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CENTRE CANADIEN DE RECHERCHES POLICIÈRES

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Comparative Analysis of Lead, Barium and Antimony Emission from Handgun Ammunition

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NOTE: Further information about this report can be obtained by calling the CPRC information number **(613) 998-6342**

SUMMARY

A variety of 9mm x 19 and calibre .38 Special handgun ammunition was examined for comparative metal emissions. The presence of the three metals, lead, barium and antimony was determined through atomic emission spectrometry and their relative amounts are provided in this report.

RÉSUMÉ

Diverses munitions pour pistolets de calibre 9mm x 19 et .38 spécial ont été examinées en vue de comparer les émissions de métaux. La présence de trois métaux, soit le plomb, le baryum et l'antimoine, a été déterminée par spectrométrie d'émission atomique; leurs quantités relatives sont données dans ce rapport.

CONTENTS

1) INTRODUCTION

During the past decade considerable work has been undertaken with respect to air pollution in police indoor shooting ranges. A significant portion of this work has dealt with the problem of inorganic lead produced as a result of handgun (and long gun) training sessions in the ranges. Usually this lead, or at least the ma jority of it, is generated in the immediate vicinity of the shooter and is the result of various factors including; friction of the bullet traversing the gun barrel, vaporization of the rear of the bullet due to extremely high temperatures of powder ignition, and lead compounds in the cartridge primer.

Various approaches have been taken in attempts to decrease or even eliminate these harmful lead emissions. Bullets have been coated with Teflon to decrease the friction and lessen the amount of lead lost while exiting the barrel. Many bullets are copper jacketed (over the lead core). Some have had copper bases applied to the rear of the bullet (referred to as a gas check). Some have been constructed entirely from materials other than lead or from composites completely free from lead. Some have proved successful to the extent that the measurable amount of inorganic lead produced at the shooting line has been reduced to near zero. Since the type of ammunition used is the ma jor factor in lead emission, many police forces are concerned when purchasing ammunition and would like to be informed as to the amount of lead emission to be expected from specific types of ammunition. This report attempts to address this problem with respect to the measurement of lead emission from several types of ammunition. It also examines, as noted below, the amount of both barium and antimony present in the gaseous emission of this same ammunition.

A request from the Canadian Police Research Centre to the Environmental Measurement Science Group of the Institute for Environmental Research and Technology was received and acted upon. This request specified that nine different types of ammunition be examined for their relative emissions of three heavy metals; specifically - lead(Pb), barium(Ba) and antimony(Sb). The various procedures followed in the course of obtaining the required data are outlined within this report in addition to the data pertinent to specific metal emission measured.

2) AMMUNITION

2.1- In total nine different types of ammunition were received and examined for lead, barium and antimony emission content. There were two separate calibres represented by the nine types of ammunition, so the entire lot was divided into two groups (each of a different calibre). There were five kinds of 9mm (9 x 19) and four kinds of .38 Special. A description of each is listed here with an assigned sample identification. Any reference to a specific type of ammunition henceforth in this report is by Sample identification as outlined in paragraph 2.2.

2.2.- Samples

Group R (9mm x 19)

Sample A- manufactured by Federal, #9BP, 115 grain jacketed hollow point bullet, lot # 2445901509

Sample B - manufactured by Blount Inc., Speer "Lawman Cleanfire", #3824, 124 grain TMJ bullet, lot #F25Y23

Sample C - manufactured by Blount Inc., Speer "Cleanfire LFS", #53613, 115 grain lead free solid bullet, lot # H16Y21
Sample D - manufactured by Blount Inc., Blazer Lead Free, #3460, 124 grain TMJ bullet, lot #K06Y25.
Sample E - manufactured by SNC Industrial Technologies Inc., "Simunition", Training ammunition, lot # 93 04-22

Group S (.38 Special)

Sample F - manufactured by Blount Inc., Speer, "Lawman Cleanfire", #53830, 148 grain Match WC, TMJ bullet,
Sample G - manufactured by SNC Industrial Technologies Inc., "Greenshield, Frangible lead free training cartridges"
Sample H - manufactured by Blount Inc., CCI Blazer "Lead Free", #3475, 158 grain, +P, L.H.P. bullet, lot # H26Y22
Sample J - manufactured by Winchester-Western, # Q4191, 158 grain, +P, L.H.P. bullet, lot # 06EH20 67 01

3) TEST SETUP

Since collections of lead emission from the firing of handgun ammunition had been undertaken on previous occasions, a basic collection box or container for the sampling of lead (and other metal) emissions was available in the laboratory. This box was a sealed unit in which a handgun of a calibre suitable for the ammunition being examined was placed. A rig held the handgun in place and access to fire it was via two gloves attached to sealed ports on either side of the box. Dimensions of the box allowed for a containment volume of approximately 400 litres from which to sample the emissions produced. The ammunition was fired through one end of this sealed box which had an opening of 20cm square cut in it and a self-sealing rubber diaphragm positioned over the opening. Ports through which the air in the box could be sampled were drilled at various locations around the box. For this series of sampling, four positions were employed. They were:
a) rear left side of container
b) rear right side of container
c) forward left side of container
d) forward right side of container.
A separate sampling pump and filter was used at each port. Where possible the same pump was used at all times in the same box sampling position. The filter was changed with each separate series of tests as noted in section 5.

4) TEST EQUIPMENT

4.1 - Collection box
4.2 - Firearms
4.2.1. - Smith and Wesson Model 10, .38 Special, 5 inch barrel.
4.2.2. - Browning Hi-Power (Model 35), 9mm, 4 inch barrel.

4.3 - Ransom Machine Rest. This jig was used to hold the firearm securely in the collector box.
4.4. - Air sampling equipment. Four Bendix Model BDX44 sampling pumps were used for drawing the contaminated air from the collector box.
4.5 - Filters. Aerosol 0.8 micron filters , Catalogue No.MAWPO37A0 (Millipore) were used in conjunction with the pumps in section 4.4. Filter Lot # H4AM01067 .
4.6 - Ammunition. As noted in Section 2.

5) **PROCEDURE**

5.1 - All sampling pumps were calibrated prior to the beginning of these tests and set to draw (with filters attached, and connected to the collector box) at a rate of two (2) litres per minute.
5.2 - All filters were pre-numbered in a consecutive series from #001 to #150.They were then used randomly with the sampling pumps for the various tests. Filter numbers were recorded with reference to the specific test, location and number of pump, and the ammunition being used. These data later used to correlate the resulting filter analyses.
5.3 - Sampling ports or positions on the collector box were identified by the letters "W, X, Y and Z". These positions were as follows: "W" and "Z" to the left and right of the firearm consecutively and at the firearm muzzle. "X" and "Y" to the left and right of the firearm but at the front of the collector box near the rubber diaphragm.
5.4 - Four separate tests composed of firing ten rounds each was undertaken for each of the ammunition samples examined. Each of these one hundred and forty-four (144) tests can be identified in Table B and Table C in the following manner : Test **3AY**, etc., where
-3 represents the number (from 1 to 4) of the ten round test.
-A represents the ammunition sample (para 2.2)
-Y represents the sampling position on the collector box (front right).
The chronology of testing the various ammunition samples was not alphabetical but as follows: The order of testing was Sample B, A, C, D, E, G, H, F, and finally J.
5.5 - Each separate test within a different ammunition group comprised a ten minute sampling period during which the pumps were operational and drawing in contaminated air at the rate of two liters per minute. The timing of the firing of all rounds in each test was identical.
5.6 - The firearm being used was thoroughly cleaned prior to beginning each separate test.
5.7 - Upon the completion of each test the collector box was washed and dried on the inside. Checks were made of the rubber diaphragm and of the air entry and exit ports to ensure proper operating conditions.
5.8 - All filters were collected and forwarded to the Environmental Measurement Science Section of the Institute for Environmental Research and Technology for determination of total amounts of Barium, Lead and Antimony. After disolving the residue collected on the filters, inductively coupled plasma atomic emission spectometry(ICP-AES) was used to quantitatively determine the three elements of interest.

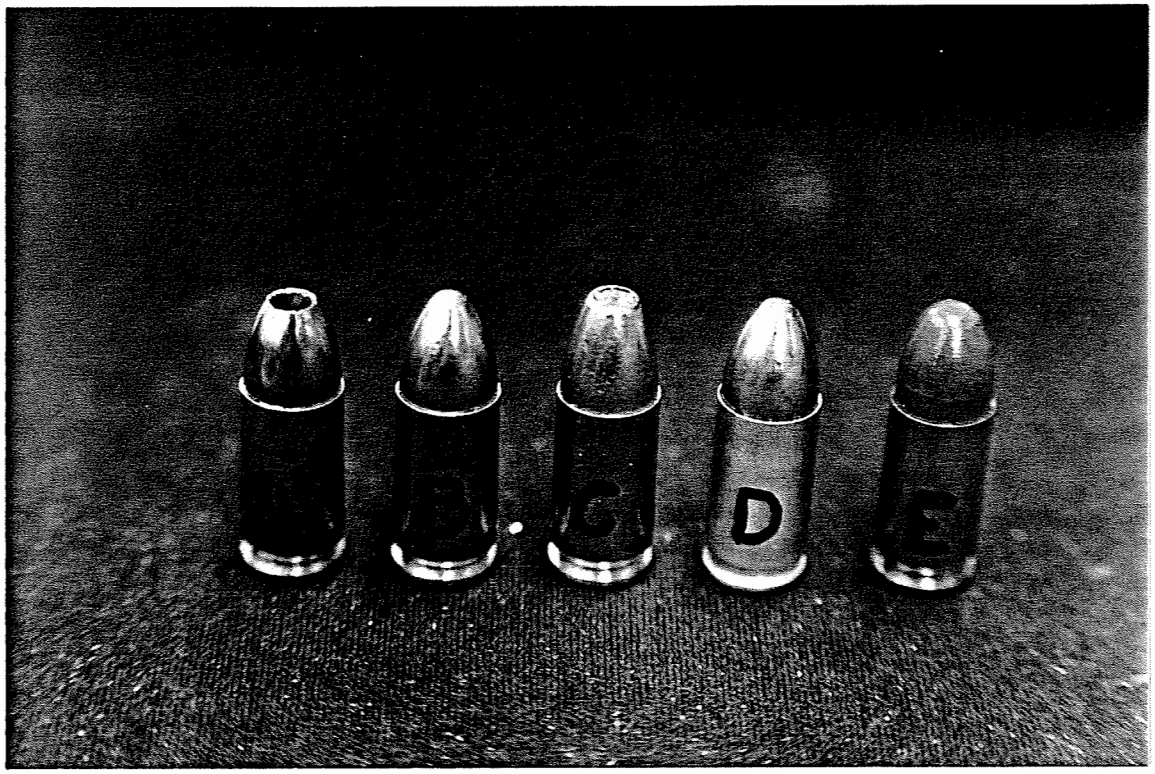
6) **RESULTS**

6.1 - Figure 1 provides a photographic record of the two calibres of ammunition examined.
6.2 - Table A provides a listing of the ammunition, the sampling position at the collector box and the pump and filter number corresponding to the sampling position. In each case the same pump was employed at the same position on the box. This practice was altered slightly when one of the sampling pumps began to show signs of a deteriorating battery and a new pump had to be used.

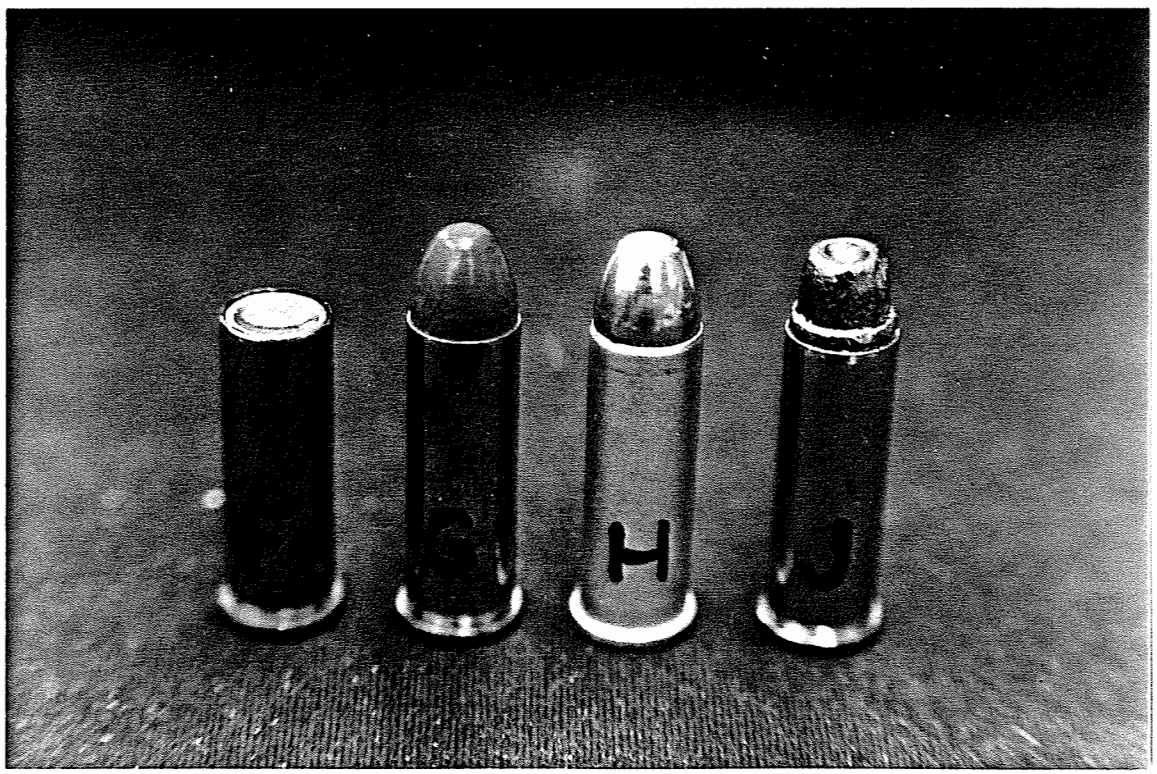
6.3 - Table B provides data relative to the actual amounts of metals (i.e. - lead, barium and antimony) found on each filter medium. In this table a correlation is provided between the filter, the particular test, the ammunition sample and the sampling position.
6.4 - Table C is a summary of the data shown in Table B and provides a total amount of lead, barium and antimony determined for each type of ammunition. These data are obtained through calculating the average of 16 filter analyses results from each separate type of ammunition examined.
6.5 - Table D provides the individual filter data as received from the laboratory. Due to background levels when looking for lead and antimony any data under 10 and 15 micrograms respectively were not listed. Instead the data indicates <10µg or <15µg. Such was not the case with data relative to barium where very low amounts are indicated.
6.6 - Table E - sets forth a comparison of the metal emission from the various types of ammunition in a bar graph. This same comparison is shown again in Table F using a scale that allows the lower end of the emissions to be compared to each other. In Table F the "Y" axis has been broken to allow for a proper numerical representation of the lead found present with ammunition Type "J".
6.7 - Table G merely provides a single page comparison in bar graphs, of each element shown relative to the ammunition from which they were emitted. In these graphs they are shown in ascending order of measurement.

7) **REMARKS**

7.1 - It is interesting to note that at a glance (Table F) ammunition type B - C - D - and F are the ones producing the lowest emissions of all three metal. In looking at the actual ammunition it is seen that of these four types three represent calibre .38 Special while a fourth is 9mm calibre. All four are manufactured by the same company. The next closest in terms of low emissions is Type "H" which again is manufactured by the same company that produces types B,C,D & F .
7.2 - Although the lead emissions from the frangible bullets E and G are low, they are greater in comparison to B,C,D & F and both the antimony and the barium shows significantly higher levels
7.3 - It should be noted that the data provided in the accompanying Tables are for comparison purposes between the different types of ammunition only. They represent an average ten minute sampling of the emissions produced from the firing of ten rounds of a particular type of ammunition and should not be taken as a specific emission figure for any one type of ammunition.



9mm



38 Special

FIGURE 1 - Ammunition

TABLE A

Pump, Filter and Sampling Position Reference

Test #	Ammo Sample	Sampling Position	Filter #	Pump #	Test #	Ammo Sample	Sampling Position	Filter #	Pump #	Test #	Ammo Sample	Sampling Position	Filter #	Pump #
1	A	W	033	3	2	C	W	068	3	3	E	W	104	3
1	A	X	087	2	2	C	X	074	4	3	E	X	137	4
1	A	Y	106	1	2	C	Y	029	1	3	E	Y	126	1
1	A	Z	028	5	2	C	Z	041	5	3	E	Z	141	5
2	A	W	091	3	3	C	W	108	3	4	E	W	102	3
2	A	X	092	2	3	C	X	139	4	4	E	X	111	4
2	A	Y	077	1	3	C	Y	070	1	4	E	Y	103	1
2	A	Z	084	5	3	C	Z	061	5	4	E	Z	115	5
3	A	W	039	3	4	C	W	094	3	1	F	W	059	3
3	A	X	121	2	4	C	X	049	4	1	F	X	001	2
3	A	Y	088	1	4	C	Y	043	1	1	F	Y	016	1
3	A	Z	058	5	4	C	Z	114	5	1	F	Z	144	5
4	A	W	117	3	1	D	W	109	3	2	F	W	040	3
4	A	X	063	2	1	D	X	122	4	2	F	X	067	2
4	A	Y	013	1	1	D	Y	124	1	2	F	Y	021	1
4	A	Z	034	5	1	D	Z	123	5	2	F	Z	012	5
1	B	W	030	3	2	D	W	100	3	3	F	W	149	3
1	B	X	125	4	2	D	X	097	4	3	F	X	095	2
1	B	Y	045	1	2	D	Y	133	1	3	F	Y	014	1
1	B	Z	007	5	2	D	Z	113	5	3	F	Z	145	5
2	B	W	135	3	3	D	W	129	3	4	F	W	127	3
2	B	X	116	4	3	D	X	071	4	4	F	X	134	2
2	B	Y	052	1	3	D	Y	065	1	4	F	Y	044	1
2	B	Z	047	5	3	D	Z	118	5	4	F	Z	032	5
3	B	W	017	3	4	D	W	090	3	1	G	W	073	3
3	B	X	038	4	4	D	X	086	4	1	G	X	083	2
3	B	Y	119	1	4	D	Y	112	1	1	G	Y	020	1
3	B	Z	080	5	4	D	Z	132	5	1	G	Z	081	5
4	B	W	089	3	1	E	W	138	3	2	G	W	136	3
4	B	X	072	4	1	E	X	107	4	2	G	X	015	2
4	B	Y	093	1	1	E	Y	131	1	2	G	Y	027	1
4	B	Z	025	5	1	E	Z	105	5	2	G	Z	002	5
1	C	W	120	3	2	E	W	130	3	3	G	W	082	3
1	C	X	078	4	2	E	X	110	4	3	G	X	026	2
1	C	Y	004	1	2	E	Y	101	1	3	G	Y	035	1
1	C	Z	057	5	2	E	Z	148	5	3	G	Z	079	5

TABLE A

Pump, Filter and Sampling Position Reference

Test #	Ammo Sample	Sampling Position	Filter #	Pump #	Test #	Ammo Sample	Sampling Position	Filter #	Pump #	Test #	Ammo Sample	Sampling Position	Filter #	Pump #
4	G	W	053	3	4	H	W	037	3	4	J	W	005	4
4	G	X	128	2	4	H	X	050	2	4	J	X	060	2
4	G	Y	010	1	4	H	Y	024	1	4	J	Y	140	1
4	G	Z	085	5	4	H	Z	019	5	4	J	Z	142	5
1	H	W	011	3	1	J	W	031	4	n/a	n/a	blank	099	
1	H	X	076	2	1	J	X	146	2	n/a	n/a	blank	036	
1	H	Y	075	1	1	J	Y	062	1	n/a	n/a	blank	008	
1	H	Z	042	5	1	J	Z	056	5	n/a	n/a	blank	147	
										n/a	n/a	blank	066	
2	H	W	022	3	2	J	W	018	4	n/a	n/a	blank	069	
2	H	X	046	2	2	J	X	143	2					
2	H	Y	098	1	2	J	Y	054	1					
2	H	Z	055	5	2	J	Z	150	5					
3	H	W	023	3	3	J	W	096	4					
3	H	X	009	2	3	J	X	006	2					
3	H	Y	048	1	3	J	Y	051	1					
3	H	Z	003	5	3	J	Z	064	5					

TABLE B

Determined Levels of
Barium, Lead and Antimony

Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug	Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug
1	A	W	033	951.6	320.7	216.8	1	C	W	120	<10	5.0	<15
1	A	X	087	940.6	319.5	242.7	1	C	X	078	<10	3.1	<15
1	A	Y	106	913.8	320.8	204.6	1	C	Y	004	<10	3.1	<15
1	A	Z	028	860.1	318.2	209.3	1	C	Z	057	<10	3.8	<15
				916.5	**319.8**	**218.4**					**<10**	**3.8**	**<15**
2	A	W	091	622.2	270.2	154.0	2	C	W	068	<10	3.8	<15
2	A	X	092	893.7	316.8	199.9	2	C	X	074	<10	2.6	<15
2	A	Y	077	917.8	317.5	179.3	2	C	Y	029	<10	2.9	<15
2	A	Z	084	550.4	252.0	120.9	2	C	Z	041	<10	3.4	<15
				746.0	**289.1**	**163.5**					**<10**	**3.2**	**<15**
3	A	W	039	666.6	286.3	164.6	3	C	W	108	<10	3.8	<15
3	A	X	121	953.7	320.3	240.4	3	C	X	139	<10	2.5	<15
3	A	Y	088	1092.0	317.9	264.1	3	C	Y	070	<10	3.1	<15
3	A	Z	058	837.9	315.2	211.4	3	C	Z	061	<10	2.9	<15
				887.6	**309.9**	**220.1**					**<10**	**3.1**	**<15**
4	A	W	117	850.1	317.5	217.5	4	C	W	094	<10	4.1	<15
4	A	X	063	756.4	302.8	183.4	4	C	X	049	<10	2.7	<15
4	A	Y	013	648.2	277.0	159.6	4	C	Y	043	<10	2.8	<15
4	A	Z	034	645.9	282.6	157.7	4	C	Z	114	<10	4.0	<15
				725.2	**295.0**	**179.6**					**<10**	**3.4**	**<15**
	"A"			***818.8***	***303.5***	***195.4***		**"C"**			***<10***	***3.3***	***<15***
1	B	W	030	<10	5.8	<15	1	D	W	109	38.1	33.5	<15
1	B	X	125	<10	4.5	<15	1	D	X	122	24.1	24.2	<15
1	B	Y	045	<10	4.9	<15	1	D	Y	124	22.4	22.9	<15
1	B	Z	007	<10	6.1	<15	1	D	Z	123	37.8	32.2	<15
				<10	**5.3**	**<15**					**30.6**	**28.2**	**<15**
2	B	W	135	17.8	4.9	<15	2	D	W	100	28.7	16.6	<15
2	B	X	116	<10	4.8	<15	2	D	X	097	20.5	11.8	<15
2	B	Y	052	<10	4.2	<15	2	D	Y	133	15.7	11.4	<15
2	B	Z	047	<10	4.2	<15	2	D	Z	113	27.1	14.9	<15
				<10	**4.5**	**<15**					**23.0**	**13.7**	**<15**
3	B	W	017	<10	4.7	<15	3	D	W	129	11.9	7.9	<15
3	B	X	038	<10	2.8	<15	3	D	X	071	<10	5.2	<15
3	B	Y	119	<10	4.2	<15	3	D	Y	065	<10	6.4	<15
3	B	Z	080	<10	3.8	<15	3	D	Z	118	14.0	8.3	<15
				<10	**3.9**	**<15**					**<11.5**	**7.0**	**<15**

TABLE B

Determined Levels of
Barium, Lead and Antimony

Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug	Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug
4	B	W	089	<10	5.8	<15	4	D	W	090	13.3	6.7	<15
4	B	X	072	<10	3.5	<15	4	D	X	086	<10	5.7	<15
4	B	Y	093	<10	4.1	<15	4	D	Y	112	<10	6.0	<15
4	B	Z	025	<10	3.9	<15	4	D	Z	132	11.5	5.9	<15
				<10	**4.3**	**<15**					**<11.2**	**6.1**	**<15**
	"B"			***<10***	***4.5***	***<15***		**"D"**			***<19.1***	***13.8***	***<15***
1	E	W	138	71.6	322.5	331.8	1	G	W	073	33.8	316.3	426.3
1	E	X	107	54.0	318.1	346.4	1	G	X	083	17.1	252.8	269.5
1	E	Y	131	52.9	317.3	274.5	1	G	Y	020	24.6	260.6	284.6
1	E	Z	105	67.0	320.9	329.9	1	G	Z	081	31.6	295.8	337.5
				61.4	**319.7**	**320.7**					**26.8**	**281.4**	**329.5**
2	E	W	130	37.7	324.5	349.5	2	G	W	136	50.7	323.6	383.6
2	E	X	110	26.4	320.4	394.5	2	G	X	015	18.8	247.3	255.7
2	E	Y	101	28.8	320.9	376.1	2	G	Y	027	20.0	255.0	275.7
2	E	Z	148	40.7	324.1	352.7	2	G	Z	002	33.4	300.5	334.6
				33.4	**322.5**	**368.2**					**30.7**	**281.6**	**312.4**
3	E	W	104	22.2	320.7	332.0	3	G	W	082	21.8	306.8	328.3
3	E	X	137	26.2	315.7	334.1	3	G	X	026	12.7	257.2	270.9
3	E	Y	126	11.2	313.9	267.7	3	G	Y	035	10.9	264.4	265.7
3	E	Z	141	19.0	322.3	320.9	3	G	Z	079	17.5	297.8	283.1
				19.7	**318.2**	**313.7**					**15.7**	**281.6**	**287.0**
4	E	W	102	36.0	314.2	283.7	4	G	W	053	15.9	300.9	336.7
4	E	X	111	46.8	294.6	276.5	4	G	X	128	<10	258.3	209.7
4	E	Y	103	21.2	298.7	280.3	4	G	Y	010	<10	272.8	282.9
4	E	Z	115	27.0	309.6	303.0	4	G	Z	085	11.5	303.6	331.0
				32.8	**304.3**	**285.9**					**13.7**	**283.9**	**290.1**
	"E"			***36.8***	***316.2***	***322.1***		**"G"**			***21.7***	***282.1***	***304.7***
1	F	W	059	<10	8.2	<15	1	H	W	011	61.2	71.5	28.2
1	F	X	001	<10	4.5	<15	1	H	X	076	47.5	48.2	22.2
1	F	Y	016	<10	4.0	<15	1	H	Y	075	55.4	54.4	22.0
1	F	Z	144	<10	6.6	<15	1	H	Z	042	67.4	72.5	29.3
				<10	**5.8**	**<15**					**57.9**	**61.7**	**25.4**
2	F	W	040	<10	6.1	<15	2	H	W	022	83.4	50.4	19.2
2	F	X	067	<10	4.0	<15	2	H	X	046	64.9	30.9	<15
2	F	Y	021	<10	4.3	<15	2	H	Y	098	63.0	33.6	<15
2	F	Z	012	<10	5.9	<15	2	H	Z	055	83.4	48.5	17.6
				<10	**5.1**	**<15**							

TABLE B

Determined Levels of
Barium, Lead and Antimony

Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug	Test #	Ammo Sample	Sampling Position	Filter #	Pb ug	Ba ug	Sb ug
3	F	W	149	<10	6.9	<15	3	H	W	023	74.6	31.2	<15
3	F	X	095	<10	4.6	<15	3	H	X	009	48.3	17.7	<15
3	F	Y	014	<10	4.3	<15	3	H	Y	048	56.7	19.7	<15
3	F	Z	145	<10	5.4	<15	3	H	Z	003	74.7	31.5	<15
				<10	**5.3**	**<15**					**63.6**	**25.0**	**<15**
4	F	W	127	<10	6.0	<15	4	H	W	037	48.2	18.2	<15
4	F	X	134	<10	3.3	<15	4	H	X	050	35.5	11.9	<15
4	F	Y	044	<10	4.2	<15	4	H	Y	024	38.9	12.5	<15
4	F	Z	032	<10	6.2	<15	4	H	Z	019	59.2	18.2	<15
				<10	**4.9**	**<15**					**45.5**	**15.2**	**<15**
	"F"			***<10***	***5.3***	***<15***		**"H"**			***60.2***	***35.7***	***<15***
1	J	W	031	damaged		filter							
1	J	X	146	12340.0	280.9	211.8							
1	J	Y	062	7955.0	236.1	172.4	N/A	N/A	*blank*	147	<10	0.0	<15
1	J	Z	056	10860.0	285.6	231.4							
				10385.0	**267.5**	**205.2**	N/A	N/A	*filter*	066	<10	0.0	<15
2	J	W	018	8799.0	292.3	259.9	N/A	N/A	*directly*	069	<10	0.0	<15
2	J	X	143	12490.0	254.6	229.8							
2	J	Y	054	11410.0	266.3	263.3	N/A	N/A	*from*	099	<10	0.0	<15
2	J	Z	150	15280.0	298.4	322.8							
				11995.0	**277.9**	**269.0**	N/A	N/A	*factory*	036	<10	0.0	<15
3	J	W	096	14520.0	293.2	322.7	N/A	N/A	*container*	008	<10	0.0	<15
3	J	X	006	9988.0	216.3	241.9							
3	J	Y	051	11960.0	244.6	241.0							
3	J	Z	064	11920.0	278.2	310.9							
				12097.0	**258.1**	**279.1**							
4	J	W	005	12040.0	287.7	333.7							
4	J	X	060	9171.0	209.2	238.7							
4	J	Y	140	11500.0	261.0	282.1							
4	J	Z	142	10980.0	288.4	318.7							
				10923.0	**261.6**	**293.3**							
	"J"			***11350.0***	***266.3***	***261.7***							

TABLE C

Total Measured Metals

Ammo	Total amount of matter on filter		
Sample	Pb (ug)	Ba (ug)	Sb (ug)
A	818.8	303.5	195.4
B	<10	4.5	<15
C	<10	3.3	<15
D	20.0	6.1	<15
E	36.8	316.2	322.1
F	<10	5.3	<15
G	21.7	282.1	304.7
H	60.2	35.7	<15
J	11350.0	266.3	261.7

TABLE D
FILTER ANALYSES

Filter	Total material on filter			Filter	Total material on filter		
#	Pb	Ba	Sb	#	Pb	Ba	Sb
	(ug)	(ug)	(ug)		(ug)	(ug)	(ug)
001	<10	4.5	<15	039	666.6	286.3	164.6
002	33.4	300.5	334.6	040	<10	6.1	<15
003	74.7	31.5	<15	041	<10	3.4	<15
004	<10	3.1	<15	042	67.4	72.5	29.3
005	12040.0	287.7	333.7	043	<10	2.8	<15
006	9988.0	216.3	241.9	044	<10	4.2	<15
007	<10	6.1	<15	045	<10	4.9	<15
008	<10	0.0	<15	046	64.9	30.9	<15
009	48.3	17.7	<15	047	<10	4.2	<15
010	<10	272.8	282.9	048	56.7	19.7	<15
011	61.2	71.5	28.2	049	<10	2.7	<15
012	<10	5.9	<15	050	35.5	11.9	<15
013	648.2	277.0	159.6	051	11960.0	244.6	241.0
014	<10	4.3	<15	052	<10	4.2	<15
015	18.8	247.3	255.7	053	15.9	300.9	336.7
016	<10	4.0	<15	054	11410.0	266.3	263.3
017	<10	4.7	<15	055	83.4	48.5	17.6
018	8799.0	292.3	259.9	056	10860.0	285.6	231.4
019	59.2	18.2	<15	057	<10	3.8	<15
020	24.6	260.6	284.6	058	837.9	315.2	211.4
021	<10	4.3	<15	059	<10	8.2	<15
022	83.4	50.4	19.2	060	9171.0	20.2	238.7
023	74.6	31.2	<15	061	<10	2.9	<15
024	38.9	12.5	<15	062	7955.0	236.1	172.4
025	<10	3.9	<15	063	756.4	302.8	183.4
026	12.7	257.2	270.9	064	11920.0	278.2	310.9
027	20.0	255.0	275.7	065	<10	6.4	<15
028	860.1	318.2	209.3	066	<10	0.0	<15
029	<10	2.9	<15	067	<10	4.0	<15
030	<10	5.8	<15	068	<10	3.8	<15
031 *				069	<10	0.0	<15
032	<10	6.2	<15	070	<10	3.1	<15
033	951.6	320.7	216.8	071	<10	5.2	<15
034	645.9	282.6	2157.7	072	<10	3.5	<15
035	10.9	264.4	265.7	073	33.8	316.3	426.3
036	<10	0.0	<15	074	<10	2.6	<15
037	48.2	18.2	<15	075	55.4	54.4	22.0
038	<10	2.8	<15	076	47.5	48.2	22.2

* - damaged filter, no analysis possible.

TABLE D
FILTER ANALYSES

Filter	Total material on filter			Filter	Total material on filter		
#	Pb	Ba	Sb	#	Pb	Ba	Sb
	(ug)	(ug)	(ug)		(ug)	(ug)	(ug)
077	917.8	317.5	179.3	115	27.0	309.6	303.0
078	<10	3.1	<15	116	<10	4.8	<15
079	17.5	297.8	283.1	117	850.1	317.5	217.5
080	<10	3.8	<15	118	14.0	8.3	<15
081	31.6	295.8	337.5	119	<10	4.2	<15
082	21.8	306.8	328.3	120	<10	5.0	<15
083	17.1	252.8	269.5	121	953.7	320.3	240.4
084	550.4	252.0	120.9	122	24.1	24.2	<15
085	11.5	303.6	331.0	123	37.8	32.2	<15
086	<10	5.7	<15	124	22.4	22.9	<15
087	940.6	319.5	242.7	125	<10	4.5	<15
088	1092.0	317.9	264.1	126	11.2	313.9	267.7
089	<10	5.8	<15	127	<10	6.0	<15
090	13.3	6.7	<15	128	<10	258.3	209.7
091	622.2	270.2	154.0	129	11.9	7.9	<15
092	893.7	316.8	199.9	130	37.7	324.5	349.5
093	<10	4.1	<15	131	52.9	317.3	274.5
094	<10	4.1	<15	132	11.5	5.9	<15
095	<10	4.6	<15	133	15.7	11.4	<15
096	14520.0	293.2	322.7	134	<10	3.3	<15
097	20.5	11.8	<15	135	17.8	4.9	<15
098	63.0	33.6	<15	136	50.7	323.6	383.6
099	<10	0.0	<15	137	26.2	315.7	334.1
100	28.7	16.6	<15	138	71.6	322.5	331.8
101	28.8	320.9	376.1	139	<10	2.5	<15
102	36.0	314.2	283.7	140	11500.0	261.0	282.1
103	21.2	298.7	280.3	141	19.0	322.3	320.9
104	22.2	320.7	332.0	142	10980.0	288.4	318.7
105	67.0	320.9	329.9	143	12490.0	254.6	229.8
106	913.8	320.8	204.6	144	<10	6.6	<15
107	54.0	318.1	346.4	145	<10	5.4	<15
108	<10	3.8	<15	146	12340.0	280.9	211.8
109	38.1	33.5	<15	147	<10	0.0	<15
110	26.4	320.4	394.5	148	40.7	3324.1	352.7
111	46.8	294.6	276.5	149	<10	6.9	<15
112	<10	6.0	<15	150	15280.0	298.4	322.8
113	27.1	14.9	<15				
114	<10	4.0	<15				

* - damaged filter, no analysis possible.

TABLE F - Comparison of metal emission from different ammunition