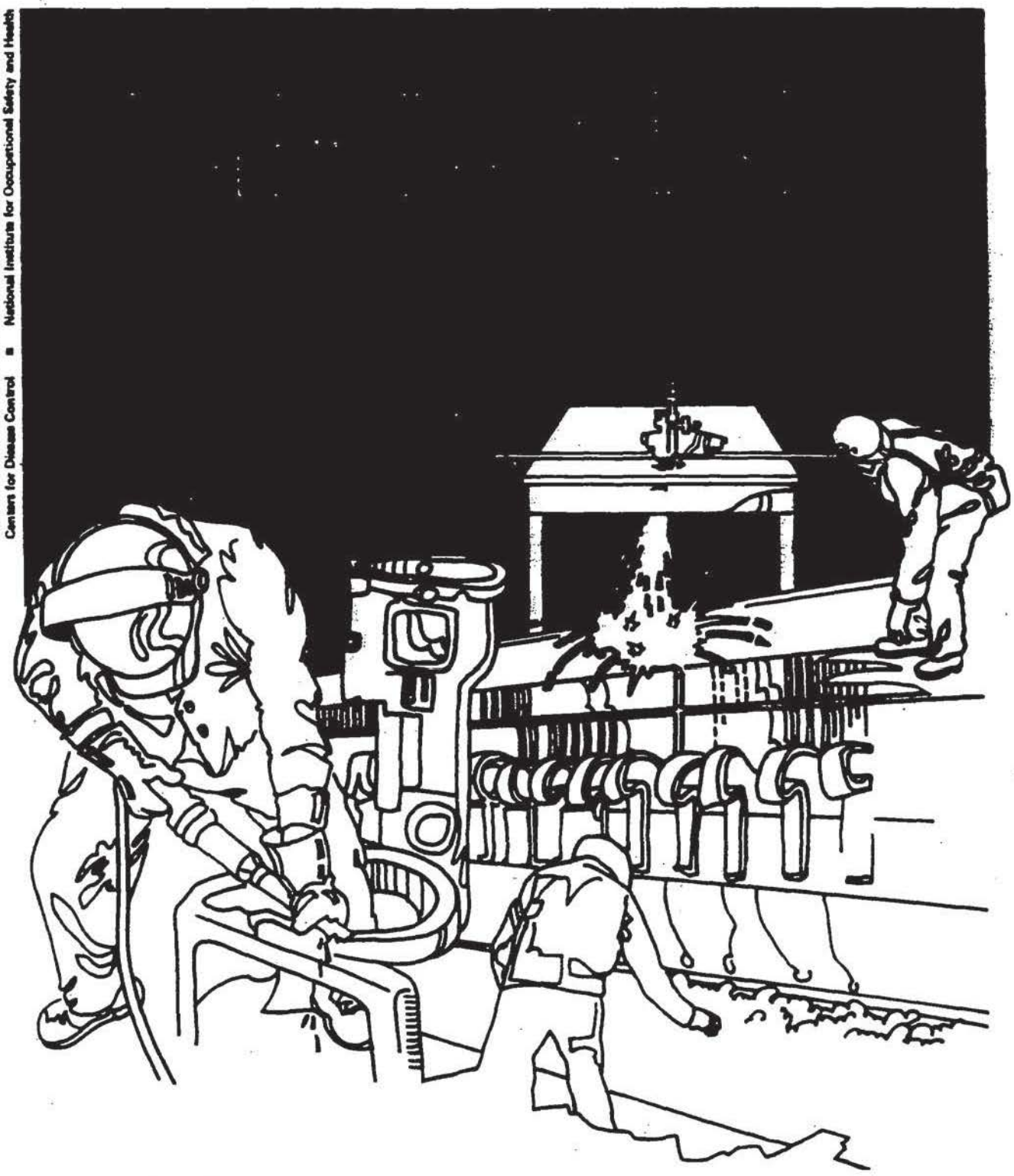
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-195-1200
U.S. SECRET SERVICE
WASHINGTON, D.C.

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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NIOSH INVESTIGATOR:
Steven A. Lee, I.H.

I. SUMMARY

In March 1982, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Safety Division of the U.S. Department of Treasury, Washington, D.C., to evaluate the possible health hazards to U.S. Secret Service officers of exposure to airborne lead during the use of indoor firing ranges.

On May 5, 1982, NIOSH conducted environmental sampling at indoor ranges in Beltsville, Maryland and Washington, D.C. Personal breathing-zone air samples were collected on filters and analyzed for lead and copper by atomic absorption spectroscopy.

Four shooters at the Beltsville range were found to be exposed to airborne lead concentrations ranging from non-detectable to 1500 ug/m^3 with a mean of 720 ug/m^3 during the 25 minute exposures. These levels correspond to 8-hour average lead concentrations ranging from non-detectable to 78 ug/m^3 with a mean of 38 ug/m^3. The OSHA standard is 50 ug/m^3, averaged over an 8-hour work day, 40-hour work week. No lead was detected in the rangemaster's control booth. The excessive lead concentrations were attributed primarily to the atypically high rate of fire of lead bullets in this range. No airborne copper was detected. Although airborne lead exposures exceeded the OSHA standard for two of the officers, ventilation design at the range appeared to be adequate for normal operations. It should also be noted that officers would rarely shoot indoors on a daily basis.

Two officers at the Washington range were exposed to airborne lead concentrations (8-hour TWA) ranging from non-detectable to 18 ug/m^3. One of the shooters was exposed to an 8-hour copper concentration of 3.6 ug/m^3. Although the ventilation design of these ranges was judged fairly poor, shooters were not overexposed to lead, most likely because copper-jacketed bullets were used. No lead or copper was detected in the rangemaster's control booth.

On the basis of the data obtained in this investigation, NIOSH has determined that a potential hazard from overexposure to inorganic lead did exist at the U.S. Secret Service Training Facility at the time of this investigation. Recommendations for limiting the use of lead bullets and improving ventilation are presented in Section VII of this report.

KEYWORDS: SIC 922 (Public Order and Safety) law enforcement, indoor firing range, pistol range, inorganic lead, copper.

II. INTRODUCTION

In March 1982, NIOSH received a request for health hazard evaluations of U.S. Secret Service indoor firing ranges in Washington, D.C. and Beltsville, Maryland. The request was submitted by the Safety Division of the U.S. Department of the Treasury. The requesters were concerned about the possible health hazards to Secret Service officers and range instructors exposed to airborne inorganic lead generated during use of the firing ranges.

III. BACKGROUND

A. Beltsville Ranges

Two firing ranges are located side-by-side at the Beltsville Training Facility in Beltsville, Maryland. Both ranges are about 90 feet long, 8-1/2 feet high, and 50 feet wide.

These ranges are used for training Secret Service officers for proficiency with .38 caliber revolvers, 12 gauge shotguns, and 9 millimeter machine pistols. Both swaged lead and copper jacketed bullets are used in the ranges.

Each range has twelve shooting booths located about 12 feet from the back wall. The range officials' control booths are located separate from the ranges behind viewing windows at the back walls.

An attempt was made to supply air to the ranges uniformly from a porous plenum at the back wall. However, the ceiling tile was more permeable than expected so air was also being supplied from the ceiling behind the shooting booths. Air was exhausted from both the bullet trap and from ceiling exhausts about 15 feet downrange from the shooting booths.

B. Washington, D.C. Ranges

Two firing ranges are located end-to-end at the Washington facility in Washington, D.C. Both ranges are about 80 feet long, 8 feet high, and 22 feet wide. Air is supplied from grills located at each corner of the back walls, and air is exhausted at the bullet traps.

Each range has six shooting booths located about 16 feet from the back wall. The range officials' control booths are located separate from the range behind viewing windows at the back walls.

These ranges are used for mandatory monthly qualification with .38 caliber revolvers. Only copper jacketed bullets are used.

IV. EVALUATION DESIGN AND METHODS

Four personal breathing-zone air samples for lead and copper were taken from shooters at one of the Beltsville ranges and two personal breathing-zone samples were taken from shooters at one of the Washington ranges. Area samples were used to measure airborne lead in the control booths and for checking clearance rates of airborne lead from the firing line after shooting. A total of about 600 copper jacketed bullets and 400 swaged lead bullets were fired in 25 minutes at the Beltsville range. About 300 copper jacketed bullets were fired in 35 minutes at the Washington range.

The samples were collected on mixed cellulose ester filters using battery-powered sampling pumps operating at 2.0 liters per minute. Analysis was by atomic absorption spectroscopy according to NIOSH Method P&CAM 173.

Ventilation measurements were taken with a Kurz Air Velocity Meter, Model 441. A series of three linear air velocity measurements were taken in each shooting booth. Smoke tubes were used for delineating airflow patterns.

V. EVALUATION CRITERIA

Lead

A. Toxicological

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/deciliter whole blood are considered to be normal levels which may result from daily environmental exposure.[1] However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/deciliter. Lead levels between 40-60 ug/deciliter in lead-exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/deciliter represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/deciliter are considered dangerous and often require hospitalization and medical treatment.

The Occupational Safety and Health Administration (OSHA) standard for lead in air is 50 ug/m^3 calculated as an 8-hour time-weighted average for daily exposure.[1] The standard also dictates that workers with blood lead levels greater than 60 ug/deciliter must be immediately removed from further lead exposure and, in some circumstances, workers with lead levels of less than 60 ug/deciliter must also be removed. Removed workers have protection for wage, benefits, and seniority for up to 18 months until their blood levels decline to below 50 ug/deciliter and they can return to lead exposure areas.

VI. RESULTS

A. Beltsville Range

Shooters were exposed to lead at concentrations ranging from non-detectable to 1500 ug/m^3 with a mean of 720 ug/m^3 during the 25 minute exposure (Table I). The corresponding 8-hour TWA concentrations ranged from non-detectable to 78 ug/m^3 with a mean of 38 ug/m^3.

There was no airborne lead detected in the rangemaster's control booth. There were also no detectable lead levels in the air at the firing line within five minutes after shooting stopped. Copper was not detected in any of the personal or area samples.

Ventilation measurements indicated that plenty of air was being supplied to the range. However, it was not being distributed quite as evenly as it should (Table II). Air velocities were generally highest within one to three feet above the floor.

Smoke tube observations indicated that the ventilation system of this range was working better than most of the ranges studied by NIOSH. Very little turbulence was noted and no smoke was seen moving backwards toward the shooters.

B. Washington Range

Two shooters were exposed to lead concentrations of non-detectable and 240 ug/m^3 during the 35 minute exposure (Table III). The corresponding 8-hour TWA concentrations were non-detectable and 18 ug/m^3. One shooter was exposed to copper at an 8-hour TWA concentration of 3.6 ug/m^3.

There was no airborne lead or copper detected in the rangemaster's control booth. Copper was detected at the firing line in one sample at a concentration of 120 ug/m^3 within 5 - 15 minutes after shooting stopped.

Ventilation measurements indicated that plenty of air was also being supplied to these ranges, but like many of the firing ranges studied by NIOSH, the air flow was distributed very poorly (Table IV). Air velocities were generally much higher along the sides of the ranges directly in front of where the air was introduced from the back corners.

When smoke was generated it swirled around with considerable turbulence, often traveling backwards into the shooter's face.

VII. CONCLUSIONS/RECOMMENDATIONS

A. Beltsville Ranges

Two of the four shooters were overexposed to lead at the time of the NIOSH visit. However, engineering representatives for the U.S. General Services Administration who were present during the NIOSH visit pointed out that the design specifications for each range were supposed to limit the rate of fire to about 1500 rounds/hour. Over 2000 rounds/hour were fired while the air samples were taken for this study, therefore, stretching the design limitations by about 25%.

Previous studies by NIOSH have also shown that the use of lead bullets for rapid-fire practice in revolvers dramatically increases the generation of airborne lead. The use of lead bullets should be restricted as much as possible at the Beltsville indoor ranges. From a practical view, the use of the milder-loaded target cartridges should only be necessary for briefly introducing new shooters to the .38 revolver. Even then, however, suitable substitutes for lead bullets are available and they should be considered. These have included bullets comprised of other metals, such as zinc, and lead target bullets jacketed or coated with nylon or copper.

Considering all aspects of this study, the ventilation sytems of these ranges appear to be well designed and no lead hazard to officers should be present during typical use of the ranges with cartridges suitable for indoor shooting. Further improvements could probably be made by replacing the ceiling tile with a more impervious material which should help distribute the air supply more evenly. The porous back wall plenum is a good way of overcoming the disadvantage of only having 12 feet of distance from the back wall to the shooting booths.

Rangemasters and instructors should limit their lead exposure by using the control booths as a means of staying out of the ranges as much as possible.

B. Washington Ranges

Although the ventilation design of these ranges was inferior to that of the Beltsville ranges, shooters were exposed to lead concentrations well below the evaluation criteria. Airborne copper exposure was also well below the 8-hour permissible exposure level of 100 ug/m^3. The most probable reason for these results was that no lead bullets were used during the study, thereby limiting the source of lead emission to the cartridge primer.

Lead bullets should never be used at these ranges unless the ventilation system is redesigned to eliminate the excessive turbulence at the firing line. NIOSH recommends a smooth and evenly distributed flow of air with a linear velocity of 50 - 75 feet per minute across the firing line.[2]

Periodic blood-lead determinations should be conducted, particularly for rangemasters, instructors, firing-range workers, and officers participating in competitive shooting activities requiring frequent practice.

VIII. REFERENCES

1. Occupational Safety and Health Administration. Occupational exposure to lead--final standard. Federal Register 1978 Nov 14:53007.

2. Lead Exposure and Design Considerations for Indoor Firing Ranges, DHHS (NIOSH) Publication No. 76-130, 1975.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by: Steven A. Lee, M.S.
Industrial Hygienist
Industrial Hygiene Section

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By: Pat Lovell
Clerk-Typist
Industrial Hygiene Section

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service

(NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. U.S. Department of Treasury
2. U.S. Secret Service
3. NIOSH, Region III

TABLE I

Sampling Results for Airborne Lead

U.S. Secret Service
Beltsville Training Facility
Beltsville, Maryland
HETA 82-195

May 5, 1982

Location	Sample Type	Cartridges Fired	Sampling Time	Copper Concentration (ug/m^3)	Lead Concentration (ug/m^3)	Lead, 8-Hour TWA (ug/m^3)
Booth 4	Breathing Zone	100 (.38 copper jacketed) 100 (.38 lead wadcutter) 150 (9 mm copper jacketed)	11:15-11:40	N.D.*(<40)	1,200	63
Booth 5	Breathing Zone	100 (.38 copper jacketed) 100 (.38 lead wadcutter)	11:15-11:40	N.D.(<40)	1,500	78
Booth 6	Breathing Zone	50 (.38 copper jacketed) 150 (.38 lead wadcutter) 60 (9 mm copper jacketed)	11:15-11:40	N.D.(<40)	N.D.(<60)	N.D.(<3)
Booth 8	Breathing Zone	100 (.38 copper jacketed) 30 (.38 lead wadcutter)	11:15-11:40	N.D.(<40)	160	8.3
Control Booth	Area	-	10:45-12:00	N.D.(<10)	N.D.(<20)	-
Firing Line (Clearance)	Area	-	11:45-11:55	N.D.(<100)	N.D.(<150)	-
Evaluation Criteria				100 ug/m^3		50 ug/m^3

* N.D. = Non Detected

TABLE II

Ventilation Results,* Air Velocity in Linear Feet Per Minute

U.S. Secret Service
Beltsville Training Facility
Beltsville, Maryland
HETA 82-195

May 5, 1982

	Booth 1	Booth 2	Booth 3	Booth 4	Booth 5	Booth 6	Booth 7	Booth 8	Booth 9	Booth 10	Booth 11	Booth 12
One foot above floor	110	100	130	200	190	130	100	130	100	150	150	130
Three feet above floor	60	80	100	130	120	80	100	100	110	110	120	90
Five feet above floor	60	80	80	50	60	70	70	70	110	100	120	90

* Visual observations via smoke generation indicated that air flow was fairly smooth.

TABLE III

Sampling Results for Airborne Lead

U.S. Secret Service
Washington Firing Range #2
Washington, D.C.
HETA 82-195

May 5, 1982

Location	Sample Type	Cartridges Fired	Sampling Time	Copper Concentration (ug/m^3)	Copper, 8-Hour TWA (ug/m^3)	Lead Concentration (ug/m^3)	Lead, 8-Hour TWA (ug/m^3)
Booth 2	Breathing Zone	200 (.38 copper jacketed)	2:55-3:30	50	3.6	240	18
Booth 4	Breathing Zone	90 (.38 copper jacketed)	2:55-3:30	N.D.(<30)	N.D.(<2)	N.D.(<40)	N.D.(<2)
Firing Line (Clearance)	Area	-	3:35-3:45	120	-	N.D.(<40)	-
Firing Line (Clearance)	Area	-	3:35-3:45	N.D.(<100)	-	N.D.(<150)	-
Control Booth	Area	-	2:50-3:30	N.D.(<25)	-	N.D.(<35)	-
Evaluation Criteria					100 ug/m^3		50 ug/m^3

* N.D. = Non Detected

TABLE IV

Ventilation Results,* Air Velocity in Linear Feet Per Minute

U.S. Secret Service
Washington Firing Range
Washington, D.C.
HETA 82-195

May 5, 1982

RANGE #1

	BOOTH 1	BOOTH 2	BOOTH 3	BOOTH 4	BOOTH 5	BOOTH 6
One Foot Above Floor	150	90	50	40	50	70
Three Feet Above Floor	50	40	30	50	80	100
Five Feet Above Floor	50	100	50	40	90	120

RANGE #2

	BOOTH 1	BOOTH 2	BOOTH 3	BOOTH 4	BOOTH 5	BOOTH 6
One Foot Above Floor	100	50	50	60	30	50
Three Feet Above Floor	120	100	40	50	30	100
Five Feet Above Floor	150	150	50	30	50	100

* Visual observations via smoke generation indicated that the air flow in both ranges was very turbulent