, Suite 112

Franklin, TN 37067

TEST REPORT NUMBER:

TR-P32086-01-NC

REPORT DATE:

July 16, 2012

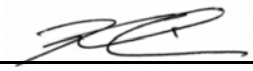
TEST DATE:

June 8, 2012

KARCO Engineering, LLC.
Automotive Research Center
9270 Holly Road
Adelanto, CA 92301
Tel: (760) 246-1672
Fax: (760) 246-8112

ACCREDITED
ISO/ IEC 17025: 2005

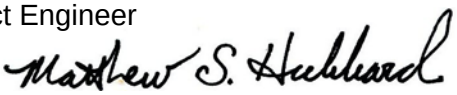
KARCO Engineering compiled this publication for information gathering only. The findings and conclusions expressed in this publication are those of the authors and not necessarily those of any other organization. KARCO Engineering provides test services only and is not involved in consulting, product design or the manufacturing of any automotive products. KARCO does not warrant, supervise or monitor compliance of products or services except as specifically agreed to in writing. By their very nature, testing, analysis and other KARCO services are limited in scope and subject to expected measurement variability. No activity by KARCO Engineering can release a manufacturer from product or any other liability. The results, findings and conclusions expressed in this publication relate only to the items tested for the specific situation simulated in the test.

Tested By: 

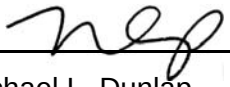
Mr. Kelsey A. Chiu
Engineering Department Supervisor

Report By: 

Mr. Steven D. Matsusaka
Project Engineer

Reviewed By: 

Mr. Matthew S. Hubbard
Quality Assurance Manager

Approved By: 

Mr. Michael L. Dunlap
Director of Operations

Approval Date: July 16, 2012

REVISION CONTROL LOG

TR-P32086-01

Revision	Date	Description
-NC	07/16/12	Original Test Report

TABLE OF CONTENTS

SECTION 1
INTRODUCTION

1.1 – OBJECTIVES

The primary objective of this impact test was to determine a penetration rating for the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft (test article) per the ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'* to the M50 level. The intent of this test was to evaluate the ability of the barrier to arrest a 6,800 kg (15,000 lb) vehicle from penetrating or vaulting a secured area and the extent, if any, of barrier deformation.

This report presents the results of the performance and evaluation of one (1) full-scale impact test conducted on one (1) Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft to the M50 (80 km/h, 50 mph) level. Testing and reporting of test results are described in the test procedure and are not repeated in this report.

1.2 – TEST FACILITY

This test was conducted at KARCO Engineering's test facility in Adelanto, California. The tow road is a continuous level surface constructed of reinforced concrete and measures 850 feet in length, is 14 feet wide, and 6 in. thick. A steel rail is embedded in the road to provide vehicle guidance. Vehicle tow propulsion is provided by a 1 ton truck using a 1-to-2 pulley system coupled to a fixed prime mover (an internal combustion engine, Chevrolet V-8, 454 cubic inches displacement, with TH-400 automatic transmission) and a continuous cable drive system. The test vehicle is towed to within 25 feet of the barrier by a nylon rope clamped to a 3/8-inch steel cable. The clamp is released from the cable on contact with a cable release mechanism positioned to allow the test vehicle to proceed under its own momentum for a maximum of 25 feet before impacting the barrier.

1.3 – TEST PROCEDURE

The Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft was tested per ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'*. This ASTM standard contains specific requirements for test article installation, vehicle properties, impact conditions, test instrumentation, and evaluation criterion.

1.3.1 – Test Article Installation

The materials, assembly instructions, and physical configuration of the test article are specified in the manufacturer's literature and are not repeated in this test report. Installation of

the test article was conducted by Heavy Duty Gates, Inc. The test article, as installed at the test facility, is illustrated in Appendices A and D.

1.3.2 – Test Vehicle Properties

ASTM F 2656-07 specifies four (4) different vehicle levels for possible penetration ratings: C (Small Passenger Car), P (Pickup Truck), M (Medium Duty Truck) and H (Heavy Goods Vehicle). All test vehicles must be structurally sound with no major damage or modifications and must have original equipment bumpers. Tire sizes shall be those recommended by the vehicle manufacturer unless otherwise specified by a specific agency. Test Vehicle properties for each vehicle are presented in Table 1.

Table 1 – Test Vehicle Properties

Vehicle Type	Small Passenger Car C	Pickup Truck P	Medium Duty Truck M	Heavy Goods Vehicle H
Gross Vehicle Test Mass (kg)	1,100 ± 20	2,300 ± 50	6,800 ± 140	29,500 ± 590
Year	Within 10 Model Years	Within 10 Model Years		
Wheelbase (m)			5.28 ± 0.51	
Bed Length (m)			5.49 ± 0.61	
Other	Sedan or Coupe	3/4 Ton, Single Cab	Flatbed	Tandem Axle Dump Truck or Drop Axle Truck

This test of the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft was conducted with the M test vehicle. To meet the recommended properties a commercially available production model test vehicle was selected. This test vehicle was a 1996 Ford F-700 medium duty truck with conventional cab, front mounted diesel engine, rear wheel drive, and a manual transmission. The bumpers were standard equipment and were not modified.

1.3.2.1 Test Mass: The Gross Vehicle Test Mass of the M test vehicle as specified in the ASTM standard is 6,800 kg ± 140 kg. The actual Gross Vehicle Test Mass with instrumentation and ballast was 6776.0 kg.

1.3.3 – Impact Conditions

ASTM F 2656-07 has specific requirements for impact conditions for a qualifying test which include vehicle impact velocity, approach angle and impact location.

1.3.3.1 – Velocity: Vehicle velocity at impact with the test article shall be dependent upon the test vehicle mass. For this test, designated M50, the target kinetic energy was 1,680 kJ. The calculated target velocity was 80.2 km/h (49.8 mph). Actual velocity at impact was 76.8 km/h (47.7 mph).

1.3.3.2 – Approach Angle and Impact Point: The test vehicle was oriented so it approached the test article at a critical impact angle of ninety degrees (90° ± 3°) relative to the barrier, with the centerline of the vehicle impacting the test article at the impact point designated by the client. The actual impact point must be within ± 300 mm (1 ft.) of the target.

The impact point was selected to be the center of the span between the termination posts. The actual point of impact was perpendicular within 1.0° and within 13 mm (0.5 in.) of the target.

1.3.4 – Test Instrumentation and Data Acquisition Procedures

All data acquisition for this test of the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft was performed in accordance with the ASTM F 2656-07 Standard Test Method requirements.

1.3.4.1 – Test Vehicle Instrumentation: The test vehicle was instrumented with two (2) tri-axial accelerometers. One (1) was located along the driver's side frame rail at the longitudinal center of mass and the other at the rear of the same frame rail. The accelerometers measured longitudinal (x), lateral (y), and vertical (z) acceleration. Data was recorded using the on-board TDAS. Data was linked to a personal computer and processed using the TDAS Control software. All equipment used in this test meets the requirements of SAE J211.

1.3.4.2 – Calibration: All instrumentation used in this test has been calibrated through standards traceable to NIST and is maintained in a calibrated condition.

1.3.4.3 – TDAS Software: The software utilized in this system is written in National Instruments Lab Windows/CVI (C, Visual Interface) programming language, which is a Windows based software package with emphasis on ease of use and good engineering test practices.

1.3.4.4 – SAE Compatibility: The software contains standard point and click processing options for selecting Society of Automotive Engineers (SAE) class post filters and calculating the required integrals, resultants, Head Injury Criteria (HIC), clips, and other data processing parameters that may be required.

1.3.4.5 – Photographic Documentation: Photographic documentation of this test included a minimum of two (2) real-time video cameras at 30 frames per second (fps), and four (4) high-speed color digital video cameras at 1,000 fps. All high-speed cameras were activated by a pressure-sensitive tape switch which was positioned on the test article to indicate the instant of contact (time zero). A digital still camera was used for documenting the pre- and post-test condition of the test article and the test vehicle.

1.3.4.6 – Measurement Uncertainty: Measurement uncertainties have been determined for pertinent values affecting the results of this test. KARCO maintains these uncertainty budgets, which are available upon request, but are not included in this report. In certain cases the nature of the test method may preclude rigorous and statistically valid calculation of uncertainty of measurement. In these cases KARCO attempts to identify the components of uncertainty and make a reasonable estimation. Reasonable estimation is based on knowledge of the performance of the method and on the measurement scope and makes use of, for example, previous experience and validation data.

1.4 – EVALUATION CRITERION

This full scale impact test was performed to evaluate the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft per the specifications of ASTM F 2656-07. Test articles are evaluated for and given a penetration rating.

Table 2 – Penetration Ratings

Measured Penetration	Rating
Less than 1 m	P1
1.01 m - 7.0 m	P2
7.01 - 30.0 m	P3
Greater than 30 m	P4

1.4.1 – Penetration Rating

A penetration rating per ASTM F 2656-07 is given to each test article. The measurements used to formulate this rating are taken from penetration reference points on the test vehicle and the test article.

The test vehicle reference points are defined in ASTM F 2656-07 as follows: for small passenger cars the reference point is the center of the base of the A-Pillar; for the remaining three test vehicles (Pickup Truck, Medium Duty Truck, and Heavy Goods Vehicle) the reference point is the lower leading edge of the cargo bed.

The penetration reference point on the test article varies depending on the type of test article. Several examples are outlined in Annex A1 of ASTM F 2656-07. For this evaluation of the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft, the test article penetration reference point is the vertical plane created by the back (non-impacted) side of the cables.

Penetration measurements are taken in both static and dynamic modes. The static penetration measurement is based on the vehicle's final resting position and the dynamic

penetration is measured from high speed video. The highest value of both static and dynamic penetration for both the left and right sides of the test vehicle is used to assess the penetration rating. Penetration limits are presented in Table 2.

For a test article to be given a penetration rating per ASTM F 2656-07, the test article must disable the test vehicle to prevent the vehicle from propelling itself forward. If a test article does not sufficiently disable the vehicle it will be considered unrated.

SECTION 2
TEST ARTICLE DETAILS

2.1 – TEST ARTICLE

The Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft is a 15.24 m (50.0 ft) stationary cable fence. The as-tested unit consisted of two (2) terminal post assemblies, two (2) terminal post knee braces, four (4) intermediate line posts, and three (3) cables. The blocking portion of the fence consists of three (3) 32 mm (1.3 in.) steel cables. The bottom cable height is 838 mm (33.0 in.), the middle cable height is 99 mm (39.0 in.), and the top cable height is 1143 mm (48.0 in.) above grade.

The terminal posts are made of 3.1 m (10.0 ft) long, 406 mm (16.0 in.) by 406 mm (16.0 in.) square steel tube with a wall thickness of 12 mm (0.5 in.). The bottom corners of the terminal post are welded to four (4) 777 mm (30.6 in) long, 508 mm (2.0 in) by 508 mm (2.0 in) by 6 mm (0.25 in) thick steel angle. The steel angles are then welded to one (1) 419 mm (16.5 in) by 419 mm (16.5 in) steel plate with a thickness of 6 mm (0.25 in), which completes the terminal post assembly. The terminal post has three (3) 25 mm (1.0 in) thick steel plates with a 508 mm (2.0 in) diameter hole cut out to secure the three (3) 32 mm (1.25 in) closed spelter socket with polyester resin with one (1) 45 mm (1.8 in) socket pin. The assembly is placed in a 914 mm (3.0 ft) diameter, 2.4 m (8.0 ft) deep hole with a rebar cage made out of #6 rebar.

The holes and terminal post assemblies are filled with 4,000 psi concrete, with the concrete finishing with a dome on top of the assembly.

Two (2) 102 mm (4.0 in.) by 102 mm (4.0 in.) rectangular tubes with a wall thickness of 10 mm (0.38 in.) create the knee braces and bolt at the top of each of the terminal posts; they also are attached to an in-ground brace channel. The knee braces bolt at a 42° angle from the post. The in-ground brace channels are steel channels that are 762 mm (30 in) long, 254 mm (10 in.) wide with 77 mm (3.0 in.) flanges and 17 mm (0.65 in.) wall thickness. These in-ground brace channels are in a 914 mm (3.0 ft) by 762 mm (2.5 ft) hole filled with 4,000 psi concrete and reinforced with #6 rebar cage.

On the terminal post end of each cable, one (1) closed spelter socket with polyester resin is secured to the terminal post with a socket pin. The cables have approximately 51 mm (2.0 in) sag at the midpoint of each span, thus the total length of each cable is approximately 15.5 m (50.8 ft)

The intermediate line posts are made using 2.4 m (8 ft) galvanized U-Channel. Each post is placed in a 229 mm (9.0 in) diameter, 914 mm (3.0 ft) deep hole filled with 2,800 psi concrete. The posts have a slit in the sides at ground level to accommodate the shearing required during the impact. The cable is held to the line posts using a total of three (3) u-bolts

per post. The posts are spaced 3.0 m (10 ft.) apart with a total of 4 intermediate posts between the terminal assemblies.

Photographs of the as-tested unit and installation are available in Appendix A of this report. Manufacturer's installation instructions are available in Appendix D; a complete set of manufacturer's drawings is available on KARCO CD-R 2012-2431.

SECTION 3
TEST RESULTS

3.1 TEST RESULTS

As recommended in ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'* the following full-scale impact test was conducted to evaluate the impact performance of the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft to the M50 test level.

Test M50 was conducted on the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft on June 8, 2012. The test article was positioned at an angle of ninety degrees (90°) to the direction of travel of the test vehicle, with the vehicle's centerline intersecting the center of the span between the termination posts. The test was conducted using a commercially available 1996 Ford F-700 medium duty truck with a test inertial mass of 6776.0 kg. Test vehicle information is presented in Data Sheets No. 1 and No. 2. The test vehicle impacted the fence at a velocity of 76.8 km/h (47.7 mph). Evaluation of the crash fence performance is presented in Data Sheet No. 5.

This test was documented by a minimum of two (2) real-time video cameras and four (4) high-speed digital color video cameras. Photographs of the test vehicle and the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft are shown in Appendix A. Data plots of the instrumentation are available in Appendix B.

The test vehicle's forward motion was completely arrested by the Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft within the 1.01 m to 7.0 m penetration limit for a P2 rating. The maximum penetration recorded was 2.51 m on the driver's side measured dynamically using high speed video analysis. The maximum penetration on the passenger's side was 2.46 m measured dynamically using high speed video analysis.

The test vehicle sustained severe damage and was completely disabled by the impact. The cables engaged the front of the engine block and pushed rearward into the cab of the truck. After impact the test vehicle was propelled backwards, away from the protected side of the fence.

The left and right side termination post and knee brace foundations shifted inward and toward the protected side of the fence. The right side knee brace deformed. Upon impact, each intermediate post sheared at the engineered break point, just above its respective foundation. The opening remained blocked during the impact. After the cables were dislodged from the test vehicle and the test vehicle was removed from the fence, the cables rested on the ground and the opening was not blocked.

SECTION 4

DATA SHEETS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in^2	kPa	6.895
Temperature	General Use	^oF	^oC	=(Tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET 1

TEST VEHICLE INFORMATION

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

TEST VEHICLE INFORMATION

Make	Ford	Cylinders	V6
Model	F-700	Engine Displacement (L)	
Body Style	Medium Duty Truck	Engine Placement	Longitudinal
VIN	1FDNF80C4VVA24949	Fuel Type	Diesel
Color	White	No. of Axles	2
Odometer Reading (mi)	263,829	Disc Brakes, Front	Yes
Transmission	4-Speed Automatic	Disc Brakes, Rear	No
Final Drive	Rear	Anti-Lock Brakes	No

TIRE INFORMATION

Front Tire Size	295/75R22.5	Rear Tire Size	10Rx22.5

TEST VEHICLE MASS

	As Received (kg)			As Tested (kg)		
	Front	Rear	Total	Front	Rear	Total
Left	1,236.0	1,142.5	2,378.5	1,844.0	1,637.0	3,481.0
Right	1,197.5	1,016.5	2,214.0	1,802.0	1,493.0	3,295.0
Ratio (%)	53.0	47.0	100.0	53.8	46.2	100.0
Total	2,433.5	2,159.0	4,592.5	3,646.0	3,130.0	6,776.0

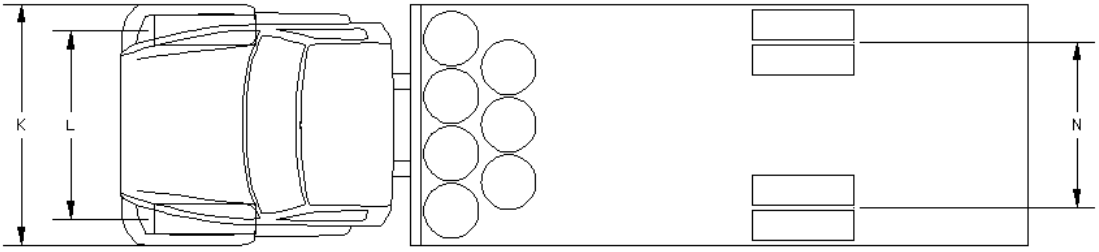
DATA SHEET 2

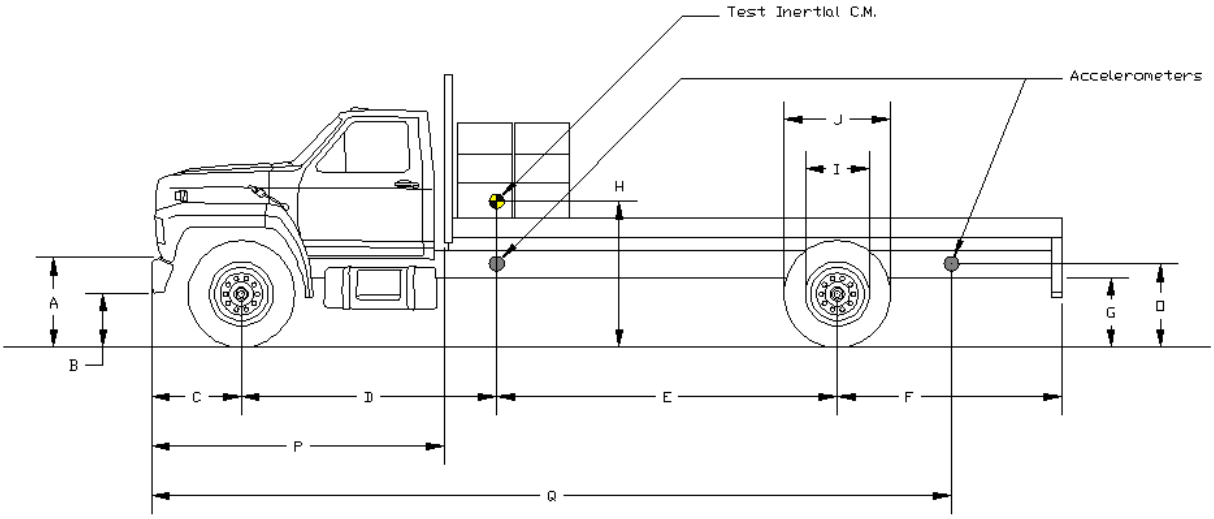
TEST VEHICLE GEOMETRY

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12





TEST VEHICLE GEOMETRY

No.	mm	in.	No.	mm	in.	No.	mm	in.
A	723	28.5	G	775	30.5	N	1,865	73.4
B	453	17.8	H	1,415	55.7	O	880	34.6
C	914	36.0	I	595	23.4	P	2,724	107.2
D	2,597	102.2	J	990	39.0	Q	8,080	318.1
E	3,131	123.3	K	2,432	95.7			
F	2,263	89.1	L	2,020	79.5			

All measurements in millimeters (mm).
Left side measurements reported.

DATA SHEET 3

INSTALLATION DATA

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

CONCRETE STRENGTH DATA

Description	Units	Compressive Strength
Concrete Strength Specification	psi	4,000
Sample 1	psi	3,930

SOIL COMPACTION DATA

Description	Units	Density
Maximum Dry Density	lbs/cu.ft.	132.0
As-Tested Dry Density		
Sample 1 - Left Terminal Post	lbs/cu.ft.	123.0
Sample 2 - Right Terminal Post	lbs/cu.ft.	124.6
Minimum Percentage Requirement	%	90.0
Dry Compaction Percentage of Maximum		
Sample 1 - Left Terminal Post	%	93.2
Sample 2 - Right Terminal Post	%	94.4

.

DATA SHEET 4

IMPACT CONDITIONS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

IMPACT CONDITIONS

Item	Value	
Test Time	5:56 PM	
Temperature (°F)	91	[1]
Wind Velocity (km/h)	2	[1]
Wind Direction	West	[1]
Impact Speed (km/h)	76.8	
Impact Angle (°)	0.5	
Impact Location (mm)	0	

Impact Angle and impact location measured using high speed video analysis

[1] - Information for reference only.

DATA SHEET 5

EVALUATION OF TEST RESULTS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

PENETRATION RATINGS

Measured Penetration	Rating
Less than 1 m	P1
1.01 m - 7.0 m	P2
7.01 - 30.0 m	P3
Greater than 30 m	P4

MEASURED PENETRATION

Description	Units	Value
Driver's Side Penetration (Dynamic)	m	2.51
Passenger's Side Penetration (Dynamic)	m	2.46
Maximum Dynamic Penetration	m	2.51
Driver's Side Penetration (Static)	m	-4.07
Passenger's Side Penetration (Static)	m	-4.02
Maximum Static Penetration	m	-4.02
Maximum Penetration	m	2.51

PENETRATION RATING

ASTM F 2656-07 penetration rating for test P32086-01	**P2**

Comments:

The Smith & Wesson M50 Post and Cable System - 50 ft completely arrested the test vehicle within the 1.01 m to 7.0 m penetration limit for a P2 rating.

The test vehicle was completely disabled by the impact. The cables engaged the engine and pushed it rearward into the occupant compartment. After impact, the vehicle was propelled backward and away from the protected side of the fence.

DATA SHEET 6

OBSERVATIONS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

TERMINATION POST FACE ANGLE MEASUREMENTS

Post Location	Angle (°)		
	Pre-Test	Post-Test	Difference
Left Side Termination Post	89.5	85.7	3.8
Right Side Termination Post	89.8	88.1	1.7

TERMINATION POST SIDE ANGLE MEASUREMENTS

Post Location	Angle (°)		
	Pre-Test	Post-Test	Difference
Left Side Termination Post	89.6	84.8	4.8
Right Side Termination Post	90.0	84.7	5.3

PRE-TEST CABLE HEIGHT MEASUREMENTS

Post Location	Cable Height (mm)	
Top Cable	1093	[2]
Middle Cable	945	[2]
Bottom Cable	789	[2]

[2] – Cable heights were measured at the impact location.

DATA SHEET 7

SENSOR DATA

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

TEST VEHICLE ACCELERATION PEAK DATA

Location	Axis	Vehicle			
		Max (g)	Time (ms)	Min (g)	Time (ms)
CG	X	9.5	118.4	-19.7	90.6
CG	Y	14.9	175.8	-21.5	171.0
CG	Z	15.9	161.8	-17.1	165.8
CG Resultant		63.5	165.0		
Rear Frame Member	X	11.1	84.6	-21.6	77.4
Rear Frame Member	Y	21.8	138.8	-23.5	96.8
Rear Frame Member	Z	13.4	318.2	-27.2	206.8
Rear Frame Member Resultant		70.2	207.2		

OCCUPANT RISK FACTORS

Location	Axis	Units	Vehicle	
			Max	Time (ms)
Occupant Impact Velocity	X	m/s	6.7	293.2
	Y	m/s	-0.5	293.2
Occupant Ridedown Acceleration	X	g	-12.0	367.8
	Y	g	-12.3	301.4

APPENDIX A
PHOTOGRAPHS

LIST OF PHOTOGRAPHS

LIST OF PHOTOGRAPHS … (CONTINUED)

FIGURE 1. Test Article, As-Received

FIGURE 2. Test Article, As-Received

FIGURE 3. Test Article Installation

FIGURE 4. Test Article Installation

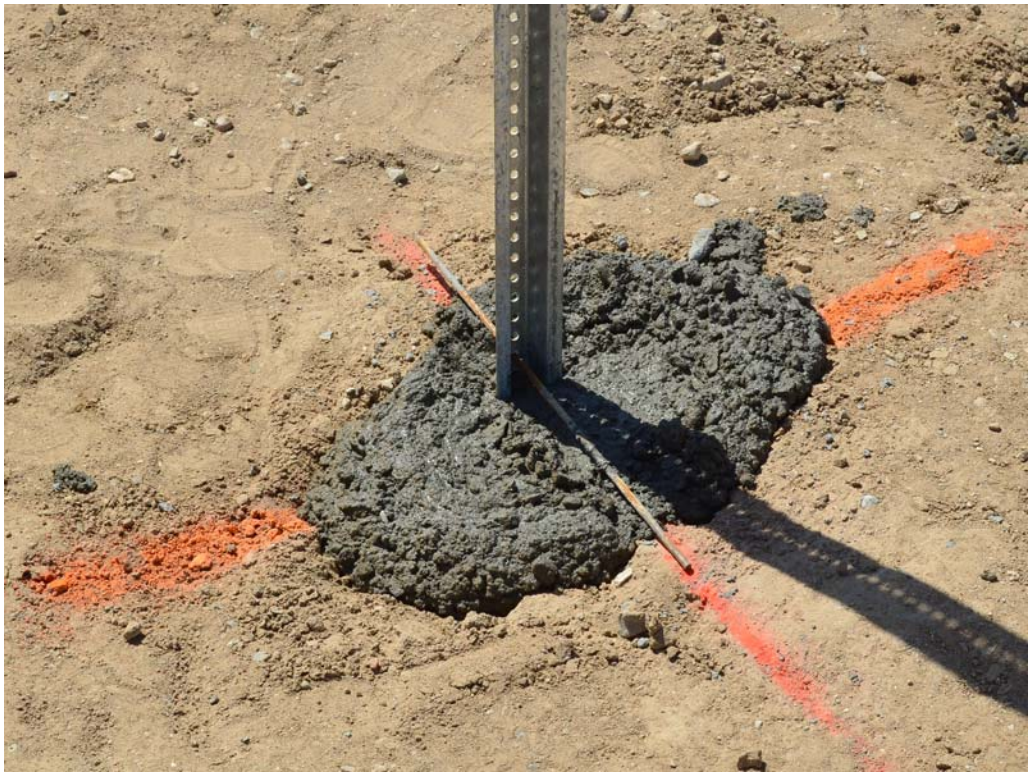


FIGURE 5. Test Article Installation

FIGURE 6. Test Article Installation

FIGURE 7. Test Setup

FIGURE 8. Test Setup Close-Up

FIGURE 9. Test Setup

FIGURE 10. Test Setup Close-Up

FIGURE 11. Test Setup

FIGURE 12. Test Setup Close-Up

FIGURE 13. Test Setup

FIGURE 14. Test Setup Close-Up

FIGURE 15. Test Setup

FIGURE 16. Post-Test

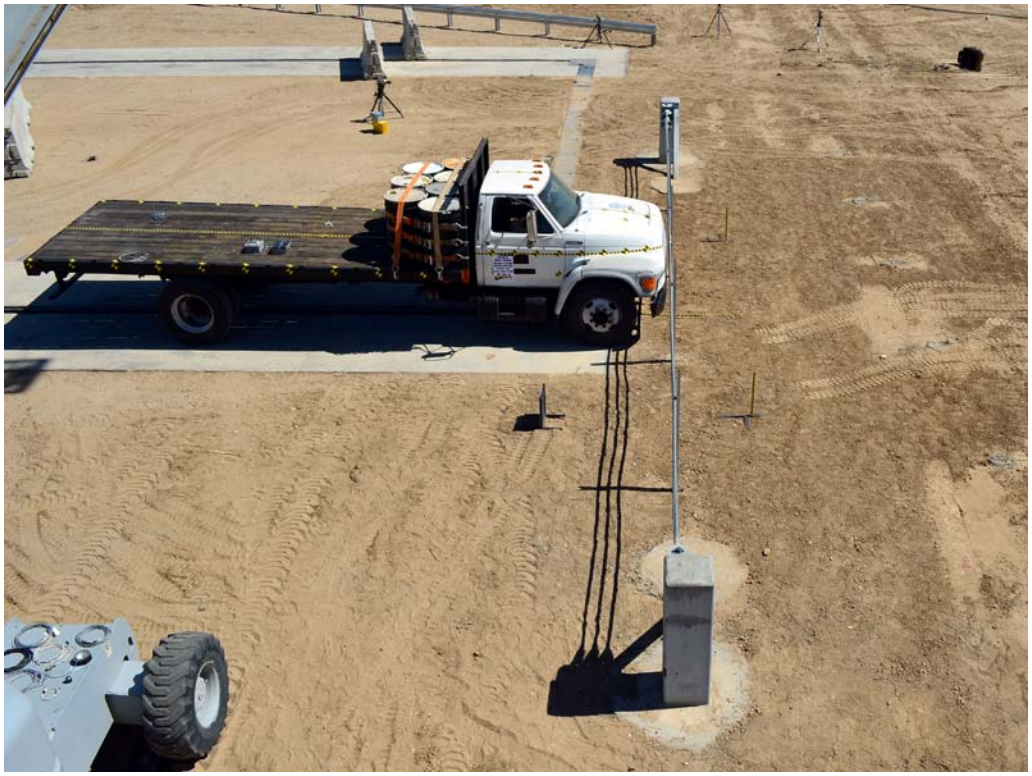


FIGURE 17. Test Setup

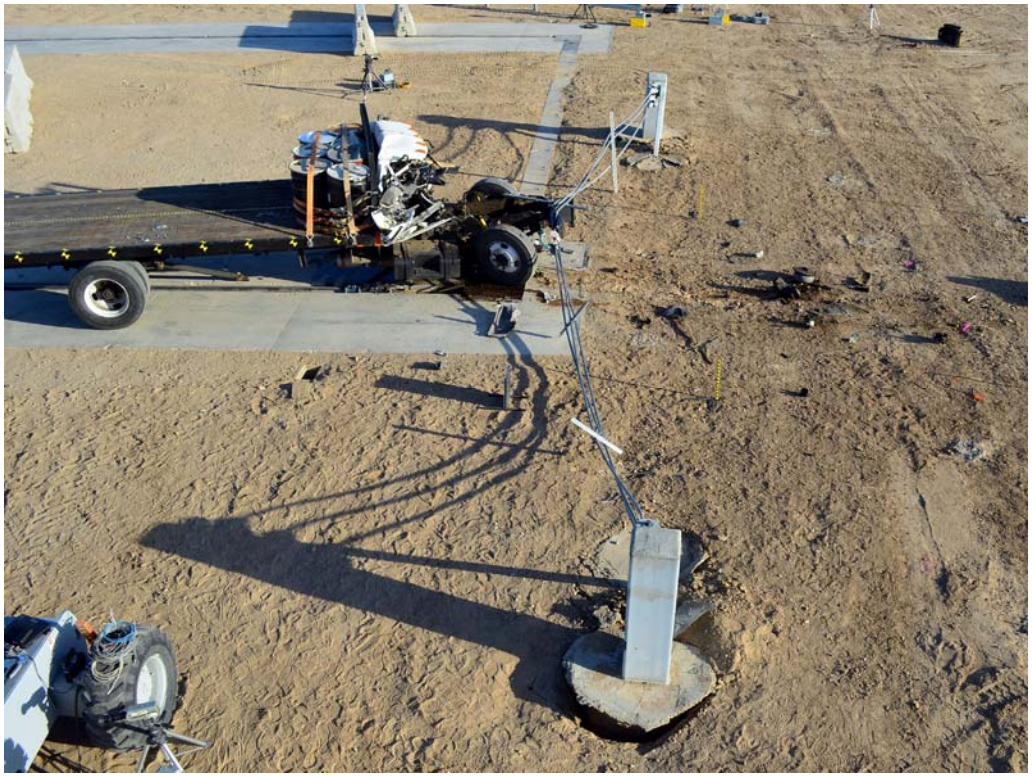


FIGURE 18. Post-Test

FIGURE 19. Test Article, Pre-Test Front

FIGURE 20. Test Article, Post-Test Front

FIGURE 21. Test Article, Pre-Test Left Front ¾

FIGURE 22. Test Article, Post-Test Left Front ¾

FIGURE 23. Test Article, Pre-Test Left Side

FIGURE 24. Test Article, Post-Test Left Side

FIGURE 25. Test Article, Pre-Test Left Rear ¾

FIGURE 26. Test Article, Post-Test Left Rear ¾

FIGURE 27. Test Article, Pre-Test Rear

FIGURE 28. Test Article, Post-Test Rear

FIGURE 29. Test Article, Pre-Test Right Rear ¾

FIGURE 30. Test Article, Post-Test Right Rear ¾

FIGURE 31. Test Article, Pre-Test Right Side

FIGURE 32. Test Article, Post-Test Right Side

FIGURE 33. Test Article, Pre-Test Right Front ¾

FIGURE 34. Test Article, Post-Test Right Front ¾

FIGURE 35. Test Article, Post-Test Damage

FIGURE 36. Test Article, Post-Test Damage

FIGURE 37. Test Article, Post-Test Damage

FIGURE 38. Test Article, Post-Test Damage

FIGURE 39. Test Article, Post-Test Damage

FIGURE 40. Test Article, Post-Test Damage

FIGURE 41. Test Article, Post-Test Damage

FIGURE 42. Test Article, Post-Test Damage

FIGURE 43. Test Article, Post-Test Damage

FIGURE 44. Test Article, Post-Test Damage

FIGURE 45. Test Article, Post-Test Damage

FIGURE 46. Test Article, Post-Test Damage

FIGURE 47. Test Article, Post-Test Damage

FIGURE 48. Test Article, Post-Test Damage

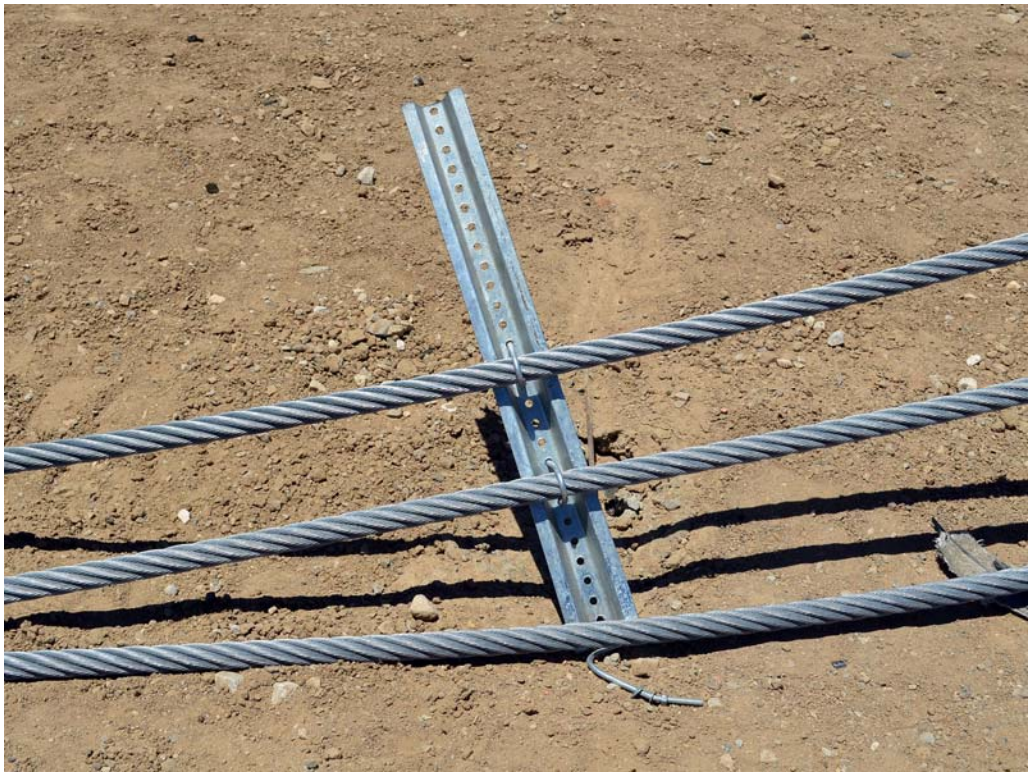


FIGURE 49. Test Article, Post-Test Damage

FIGURE 50. Test Article, Post-Test Damage

FIGURE 51. Test Vehicle, Pre-Test Left Front ¾

FIGURE 52. Test Vehicle, Post-Test Left Front ¾

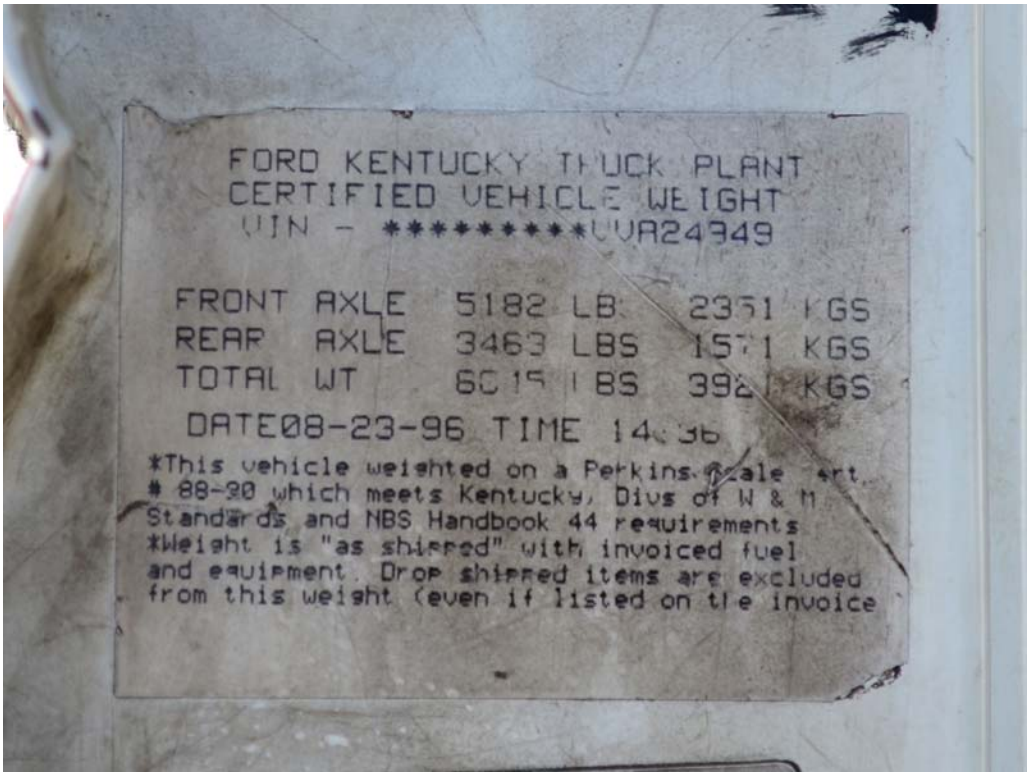


FIGURE 53. Test Vehicle Manufacturer's Label

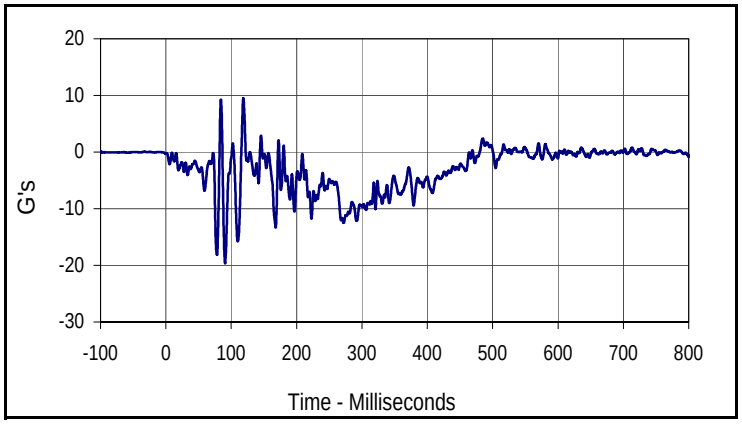
FIGURE 54. Test Vehicle Manufacturer's Label

APPENDIX B

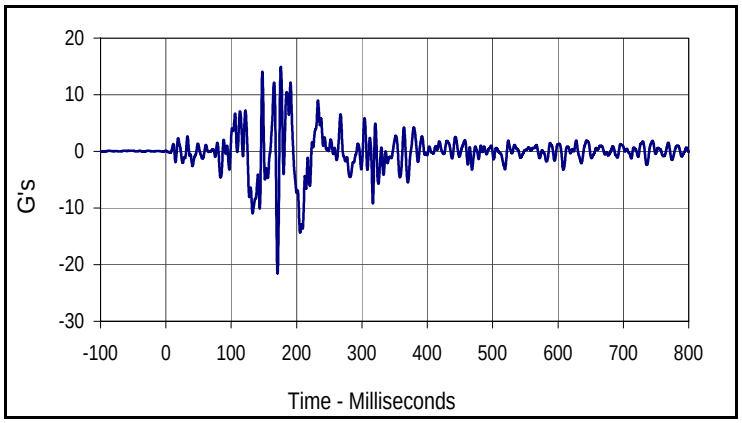
DATA PLOTS

LIST OF DATA PLOTS

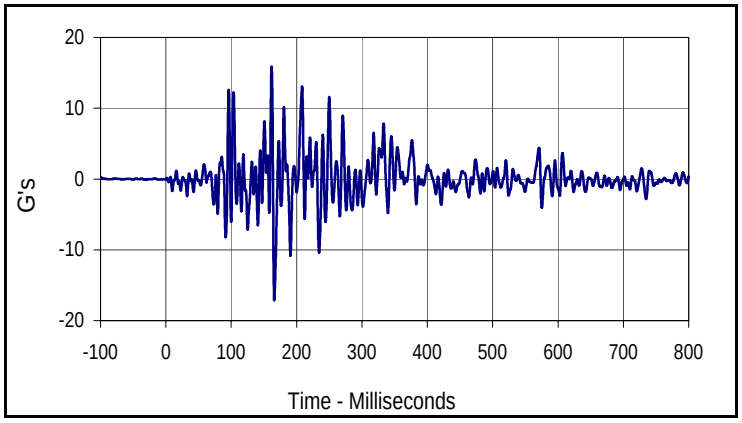
Test Article:	Smith & Wesson Security Systems	Project No.:	P32086-01
Test Program:	ASTM F2656-07 M50	Test Date	6/8/12
Test Vehicle:	1996 Ford F-700		



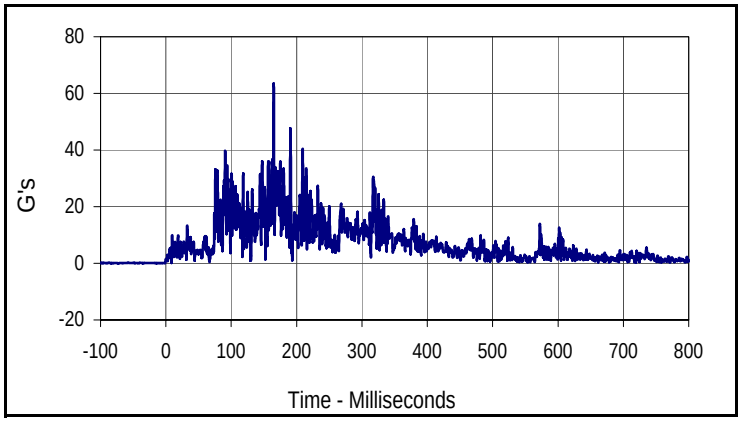
Curve Description			
Vehicle CG X			
CURNO	Type	SAE Class	Units
001	FIL	60	G's
Max	Time	Min	Time
9.5	118.4	-19.7	90.6



Curve Description			
Vehicle CG Y			
CURNO	Type	SAE Class	Units
002	FIL	60	G's
Max	Time	Min	Time
14.9	175.8	-21.5	171.0

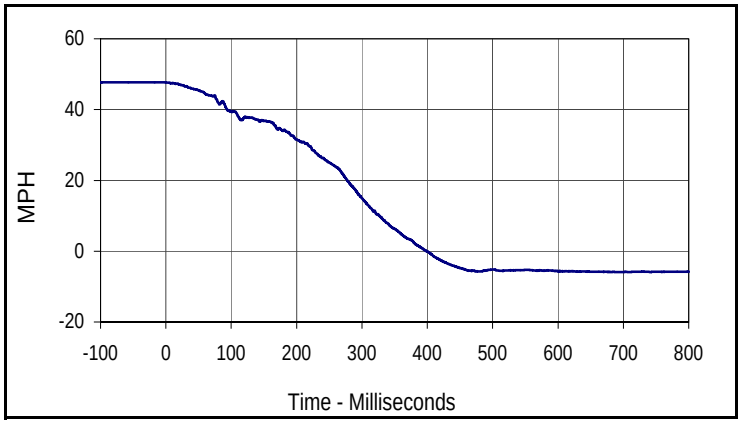


Curve Description			
Vehicle CG Z			
CURNO	Type	SAE Class	Units
003	FIL	60	G's
Max	Time	Min	Time
15.9	161.8	-17.1	165.8

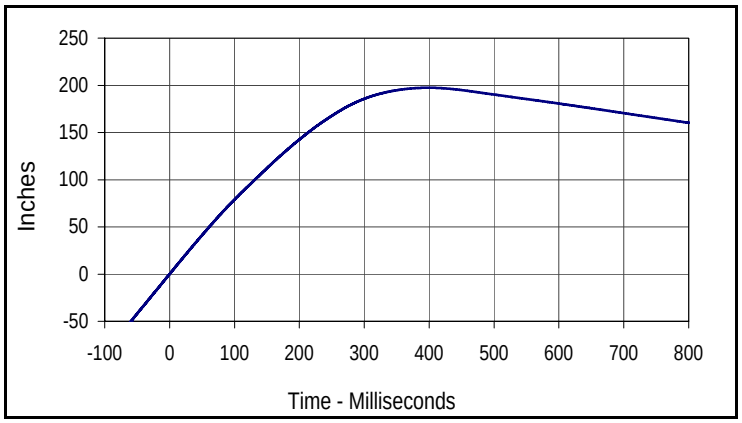


Curve Description			
Vehicle CG Resultant			
CURNO	Type	SAE Class	Units
001	RES	60	G's
Max	Time	Min	Time
63.5	165.0	0.0	-1.4

Test Article:	Smith & Wesson Security Systems	Project No.:	P32086-01
Test Program:	ASTM F2656-07 M50	Test Date	6/8/12
Test Vehicle:	1996 Ford F-700		

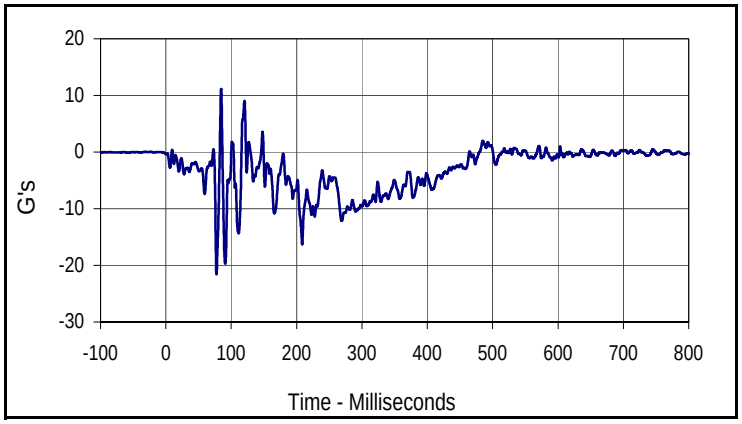


Curve Description			
Vehicle CG X Velocity			
CURNO	Type	SAE Class	Units
001	IN1	180	MPH
Max	Time	Min	Time
47.7	-21.8	-5.9	695.8

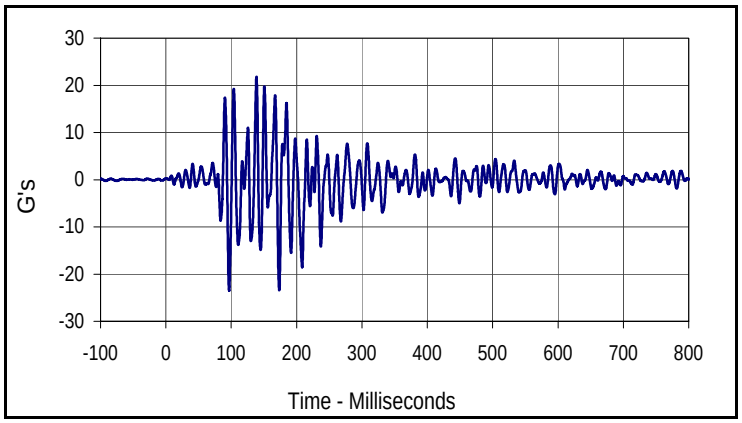


Curve Description			
Vehicle CG X Displacement			
CURNO	Type	SAE Class	Units
001	IN1	180	Inches
Max	Time	Min	Time
197.4	398.8	-33.6	-40.0

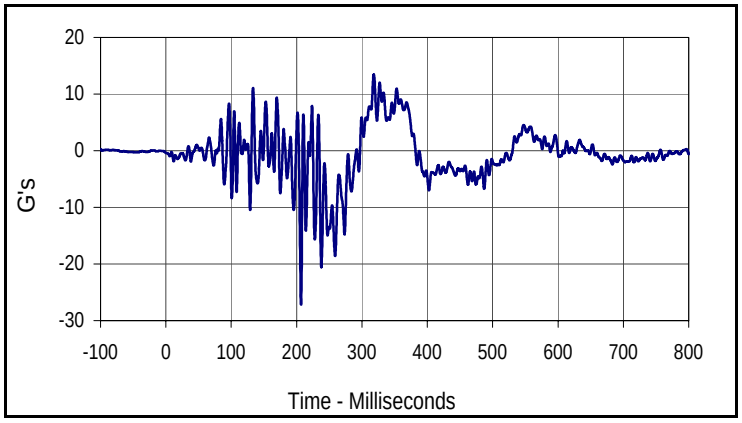
Test Article:	Smith & Wesson Security Systems	Project No.:	P32086-01
Test Program:	ASTM F2656-07 M50	Test Date	6/8/12
Test Vehicle:	1996 Ford F-700		



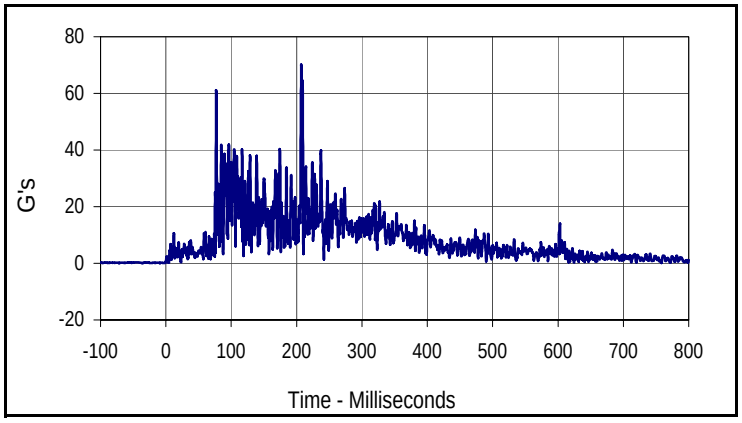
Curve Description			
Vehicle Rear Frame Member X			
CURNO	Type	SAE Class	Units
004	FIL	60	G's
Max	Time	Min	Time
11.1	84.6	-21.6	77.4



Curve Description			
Vehicle Rear Frame Member Y			
CURNO	Type	SAE Class	Units
005	FIL	60	G's
Max	Time	Min	Time
21.8	138.8	-23.5	96.8

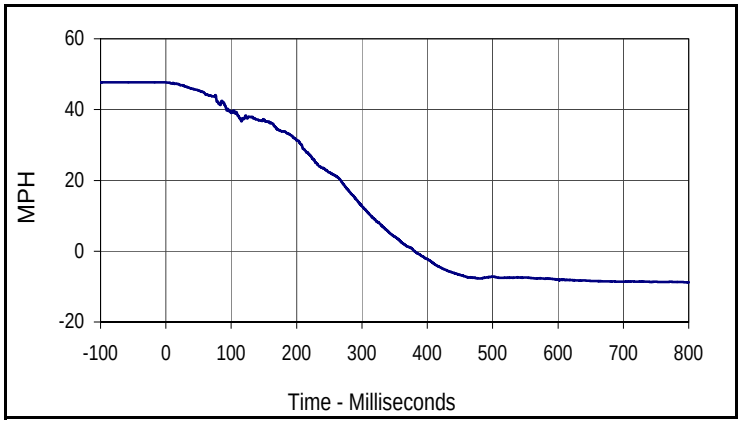


Curve Description			
Vehicle Rear Frame Member Z			
CURNO	Type	SAE Class	Units
006	FIL	60	G's
Max	Time	Min	Time
13.4	318.2	-27.2	206.8

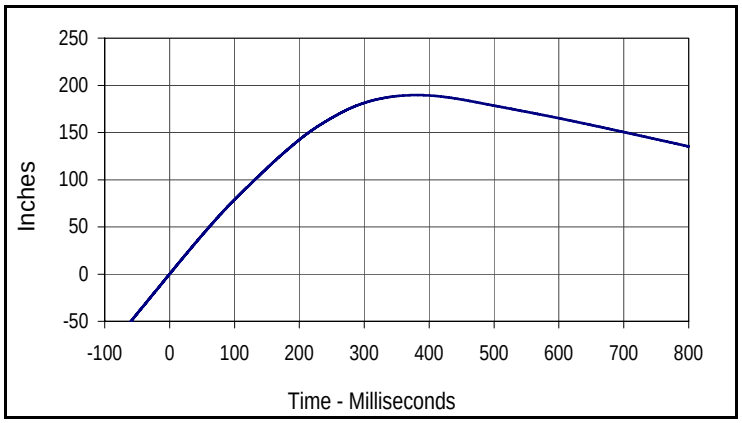


Curve Description			
Vehicle Rear Frame Member Resultant			
CURNO	Type	SAE Class	Units
004	RES	60	G's
Max	Time	Min	Time
70.2	207.2	0.0	-9.2

Test Article:	Smith & Wesson Security Systems	Project No.:	P32086-01
Test Program:	ASTM F2656-07 M50	Test Date	6/8/12
Test Vehicle:	1996 Ford F-700		



Curve Description			
Vehicle Rear Frame Member X Velocity			
CURNO	Type	SAE Class	Units
004	IN1	180	MPH
Max	Time	Min	Time
47.7	-40.0	-8.8	799.8



Curve Description			
Vehicle Rear Frame Member X Displacement			
CURNO	Type	SAE Class	Units
004	IN1	180	Inches
Max	Time	Min	Time
189.6	380.6	-33.6	-40.0

APPENDIX C
DATA ACQUISITION INFORMATION

DATA ACQUISITION INFORMATION

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 50 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32086-01

Test Vehicle: 1996 Ford F-700 Test Date: 06/08/12

VEHICLE INSTRUMENTATION INFORMATION

CH	Location	Axis	Ident. No.	Description	MFR	Model	Units
1	Vehicle CG	X	KETX12A	Accel, Triax	I.C. Sensor	3031-500	g
2	Vehicle CG	Y	KETX12B	Accel, Triax	I.C. Sensor	3031-500	g
3	Vehicle CG	Z	KETX12Z	Accel, Triax	I.C. Sensor	3031-500	g
4	Vehicle Rear Frame	X	KETX11A	Accel, Triax	Measurement Specialties	3038-500	g
5	Vehicle Rear Frame	Y	KETX11B	Accel, Triax	Measurement Specialties	3038-500	g
6	Vehicle Rear Frame	Z	KETX11C	Accel, Triax	Measurement Specialties	3038-500	g

HIGH SPEED CAMERA INFORMATION

View No.	Location	Identification No.	Manufacturer	Type
1	Driver's Side Profile View	7959	Phantom	V9
2	Driver's Side Oblique View	2756	Phantom	V5
3	Inline View	2706	Phantom	V5
4	Overhead View	2891	Phantom	V5

APPENDIX D
DRAWINGS AND ILLUSTRATIONS

LIST OF FIGURES

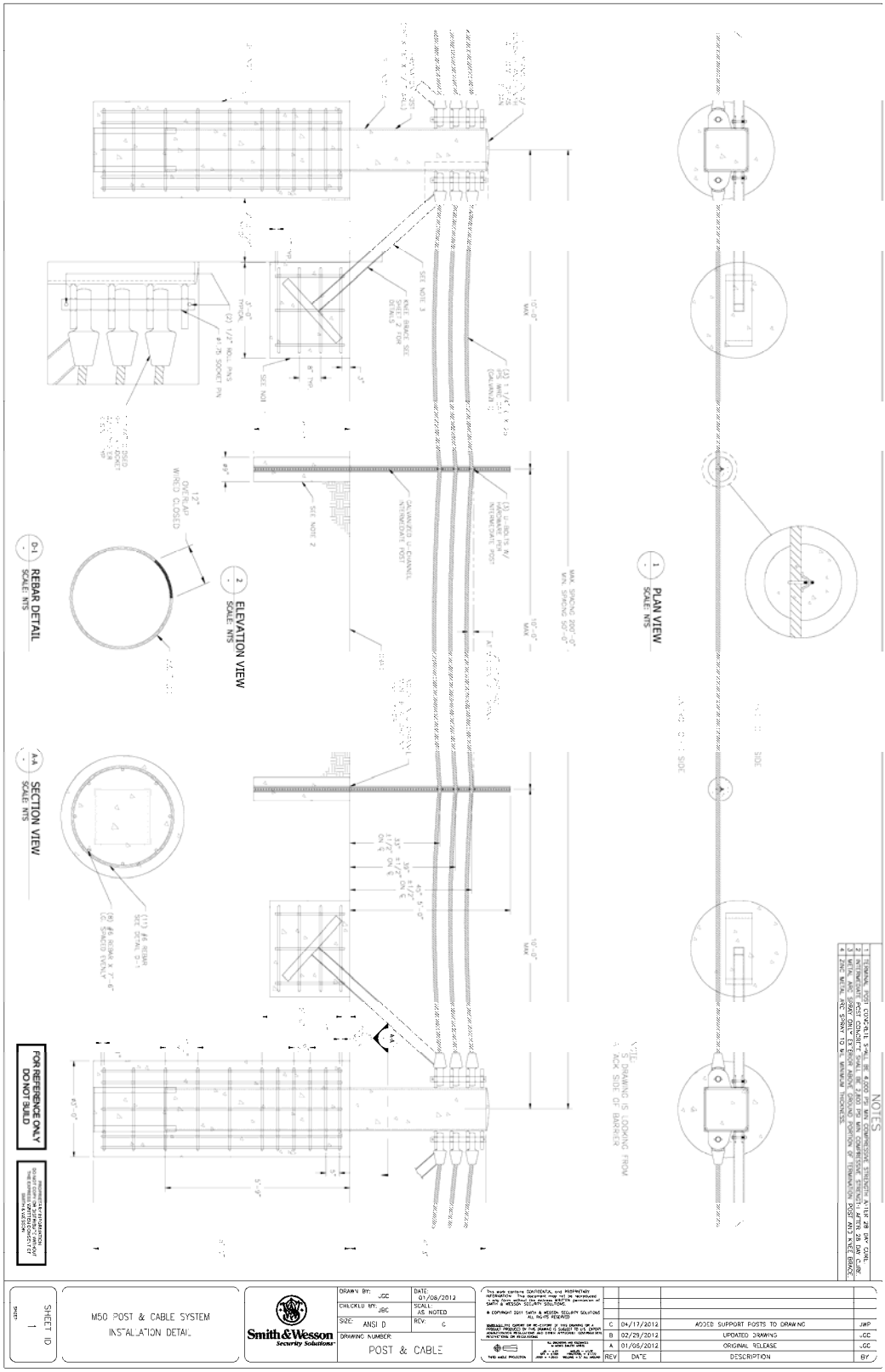


Figure 55: Manufacturer's Drawing

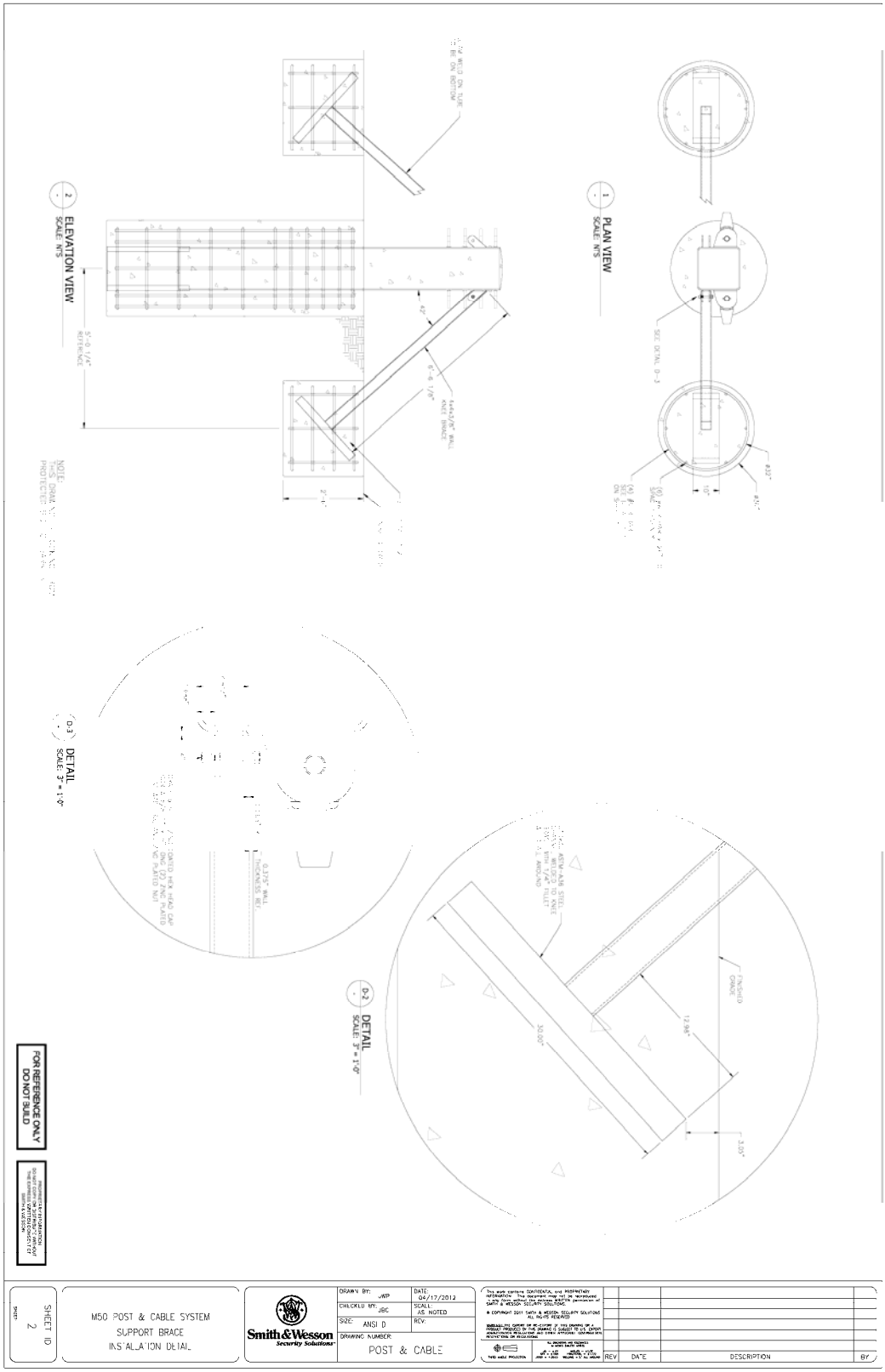


Figure 56: Manufacturer's Drawing

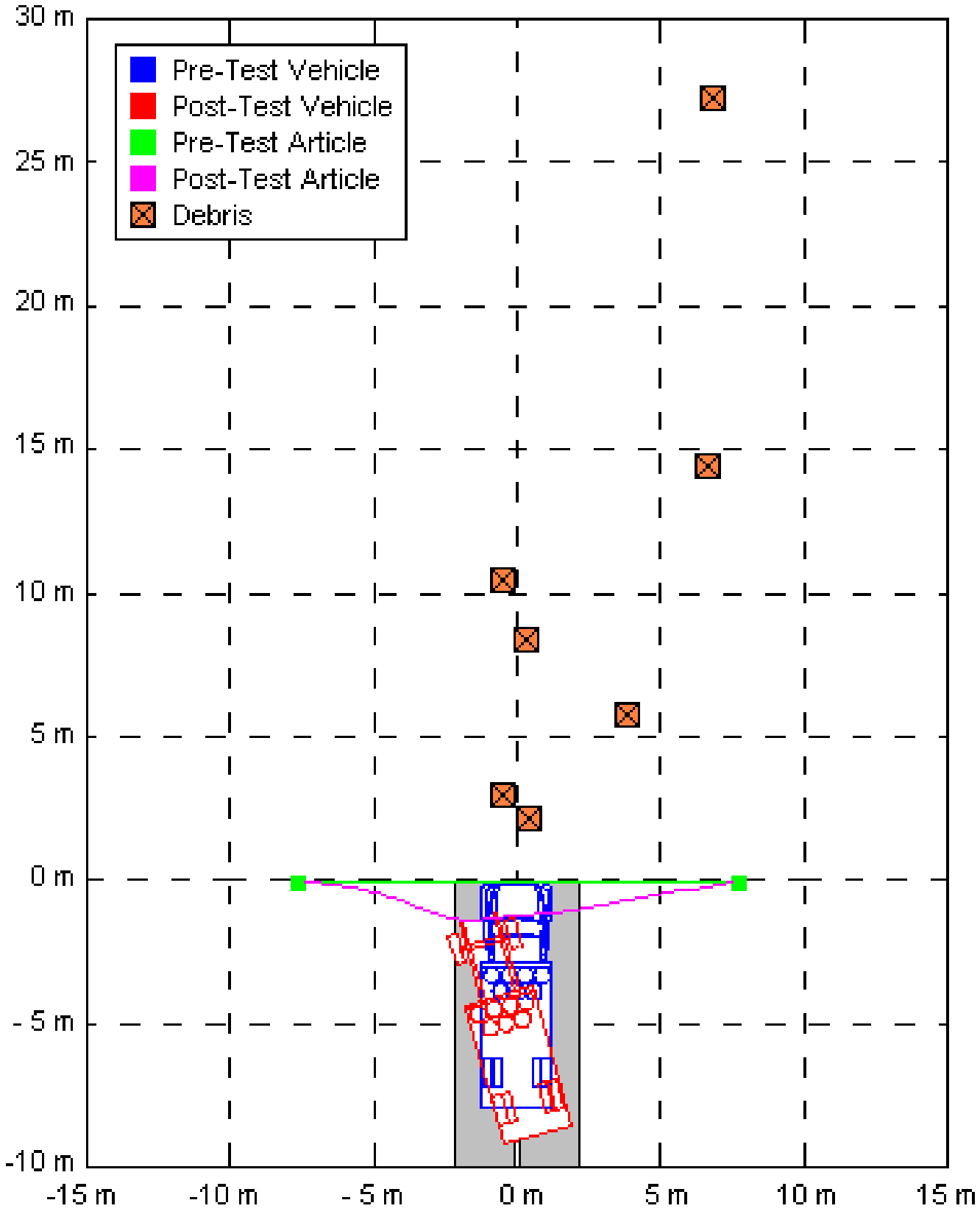


Figure 57: Overhead Illustration

FINAL PAGE OF REPORT

GLOBAL GRAB TECHNOLOGIES

YOUR COMPLETE SECURITY SOLUTIONS PARTNER

Testing Results for 200ft

277 Mallory Station Road, Suite 112 Franklin, Tennessee 37067-8251
615-224-0400 • 877-260-4722 toll free • 615-224-0411 fax • www.grabglobal.com

TEST REPORT FOR:

Smith & Wesson Security Solutions

M50 Post and Cable System - 200 ft

TESTED TO:

ASTM F 2656-07

Standard Test Method for Vehicle Crash Testing of Perimeter Barriers

Test M50

PREPARED FOR:

Smith & Wesson Security Solutions

277 Mallory Station Road, Suite 112

Franklin, TN 37067

TEST REPORT NUMBER:

TR-P32117-01-A

REPORT DATE:

August 31, 2012

TEST DATE:

August 3, 2012

KARCO Engineering, LLC.
Automotive Research Center
9270 Holly Road
Adelanto, CA 92301
Tel: (760) 246-1672
Fax: (760) 246-8112

ACCREDITED
ISO/ IEC 17025: 2005

KARCO Engineering compiled this publication for information gathering only. The findings and conclusions expressed in this publication are those of the authors and not necessarily those of any other organization. KARCO Engineering provides test services only and is not involved in consulting, product design or the manufacturing of any automotive products. KARCO does not warrant, supervise or monitor compliance of products or services except as specifically agreed to in writing. By their very nature, testing, analysis and other KARCO services are limited in scope and subject to expected measurement variability. No activity by KARCO Engineering can release a manufacturer from product or any other liability. The results, findings and conclusions expressed in this publication relate only to the items tested for the specific situation simulated in the test.

Tested By: _____

Mr. Kelsey A. Chiu
Engineering Department Supervisor

Report By: _____

Mr. Steven D. Matsusaka
Project Engineer

Reviewed By: Matthew S. Hubbard

Mr. Matthew S. Hubbard
Quality Assurance Manager

Approved By: _____

Mr. Michael L. Dunlap
Director of Operations

Approval Date: August 31, 2012

REVISION CONTROL LOG

TR-P32117-01

Revision	Date	Description
-NC	08/31/12	Original Test Report
-A	09/07/12	Added discrepencies and changed cable length in Test Article Details

TABLE OF CONTENTS

SECTION 1
INTRODUCTION

1.1 – OBJECTIVES

The primary objective of this impact test was to determine a penetration rating for the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft (test article) per the ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'* to the M50 level. The intent of this test was to evaluate the ability of the barrier to arrest a 6,800 kg (15,000 lb) vehicle from penetrating or vaulting a secured area and the extent, if any, of barrier deformation.

This report presents the results of the performance and evaluation of one (1) full-scale impact test conducted on one (1) Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft to the M50 (80 km/h, 50 mph) level. Testing and reporting of test results are described in the test procedure and are not repeated in this report.

1.2 – TEST FACILITY

This test was conducted at KARCO Engineering's test facility in Adelanto, California. The tow road is a continuous level surface constructed of reinforced concrete and measures 850 feet in length, is 14 feet wide, and 6 in. thick. A steel rail is embedded in the road to provide vehicle guidance. Vehicle tow propulsion is provided by a 1 ton truck using a 1-to-2 pulley system coupled to a fixed prime mover (an internal combustion engine, Chevrolet V-8, 454 cubic inches displacement, with TH-400 automatic transmission) and a continuous cable drive system. The test vehicle is towed to within 25 feet of the barrier by a nylon rope clamped to a 3/8-inch steel cable. The clamp is released from the cable on contact with a cable release mechanism positioned to allow the test vehicle to proceed under its own momentum for a maximum of 25 feet before impacting the barrier.

1.3 – TEST PROCEDURE

The Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft was tested per ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'*. This ASTM standard contains specific requirements for test article installation, vehicle properties, impact conditions, test instrumentation, and evaluation criterion.

1.3.1 – Test Article Installation

The materials, assembly instructions, and physical configuration of the test article are specified in the manufacturer's literature and are not repeated in this test report. Installation of

the test article was conducted by Desert Construction Services. The test article, as installed at the test facility, is illustrated in Appendices A and D.

1.3.2 – Test Vehicle Properties

ASTM F 2656-07 specifies four (4) different vehicle levels for possible penetration ratings: C (Small Passenger Car), P (Pickup Truck), M (Medium Duty Truck) and H (Heavy Goods Vehicle). All test vehicles must be structurally sound with no major damage or modifications and must have original equipment bumpers. Tire sizes shall be those recommended by the vehicle manufacturer unless otherwise specified by a specific agency. Test Vehicle properties for each vehicle are presented in Table 1.

Table 1 – Test Vehicle Properties

Vehicle Type	Small Passenger Car C	Pickup Truck P	Medium Duty Truck M	Heavy Goods Vehicle H
Gross Vehicle Test Mass (kg)	1,100 ± 20	2,300 ± 50	6,800 ± 140	29,500 ± 590
Year	Within 10 Model Years	Within 10 Model Years		
Wheelbase (m)			5.28 ± 0.51	
Bed Length (m)			5.49 ± 0.61	
Other	Sedan or Coupe	3/4 Ton, Single Cab	Flatbed	Tandem Axle Dump Truck or Drop Axle Truck

This test of the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft was conducted with the M test vehicle. To meet the recommended properties a commercially available production model test vehicle was selected. This test vehicle was a 1986 International 1654 medium duty truck with conventional cab, front mounted diesel engine, rear wheel drive, and an automatic transmission. The bumpers were standard equipment and were not modified.

1.3.2.1 Test Mass: The Gross Vehicle Test Mass of the M test vehicle as specified in the ASTM standard is 6,800 kg ± 140 kg. The actual Gross Vehicle Test Mass with instrumentation and ballast was 6862.5 kg.

1.3.3 – Impact Conditions

ASTM F 2656-07 has specific requirements for impact conditions for a qualifying test which include vehicle impact velocity, approach angle and impact location.

1.3.3.1 – Velocity: Vehicle velocity at impact with the test article shall be dependent upon the test vehicle mass. For this test, designated M50, the target kinetic energy was 1,680 kJ. The calculated target velocity was 79.7 km/h (49.5 mph). Actual velocity at impact was 79.8 km/h (49.6 mph).

1.3.3.2 – Approach Angle and Impact Point: The test vehicle was oriented so it approached the test article at a critical impact angle of ninety degrees (90° ± 3°) relative to the barrier, with the centerline of the vehicle impacting the test article at the impact point designated by the client. The actual impact point must be within ± 300 mm (1 ft.) of the target.

The impact point was selected to be the center of the span between the termination posts. The actual point of impact was perpendicular within 1.0° and within 76 mm (3.0 in.) of the target.

1.3.4 – Test Instrumentation and Data Acquisition Procedures

All data acquisition for this test of the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft was performed in accordance with the ASTM F 2656-07 Standard Test Method requirements.

1.3.4.1 – Test Vehicle Instrumentation: The test vehicle was instrumented with two (2) tri-axial accelerometers. One (1) was located along the driver's side frame rail at the longitudinal center of mass and the other at the rear of the same frame rail. The accelerometers measured longitudinal (x), lateral (y), and vertical (z) acceleration. Data was recorded using the on-board TDAS. Data was linked to a personal computer and processed using the TDAS Control software. All equipment used in this test meets the requirements of SAE J211.

1.3.4.2 – Calibration: All instrumentation used in this test has been calibrated through standards traceable to NIST and is maintained in a calibrated condition.

1.3.4.3 – TDAS Software: The software utilized in this system is written in National Instruments Lab Windows/CVI (C, Visual Interface) programming language, which is a Windows based software package with emphasis on ease of use and good engineering test practices.

1.3.4.4 – SAE Compatibility: The software contains standard point and click processing options for selecting Society of Automotive Engineers (SAE) class post filters and calculating the required integrals, resultants, Head Injury Criteria (HIC), clips, and other data processing parameters that may be required.

1.3.4.5 – Photographic Documentation: Photographic documentation of this test included a minimum of two (2) real-time video cameras at 30 frames per second (fps), and four (4) high-speed color digital video cameras at 1,000 fps. All high-speed cameras were activated by a pressure-sensitive tape switch which was positioned on the test article to indicate the instant of contact (time zero). A digital still camera was used for documenting the pre- and post-test condition of the test article and the test vehicle.

1.3.4.6 – Measurement Uncertainty: Measurement uncertainties have been determined for pertinent values affecting the results of this test. KARCO maintains these uncertainty budgets, which are available upon request, but are not included in this report. In certain cases the nature of the test method may preclude rigorous and statistically valid calculation of uncertainty of measurement. In these cases KARCO attempts to identify the components of uncertainty and make a reasonable estimation. Reasonable estimation is based on knowledge of the performance of the method and on the measurement scope and makes use of, for example, previous experience and validation data.

1.4 – EVALUATION CRITERION

This full scale impact test was performed to evaluate the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft per the specifications of ASTM F 2656-07. Test articles are evaluated for and given a penetration rating.

Table 2 – Penetration Ratings

Measured Penetration	Rating
Less than 1 m	P1
1.01 m - 7.0 m	P2
7.01 - 30.0 m	P3
Greater than 30 m	P4

1.4.1 – Penetration Rating

A penetration rating per ASTM F 2656-07 is given to each test article. The measurements used to formulate this rating are taken from penetration reference points on the test vehicle and the test article.

The test vehicle reference points are defined in ASTM F 2656-07 as follows: for small passenger cars the reference point is the center of the base of the A-Pillar; for the remaining three test vehicles (Pickup Truck, Medium Duty Truck, and Heavy Goods Vehicle) the reference point is the lower leading edge of the cargo bed.

The penetration reference point on the test article varies depending on the type of test article. Several examples are outlined in Annex A1 of ASTM F 2656-07. For this evaluation of the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft, the test article penetration reference point is the vertical plane created by the back (non-impacted) side of the cables.

Penetration measurements are taken in both static and dynamic modes. The static penetration measurement is based on the vehicle's final resting position and the dynamic

penetration is measured from high speed video. The highest value of both static and dynamic penetration for both the left and right sides of the test vehicle is used to assess the penetration rating. Penetration limits are presented in Table 2.

For a test article to be given a penetration rating per ASTM F 2656-07, the test article must disable the test vehicle to prevent the vehicle from propelling itself forward. If a test article does not sufficiently disable the vehicle it will be considered unrated.

SECTION 2
TEST ARTICLE DETAILS

2.1 – TEST ARTICLE

The Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft is a 60.96 m (200.0 ft) stationary cable fence. The as-tested unit consisted of two (2) terminal post assemblies, two (2) terminal post knee braces, nineteen (19) intermediate line posts, and three (3) cables. The blocking portion of the fence consists of three (3) 32 mm (1.3 in.) steel cables. The bottom cable height is 838 mm (33.0 in.), the middle cable height is 991 mm (39.0 in.), and the top cable height is 1143 mm (45.0 in.) above grade.

The terminal posts are made of 3.1 m (10.0 ft) long, 406 mm (16.0 in.) by 406 mm (16.0 in.) square steel tube with a wall thickness of 12 mm (0.5 in.). The bottom corners of the terminal post are welded to four (4) 777 mm (30.6 in) long, 508 mm (2.0 in) by 508 mm (2.0 in) by 6 mm (0.25 in) thick steel angles. The steel angles are then welded to one (1) 419 mm (16.5 in) by 419 mm (16.5 in) steel plate with a thickness of 6 mm (0.25 in), which completes the terminal post assembly. The terminal post has four (4) 25 mm (1.0 in) thick steel plates with a 508 mm (2.0 in) diameter hole cut out to secure the three (3) 32 mm (1.25 in) closed spelter socket with polyester resin with one (1) 45 mm (1.8 in) socket pin. The assembly is placed in a 914 mm (3.0 ft) diameter, 2.4 m (8.0 ft) deep hole with a rebar cage made out of #6 rebar.

The holes and terminal post assemblies are filled with 4,000 psi concrete, with the concrete finishing with a dome on top of the assembly.

Two (2) 102 mm (4.0 in.) by 102 mm (4.0 in.) rectangular tubes with a wall thickness of 10 mm (0.38 in.) create the knee braces and bolt at the top of each of the terminal posts; they also are attached to an in-ground brace channel. The knee braces bolt at a 42° angle from the post. The in-ground brace channels are steel channels that are 762 mm (30 in) long, 254 mm (10 in.) wide with 77 mm (3.0 in.) flanges and 17 mm (0.65 in.) wall thickness. These in-ground brace channels are in a 914 mm (3.0 ft) by 762 mm (2.5 ft) hole filled with 4,000 psi concrete and reinforced with #6 rebar cage.

On the terminal post end of each cable, one (1) closed spelter socket with polyester resin is secured to the terminal post with a socket pin. The cables have approximately 51 mm (2.0 in) sag at the midpoint of each span, thus the total length of each cable is approximately 60.4 m (198.3 ft)

The intermediate line posts are made using 2.4 m (8 ft) galvanized U-Channel. Each post is placed in a 229 mm (9.0 in) diameter, 914 mm (3.0 ft) deep hole filled with 2,800 psi concrete. The posts have a slit in the sides at ground level to establish a breakaway plane during impact. The cable is held to the line posts using a total of three (3) u-bolts per post. The

posts are spaced 3.0 m (10 ft.) apart with a total of 19 intermediate posts between the terminal assemblies.

The as-tested test article varied from the manufacturer drawings in the following ways:

- The length of the termination post assembly as referenced on drawing Termination Post Detail - Right was 147.75 in long instead of 146.6.
- The 2” x 2” x ¼” angle as referenced on drawing Termination Post Detail – Right was 31.6 in. long instead of 30.6.

Photographs of the as-tested unit and installation are available in Appendix A of this report. Manufacturer’s installation instructions are available in Appendix D; a complete set of manufacturer’s drawings is available on KARCO CD-R 2012-2448.

SECTION 3
TEST RESULTS

3.1 TEST RESULTS

As recommended in ASTM F 2656-07 *'Standard Test Method for Vehicle Crash Testing of Perimeter Barriers'* the following full-scale impact test was conducted to evaluate the impact performance of the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft to the M50 test level.

Test M50 was conducted on the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft on August 3, 2012. The test article was positioned at an angle of ninety degrees (90°) to the direction of travel of the test vehicle, with the vehicle's centerline intersecting the center of the span between the termination posts. The test was conducted using a commercially available 1986 International 1654 medium duty truck with a test inertial mass of 6862.5 kg. Test vehicle information is presented in Data Sheets No. 1 and No. 2. The test vehicle impacted the fence at a velocity of 79.8 km/h (49.6 mph). Evaluation of the crash fence performance is presented in Data Sheet No. 5.

This test was documented by a minimum of two (2) real-time video cameras and four (4) high-speed digital color video cameras. Photographs of the test vehicle and the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft are shown in Appendix A. Data plots of the instrumentation are available in Appendix B.

The test vehicle's forward motion was completely arrested by the Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft within the 1.01 m to 7.0 m penetration limit for a P2 rating. The maximum penetration recorded was 6.40 m on the driver's side measured dynamically using high speed video analysis. The maximum penetration on the passenger's side was 6.42 m measured dynamically using high speed video analysis.

The test vehicle sustained severe damage and was completely disabled by the impact. The cables engaged the front of the engine block and pushed rearward into the cab of the truck. After impact the test vehicle was propelled backwards, away from the protected side of the fence.

The left and right side termination post and knee brace foundations shifted inward and toward the protected side of the fence. The right side knee brace deformed. Upon impact, each intermediate post sheared at the engineered break point, just above its respective foundation. The opening remained blocked during the impact. After the cables were dislodged from the test vehicle and the test vehicle was removed from the fence, the cables rested on the ground and the opening was not blocked.

SECTION 4

DATA SHEETS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in^2	kPa	6.895
Temperature	General Use	^oF	^oC	=(Tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET 1

TEST VEHICLE INFORMATION

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

TEST VEHICLE INFORMATION

Make	International	Cylinders	V8
Model	1654	Engine Displacement (L)	
Body Style	Medium Duty Truck	Engine Placement	Longitudinal
VIN	1HTLAHEM3GHA29563	Fuel Type	Diesel
Color	White	No. of Axles	2
Odometer Reading (mi)	6	Disc Brakes, Front	Yes
Transmission	4-Speed Automatic	Disc Brakes, Rear	No
Final Drive	Rear	Anti-Lock Brakes	No

TIRE INFORMATION

Front Tire Size	9.00 R20	Rear Tire Size	9.00 R20

TEST VEHICLE MASS

	As Received (kg)			As Tested (kg)		
	Front	Rear	Total	Front	Rear	Total
Left	1,156.0	983.0	2,139.0	1,860.5	1,743.5	3,604.0
Right	1,223.0	914.0	2,137.0	1,844.5	1,414.0	3,258.5
Ratio (%)	55.6	44.4	100.0	54.0	46.0	100.0
Total	2,379.0	1,897.0	4,276.0	3,705.0	3,157.5	6,862.5

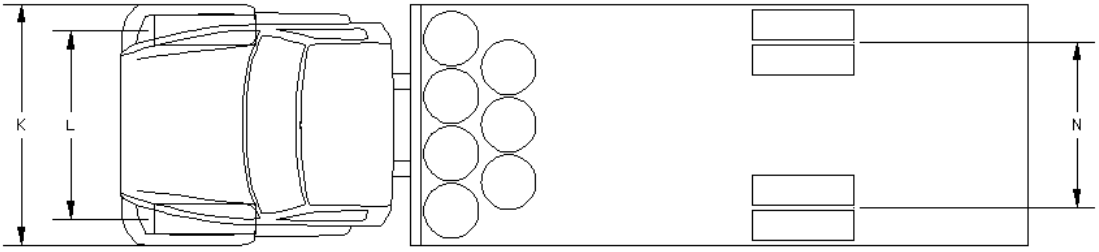
DATA SHEET 2

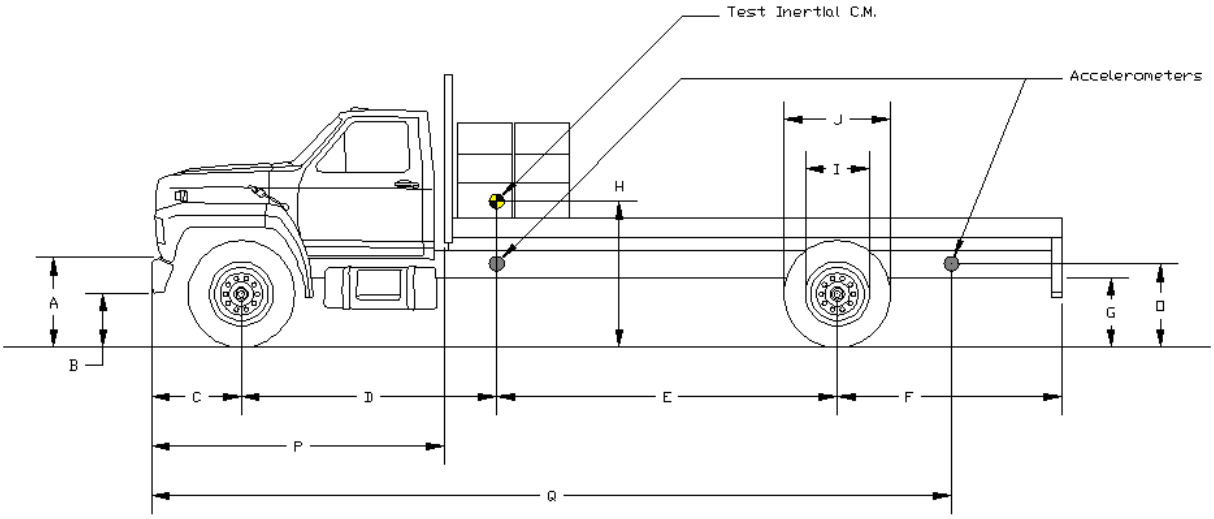
TEST VEHICLE GEOMETRY

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12





TEST VEHICLE GEOMETRY

No.	mm	in.	No.	mm	in.	No.	mm	in.
A	740	29.1	G	740	29.1	N	1,810	71.3
B	480	18.9	H	1,467	57.8	O	870	34.3
C	780	30.7	I	585	23.0	P	2,580	101.6
D	3,075	121.1	J	990	39.0	Q	7,440	292.9
E	2,445	96.3	K	2,425	95.5			
F	1,875	73.8	L	1,965	77.4			

All measurements in millimeters (mm).
Left side measurements reported.

DATA SHEET 3

INSTALLATION DATA

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

CONCRETE STRENGTH DATA

Description	Units	Compressive Strength
Concrete Strength Specification	psi	5,390
Sample 1	psi	5,430

SOIL COMPACTION DATA

Description	Units	Density
Maximum Dry Density	lbs/cu.ft.	137.5
As-Tested Dry Density		
Sample 1 - Left Terminal Post	lbs/cu.ft.	123.6
Sample 2 - Right Terminal Post	lbs/cu.ft.	124.8
Minimum Percentage Requirement	%	90.0
Dry Compaction Percentage of Maximum		
Sample 1 - Left Terminal Post	%	89.9
Sample 2 - Right Terminal Post	%	90.8

.

DATA SHEET 4

IMPACT CONDITIONS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

IMPACT CONDITIONS

Item	Value	
Test Time	5:54 PM	
Temperature (°F)	99	[1]
Wind Velocity (km/h)	13	[1]
Wind Direction	West	[1]
Impact Speed (km/h)	79.8	
Impact Angle (°)	0.3	
Impact Location (mm)	76	

Impact Angle and impact location measured using high speed video analysis

[1] - Information for reference only.

DATA SHEET 5

EVALUATION OF TEST RESULTS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

PENETRATION RATINGS

Measured Penetration	Rating
Less than 1 m	P1
1.01 m - 7.0 m	P2
7.01 - 30.0 m	P3
Greater than 30 m	P4

MEASURED PENETRATION

Description	Units	Value
Driver's Side Penetration (Dynamic)	m	6.40
Passenger's Side Penetration (Dynamic)	m	6.42
Maximum Dynamic Penetration	m	6.42
Driver's Side Penetration (Static)	m	-15.37
Passenger's Side Penetration (Static)	m	-17.56
Maximum Static Penetration	m	-15.37
Maximum Penetration	m	6.42

PENETRATION RATING

ASTM F 2656-07 penetration rating for test P32117-01	**P2**

Comments:

The Smith & Wesson M50 Post and Cable System - 200 ft completely arrested the test vehicle within the 1.01 m to 7.0 m penetration limit for a P2 rating.

The test vehicle was completely disabled by the impact. The cables engaged the engine and pushed it rearward into the occupant compartment. After impact, the vehicle was propelled rearward and away from the protected side of the fence.

DATA SHEET 6

OBSERVATIONS

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

TERMINATION POST FACE ANGLE MEASUREMENTS

Post Location	Angle (°)		
	Pre-Test	Post-Test	Difference
Left Side Termination Post	90.4	88.4	2.0
Right Side Termination Post	90.0	88.4	1.6

TERMINATION POST SIDE ANGLE MEASUREMENTS

Post Location	Angle (°)		
	Pre-Test	Post-Test	Difference
Left Side Termination Post	89.6	78.1	11.5
Right Side Termination Post	90.1	87.4	2.7

PRE-TEST CABLE HEIGHT MEASUREMENTS

Post Location	Cable Height (mm)	
Top Cable	1137	[2]
Middle Cable	984	[2]
Bottom Cable	832	[2]

[2] – Cable heights were measured at the impact location.

DATA SHEET 7

SENSOR DATA

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

TEST VEHICLE ACCELERATION PEAK DATA

Location	Axis	Vehicle			
		Max (g)	Time (ms)	Min (g)	Time (ms)
CG	X	5.6	336.6	-12.1	347.0
CG	Y	11.7	346.4	-14.2	340.4
CG	Z	8.8	338.6	-8.1	333.2
CG Resultant		17.9	346.6		
Rear Frame Member	X	5.3	336.4	-13.1	346.4
Rear Frame Member	Y	7.9	375.6	-8.0	369.8
Rear Frame Member	Z	10.4	366.6	-12.6	423.4
Rear Frame Member Resultant		15.3	423.4		

OCCUPANT RISK FACTORS

Location	Axis	Units	Vehicle	
			Max	Time (ms)
Occupant Impact Velocity	X	m/s	4.9	389.2
	Y	m/s	0.4	389.2
Occupant Ridedown Acceleration	X	g	-8.1	485.4
	Y	g	5.9	442.2

APPENDIX A

PHOTOGRAPHS

LIST OF PHOTOGRAPHS

LIST OF PHOTOGRAPHS … (CONTINUED)

FIGURE 1. Test Article, As-Received

FIGURE 2. Test Article, As-Received

FIGURE 3. Test Article Installation

FIGURE 4. Test Article Installation

FIGURE 5. Test Article Installation

FIGURE 6. Test Article Installation

FIGURE 7. Test Setup

FIGURE 8. Test Setup Close-Up

FIGURE 9. Test Setup

FIGURE 10. Test Setup Close-Up

FIGURE 11. Test Setup

FIGURE 12. Test Setup Close-Up

FIGURE 13. Test Setup

FIGURE 14. Test Setup Close-Up

FIGURE 15. Test Setup

FIGURE 16. Post-Test

FIGURE 17. Test Article, Pre-Test Front

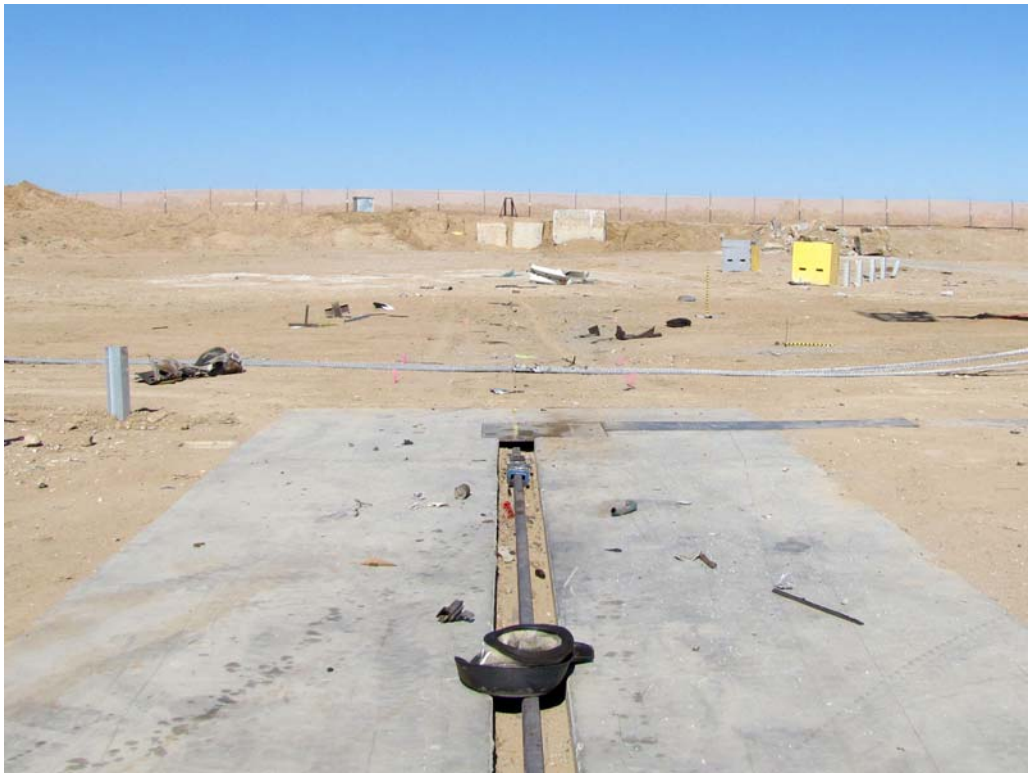


FIGURE 18. Test Article, Post-Test Front

FIGURE 19. Test Article, Pre-Test Left Front ¾

FIGURE 20. Test Article, Post-Test Left Front ¾

FIGURE 21. Test Article, Pre-Test Left Side

FIGURE 22. Test Article, Post-Test Left Side

FIGURE 23. Test Article, Pre-Test Left Rear ¾

FIGURE 24. Test Article, Post-Test Left Rear ¾

FIGURE 25. Test Article, Pre-Test Rear

FIGURE 26. Test Article, Post-Test Rear

FIGURE 27. Test Article, Pre-Test Right Rear ¾

FIGURE 28. Test Article, Post-Test Right Rear ¾

FIGURE 29. Test Article, Pre-Test Right Side

FIGURE 30. Test Article, Post-Test Right Side

FIGURE 31. Test Article, Pre-Test Right Front ¾

FIGURE 32. Test Article, Post-Test Right Front ¾

FIGURE 33. Test Article, Post-Test Damage

FIGURE 34. Test Article, Post-Test Damage

FIGURE 35. Test Article, Post-Test Damage

FIGURE 36. Test Article, Post-Test Damage

FIGURE 37. Test Vehicle, Pre-Test Left Front ¾

FIGURE 38. Test Vehicle, Post-Test Left Front ¾

FIGURE 39. Test Vehicle Manufacturer's Label

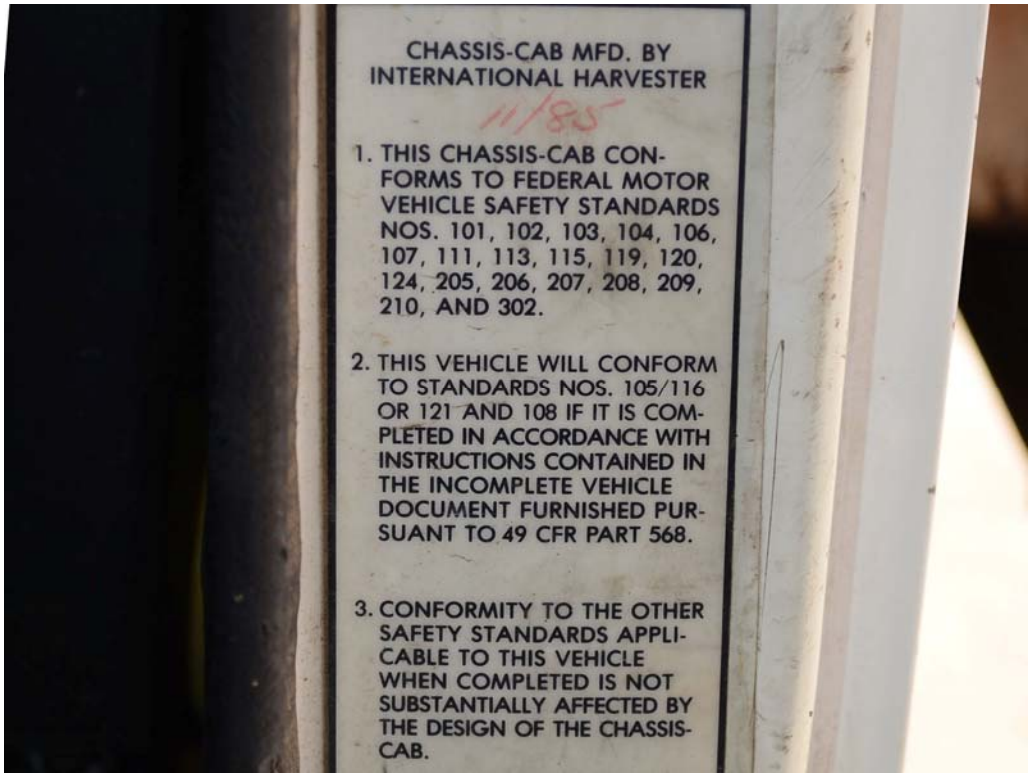


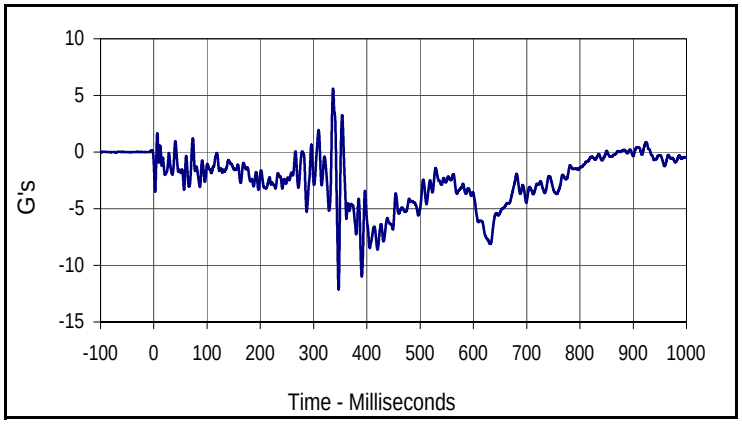
FIGURE 40. Test Vehicle Manufacturer's Label

APPENDIX B

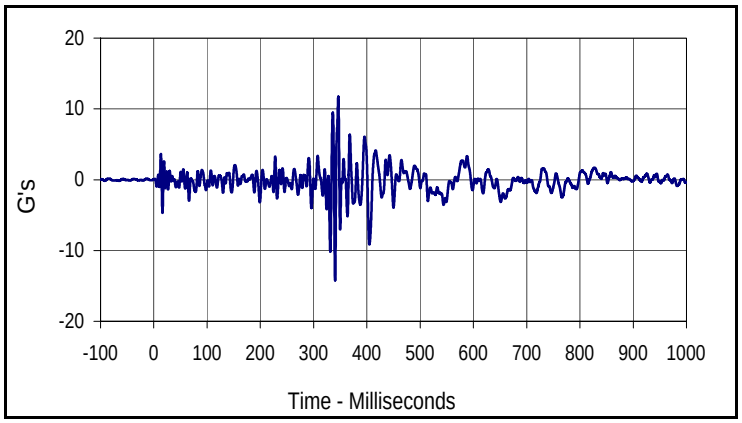
DATA PLOTS

LIST OF DATA PLOTS

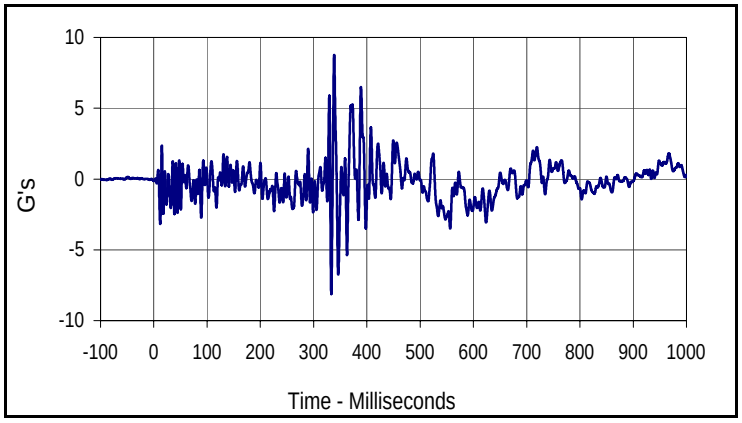
Test Article:	Smith & Wesson Security Solutions	Project No.:	P32117-01
Test Program:	ASTM F2656-07 M50	Test Date	8/3/12
Test Vehicle:	1986 International		



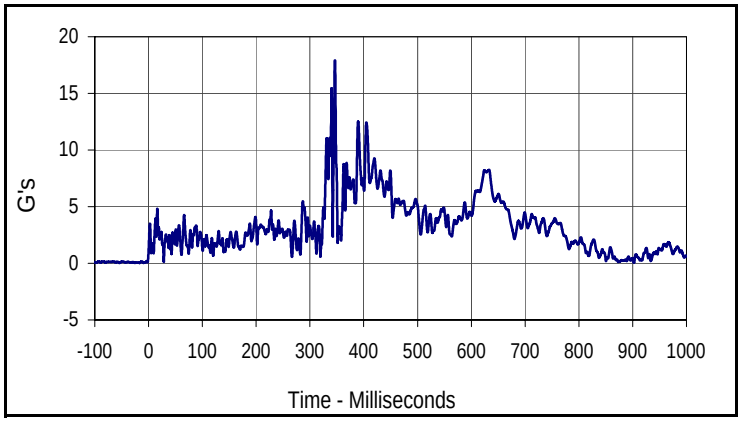
Curve Description			
Vehicle CG X			
Plot	Type	SAE Class	Units
001	FIL	60	G's
Max	Time	Min	Time
5.6	336.6	-12.1	347.0



Curve Description			
Vehicle CG Y			
Plot	Type	SAE Class	Units
002	FIL	60	G's
Max	Time	Min	Time
11.7	346.4	-14.2	340.4

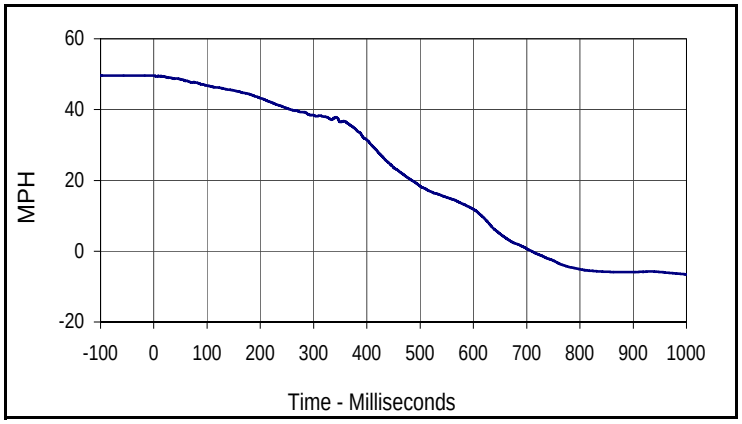


Curve Description			
Vehicle CG Z			
Plot	Type	SAE Class	Units
003	FIL	60	G's
Max	Time	Min	Time
8.8	338.6	-8.1	333.2

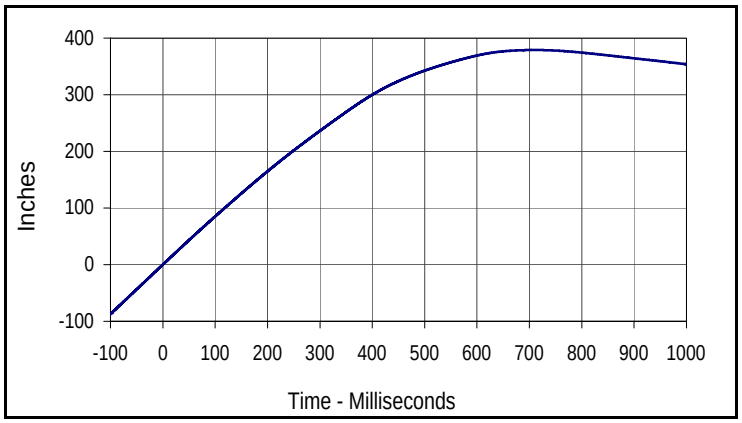


Curve Description			
Vehicle CG Resultant			
Plot	Type	SAE Class	Units
004	RES	60	G's
Max	Time	Min	Time
17.9	346.6	0.0	-17.0

Test Article:	Smith & Wesson Security Solutions	Project No.:	P32117-01
Test Program:	ASTM F2656-07 M50	Test Date	8/3/12
Test Vehicle:	1986 International		

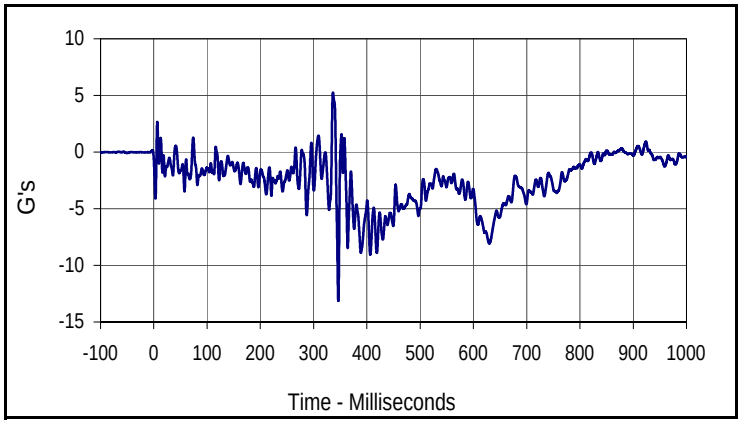


Curve Description			
Vehicle CG X Velocity			
Plot	Type	SAE Class	Units
005	IN1	180	MPH
Max	Time	Min	Time
49.6	1.0	-6.5	999.8

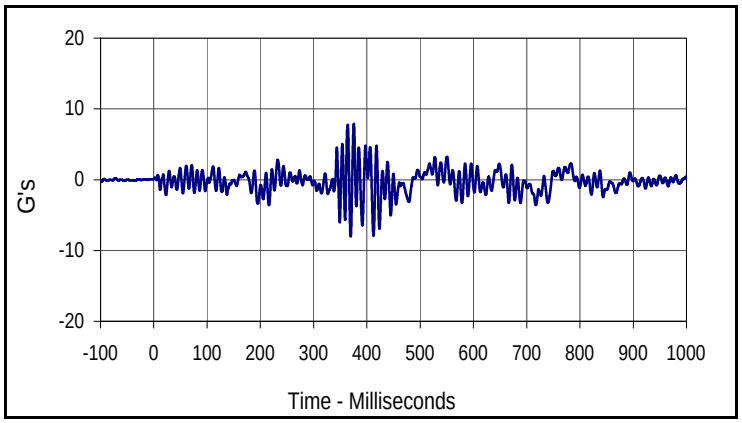


Curve Description			
Vehicle CG X Displacement			
Plot	Type	SAE Class	Units
006	IN1	180	Inches
Max	Time	Min	Time
379.0	709.4	-34.9	-40.0

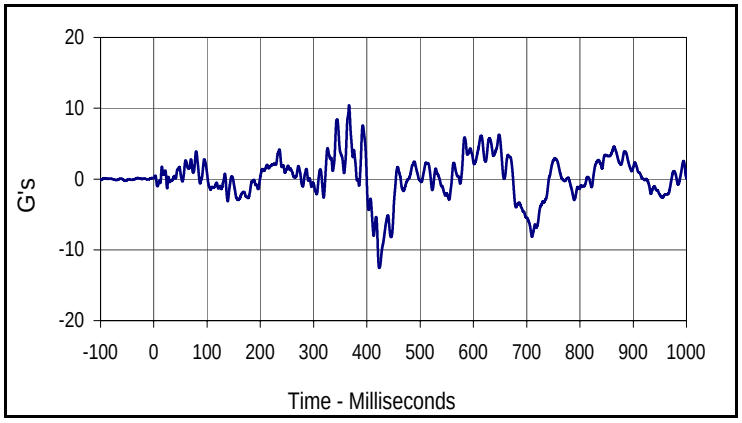
Test Article:	Smith & Wesson Security Solutions	Project No.:	P32117-01
Test Program:	ASTM F2656-07 M50	Test Date	8/3/12
Test Vehicle:	1986 International		



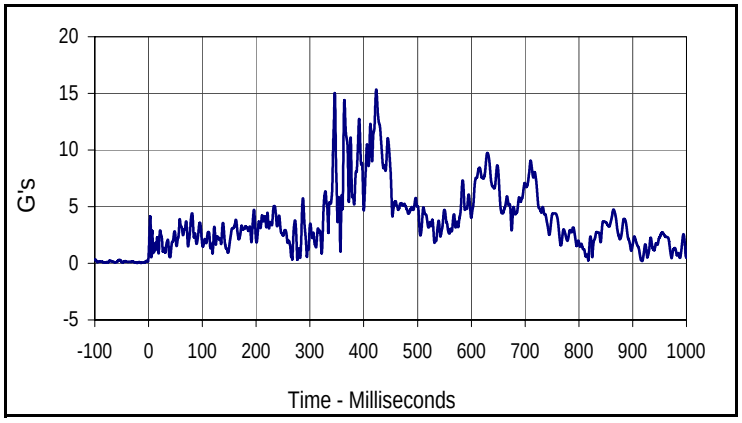
Curve Description			
Vehicle Rear Frame Member X			
Plot	Type	SAE Class	Units
007	FIL	60	G's
Max	Time	Min	Time
5.3	336.4	-13.1	346.4



Curve Description			
Vehicle Rear Frame Member Y			
Plot	Type	SAE Class	Units
008	FIL	60	G's
Max	Time	Min	Time
7.9	375.6	-8.0	369.8

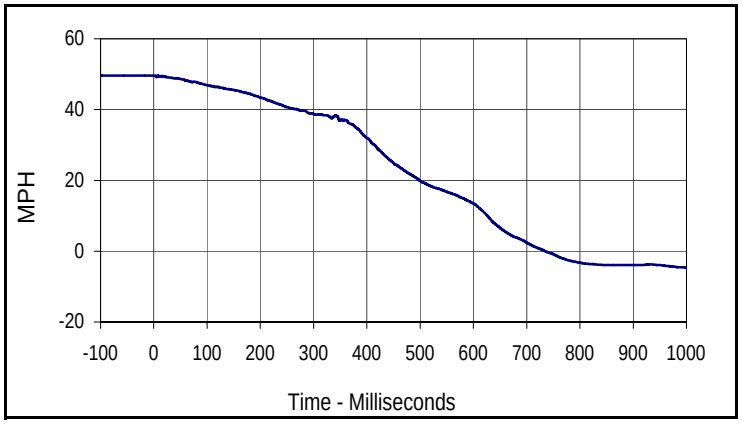


Curve Description			
Vehicle Rear Frame Member Z			
Plot	Type	SAE Class	Units
009	FIL	60	G's
Max	Time	Min	Time
10.4	366.6	-12.6	423.4

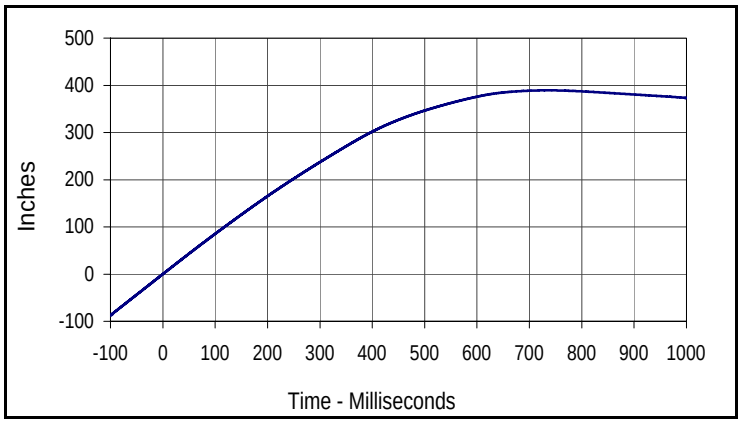


Curve Description			
Vehicle Rear Frame Member Resultant			
Plot	Type	SAE Class	Units
010	RES	60	G's
Max	Time	Min	Time
15.3	423.4	0.0	-20.8

Test Article:	Smith & Wesson Security Solutions	Project No.:	P32117-01
Test Program:	ASTM F2656-07 M50	Test Date	8/3/12
Test Vehicle:	1986 International		



Curve Description			
Vehicle Rear Frame Member X Velocity			
Plot	Type	SAE Class	Units
011	IN1	180	MPH
Max	Time	Min	Time
49.6	-40.0	-4.6	999.8



Curve Description			
Vehicle Rear Frame Member X Displacement			
Plot	Type	SAE Class	Units
012	IN1	180	Inches
Max	Time	Min	Time
389.3	734.4	-34.9	-40.0

APPENDIX C
DATA ACQUISITION INFORMATION

DATA ACQUISITION INFORMATION

Test Article: Smith & Wesson Security Solutions M50 Post and Cable System - 200 ft

Test Program: ASTM F 2656-07 M50 Project No.: P32117-01

Test Vehicle: 1986 International 1654 Test Date: 08/03/12

VEHICLE INSTRUMENTATION INFORMATION

CH	Location	Axis	Ident. No.	Description	MFR	Model	Units
1	Vehicle CG	X	KETX11A	Accel, Triax	I.C. Sensor	3031-500	g
2	Vehicle CG	Y	KETX11B	Accel, Triax	I.C. Sensor	3031-500	g
3	Vehicle CG	Z	KETX11C	Accel, Triax	I.C. Sensor	3031-500	g
4	Vehicle Rear Frame	X	KETX12A	Accel, Triax	Measurement	3038-500	g
5	Vehicle Rear Frame	Y	KETX12B	Accel, Triax	Measurement	3038-500	g
6	Vehicle Rear Frame	Z	KETX12C	Accel, Triax	Measurement	3038-500	g

HIGH SPEED CAMERA INFORMATION

View No.	Location	Identification No.	Manufacturer	Type
1	Driver's Side Profile View	7959	Phantom	V9
2	Driver's Side Oblique View	2756	Phantom	V5
3	Inline View	2706	Phantom	V5
4	Overhead View	2891	Phantom	V5.1

APPENDIX D
DRAWINGS AND ILLUSTRATIONS

LIST OF FIGURES

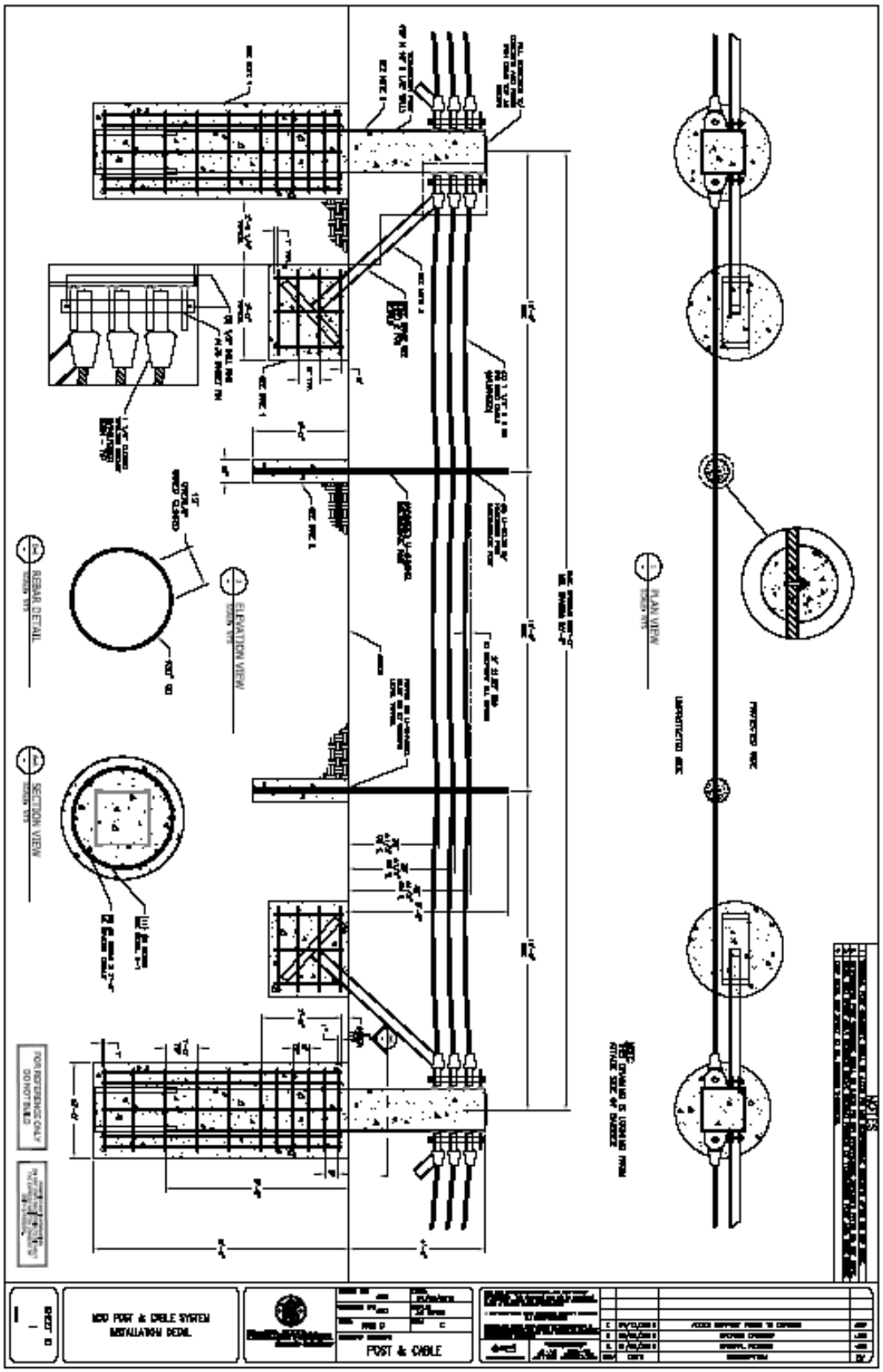


Figure 41: Manufacturer’s Drawing

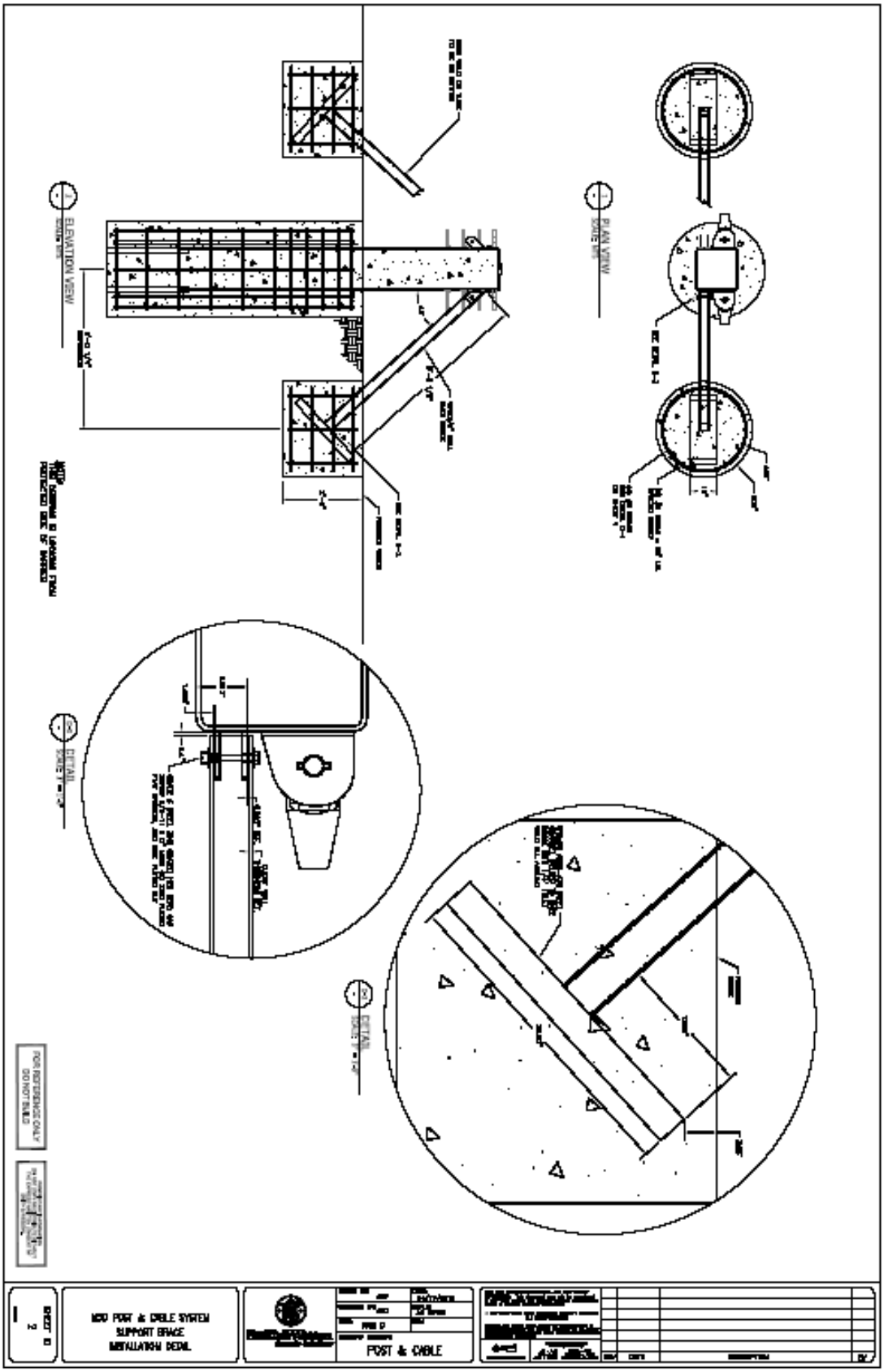


Figure 42: Manufacturer's Drawing

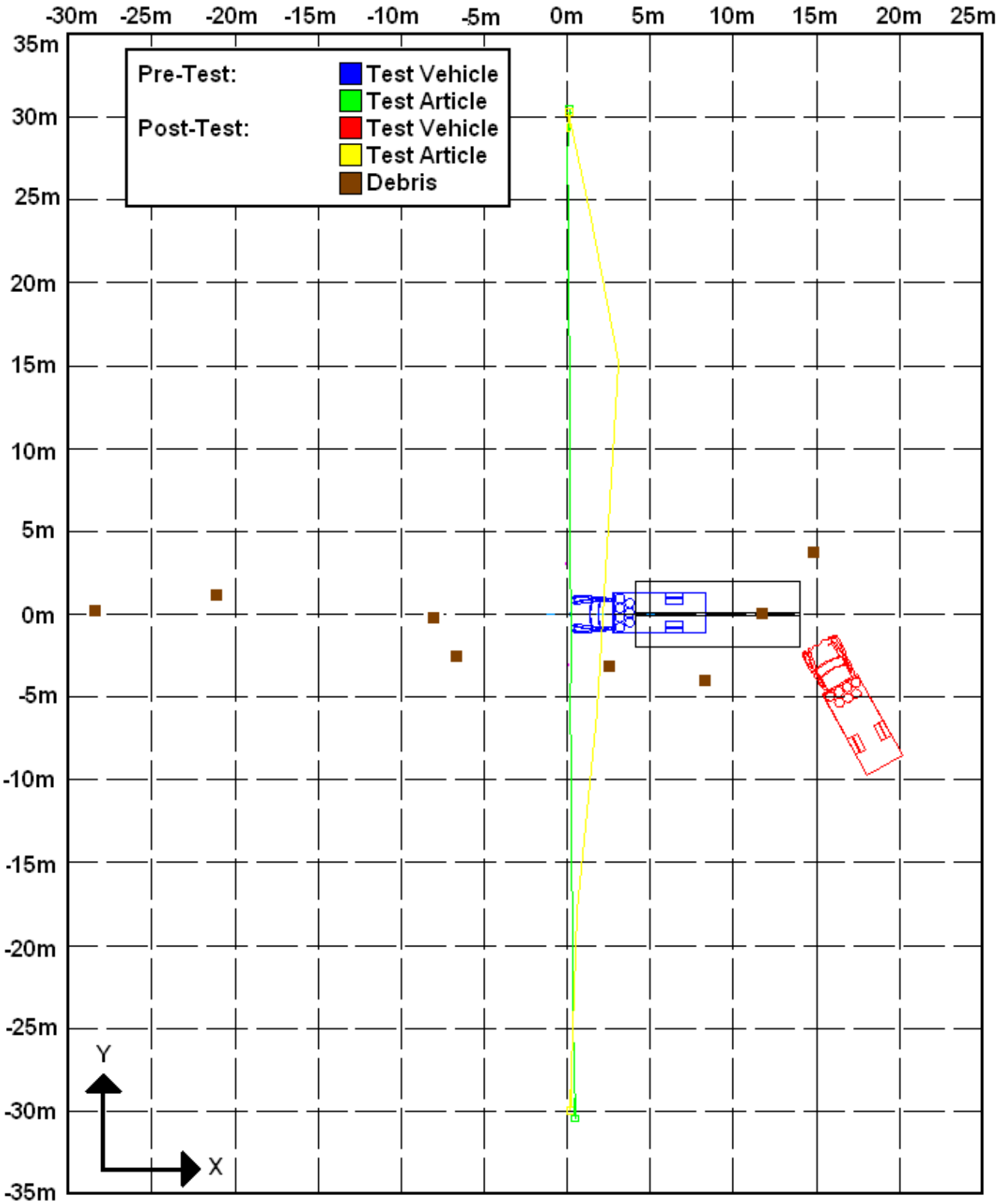


Figure 43: Overhead Illustration

FINAL PAGE OF REPORT