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Evaluation of 9mm Ammunition
Phase 1

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SUMMARY

In order to ascertain practical velocities and energies being obtained with "off-the-shelf" ammunition, a study was undertaken of eleven different types of 9 mm cartridges. Several manufacturers as well as a variety of bullet types and cartridge loadings were examined. In addition, the tests were undertaken using two separate self-loading pistols each having a different barrel length.

The resulting data collected relative to measured muzzle velocity and calculated bullet energy, and a comparison of each associated with the pistols used is given in this report. It should be noted that the figures provided for bullet energy should not be directly related to target incapacitation. An extension of this study using gelatin as a target medium will provide more specific data on bullet expansion and penetration which may be directly related to transfer of bullet energy to target.

1.0 INTRODUCTION

For many decades the traditional police handgun in North America has been a revolver. Some self-loading pistols have been employed by law-enforcement agencies, but the revolver, because of its basic simplicity has enjoyed the majority of use by police. The introduction of the self-loading pistol at the beginning of this century and the proliferation of this type of firearm during the First and Second World Wars saw most European police adopt the pistol. It was not until relatively recently that many U.S. police forces adopted a serious attitude towards the pistol and began issuing it as a standard sidearm to their personnel. It has by no means replaced the revolver completely but appears to be firmly entrenched in the police community.

The proximity of Canada to the U.S., has sometimes resulted in various aspects of life in the U.S. being reflected in Canada. This appears to be true to some extent with regard to the use of the pistol instead of the revolver by police forces. Questions have been asked and studies undertaken with a view towards use of the pistol by various Forces in Canada. Some already employ the pistol as their issue side-arm. Unfortunately the change from revolver to self-loader necessitates a basic change in ammunition; thus, in addition to evaluating the difference between pistol and revolver relative to training procedures, use, mechanical properties, and other criteria, the question of ammunition and its associated parameters must also be considered.

It is with this latter factor in mind that this brief evaluation of some "off-the-shelf" ammunition was undertaken. Although there is a variety of calibres available in pistols from various manufacturers (eg., - .32 auto, .38 auto, .45 auto, 10 mm, etc.) it would seem that the most common and the most popular at present is the 9 mm. Reference to the 9 mm is specifically to the 9 x 19 mm NATO round, variously referred to as 9 mm Luger, 9 mm military, 9 mm parabellum to name a few. The popularity of this round can be in part attributed to the fact that this is the standard NATO small arms (pistol and submachine gun) calibre. This has resulted in a great proliferation of pistols chambered for this round as well as apparent endless supply of surplus military ammunition available to the civilian market.

The ammunition obtained and examined for this project included at least one example of standard military issue 9 mm. The majority of the samples were produced by one manufacturer and provided an excellent cross-section of the different bullet shapes, weights and cartridge loadings available in this one calibre.

Bullets were chronographed approximately 2 meters from firearm muzzle, and two separate and different 9 mm pistols were employed. These pistols had different length barrels which affected the measured bullet velocities to a noticeable degree.

Comparison of velocities vs. barrel lengths are provided herein for the ammunition examined.

2.0 AMMUNITION TESTED

The following types of 9 mm ammunition were subjected to velocity measurements from the two pistols listed in Section 3.1. For ease of identity and to ensure impartiality when examining resulting data each different loading and/or manufacturer was designated by Sample Number. The following were examined:

Sample #1 - Federal 95 Gr., J.S.P., Manufacturer identification No. 9CP, Lot No. 24A-9419

Sample #2 - Federal 124 Gr., M.C.S.W.C., Manufacturer identification No. 9MP, Lot No. 24C-9458

Sample #3 - Federal 124, Gr., M.C., Manufacturer identification No. 9AP, Lot No. 23A-7700

Sample #4 - Federal 115 Gr., J.H.P., Manufacturer Identification No. 9BP, Lot No. 22-B-9643

Sample #5 - Federal 124 Gr., J.H.P., Hydra-Shok, +P+, Manufacturers Identification No. P9HS3, Lot No. 24A-8692

Sample #6 - Federal 124 Gr., J.H.S.H.P., Manufacturers Identification No. P9HSl, Lot No. 24C-9437

Sample #7 - Federal 147 Gr., J.H.S.H.P., Manufacturers Identification No. P9HS2, Lot No. 24A-9469

Sample #8 - Valcartier Industries Ltd. (IVI), 115 Gr., F.M.J., Military issue (NATO) Lot No. IVI 82J0I-06

Sample #9 - Hornady Frontier Cartridges, 115 Gr., J.H.P., Manufacturers Identification No. 9025, Lot No. 1-26-85-3011

Sample #10 - (Federal) American Eagle, 115 Gr., M.C., Manufacturers Identification No. AE9DP, Lot No. 24A-9656

Sample #11 - Federal 124 Gr., H.P. Nyclad, Manufacturers Identification No. N9BP, Lot No. 24C-9648

2.1 ABBREVIATIONS

Gr.	-	Grain
J.S.P.	-	Jacketed soft point
M.C.S.W.C.	-	Metal case semi-wadcutter
M.C.	-	Metal case
J.H.P.	-	Jacketed hollowpoint
J.H.S.H.P.	-	Jacketed hydra-shok hollowpoint
F.M.J.	-	Full metal jacket

3.0 EVALUATION EQUIPMENT AND MATERIAL

3.1 FIREARMS

Two different 9 mm pistols were used for these tests. They were:

a) Browning Hi-Power P-35

b) Heckler & Koch P-7

Barrel lengths and rifling configuration differ in each handgun. The Browning has a barrel length (Ref: 1) of 4 5/8 inches whereas the Heckler & Koch barrel is 4 inches long. The internal profile of the Heckler and Koch barrel differs considerably from that of the Browning in that it is polygonal, thus providing excellent obturation. The Browning barrel has conventional land and groove rifling.

3.2 CHRONOGRAPH

An Oehler chronograph system was used for measurement of projectile velocity. The system consisted of three parts, as follows:

3.2.1 Oehler Research Model 30 Chronotach
3.2.2 Oehler Research Model 82 with printout
3.2.3 Oehler Research Model 55 photo-electric triggering screens

3.3 FIREARM JIG

A Ransom Pistol Rest was used to firmly hold the pistols noted in Section 3.1 as they were being fired. This jig allowed the firearms to be returned to the same aim point for each shot after recoil from the previous shot had misaligned sights and target.

3.4 MISCELLANEOUS

Various bits of ancillary equipment were used during the course of these tests. No detailed description is provided here, but such items would include bullet trap, target fixing jigs, photographic equipment, etc. Complete details are recorded in laboratory files.

4.0 PROCEDURE

4.1 SET-UP

Equipment was set up as shown in Figure 1. The chronograph triggering screens were

arranged so that mid-distance between them was a nominal five feet from the muzzle of the test firearm. Although not indicated in Figure 1, the firearm muzzle was positioned several inches behind a section of half-inch polycarbonate sheet which had a small opening through which the bullet passed when fired. This ensured no accidental pre-triggering of the photo-electric chronograph screens from a shock wave emanating from the muzzle blast.

4.2 Test procedure was as follows:

a) All ammunition was acclimatized at 20°C (68°F) for 48 hours prior to use.

b) Both pistols described in Section 3.1 were thoroughly cleaned.

c) A single box of ammunition (50 rounds) from each lot was selected and twenty rounds removed from the box.

d) Each batch of twenty rounds was loaded and fired using the pistol (P-7) described in Section 3.1. After each shot, the pistol which had been mounted in the Ransom rest, was gently returned from the muzzle up recoil position to firing position. This procedure attempted to ensure a relatively consistent placement of powder in the cartridge case for each shot.

e) After twenty rounds of one type of ammunition had been expended, the pistol was removed from the rest and thoroughly cleaned before firing the next lot of twenty.

f) After firing each twenty round lot of ammunition the chronograph recording system was programmed to provide a printout of: the mean bullet velocity, the standard deviation, the maximum and minimum recorded velocities, the extreme velocity spread and the mean velocity plus and minus three standard deviations. A sample of the printout relative to firearm (Section 3.1a) and ammunition (Section 2, Sample # 4) is attached as Appendix A.

g) Once twenty rounds from each sample of ammunition had been fired by one firearm, the same procedure was used to expend twenty rounds of each sample from the second firearm. It may be noted that the twenty rounds for each firearm relating to a specific sample came not only from the same lot number but from the same box of ammunition.

h) The above procedure was followed until twenty rounds of each ammunition sample had been fired from each firearm and the data as noted in (f) above recorded and printed.

5.0 RESULTS

5.1 RECORDED VELOCITIES

a) The mean recorded velocity for each ammunition sample as fired from each firearm used is set forth in Table A. Equipment printout (Appendix A) was provided in fps, thus the same units are used in the various included tables. Sample velocities ranged from 1001 fps to 1299 fps in one firearm and from 990 fps to 1248 fps in the other firearm.

b) The difference in measured velocities of different samples of ammunition fired from the two handguns is given in Table B. The figures are provided both in feet per second and as a percentage increase in velocity from the lower recorded velocity, eg.,

Sample #1 - lowest mean velocity = 1248 fps

\- difference = 51 fps

$$\text{percentage difference} = \frac{51}{1248} \times 100 = 4.1\%$$

The calculated average difference of all eleven ammunition samples when fired from each handgun, noting that in each case a higher velocity was attained from the Browning P-35, was 4% as shown in Table B.

c) The data provided in Table C serves to illustrate the difference between the actual recorded bullet (mean) velocity for different samples and the manufacturers' published figures for the same ammunition. Without exception the measured velocity in each case was less than that advertised, and the average difference as determined from the data in Table C was calculated at seven (7%) percent less than published.

5.2 CALCULATED MUZZLE ENERGY

a) The mean projectile energy nominally noted as muzzle energy was calculated from the velocity data obtained from measurements taken five feet from the firearm muzzle. These data, given in Table A were determined from the equation

$$E = \frac{MV^2}{2g}$$

where E = energy (foot pounds)

M = bullet mass (pounds)

V = bullet velocity (fps)

g = gravitational force (32.17 ft/sec$^{-2)}$

b) The difference in bullet energy using the same ammunition, but fired from different handguns, is given both in units of force and as a percentage increase from firearm P-7 (4" barrel) to firearm P-35 (4 5/8" barrel) in Table B. Taking into account the data from all eleven cartridge loadings the average calculated energy increase from the P-7 to the P-35 was slightly over 8%.

6.0 REMARKS

6.1 Examination of the recorded data reveals several points. One of these is the fact that the pistol with the slightly longer barrel consistently produced higher velocities with the same ammunition. These increased velocities translated into higher calculated energy figures which is generally, although not always, more desirable. This fact should not be forgotten when attempting to select a duty pistol. Quite often many mechanical characteristics of semi-automatics are compared when switching from revolver to pistol, but the simple feature of barrel length is overlooked.

6.2 It should be noted that although the data contained herein indicates an average discrepancy of over 7% between manufacturers' published velocities and actual recorded

velocities, this may in part be accounted for. It is reasonable to assume that some energy is lost or consumed in the act of operating the action of the pistol. This loss, although slight, is present only with a semi-automatic and not with a revolver. There are other losses which are specific to the action of a revolver (i.e. cylinder - barrel gap pressure loss) which may to some degree offset the loss attributed to action cycling in the pistol.

6.3 No trouble of any sort attributed to ammunition was experienced when using the samples provided in either of the pistols used during these tests.

6.4 The eleven samples of 9 mm listed in this paper represent a small portion of the various types presently available, even though they do include four different bullet weights and seven different bullet configurations.

7.0 REFERENCES

1. Barrel length measured as per procedures set forth in ANSI/SAAMI Z299.3-1984, "Voluntary Industry Performance Standards for Pressure and Velocity of Centerfire Pistol and Revolver Ammunition for the Use of Commercial Manufacturers".

TABLE A

Ammunition Sample	Recorded Velocity (fps) P-35	P-7	Calculated Energy (ft- lb) P-35	P-7
# 1	1299	1248	357.8	330.3
# 2	1075	1046	319.9	302.8
# 3	1071	1026	317.5	291.4
# 4	1120	1094	322.0	307.2
# 5	1183	1119	387.4	346.6
# 6	1108	1058	339.8	309.8
# 7	1001	955	328.8	299.3
# 8	1250	1212	401.1	377.1
# 9	1220	1167	382.1	349.6
# 10	1140	1116	336.6	319.7
# 11	1039	990	298.8	271.3

TABLE B

Ammunition Sample	Velocity difference between P-35 & P7		Energy difference between P-35 & P-7	
	fps	percentage	ft. lbs	percentage
# 1	51	4.1	27.5	8.3
# 2	29	2.8	17.1	5.6
# 3	45	4.4	26.1	9.0
# 4	26	2.4	14.8	4.8
# 5	64	5.7	40.8	11.8
# 6	50	4.7	30.0	9.7
# 7	46	4.8	29.5	9.9
# 8	38	3.1	24.0	6.4
# 9	53	4.5	32.5	9.3
# 10	24	2.2	13.9	4.3
# 11	49	4.9	27.5	10.1
Average	43	4.0	25.8	8.1

Average difference in velocity between P-35 & P-7 = 4%

Average difference in calculated impact energy between P-35 & P-7 = 8.1% or approx. 26 ft- lb using a calculated average impact energy figure of 318.6 ft- lb.

TABLE C

Ammunition Sample	Manufacturer Published Velocity from 4" bbl (fps)	Actual Measured velocity from 4" bbl (fps)	Actual difference (%)
#1	1300	1248	- 4.1
# 2	1120	1046	- 6.7
#3	1120	1026	- 8.4
#4	1160	1090	- 6.1
# 5	1220	1119	- 8.3
# 6	1120	1058	- 5.5
# 7	1050	955	- 9.0
# 8	1299	1212	-6.7
# 9	* N/A	1167	-
# 10	1160	1116	- 3.8
# 11	1120	990	- 11.7

* figure not available

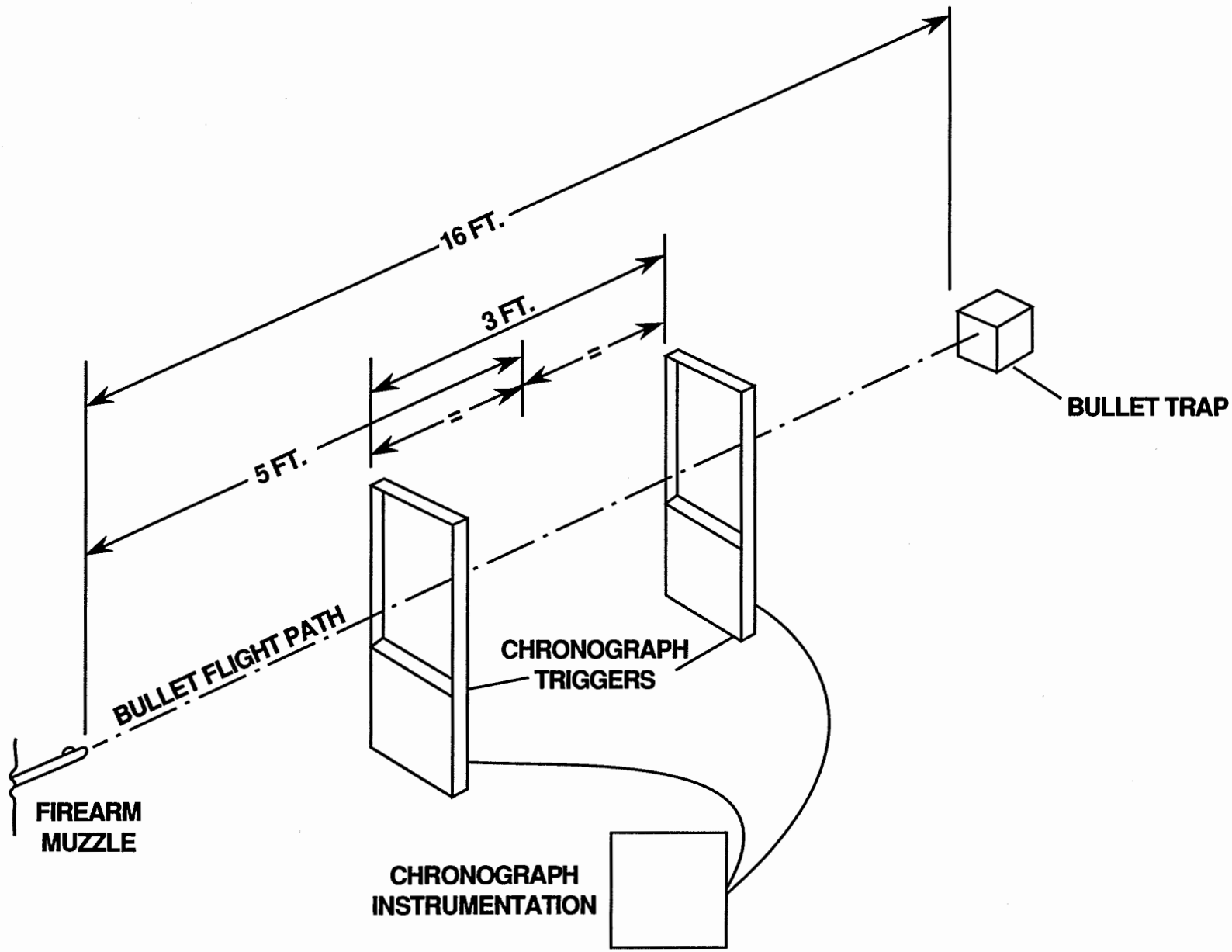

FIG. 1: TEST SETUP

AMMUNITION TESTS
OEHLER SYSTEM 82 90-06-27 09:43H SLOWFIRE...STATUS O.K. ?
←

COMMENT: VELOCITY CHECK OF SAMPLE #4 USING BROWNING HI-POWER

	0.
	3.000
ROUND	6-VEL/TA
1	1132
2	1111
3	1118
4	1092
5	1086
6	1094
7	1133
8	1120
9	1111
10	1134
11	1122
12	1135
13	1133
14	1138
15	1120
16	1114
17	1132
18	1133
19	1122
20	1116S
20	VALID ROUNDS
MEAN	1120
STD DEV	15
MAX	1138
MIN	1086
RANGE	51
MEAN+3S	1165
MEAN-3S	1074

FINISHED ? ←

COMMENT: