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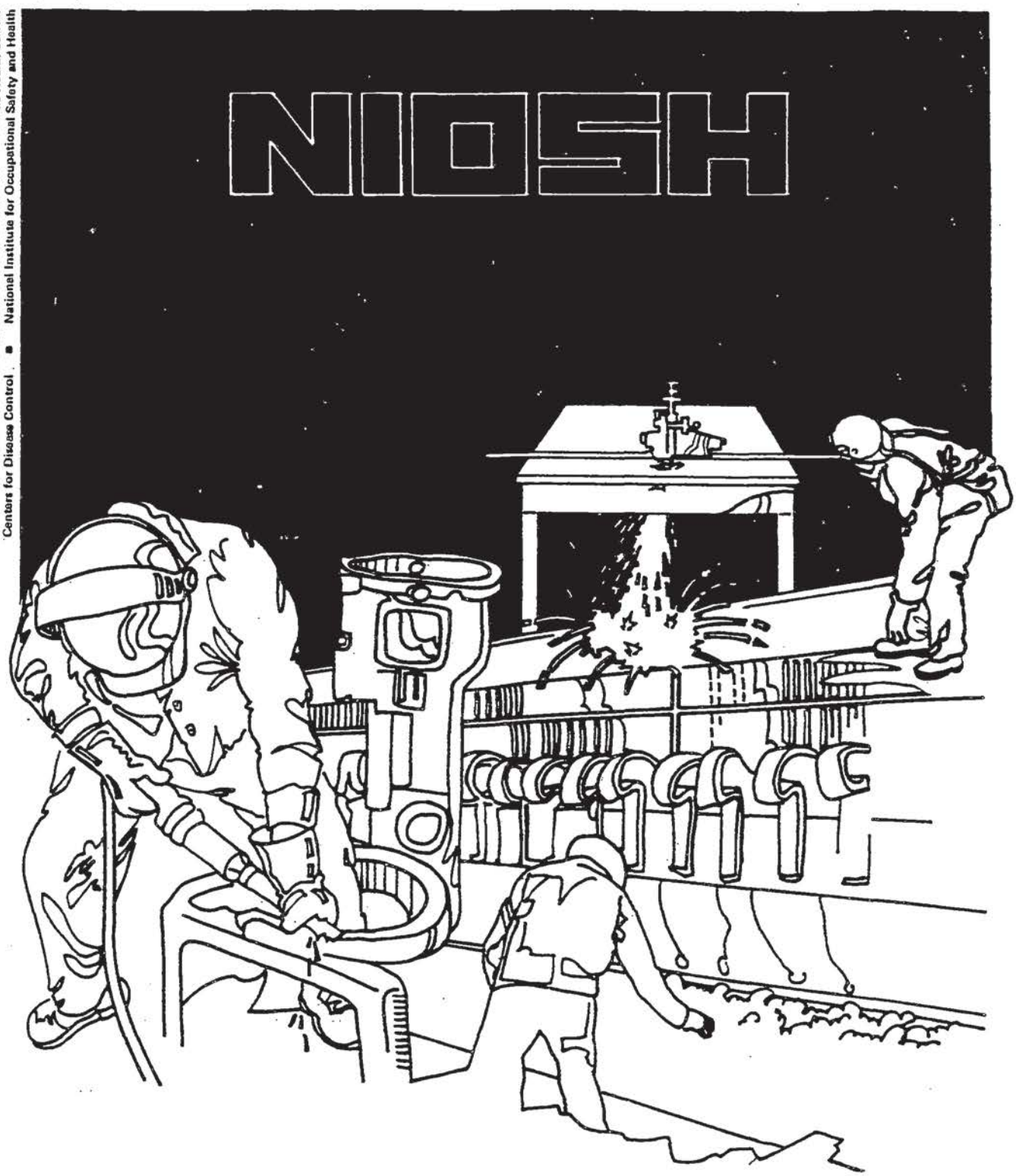

Health Hazard Evaluation Report

HETA 82-095-1297
U.S. POST OFFICE AND
COURTHOUSE BUILDING
CINCINNATI, OHIO

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.

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

HETA 82-095-1297
MAY 1983
U.S. POST OFFICE AND COURTHOUSE BUILDING
CINCINNATI, OHIO

PRINCIPAL INVESTIGATOR:
Kenneth Kronoveter

I. SUMMARY

In January 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate lead exposures to law enforcement officers using the indoor pistol range at the Post Office Building. NIOSH investigators conducted air sampling to determine lead exposures on January 19, 1982, and March 2, 1983. The ventilation systems for the range were evaluated on August 11, 1982.

While using 148-grain wadcutter bullets, two air samples on shooters both showed air lead concentrations of 2100 ug/m^3. While using a mix of wadcutter bullets and 110-grain copper-jacketed controlled expansion bullets (CEB's) two air samples on shooters showed air concentrations of 830 and 1600 ug/m^3. While using only CEB's, 12 air samples on shooters showed air concentrations ranging from 102 to 650 ug/m^3 (mean of 297 ug/m^3). Based on single qualification attempts: 1) Both of the shooters using wadcutter bullets had 8-hour time weighted average (TWA) daily exposures of 67 ug/m^3 as compared to the OSHA 8-hour TWA daily exposure standard of 50 ug/m^3; 2) The two shooters using a mix of wadcutter and CEB's had 8-hour TWA exposures of 76 and 40 ug/m^3; and 3) The 12 shooters using only CEB's had 8-hour TWA exposures ranging from 6 to 18 ug/m^3 (mean of 12 ug/m^3).

The range master had an 8-hour TWA exposure of 220 ug/m^3 while 7 shooters (16 qualification attempts) used wadcutter and CEB ammunition. The range master had an 8-hour TWA of <3 ug/m^3 while 4 shooters (4 qualification attempts) used CEB's.

The ventilation survey showed a downrange air velocity of approximately 50 fpm across the two shooters (the two outer booths were sealed off). However, the air at the shooting booths was turbulent, thus negating effective control of lead exposures.

It is concluded that use of wadcutter ammunition will produce lead exposures greater than the OSHA standard --- even with single daily qualification attempts. Use of copper-jacketed controlled expansion bullets would allow the range to be used on a restricted basis --- with resultant lead exposures being significantly less than the OSHA standard. Further details and recommendations are in this report.

KEYWORDS: SIC 9199 (General Government, Not Elsewhere Classified), lead, indoor firing ranges, pistol ranges, ammunition, bullets, ventilation

II. INTRODUCTION

In January 1982, NIOSH received a request for a health hazard evaluation from the Building Manager, General Services Administration, U.S. Post Office and Courthouse Building, Cincinnati, Ohio, 45202. NIOSH was requested to determine whether law enforcement officers, using an indoor shooting range, were experiencing hazardous lead exposures. On January 19, 1982, NIOSH conducted environmental sampling to determine lead exposures. The results of this air sampling, along with an interpretation and recommendations, were provided to building management by letter. On August 11, 1982, NIOSH evaluated the ventilation systems for the range. The results of this ventilation assessment, and recommendations, were discussed in conference with management. On March 2, 1983, NIOSH conducted further air sampling within the range to determine lead exposures resulting from a specific type of ammunition --- controlled expansion bullets. The data of the January 19, 1982, survey indicated that use of controlled expansion bullets might allow the range to be used on a restricted basis. The results of the March 2, 1983, survey, along with an interpretation and conclusions were provided to building management by letter of March 18, 1983.

III. BACKGROUND

This indoor shooting range measures approximately 15 feet in width, 9 feet in height, and 102 feet in length. There are four firing booths (about 83 feet from the bullet trap) but the two outside booths had been sealed off with plywood prior to the NIOSH survey. For the two interior booths, moveable plywood gates sealed the areas below the shooting tables. This plywood "sealing off" was intended to increase air flows across the two center firing booths, as earlier studies in the range showed excessive air lead levels. The range has automatic target setters and a steel bullet trap. The range master has a large podium located about 7 feet behind the shooting booths.

Since a number of federal agencies use this range for practice and qualification purposes, only the activities of the Federal Protective Service are described. Although each agency provides its own range master, the Federal Protective Service controls the range and probably uses it more than the other agencies. The Federal Protective Service has about 18 law enforcement officers and 11 contract officers in Cincinnati. Each of these officers must offically qualify once a year but may practice qualify once a month. During a normal qualification sequence, an officer fires 60 rounds using several target and shooter positions. The range master often allows the officers to use 40 practice rounds before the 60 round qualification attempt. It requires about 45 minutes residence time in the range for the 40 rounds of practice and 60 rounds of qualifying. The range master, who controls the range and supervises the shooting, either stands or walks behind the shooters or is seated at the podium during the qualification attempts. All individuals in the range use ear muff hearing protective devices.

Ventilation air is currently supplied to the range at four locations: 1) An 8" by 12" supply air duct runs laterally across the range just below the ceiling and 6.5 feet behind the shooters. This duct has 3 circular diffusers on the bottom side and 2 rectangular grilles on the side facing the shooters; 2) About 33 feet downrange from the shooters, a one foot deep ceiling slot with the width of the range supplies air in a downrange direction; 3) About 59 feet downrange from the shooters, a 14 inch deep ceiling slot with the width of the range supplies air in a downrange direction; and 4) About 75 feet downrange from the shooters, a 14 inch deep ceiling slot with the width of the range supplies air in a downrange direction. Five 17.5 inch by 22.5 inch supply air grilles are located on the side wall of the range (south wall), 15, 32, 46, 62, and 75 feet downrange from the shooters, respectively. These five supply air grilles were sealed off at the time of the survey but there was some leakage. Ventilation air is exhausted from the range both through ceiling exhaust grills and side wall (north side) exhaust grills. Eight 6.5 inch by 14 inch ceiling exhaust grilles run laterally across the range, about 6 feet down range from the shooters. Ten 13.5 inch by 14.5 inch exhaust grilles run along the north side wall of the range, stacked two at a time, one above the other, 39, 51, 63, 75, and 83 feet downrange from the shooters respectively. One single side wall exhaust grille at 23 feet, and one of the 2 at 39 feet, had been sealed off.

IV. METHODS

All air sampling was conducted using 37 mm diameter, mixed cellulose ester, 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 filter samples were analyzed by conventional aqueous atomic absorption spectroscopy according to NIOSH Method S-341,[1] with minor modifications.

A heated thermocouple anemometer was used to determine the volumes of air supplied to, and exhausted from, the range. A number of air velocity determinations were made at each supply and exhaust grille or opening and based upon the averages of these readings, air flow volumes were calculated. Smoke tube testing at the shooting positions showed that the air was turbulent and that the direction of air flow was not always downrange. Although an average downrange air velocity can be calculated for the shooting line, turbulence and variation of the air velocities precludes the presentation of a meaningful air velocity profile.

V. EVALUATION CRITERIA

A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a

working lifetime without experiencing adverse health effects. It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The environmental evaluation criteria judged most appropriate for this study is the OSHA legal standard which is the same as the NIOSH recommendation. The OSHA standard for occupational exposure to lead is 50 micrograms per cubic meter of air (ug/m^3) for an 8-hour TWA daily exposure of a 40-hour work week.[2] Additionally, OSHA's "action level" for occupational lead exposures is 30 ug/m^3 for an 8-hour TWA daily exposure.[2] The American Conference of Governmental Industrial Hygienists recommends a short term exposure limit of 450 ug/m^3 for a 15-minute TWA exposure.[3]

B. Toxicology

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. Another source of exposure is ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body slowly. Absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs. 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 exposures. The OSHA standard 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 blood 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 lead levels decline to below 50 ug/deciliter and they can return to lead exposure areas.

VI. RESULTS AND DISCUSSION

A. Environmental

Table 1 presents the air sample results for the survey of January 19, 1982. The two personal air samples for the range master showed air lead concentrations of 790 and 210 ug/m^3. The corresponding 8-hour TWA exposure for the range master was 220 ug/m^3 as compared to the OSHA standard of 50 ug/m^3. Twelve personal air samples for the seven shooters showed exposures ranging from 180 to 2100 ug/m^3. The corresponding 8-hour TWA exposures for the 7 shooters ranged from 8 to 220 ug/m^3 with 2 of the 7 TWA exposures exceeding the OSHA standard of 50 ug/m^3.

The data of Table 1 indicate that the air lead levels decreased as the shooting progressed and with the change from wadcutter to controlled expansion bullets (CEB's). To further elucidate this decrease in air lead levels, the data of January 19, 1982, were rearranged as shown in Table 2. The data of Table 2 show what the TWA exposures of the shooters would have been had the shooters made just one qualification attempt. The calculated, hypothetical 8-hour TWA exposures, while using the controlled expansion bullets ranged from 6 to 18 ug/m^3 for the 8 individual qualification attempts as compared to the OSHA standard of 50 ug/m^3. Both of the calculated, hypothetical, 8-hour TWA exposures for the individual qualification attempts, while using the wadcutter ammunition exclusively, were 67 ug/m^3 (exceeding the OSHA standard of 50 ug/m^3).

Table 3 presents the results of air sampling which was conducted on March 2, 1983, in order to provide further information on what the lead

exposures to the range master and shooters would be if the shooters used only the controlled expansion bullets and were limited to one qualification attempt per day. As shown on Table 3, the four shooters were exposed to lead concentrations ranging from 102 to 192 ug/m^3 for the time actually spent shooting in the range (39 to 49 minutes). The corresponding 8-hour TWA exposures for the four shooters ranged from 10 to 16 ug/m^3 as compared to the OSHA Standard of 50 ug/m^3 for an 8-hour average daily exposure. The range master and the NIOSH investigator were exposed to air concentrations ranging from less than 31 to less than 45 ug/m^3 for their periods spent in the range (up to 49 minutes). Based on the individual qualification attempts, the range master and the NIOSH investigator were exposed to 8-hour TWA exposures of less than 3 ug/m^3 as compared to the OSHA standard of 50 ug/m^3. .

The data of Table 3 shows that with the following restrictions, personnel can use the range for qualification purposes and be below both the OSHA standard of 50 ug/m^3 and OSHA action level of 30 ug/m^3 for 8-hour average daily exposures:

1. Physical characteristics of the range shall remain essentially the same as on March 2, 1983, (e.g. ventilation systems "on" and "unchanged", the two outside lanes sealed off, etc.).

2. Shooters shall be restricted to one qualification attempt per day but may use 100 rounds of ammunition and have up to one hour within the range. Both lanes (two shooters) may be used.

3. Ammunition shall be 38 Special, 110 grain, copper-jacketed hollow point, + P +, controlled expansion bullets.

4. Handguns shall be Smith & Wesson, Model 15, 6" barrel (J-Series), 38 Specials.

B. Ventilation

The results of the ventilation survey (Table 4) indicate that 6000 cfm of air is supplied to the range while 6700 cfm is exhausted from the range. This is about the proper ratio of exhaust air to supply air as it is desirable to keep the range under a slight negative pressure. Such a negative pressure helps prevent the infiltration of lead contamination to other parts of the building.

Accepted ventilation design criteria specifies a minimum uniform air velocity across the shooters of 50 fpm (clean air) in a downrange direction.[4,5] Since 2100 cfm is supplied to the range behind the shooters (Table 4) and the open areas above the shooting tables for the two inside shooting booths are 20.1 ft^2 and 20.4 ft^2 respectively, the average air velocity across the two shooters was slightly above 50 fpm. However, smoke tube testing at the shooting booths showed that the air was quite turbulent and that the direction of air flow was not always downrange. It is concluded that the amount of air supplied to the range behind the shooters is minimally adequate for the range conditions at the time of the survey but the air turbulence at the shooters does not allow the most effective control of lead emissions.

The air which is supplied to the range, downrange of the shooters, does not add to, or detract from, effective control of lead exposures to the range master and shooters.

VII. RECOMMENDATIONS

A. Bullet Substitution

This study, as well as other studies,[6] has demonstrated that either non-lead or jacketed bullets will reduce lead contamination in indoor shooting ranges. It is recommended that non-lead or jacketed bullets be used in this shooting range to reduce inhalation lead exposures to the range master and shooters.

B. Ventilation

It is recommended that the range ventilation be improved by utilizing the design criteria of either the American Conference of Governmental Industrial Hygienist's "Industrial Ventilation Manual"[4] or NIOSH Publication No. 76-130, "Lead Exposure and Design Considerations for Indoor Firing Ranges".[5]

C. Good Work Practices

It is recommended that the following good work practices be made a part of the standard operating protocol for this range.

1. The ventilation systems should be in operation while individuals are in the range.
2. The range should be cleaned by vacuum or wet methods --- not by sweeping.
3. A NIOSH certified dust respirator for lead, should be worn while cleaning or maintaining the bullet trap.
4. Eating, drinking, or smoking in the range should be prohibited.
5. After using or working in the range, individuals should wash hands and face with soap and water.

VIII. REFERENCES

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3. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1982. Cincinnati, Ohio: ACGIH, 1982.

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5. National Institute for Occupational Safety and Health. Lead exposure and design considerations for indoor firing ranges. Cincinnati, OH; National Institute for Occupational Safety and Health, 1975. (DHEW publication no. [NIOSH] 76-130).

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Study Conducted by: John Love, B.S. Chem. Engr.
John Kominsky, C.I.H.
Kenneth Kronoveter, C.I.H., P.E.

Report Written By: Kenneth Kronoveter

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies
Cincinnati, Ohio 45226

Report Typed By: Cheri Nordman
Clerk Typist

X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Building Manager, U.S. Post Office & Courthouse; Cincinnati, Ohio
2. AFGE, Local 128, Cincinnati, Ohio
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Personal Air Sample Results for Lead
January 19, 1982

Sample Time	Sample Description	Ammunition Type	Air Concentrations of Lead (ug/m^3) Actual	8-hour TWA*
0847-1048	Range Master		790	
1117-1214	Range Master		210	220
0847-0910	Shooter 1: Booth 1	Wadcutters** & CEB's***	1600	
0918-0933	Shooter 1: Booth 2	Wadcutters	2100	140
0847-0910	Shooter 2: Booth 2	Wadcutters & CEB's	830	
0918-0933	Shooter 2: Booth 1	Wadcutters	2100	
1006-1019	Shooter 2: Booth 1	CEB's	650	
1037-1048	Shooter 2: Booth 2	CEB's	270	130
1006-1020	Shooter 3: Booth 2	CEB's	540	
1037-1047	Shooter 3: Booth 1	CEB's	450	25
1116-1134	Shooter 4: Booth 1	CEB's	280	11
1116-1133	Shooter 5: Booth 2	CEB's	320	11
1155-1215	Shooter 6: Booth 2	CEB's	180	8
1155-1215	Shooter 7: Booth 1	CEB's	280	12
OSHA Standard				50

*Calculated 8-hour time weighted average exposures (assumes zero exposures when outside of the shooting range).

**Wadcutter bullets - 38 Special, 148 grain.

***Controlled Expansion Bullets - 38 Special, 110 grain, jacketed hollow point, + P +.

Note: Each shooter used 60 rounds of ammunition for each qualification attempt. The revolvers used were Smith & Wesson, Model 15, 6" barrel (J. Series), 38 Specials.

Table 2
Hypothetical 8-Hour Time Weighted Average (TWA) Air Lead Concentrations Based Upon Single Qualification Attempts and the Air Lead Concentration Data of Table 1

Sample Time	Ammunition Type	Air Lead Concentrations (ug/m^3) Personal Sample-Lane 1 Actual	Personal Sample-Lane 1 8-Hour TWA	Personal Sample-Lane 2 Actual	Personal Sample-Lane 2 8-Hour TWA
0847-0910	Wadcutters* and CEB's**	1600	76	830	40
0918-0933	Wadcutters only	2100	67	2100	67
1006-1019	CEB's only	650	18	540	16
1037-1048	CEB's only	450	9	270	6
1116-1134	CEB's only	280	11	320	11
1155-1215	CEB's only	280	12	180	8

*Wadcutter bullets - 38 Special, 148 grain
**Controlled expansion bullets - 38 Special, 110 grain, jacketed hollow point, + P +

Table 3
Personal Air Sample Results for Lead
March 2, 1983

Sample Time	Sample Description	Air Concentrations of Lead (ug/m^3) Actual	8-Hour TWA*
1028-1107	Range Master at Podium	< 39	< 3
1028-1107	Shooter 1 - Lane 1	192	16
1028-1107	Shooter 2 - Lane 2	179	15
1034-1107	NIOSH Investigator - behind shooters	< 45	< 3
1029-1107	Area sample on podium	< 40	< 3
1144-1233	Range Master at podium	< 31	< 3
1144-1233	Shooter 3 - Lane 1	102	10
1144-1233	Shooter 4 - Lane 2	122	13
1144-1233	NIOSH Investigator - behind shooter	< 31	< 3
1149-1233	Area sample on podium	< 35	< 3
OSHA Standard			50

* Calculated 8-hour time weighted average exposures (assumed zero exposures when outside of the shooting range and are based upon single qualification attempts).

Note: Each shooter of this table used 100 rounds of ammunition --- 40 rounds for practice and 60 rounds for the qualification attempt. The ammunition used was 38 Special, 110 grain, jacketed hollow point, + P +, controlled expansion bullets. The revolvers used were Smith & Wesson, Model 15, 6" barrel (J-Series), 38 Specials.

Table 4
Summary of Ventilation System Air Flows
August 11, 1982

Air Supplies	Number of Air Velocity Readings	Airflow (cfm) Based Upon Average Air Velocity
7' Behind Shooter	15	2100
33' Downrange of Shooters	24	1200
59' Downrange of Shooters	24	1100
75' Downrange of Shooters	26	700
Sealed off Supplied - Estimated leakage	--	900
Total Air Supplied to Range		6000
Air Exhausts		
6' Downrange of Shooters	32	1700
39' Downrange of Shooters	9	750
51' Downrange of Shooters	18	1400
63' Downrange of Shooters	18	1100
75' Downrange of Shooters	18	900
83' Downrange of Shooters	18	850
Total Air Exhausted From Range		6700

Notes: 1. Airflows are in cubic feet per minute (cfm).

2. Airflows less than 1000 cfm have been rounded off to the closest 50 cfm.

3. Airflows greater than 1000 cfm have been rounded off to the closest 100 cfm.