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**TR-11-98**  
**Penetration of Exterior House Walls**  
**by Modern Police Ammunition**

**R.W. Schiefke, B.Sc.**  
**Firearms Section**  
**Forensic Laboratory Vancouver**

**TECHNICAL REPORT**  
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Submitted by  
R.W. Schiefke, B.Sc.  
Firearms Section  
Forensic Laboratory  
Vancouver, British Columbia

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about this report can be  
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## EXECUTIVE SUMMARY

In this study, the penetration of exterior house walls by modern police ammunition is studied. The perforation potential and exit velocity of various calibres and bullet types of modern ammunition used in police issue handguns is noted for exterior walls of stucco, vinyl siding and cedar siding construction

## SOMMAIRE

Cette etude porte sur la penetration de murs exterieurs par les munitions de police modernes. On a mesuré le potentiel de perforation et la vitesse de sortie des munitions de différents types et calibres utilisées avec les armes de poing des policiers pour des murs exterieurs faits de stucco, de bardage en vinyle et de bardage en cèdre.

As handguns are the weapons most used by law enforcement officers in defense and other police situations, it is important to learn what may happen after a firearm is discharged and a bullet misses its intended target and strikes a residence.

Police situations are not like hunting situations in which the trigger is not pulled unless the hunter is sure that no one is in danger if he/she were to miss the target. A law enforcement officer has to make a split second lifesaving decision to shoot at an aggressor without the luxury of making a detailed study of what is beyond him/her

This study is to aid law enforcement agencies to realize what is likely to happen in the above scenario when a bullet strikes and perforates an outside wall and enters a residence. This knowledge could also be important if a deliberate shot is required to be made through a wall.

The purpose of the study is to determine the perforation potential and exit velocity (if perforation is achieved) of various calibers and bullet types of modern police ammunition when fired in police issue handguns.

## **Materials and Methods**

In order to complete this study, wall units had to be constructed as well as a framework to hold both the completed units and the chronograph screens.

The wall units were constructed as follows:

- **2" x 4"** lumber was built into 16" squares (outside measurement) to form the basic wall unit frame
- all basic wall unit frames have the following materials applied starting at the inside (painted) wall surface:

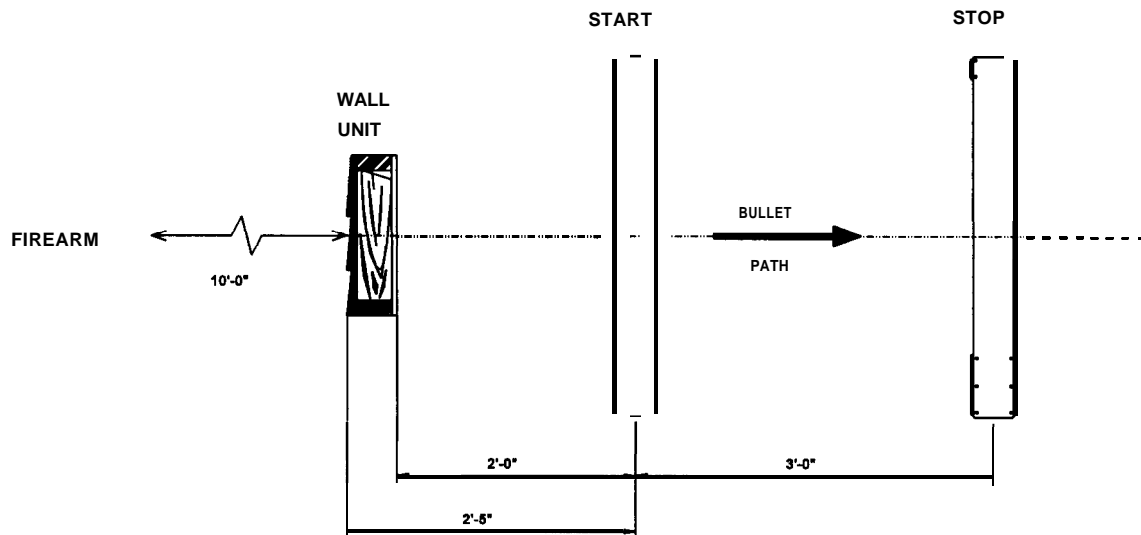
- a) 1/2" painted gypsum wallboard - 2 coats of semi-gloss latex paint applied on "inside"

- surface
- b) 6 mil vapour barrier
- c) 4 inches of fibreglass insulation
- d) 3/8" chipboard
- e) tarpaper

The three siding types were then attached to the basic units:

- a) stucco - layer of stucco screen and a 3/4" layer of stucco (Imasco Greatwall Basecoat Concentrate, sand and water)
- b) vinyl siding - 4D4 vinyl (8" wide)
- c) cedar siding 1" x 10" rough bevel siding assembled in overlapping fashion

A wood frame was constructed of 2" x 4" lumber to hold both a wall unit and the two chronograph screens. The frame was constructed so that the screens were 3 feet apart (centre to centre) and the inner (painted) surface of a wall unit was 2 feet from the first screen. The outer surface of a wall unit was approximately 29 inches from the first screen (see diagram).



The wall units were screwed to the wood frame while the chronograph screens were bolted to it.

The shots were fired at the wall units at a distance of 10 feet from the outer wall unit surface. All shots were straight on (perpendicular) shots to assure that the bullets entered the wall panels without hitting the 2" x 4" frame (representing studs in a house wall).

An Oehler model 35 chronograph with Oehler Model 55 ballistic screens was used for this study. This system was brand new with factory calibrated screens.

The firearms used in this study were as follows:

1. S & W Model 4006 Serial No. TFK 9577 (calibre .40 S & W)
2. S & W Model 3953 Serial No. VED 1092 (calibre 9mm Para.)
3. S & W Model 5946 Serial No. VDF 7485 (calibre 9mm Para.)
4. S & W Model 10-5 (5-inch barrel) Serial No. D24735 (calibre .38 Special)
5. S & W Model 10-5 (2-inch barrel) Serial No. D290747 (calibre .38 Special)

The ammunition used was as follows:

- A. .40 s & w
1. 155 gr Win. Silvertip H.P.
  2. 155 gr Federal Hydrashok JHP
  3. 155 gr Speer Gold Dot H.P.
  4. 165 gr Federal Hydrashok JHP
  5. 180 gr Win. Ranger SXT
  6. 180 gr Win. Subsonic JHP
  7. 180 gr Speer Gold Dot HP

8. 165 gr Rem. Golden Sabre JHP

B. 9mm Para.

1. 115 g Federal JHP
2. 115 g Win. Silvertip HP
3. 147 g Federal Hydrashok JHP
4. 147 g Win. Ranger SXT
5. 147 g Rem. Golden Sabre JHP
6. 147 g Speer Gold Dot H.P.
7. 115 gr Win. FMJ
8. 147 g Federal Tactical JHP

C. .38 Special

1. 158 gr Federal Semi Wadcutter HP + P

Seven of the eight types of .40 S & W ammunition, six of the seven types of 9mm Para. ammunition and the single .38 Special ammunition type used in this study are the same as those used in the ballistic gelatin penetration study done by Dean DALSTROM and Kramer POWLEY of the Firearms Section of the R.C.M.P. Forensic Laboratory in Regina, Saskatchewan in 1994.'

For measurement of the initial velocities, a piece of brown paper was placed approximately 2 feet in front of the front screen (on wall unit mount) to eliminate the effects of muzzle flash and shock wave. Cardboard was placed on the top of the screen frame to eliminate possible fluorescent light interference. Five shots of each ammunition type were fired to obtain initial velocities for establishing an average. The actual velocities of bullets entering the panels were not measured as the shot-to-shot variation was found to be minimal.

When shooting through the wall units, a piece of clear plastic sheet was mounted in front of the front

screen to reduce debris accumulation on the screen detector.

Four shots were fired with each ammunition type through the stucco and vinyl wall units and five shots were fired through the cedar siding units with each ammunition type. The extra shot into the cedar siding was centrally placed so that the extra thick portion of these overlapping tapered boards was tested.

After each panel was shot, the screen detector areas were blown with compressed air to remove any debris.

## RESULTS

Ammunition Calibre  
.40 s & W

Firearm  
S & W 4006

Ammunition	Initial Vel (fps)	Average (fps)	Wall Type	Exit Vel (fps)	Average (fps)	% Vel loss (based on average)
1. 155 gr Win. Silvertip H.P.	1217	1203	stucco	561,460,	534	55.6
	1207		cedar	526, 587,		
	1188		vinyl	1018, 1045,		
	1205			1065, 1036,		
	1198			956(c),		
S.D. = 11			1043, 1025,			
				1031, 1046		
					incl centre 1024	14.9
					-----	
					no centre 104 1	13.5
					1036	13.9
2. 155 gr Fed. Hydrashok JHP	1083	1098	stucco	321,416,	367	66.6
	1106		cedar	373,357,		
	1104		vinyl	934,931,		
	1090			946,911,		
	1109			930(c),		
S.D. = 11			970,941,			
			965,993			
					incl centre 930	15.3
					-----	
					no centre 93 1	15.2
					967	11.9
3. 155 gr Speer Gold Dot H.P.	1170	1173	stucco	385,407,	399	66.0
	1176		cedar	456, 348,		
	1166		vinyl	1011, 1033,		
	1175			988, 1026,		
	1177			987(c),		
S.D. = 5			1030, 1040,			
			1025,988			
					incl centre 1009	14.0
					-----	
					no centre 1015	13.5
					1021	13.0
4. 165 gr Fed. Hydrashok JHP	949	961	stucco	467,470,	453	52.9
	972		cedar	404,469,		
	957		vinyl	768, 816,		
	977			817, 848,		
	952			800(c),		
S.D. = 12			794, 822,			
			796,812			
					incl centre 8 10	15.7
					-----	
					no centre 812	15.5
					806	16.1*



5. 180 gr Win. Ranger SXT	922	936	stucco	411,442,	450	51.9
	930		cedar	510,437,	incl centre 796	15.0
	956		vinyl	810, 823,	-----	-----
	938		815,754,	no centre 801	14.4	
935			779(c),			
	SD. = 13			810, 827,	821	12.3
				814,831		
6. 180 gr Win. Subsonic JHP	960	949	stucco	492, 534,	470	50.5
	948		cedar	434,420,	incl centre 8 11	14.5
	941		vinyl	791, 814,	-----	-----
	955		796(c),	no centre 8 15	14.1	
939			848, 847,			
	S.D. = 9			815,847	839	11.6
7. 180 gr Speer Gold Dot HP	984	993	stucco	421,418,	396	60.1
	997		cedar	328, 417,	incl centre 8 13	18.1
	1004		vinyl	842, 792,	-----	-----
	988		778(c),	no centre 822	17.2	
992			875, 856,			
	SD. = 8			844,863	860	13.4
8. 165 gr Rem. Golden Sabre JHP	1065	1080	stucco	507,481,	513	52.5
	1071		cedar	595, 470,	incl centre 888	17.8
	1090		vinyl	905, 955,	-----	-----
	1079		826(c),	no centre 904	16.3	
1093			881,861,			
	S.D. = 12			918,948	902	16.5

(c) = shot into thickest portion  
at centre of panel

\* More velocity loss with vinyl  
(exception)

S.D. = Standard Deviation

## RESULTS

Ammunition Calibre  
9mm Para.

Firearm  
S & W 3953

Ammunition	Initial Vel (fps)	Average (fps)	Wall Type	Exit Vel. (fps)	Average (fps)	% Vel loss (based on average)
1. 115 gr Federal JHP	1163	1164	stucco	421,400,	397	65.9
	1179		cedar	368, 397,		
	1161			955, 1025,		
	1158			1005, 1014		
	1161		vinyl	988(c), 933, 1037, 907,923		
	S.D. = 8				incl centre 997 ----- no centre 1000	14.3  14.1
				950	18.4*	
2. 115 gr Win. Silvertip H.P.	1181	1161	stucco	213,258,	240	79.3**
	1159		cedar	252,235,		
	1147			963, 989,		
	1164			959,969,		
	1154		vinyl	921(c), 974, 952, 980, 1002		
	S.D. = 13				incl centre 960 ----- no centre 970	17.3  16.5
				977	15.8	
3. 147 gr Federal Hydrashok JHP	880	886	stucco	484, 502,	497	43.9
	882		cedar	496, 505,		
	890			745, 767,		
	896			710, 784,		
	880		vinyl	720(c), 760, 813, 809,812		
	S.D. = 7				incl centre 745 ----- no centre 752	15.9  15.1
				799	9.8	
4. 147 gr Win. Ranger SXT	917	924	stucco	582, 574,	567	38.6
	929		cedar	558, 554,		
	924			774, 794,		
	920			816, 820,		
	930		vinyl	746(c), 791,822, 813.818		
	S.D. = 6				incl centre 790 ----- no centre 801	14.5  13.3
				811	12.2	

5. 147 gr Rem Golden Sabre JHP	1004	978	stucco	615, 593,	607	37.9
	979		cedar	629,592,	inclu centre 830	15.1
	972			826, 832,	-----	
	961			838, 883,	no centre 845	13.6
	972		vinyl	769(c),	883	9.7
	S.D. = 16			902, 875,		
				874,882		
6. 147 gr Speer Gold Dot HP	876	897	stucco	416, 398,	403	55.1
	880		cedar	340,457,	icnl centre 746	16.8
	908			744, 767,	-----	
	901			736, 765,	no centre 753	16.1
	919		vinyl	719(c),	777	13.4
	S.D. = 18			779, 785,		
				789,755		
7. 115 gr Win. FMJ	1087	1106	stucco	680, 618,	656	40.7
	1100		cedar	640, 687,	incl centre 968	12.5
	1112			957,962,	-----	
	1113			993, 968,	no centre 970	12.3
	1116		vinyl	959(c),	984	11.0
	S.D. = 12			975,989,		
				1009,963		
8. 147 gr Federal Tactical JHP	885	867	stucco	279, 356,	313	63.9
	856		cedar	291, 327,	incl centre 743	14.3
	876			738, 741,	-----	
	846			762, 758,	no centre 750	13.5
	874		vinyl	716(c)	752	13.3
	S.D. = 16			752, 775,		
				726,755		

(c) = shot into thickest portion  
at centre of panel

\* More velocity loss with vinyl  
(exception)

\*\* More velocity loss than .38 Special  
(5" barrel) (exception)

S.D. = Standard Deviation

## RESULTS

Ammunition Calibre  
9mm P u-a.

Firearm  
s & w 5946

Ammunition	Initial Vel (fps)	Average Vel (fps)	Wall Type	Exit Vel (fps)	Average Exit Vel (fps)	% Vel loss (based on average)
1. 115 gr Federal JHP	1181	1189	Stucco	347, 320,	300	<b>74.8**</b>
	1178		cedar	242,289,	incl centre 1011	15.0
	1248		vinyl	970, 1038,	-----	14.4
	1184			1027, 1037,	no centre 1018	
1154	983(c),	1014, 1032,	1030	13.4		
	S.D. = 35			1044, 1028		
2. 115 gr Win. Silvertip H.P.	1157	1178	Stucco	290, 3 18,	325	72.4**
	1220		cedar	260,432,	incl centre 993	15.7
	1172		vinyl	956,989,	-----	15.3
	1167			1014, 1031,	no centre 998	
1173	973(c),	979, 1013,	984	16.5*		
	S.D. = 24			940.1002		
3. 147 gr Federal Hydrashok JHP	915	912	Stucco	367, 382,	381	58.2
	929		cedar	334,441,	incl centre 806	11.6
	894		vinyl	797,823,	-----	11.6
	901			802, 803,	no centre 806	
920	803(c),	819, 798,	805	11.7		
	S.D. = 14			814,788		
4. 147 gr Ranger SXT	926	937	Stucco	604, 514,	563	39.9
	943		cedar	561, 571,	incl centre 806	14.0
	945		vinyl	775, 803,	-----	13.4
	938			843, 823,	no centre 8 11	
934	785(c),	826, 843,	837	10.7		
	S.D. = 8			831,847		

5. 147 gr Rem. Golden Sabre JHP	992	992	stucco	662,551,	631	36.4
	1001		cedar	651, 659,	incl centre 850	14.3
	985		vinyl	849, 856,	-----	-----
	989			895, 865,	no centre 866	12.7
	995			891, 885,		
	S.D. = 6			911,889	894	9.9
6. 147 gr Speer Gold Dot H.P.	879	914	stucco	380,401,	407	55.5
	914		cedar	422,423,	incl centre 774	15.3
	938		vinyl	744, 774,	-----	-----
	922			811, 782,	no centre 778	14.9
	917			758(c),		
	S.D. = 22			803, 842,	844	7.7
7. 115 gr Win. FMJ	1115	1149	stucco	744, 782,	732	36.3
	1180		cedar	720, 680,	incl centre 1007	12.4
	1182		vinyl	983, 1038,	-----	-----
	1150			987,	no centre 1015	11.7
	1118			976(c),		
	S.D. = 32			1024, 1005,	1027	10.6
8. 147 gr Federal Tactical JHP	902	898	stucco	511,451,	477	46.9
	881		cedar	474,470,	incl centre 738	17.8
	915		vinyl	743,705,	-----	-----
	883			754, 749,	no centre 738	17.8
	907			739(c)		
	S.D. = 15			781, 796,	781	13.0
				777,769		

(c) = shot into thickest portion  
at centre of panel

\* More velocity loss with vinyl  
(exception)

\*\* More velocity loss than .38 Special  
(5" barrel) (exception)

S.D. = Standard Deviation

**RESULTS**

**Ammunition Calibre  
.38 Special**

**Firearm  
Model 10-5 2" Barrel**

<b>Ammunition</b>	<b>Initial Vel (fps)</b>	<b>Average Vel (fps)</b>	<b>Wall Type</b>	<b>Exit Vel (fps)</b>	<b>Average Exit Vel (fps)</b>	<b>% Vel loss (based on average)</b>
<b>158g</b> Fed. Semiwadcutter HP+P	795	809	stucco	136,	109	86.5
	805		cedar	535, 669,	596	26.3
	820		vinyl	592, 586,	679	16.1
	807		675, 690,			
	818		661,688			
S.D. = 10						

\*\*\* 6 shots-2 did not perforate  
 - 2 perforated but too slow to get reading  
 - 2 gave reading

**RESULTS**

**Ammunition Calibre  
.38 Special**

**Firearm  
Model 10-5 5" Barrel**

<b>Ammunition</b>	<b>Initial Vel (fps)</b>	<b>Average Vel (fps)</b>	<b>Wall Type</b>	<b>Exit Vel (fps)</b>	<b>Average Exit Vel (fps)</b>	<b>% Vel loss (based on average)</b>
<b>158g</b> Fed. Semiwadcutter HP+P	945	941	stucco	227, 304,	268	71.5
	938		cedar	323,217,	750	20.3
	928		vinyl	711, 778,	784	16.7
	939		755,754,			
	954		747, 801,			
S.D. = 10						

S.D. = Standard Deviation

## **Discussion:**

In 1993<sup>2</sup> the F.B.I. conducted a study in which various calibres of firearms and ammunition were used to study the penetration of bullets into ballistic gelatin after having passed through two pieces of wallboard spaced 3.5 inches apart (to simulate an interior wall) and, in a separate test, 3/4 inch plywood (to simulate a wood door or construction timber). These shots were made from 10 feet away. Testing penetration with ballistic gelatin is beyond the scope of this study, however, I believe that this is the only study utilizing actual complete wall units to simulate exterior walls and the results obtained will aid the police community in realizing what would happen should a bullet miss its target and enter a house without striking a stud.

The results indicate that all bullets in all tests are slowed by the walls as they are perforated by the bullets. The walls with the stucco surface slow the bullets the most (in the case of the Model 10-5 S & W revolver with the 2" barrel - perforation did not occur with two of six shots fired at it and two other bullets exited slowly enough that the chronograph did not read their exit velocities - these two bullets were found on the floor; they probably did not get to the second chronograph screen). The cedar siding walls in most cases slowed the bullets more than the vinyl siding walls did (exceptions are marked with an asterisk in the results tables).

On visual observation and comparison of the exit holes in the gypsum wallboard versus the entrance holes in the siding, there does not seem to be much expansion of the jacketed bullets (hollow points). As these bullets were not recovered, this was not confirmed. This lack of expansion is supported by the findings of others such as MacPHERSON who states that "impact with any solid material tends to fill the cavity with part of this solid material and/or mash the cavity shut, producing a configuration more like the round nose".'

To illustrate how this experiment can provide some useful comparisons, the data pertaining to the

Royal Canadian Mounted Police (R.C.M.P.) sidearms is selected for comparison. Comparison of results of the previously issued S & W Model 10-5 (5-inch barrel) using the R.C.M.P. previous issue ammunition (.38 Special 158 gr Federal Semiwadcutter HP + P) and the newly issued firearm/ammunition combination (S & W Model 5946 or S & W Model 3953 with 9mm Para 147 gr Win. Ranger SXT) shows the following: The exit velocity through all wall types is higher with the new issue firearm/ammunition combination (the effect most evident with stucco walls). This increase in exit velocity therefore increases the danger factor when a wall is perforated by a bullet from the newly issued ammunition. The results are even more striking when the previous S & W 10-5 (2-inch barrel) revolver with the issue .38 Special ammunition is compared with the newly issued firearm/ammunition combination through stucco and cedar walls.

With few exceptions (9mm Para. 115 gr Win. Silvertop HP in both S & W 3953 and S & W 5946 through stucco walls and 9mm Para. 115 gr Federal JHP through stucco walls - these are double asterisked on the result tables) all .40 S & W and 9mm Para. cartridges fired in the test firearms had greater exit velocities through all wall types when compared to the .38 Special ammunition fired from either revolver creating an increased risk factor.

A comparison of the exit velocities of this experiment with the results of a bullet speed/tissue penetration study done by DiMaio "et al"<sup>4</sup> in 1982 gives an indication of the danger that a person behind such exterior walls would be in. The DiMaio study indicates that a .38 calibre bullet (113 gr round nose bullet) travelling as slow as 191 fps will perforate skin and penetrate tissue up to 40mm (approximately 1 1/2") All of the firearm/ammunition combinations fired through all wall types in this study (except for the S & W Model 10-5 revolver with a 2-inch barrel firing the 158 gr Semiwadcutter bullet through stucco) exceed this bullet speed.



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