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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 78-22

U.S. POSTAL SERVICE
INDOOR FIRING RANGES
MANAGEMENT SECTIONAL CENTER
MERRIFIELD, VIRGINIA

A STUDY OF THE EFFECTIVENESS OF COPPER JACKETED AMMUNITION IN LOWERING LEAD EXPOSURES IN INDOOR FIRING RANGES

AUGUST 1978

Study Requested By:
Chief Postal Inspector
Washington, D.C.

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16. Abstract (Limit: 200 words)

Air sampling for lead exposures was recently conducted on two surveys in Ranges A and B at the U.S. Postal Service, Management Sectional Center, Merrifield, VA. The purpose of the studies was to determine whether the use of cartridges containing copper jacketed slugs would lower air lead levels in the ranges to acceptable levels. For the latter of the two surveys (the better controlled), the air lead levels in Range A varied from 0.18 to 0.69 mg/M^3 with a mean of 0.34 mg/M^3 for the copper jacketed cartridges, and varied from 0.33 to 1.02 mg/M^3 with a mean of 0.55 mg/M^3 for the lead wadcutter cartridges. The air lead levels in Range B varied from 1.30 to 1.90 mg/M^3 with a mean of 1.50 mg/M^3 for the copper jacketed cartridges, and varied from 0.84 to 2.20 mg/M^3 with a mean of 1.30 mg/M^3 for the lead wadcutter cartridges. An explanation for the differences in the jacketed-wadcutter comparisons was not clearly evident. At any rate, even with the use of cartridges containing copper jacketed slugs (and primers containing lead) a significant lead exposure hazard exists in the ranges, particularly to the range masters. Therefore, it is recommended that the Postal Service continue with their plans and efforts to install new ventilation systems within the ranges. A properly designed and installed ventilation system will lower the air lead levels to acceptable concentrations.

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I. SUMMARY

Air sampling for lead exposures was recently conducted on two surveys in Ranges A and B at the U.S. Postal Service, Management Sectional Center, Merrifield, Virginia. The purpose of the studies was to determine whether the use of cartridges containing copper jacketed slugs would lower air lead levels in the ranges to acceptable levels. For the latter of the two surveys (the better controlled), the air lead levels in Range A varied from 0.18 to 0.69 mg/M^3 with a mean of 0.34 mg/M^3 for the copper jacketed cartridges, and varied from 0.33 to 1.02 mg/M^3 with a mean of 0.55 mg/M^3 for the lead wadcutter cartridges. The air lead levels in Range B varied from 1.30 to 1.90 mg/M^3 with a mean of 1.50 mg/M^3 for the copper jacketed cartridges, and varied from 0.84 to 2.20 mg/M^3 with a mean of 1.30 mg/M^3 for the lead wadcutter cartridges. An explanation for the differences in the jacketed-wadcutter comparisons was not clearly evident. At any rate, even with the use of cartridges containing copper jacketed slugs (and primers containing lead) a significant lead exposure hazard exists in the ranges, particularly to the range masters. Therefore, it is recommended that the Postal Service continue with their plans and efforts to install new ventilation systems within the ranges. A properly designed, and installed, ventilation system will lower the air lead levels to acceptable concentrations.

II. INTRODUCTION

At the request of the Chief Postal Inspector, the National Institute for Occupational Safety and Health (NIOSH) recently conducted surveys for lead exposures at the Merrifield, Virginia, indoor firing ranges. The U.S. Army Environmental Hygiene Agency had conducted air sampling in these ranges on April 2, 1976, and May 27, 1976, and for 12 air samples found air concentrations of lead which ranged from 0.13 mg/M^3 to 0.73 mg/M^3 with a mean value of 0.40 mg/M^3. On the basis of studies conducted by the National Bureau of Standards[1] (NBS), it was felt by the U.S. Postal Service that the use of copper jacketed ammunition might lower the air lead levels within the ranges so that the levels would "not only meet but exceed the 0.20 mg/M^3 standard set by O.S.H.A.". The purpose of the NIOSH study was to determine whether or not the use of copper jacketed ammunition would lower air lead levels in the ranges to acceptable levels.

On February 16-17, 1978, NIOSH conducted an industrial hygiene survey at the Merrifield ranges. On the basis of the air sample data from the February survey, it appeared that the use of the copper jacketed slugs would lower the air lead levels but not by the magnitude suggested by the NBS study. Since several parameters were not controlled during the February survey, NIOSH resurveyed the ranges on March 23-24, 1978, with the intent of obtaining more conclusive data. For the March 23-24 study, all known parameters which could influence the results of the survey, were controlled to the extent feasible. Several of the controlled parameters were:

1. The ranges were cleaned prior to the study (floors scrubbed, walls vacuumed, etc.)

2. All weapons were cleaned prior to each day of shooting.

3. Shooting rates were standardized at about 100 rounds per shooter per hour.

4. The air supplies to the ranges were sampled during shooting to determine whether significant lead levels were present in the makeup air (none were present).

5. Air samples were taken early morning in each range prior to each day's shooting to determine whether significant "residual" air lead levels were present (none were). The ventilation systems were operating during these samples.

III. EVALUATION

A. Description of Facility

The facility as currently being used consists of two shooting ranges ("A" and "B") which are situated end-to-end with a small class room and storage room between the two ranges. The ranges measure approximately 19 feet in width, 16 feet in height, and 100 feet in length. The ranges have a suspended ceiling which lowers the effective ceiling height to about nine feet. Each range has five firing booths equipped with automatic target setters and steel bullet traps.

The ranges have identical ventilation systems. The systems were designed to provide about 6300 cfm of conditioned air.. This air is introduced into the ranges through five ceiling diffusers (grilles - nominal 24" x 24") located about 15 feet up range (behind) the shooters. The design specified an exhaust of 4400 cfm (4 ceiling grilles - nominal 18" x 24") about 11 feet down range of the shooting line and an exhaust of 2400 cfm (4 ceiling grilles - nominal 12" x 24") about 5 feet in front of the bullet traps. The supply air is drawn in to the system through a slotted grille located about 7' above the walking surface of building west-side loading dock. The exhaust air is discharged through grilles located in the front wall of the same loading dock (below the walking surface).

B. Methods and Results

Since it was desired to test the effectiveness of copper jacketed slugs in lowering air lead levels in the two ranges, for each of the two day surveys cartridges with copper jacketed slugs were used on the first day and cartridges with lead wadcutter slugs were used on the second day. All of the individual air sample results for the Feburary 16-17, 1978, survey are presented in Tables 1 thru 4. The individual air sample results for the March 22-23, 1978, survey are presented in Tables 5 thru 8. Since the March 22-23 survey was better controlled (as regards the previously mentioned parameters) a summary of these results is presented on Table 9 along with the results of a statistical test for a difference in the mean air lead levels of the jacketed slugs versus the mean air lead levels of the wadcutter slugs. The results of several air samples taken in the classroom located between the two ranges are presented in Table 10. All of these tables are properly titled and self explanatory.

All air sampling was conducted using 37 mm diameter Millipore Type AA* cellulose membrane filters with an 0.8 micrometer pore size (closed-face three piece plastic field monitoring cassettes). Personal sampling pumps provided air flows of 2.0 liters of air per minute (lpm). The samples were analyzed by conventional aqueous atomic absorption spectroscopy (NIOSH Method P & CAM No. 173). Those samples collected on February 16th and March 23rd were analyzed for copper as well as lead.

On both February 16th and March 23rd, a Sierra Model 441* air velocity meter was used to estimate the volumes of air supplied to, and exhausted from, the ranges. On each date a minimum of 16 readings were taken at each supply and exhaust grille for each of the six ventilation systems. Based on these readings an average air volume was calculated for each of the six ventilation systems. These average air volumes are shown on

* Mention of trade names or commercial products does not constitute endorsement by the National Institute for Occupational Safety and Health.

Table 11 along with "design" volumes. Smoke tube testing showed the ranges to be under a negative pressure with respect to the classroom and the classroom to be under a negative pressure with respect to the rest of the building (these negative pressures are desirable). Smoke tube testing at the shooting positions showed that the air was quite turbulent and that the direction of air flow was not always down range. Although air velocity measurements were taken at the shooting positions, the turbulence and variable direction of air flow preclude the presentation of any meaningful air velocities for the shooting lines. Testing with a smoke bomb showed that there is a potential for a small, probably insignificant, amount of the air which is exhausted from the ranges to be brought back into the ranges through the "outside of the building" air pickups.

C. Environmental Standards

The current U.S. Department of Labor (OSHA) federal standard for occupational exposure to inorganic lead is 0.20 milligrams per cubic meter of air (mg/M^3) for an 8-hour time weighted average daily exposure. NIOSH, in its Criteria for a Recommended Standard for Occupational Exposure to Inorganic Lead (1972) recommended an exposure standard of 0.15 mg/M^3. In October to 1975, OSHA proposed that the federal standard be lowered from 0.20 mg/M^3 to 0.10 mg/M^3. In March of 1977, NIOSH presented testimony in a public hearing supporting the proposed standard of 0.10 mg/M^3. There is therefore, a possibility that the federal standard will be lowered. On this basis it is judged that the proposed standard of 0.10 mg/M^3 is the appropriate criteria for this study.

D. Physiological Effects

Prolonged absorption of lead or its inorganic compounds from inhalation of fume or dust, as well as from oral ingestion can result in severe/ gastrointestinal disturbances and anemia. With serious intoxication, neuromuscular dysfunction may occur, and severe exposure may result in encephalopathy. Presenting symptoms are often weakness, weight loss, lassitude, insomnia, and hypertension. Usually associated with these symptoms is a disturbance of the gastrointestinal tract, which includes constipation, anorexia, and abdominal pain described as colicky. The physical findings, although occurring late, usually consist of facial pallor, malnutrition, abdominal tenderness, and pallor of the eye grounds. The anemia associated with lead poisoning is of the hypochromic, microcytic type with basophilic stippling of the red cells. A lead line may appear on gingival tissues, and in severe cases of poisoning, paralysis of the extensor muscles of the wrist, and less often of the ankles, can occur. Encephalopathy while common in children is unusual in adults.[2]

Nephropathy can also result from prolonged exposure to lead or its inorganic compounds. There may be a progressive and irreversible loss of kidney function, with progressive azotemia, and occasionally hyperuricemia with or without gout. Lead is teratogenic in mammalian animals so it is advised that exposure of women, in the child bearing age, to lead be carefully monitored.

Health information related to lead suggests that blood lead levels in individual workers should be kept at values less than 60 micrograms of lead per deciliter of whole blood (µg/dl). It should be noted that persons with anemia or sickle cell trait may be at increased risk from exposure to lead. NIOSH considers blood lead levels of 0 to 40 µg/dl to be in the normal range; levels of 40 to 60 µg/dl to be in the increased absorption range; and levels above 60 µg/dl to be unacceptable.

E. Discussion

The results of this study are not remarkable in that the degree to which the use of copper jacketed slugs will reduce lead exposures in indoor firing ranges, if any, was not conclusively determined. Further, the March 23-24, 1978 study in Range B yielded results indicating that the mean air lead levels for the copper jacketed cartridges were significantly higher than the mean air lead level for the lead wadcutters, by statistical analysis. For Range A of the same study, the reverse was true, that is, the lead wadcutter cartridges yielded higher air lead levels than did the cartridges with the copper jacketed slugs. The data, and possible reasons for the inconsistent results, were carefully studied by several persons, including two board certified industrial hygienists who are also professional engineers. The reason for the reciprocal results has not become apparent. An analysis of two primers indicated that the primer mix for a jacketed cartridge contained 3.58 mg of lead while the primer mix for a wadcutter cartridge contained 3.43 mg of lead (the manufacturers provided similar data). The primer mixes for the two cartridges were then quite comparable as regards lead content.

For the National Bureau of Standards study[1], the weapon was fired in an aluminum box of 80 liters volume. The lid of the box was fitted with a 0.8 micrometer Millipore aerosol filter for air sampling purposes. This air sampling port was located above and in front of the gun muzzle. A hole was provided in the front of the box for the bullet to exit. Since the NBS study was done under artificial conditions which were not similar to those found in a shooting range, it is not surprising the NBS study results are different from those found in real life conditions. That is, an air sample drawn out of the NBS closed box is not the same as a personal sample drawn from the breathing zone of an actual shooter.

The results of Table 9 show that the air lead levels in Range B were higher than those in Range A. The underlying reason for these higher levels was undoubtedly related to air turbulence and flow patterns. The suspended ceiling behind the shooters and above the control desk in Range A had been removed. Possibly, the removal of that portion of the suspended ceiling created a plenum effect, thereby improving the air flow patterns across the shooter. Other explanations for the higher air lead levels in Range B have not been conceived. An unalterable fact is that even with the use of cartridges containing copper jacketed slugs (and primers containing lead) a significant lead hazard exists in the ranges, particularly to the range masters. It is for this reason that the following recommendations are offered.

F. Recommendations

Postal Service Officials should continue with their plans and efforts to install new ventilation systems within the ranges. They are well advised to have a performance criteria written into the purchase contract whereby the new ventilation systems will be guaranteed to provide conditions which will meet the OSHA proposed lead exposure standard of 0.10 mg/M^3. Also, the Postal Service is urged to follow the good work practices as discussed in NIOSH Publication 76-130 "Lead Exposure and Design Considerations for Indoor Firing Ranges".[3]

IV. REFERENCES

1. Juhasz, A.A. The Reduction of Airborne Lead in Indoor Firing Ranges by Using Modified Ammunition. NBS Special Publication 480-26. November 1977.

2. Carl Zenz, Editor. Occupational Medicine - Principles and Practical Applications (Chicago; Year Book Publishers, Inc.) 1975.

3. Anania, T.L. and J.A. Seta. Lead Exposure and Design Considerations for Indoor Firing Ranges. HEW Publication No. (NIOSH) 76-130. December 1975.

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Table 1

Results of Air Samples for Lead and Copper
Range "A" - Copper Jacketed Slugs*

February 16, 1978

U.S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)	Copper (mg/M^3)
0847-1054	Personal	Shooter, Lane 1, 120 rounds	0.51	0.04
0845-1054	Personal	Shooter, Lane 2, 120 rounds	0.47	0.03
0845-1054	Personal	Shooter, Lane 4, 120 rounds	0.25	0.02
0846-1054	Personal	Shooter, Lane 5, 120 rounds	0.25	0.02
1056-1148	Personal	Shooter, Lane 1, 60 rounds	0.40	0.03
1056-1148	Personal	Shooter, Lane 2, 60 rounds	0.29	0.02
1057-1148	Personal	Shooter, Lane 4, 60 rounds	0.27	0.01
1057-1148	Personal	Shooter, Lane 5, 60 rounds	0.33	0.02
1317-1432	Personal	Shooter, Lane 1, 100 rounds	0.40	0.04
1318-1432	Personal	Shooter, Lane 2, 100 rounds	0.34	0.04
1318-1432	Personal	Shooter, Lane 4, 100 rounds	0.16	0.03
1316-1432	Personal	Shooter, Lane 5, 100 rounds	0.24	0.05
0847-1148	Personal	Range Officer	0.50	0.04
1314-1432	Personal	Range Officer	0.29	0.03
0848-1148	Area	Range Officer's Console	0.81	0.02
1315-1432	Area	Range Officer's Console	0.36	0.03
Current OSHA Standard			0.20	1.00
Proposed OSHA Standard			0.10	

*38 Special 158 grain jacketed soft points

Table 2

Results of Air Samples for Lead and Copper
Range "B" - Copper Jacketed Slugs*

February 16, 1978

U.S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)	Copper (mg/M^3)
1057-1145	Personal	Shooter, Lane 1, 60 rounds	0.52	0.08
1057-1145	Personal	Shooter, Lane 2, 60 rounds	0.34	0.02
1058-1145	Personal	Shooter, Lane 4, 60 rounds	0.57	0.02
1058-1145	Personal	Shooter, Lane 5, 60 rounds	0.31	0.01
1312-1418	Personal	Shooter, Lane 1, 100 rounds	0.72	0.08
1312-1418	Personal	Shooter, Lane 2, 100 rounds	0.73	0.04
1312-1418	Personal	Shooter, Lane 4, 100 rounds	0.98	0.05
1312-1418	Personal	Shooter, Lane 5, 100 rounds	0.75	0.03
1100-1146	Personal	Range Officer	0.85	0.03
1315-1420	Personal	Range Officer	1.20	0.05
1100-1148	Area	Range Officer's Console	0.84	0.02
1315-1420	Area	Range Officer's Console	1.10	0.04
Current OSHA Standard			0.20	1.00
Proposed OSHA Standard			0.10	

*38 Special + P 158 grain jacketed soft points.

Table 3

Results of Air Samples for Lead
Range "A" Lead Wadcutter Slugs*
February 17, 1978

U.S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)
0841-0945	Personal	Shooter, Lane 1, 60 rounds	0.94
0843-0945	Personal	Shooter, Lane 2, 60 rounds	0.76
0842-0945	Personal	Shooter, Lane 4, 60 rounds	0.48
0842-0945	Personal	Shooter, Lane 5, 60 rounds	0.60
0945-1125	Personal	Shooter, Lane 1, 90 rounds	0.65
0945-1125	Personal	Shooter, Lane 2, 90 rounds	0.49
0945-1125	Personal	Shooter, Lane 4, 90 rounds	0.47
0945-1125	Personal	Shooter, Lane 5, 90 rounds	0.28
0843-0946	Personal	Range Officer	0.56
0946-1203	Personal	Range Officer	0.37
1026-1202	Personal	Range Officer	0.43
0841-0947	Area	Range Officer's Console	0.75
0947-1202	Area	Range Officer's Console	0.41
		Current OSHA Standard	0.20
		Proposed OSHA Standard	0.10

*38 Special 148 grain lead wadcutters

Table 4

Results of Air Samples for Lead
Range "B" Lead Wadcutter Slugs*
February 17, 1978

U.S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)
0915-1025	Personal	Shooter, Lane 1, 60 rounds	1.40
0915-1025	Personal	Shooter, Lane 2, 60 rounds	0.62
0916-1025	Personal	Shooter, Lane 4, 60 rounds	0.59
0916-1025	Personal	Shooter, Lane 5, 60 rounds	0.51
1036-1140	Personal	Shooter, Lane 1, 60 rounds	1.72
1037-1140	Personal	Shooter, Lane 2, 60 rounds	0.71
1037-1140	Personal	Shooter, Lane 4, 60 rounds	0.71
1038-1140	Personal	Shooter, Lane 5, 60 rounds	0.68
0918-1026	Personal	Range Officer	0.35
1038-1142	Personal	Range Officer	0.69
0918-1026	Area	Range Officer's Console	1.03
1038-1141	Area	Range Officer's Console	1.03

Current OSHA Standard	0.20
Proposed OSHA Standard	0.10

*38 Special 148 grain lead wadcutter

Table 5

Results of Air Samples for Lead and Copper
Range "A" Copper Jacketed Slugs *
March 23, 1978

U. S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)	Copper (mg/M^3)
0630-0758	Area	Console, Preshooting	N.D.**	N.D.
0631-0757	"	Lane 3, "	N.D.	N.D.
0631-0757	"	At Trap, "	N.D.	N.D.
0834=0930	Personal	Shooter, Lane 1, 100 Rounds	0.57	0.01
0834-0930	"	" " 2, " "	0.69	0.01
0833-0930	"	" " 3, " "	0.22	0.01
0833-0930	"	" " 4, " "	0.24	0.01
0832-0930	"	" " 5, " "	0.25	0.02
0835-0931	"	Range Officer	0.33	0.01
0835-0931	Area	Range Officer's Console	0.25	0.01
0850-0955	"	Air Supply - Outside	N.D.	N.D.
1000-1100	Personal	Shooter, Lane 1, 100 Rounds	0.42	0.01
1000-1100	"	" " 2, "	0.36	0.01
1000-1100	"	" " 3, "	0.18	0.01
1000-1100	"	" " 4, "	0.21	0.02
1000-1100	"	" " 5, "	0.23	0.02
1000-1059	"	Range Officer	0.36	0.01
0959-1059	Area	Range Officer's Console	0.19	0.01
0955-1106	Area	Air Supply - Outside	N.D.	N.D.
1020-1109	"	" " - Inside	N.D.	N.D.
1209-1305	Personal	Shooter, Lane 1, 100 Rounds	0.64	0.01
1209-1305	"	" " 2, "	0.41	0.01
1208-1305	"	" " 3, "	0.21	N.D.
1208-1305	"	" " 4, "	0.20	0.02
1208-1305	"	" " 5, "	0.22	0.02
1210-1307	"	Range Officer	0.34	0.01
1212-1307	Area	" Officer's Console	0.23	0.02
1219-1318	"	Air Supply - Outside	N.D.	N.D.
1211-1307	"	Air Supply - Inside	N.D.	N.D.
Current OSHA Standard			0.20	1.00
Proposed OSHA Standard			0.10	

*38 Special +P 125 grain jacketed hollow point
**N.D. = None Detected

Table 6

Results of Air Samples for Lead and Copper
Range "B" - Copper Jacketed Slugs*

March 23, 1978

U.S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)	Copper (mg/M^3)
0632-0755	Area	Console, Preshooting	N.D.**	N.D.
0632-0755	"	Lane 3, "	N.D.	N.D.
0632-0755	"	At trap, "	N.D.	N.D.
0834-0926	Personal	Shooter, Lane 1, 100 Rounds	1.51	0.05
0823-0926	"	" " 2, "	1.34	0.02
0823-0925	"	" " 3, "	1.53	0.02
0827-0925	"	" " 4, "	1.55	0.03
0829-0925	"	" " 5, "	1.43	0.02
0822-0925	"	Range Officer	1.59	0.02
0821-0925	Area	Range Officer's Console	1.88	0.03
0852-0957	Area	Air Supply - Outside	N.D.	N.D.
1003-1054	Personal	Shooter, Lane 1, 100 Rounds	1.76	0.06
1005-1054	"	" " 2, "	1.33	0.03
1003-1054	"	" " 3, "	1.47	0.03
1003-1054	"	" " 4, "	1.47	0.04
1003-1054	"	" " 5, "	1.57	0.02
1003-1055	"	Range Officer	1.63	0.03
1004-1055	Area	" Officer's Console	1.96	0.03
0957-1106	Area	Air Supply - Inside	N.D.	N.D.
1025-1113	"	" " Inside	N.D.	N.D.
1213-1256	Personal	Shooter, Lane 1, 100 Rounds	1.86	0.06
1214-1256	"	" " 2, "	1.31	0.02
1214-1256	"	" " 3, "	1.43	0.02
1214-1256	"	" " 4, "	1.31	0.01
1215-1256	"	" " 5, "	1.83	0.02
1214-1259	"	Range Officer	1.33	0.02
1214-1259	Area	" Officer's Console	1.78	0.02
1220-1318	Area	Air Supply, Outside	N.D.	N.D.
1213-1300	"	" " Inside	N.D.	N.D.
Current OSHA Standard			0.20	1.00
Proposed "	"		0.10	

*38 Special +P 125 grain jacketed hollow points
** N.D. = None Detected

Table 7

Results of Air Samples for Lead
Range "A" Lead Wadcutter Slugs*
March 24, 1978

U. S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)
0600-0730	Area	Console, Pre-shooting	N.D.**
0600-0731	"	Lane 3, "	N.D.
0600-0731	"	At Trap, "	N.D.
0834-0929	Personal	Shooter, Lane 1, 100 Rounds	0.34
0833-0929	"	" 2, "	0.37
0832-0929	"	" 3, "	0.33
0832-0930	"	" 4, "	0.55
0832-0931	"	" 5, "	1.02
0835-0931	"	Range Officer	0.39
0834-0931	Area	Range Officer's Console	0.40
0843-0935	Area	Air Supply - Outside	N.D.
0835-0931	"	" " Inside	N.D.
1007-1059	Personal	Shooter, Lane 1, 100 Rounds	0.40
1006-1059	"	" 2 "	0.44
1006-1059	"	" 3 "	0.39
1005-1059	"	" 4 "	0.56
1005-1059	"	" 5 "	1.02
1008-1100	"	Range Officer	0.40
1007-1100	Area	" Officer's Console	0.46
1013-1113	Area	Air Supply - Outside	N.D.
1008-1100	"	Air Supply - Inside	N.D.
1206-1258	Personal	Shooter, Lane 1, 100 Rounds	0.40
1206-1258	"	" " 2, "	0.74
1207-1258	"	" " 3, "	0.44
1207-1258	"	" " 4, "	0.64
1208-1258	"	" " 5, "	0.98
1209-1259	"	Range Officer	0.49
1209-1259	Area	" Officer's Console	0.56
1213-1307	Area	Air Supply - Outside	N.D.
1209-1259	"	" " Inside	N.D.
Current OSHA Standard			0.20
Proposed " "			0.10

*38 Special 148 grain lead wadcutters
**N.D. = None Detected

Table 8

Results of Air Samples for Lead
Range "B" Lead Wadcutter Slugs
March 24, 1978

U. S. Postal Service
Merrifield, Virginia

Time	Sample Type	Description	Lead (mg/M^3)
0559-0730	Area	Console, Preshooting	N.D.
0602-0730	"	Lane 3, "	N.D.
0602-0730	"	At Trap, "	N.D.
0837-0937	Personal	Shooter, Lane 1, 100 Rounds	2.00
0838-0937	"	" " 2, "	1.02
0838-0937	"	" 3, "	1.10
0838-0937	"	" " 4, "	1.10
0838-0937	"	" " 5, "	Lost
0839-0938	"	Range Officer	1.36
0839-0938	Area	Range Officer's Console	1.36
0844-0935	Area	Air Supply - Outside	N.D.
0839-0939	"	Air Supply - Inside	N.D.
1006-1100	Personal	Shooter, Lane 1, 100 Rounds	2.22
1006-1100	"	" " 2, "	1.02
1006-1100	"	" " 3, "	1.02
1006-1100	"	" " 4, "	1.02
1006-1100	"	" " 5, "	1.11
1008-1101	"	Range Officer	1.23
1008-1101	Area	Range Officer's Console	1.23
1014-1114	Area	Air Supply - Outside	N.D.
1008-1101	"	Air Supply - Inside	N.D.
1209-1300	Personal	Shooter, Lane 1, 100 Rounds	2.06
1209-1300	"	" " 2, "	0.84
1209-1300	"	" " 3, "	0.98
1209-1300	"	" " 4, "	0.98
1209-1300	"	" " 5, "	1.08
1210-1300	"	Range Officer	1.20
1210-1300	Area	" Officer's Console	1.20
1214-1308	Area	Air Supply - Outside	0.03
1210-1300	"	Air Supply - Inside	N.D.
Current OSHA Standard			0.20
Proposed " "			0.10

Table 9

Summary of Personal Air Sample Results for Lead

Ranges "A" and "B"

March 23 - 24, 1978

U. S. Postal Service
Merrifield, Virginia

Date	Range	Cartridge	Number of Samples	Lead (mg/M^3) Mean	Range	S.D.*
3/23/78	A	Jacketed*	18	0.34*	0.18-0.69	.16
3/24/78	A	Wadcutters*	18	0.55*	0.33-1.02	.23
3/23/78	B	Jacketed*	18	1.50*	1.30-1.90	.19
3/24/78	B	Wadcutters*	17	1.30*	0.84-2.20	.41

*Notes:
1. All jacketed cartridges were S & W 38 Special +P 125 grain jacketed hollow point centerfire cartridges
2. All wadcutter cartridges were Remington 38 Special 148 grain lead wadcutter center fire cartridges
3. S.D. = Standard deviation
4. By a two sample t - test: 1) the mean air lead levels for Range A are significantly different ($t=3.19$) at $p<0.05$ with 34 degrees of freedom; and 2) the mean air lead levels for Range B are significantly different ($t = 2.42$) at $p < 0.05$ with 33 degrees of freedom.

Table 10

Results of Fixed Location Air Samples for Lead
Classroom between Ranges "A" and "B"
March 23 - 24, 1978

U. S. Postal Service
Merrifield, Virginia

Date	Time	Lead (mg/M^3)
3-23-78	0830-0928	N.D.
"	1004-1057	N.D.
"	1215-1309	N.D.
3-24-78	0836-0931	N.D.
"	1009-1102	0.05
"	1209-1300	0.05

Note: For all of these samples, the sampler was located on one of the desks near room center.