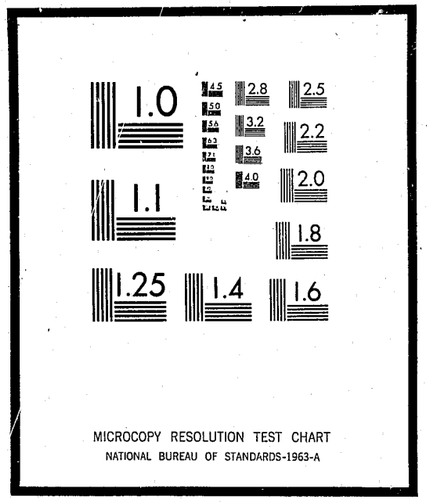

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LEAD EXPOSURE AT AN INDOOR FIRING RANGE

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SUMMARY OF REPORT

On March 28-30, 1973, the Industrial Hygiene Services Branch and the Medical Services Branch of the National Institute for Occupational Safety and Health conducted an environmental and medical survey at the Orlando Police Indoor Firing Range in Orlando, Florida.

Environmental

A total of 56 samples for inorganic lead were taken during the survey of which 29 were general area air samples and 27 were personal air samples. All samples taken exceeded the existing standard of 0.2 milligrams of lead per cubic meter of air (mg/M^3) with the exception of one sample taken during the lunch break and four general air samples taken from 6:00 pm to 2:00 am. These four samples were taken to determine the time needed to purge the Range of lead fumes to an acceptable level. (Tables 1 and 2) Six area samples were taken on March 28, and ranged from a low of 0.24 mg/M^3 to a high of 2.67 mg/M^3. Eighteen area samples were taken on March 29, during working hours (6:30 am - 6:00 pm) and four were taken after working hours (6:00 pm - 2:00 am). Of the eighteen samples taken during working hours the low concentration was 0.45 mg/M^3 and the high 7.76 mg/M^3 with an average concentration of 2.69 mg/M^3.

Of the total 27 personal samples, the concentration varied widely depending upon the number of men firing. (Figure 1) The concentrations ranged from a low of 1.90 mg/M^3 to a high of 12.12 mg/M^3. The Range

Officer (RO) and Scorekeeper (SK) levels are not included in this group. As can be seen from Table 1, the exposure to the Range Officer ranged from a low of 0.63 mg/M^3 to a high of 1.2 mg/M^3. The low was recorded at a time when the Range Officer spent most of his time in the control room. The high was recorded when he was assisting the Scorekeeper in recording scores. The Scorekeeper was stationed outside the control booth during the firing. The eight-hour time-weighted average concentration for the Range Officer was 0.92 mg/M^3 and for the Scorekeeper, 2.42 mg/M^3. This Scorekeeper's average corresponds very closely to the atmospheric concentration of 2.69 mg/M^3.

The ventilation was found to be inadequate. The total intake or make up air is approximately 6900 cubic feet per minute (cfm) and the exhaust is approximately 4200 cfm. (Table 3) This indicates that the system is not balanced. The air intakes are located above and slightly in front of the shooters with the exhaust located four feet down range from the intake. The intake should be located in back of the shooter and far enough away from the exhaust to create a "sweeping" effect of air in the booth.

The lighting in the shooters' area was found to be adequate since the levels measured, closely approximate conditions under which officers would fire their weapons away from the Range.

Medical

1. Biological sampling confirmed that excessive atmospheric lead concentrations are present within the confines of the Orlando Police Firing Range. (Table 4)

2. While no definite cases of illness were encountered, the person serving as Range Officer experiences a significant risk of developing overt lead intoxication. The intermittent nature of the exposure throughout the monthly cycle is probably the principal factor that has prevented to date serious illness in those working within the area.

3. Because of the brief exposure sustained by officers who simply use the facility for qualifying purposes, their risk is minimal since ample time exists for lead excretion between exposures and no accumulation should result in such individuals, barring additional non-occupational exposures.

Appropriate recommendations to alleviate the existing conditions at the Firing Range are made in this report.

INTRODUCTION AND PURPOSE

On March 28-30, 1973, at the request of Captain Donald VanScoyoc, Orlando Police Department, an industrial hygiene and medical survey was conducted of the Orlando, Florida Police Indoor Firing Range. The purpose of the survey was to determine if a potential health hazard exists from lead exposure during firing; to evaluate existing environmental controls;

and to conduct medical examinations of some of the police officers. The study was conducted by the Industrial Hygiene Services Branch (IHSB) and by the Medical Services Branch (MSB) of the National Institute for Occupational Safety and Health (NIOSH).

DESCRIPTION OF FIRING RANGE AND OPERATIONS

The police indoor firing range is located in the Orlando Police Department Building. The room is approximately 120 ft. long and 22 ft. wide, and houses the arsenal room, the control room, and the weapons cleaning room. The actual firing range is approximately 75 ft. long, 22 ft. wide, and 9 ft. high.

There are six booths for firing with each booth being approximately 4 ft. wide, 6 ft. long, and 9 ft. high. There is an intake and exhaust system located above each booth. Each booth is equipped with an automatic target setter and the range is designed with a steelplate bullet trap.

This indoor firing range is utilized by police officers who are required to qualify every two months in small arms proficiency. Other groups using this facility include: 1) Recruit Officers, 2) Secret Service Officers, 3) Postal Inspectors, 4) F.B.I., 5) U.S. Border Patrol, 6) U.S. Marshalls, and 6) Judges.

The range is staffed by a full-time Range Officer who is present when qualifications and other firing occurs. There are approximately 330 police officers who must qualify every two months. Each officer fires 60 rounds

of 38 special 148 GR wad-cutters per qualifying round. Most fire an additional 60 rounds to improve their score and this may be done immediately, or at a later date. Each qualifying round takes approximately 30 minutes from the time the weapons are loaded until their score is tallied by the Range Officer who is official scorer.

During the periods when there is no firing, the Range Officer's duties are limited. However, until recently his duties included collecting spent lead from the firing range trap and melting the lead and casting it into small ingots.

ENVIRONMENTAL STUDY PROCEDURES AND INSTRUMENTATION

Atmospheric samples for lead were collected on Millipore filters Type AA* with an 0.8μ pore size. The filters were encased in a three-piece plastic field monitor with face cap removed and the filter completely exposed. The samples were taken at the operator's breathing zone using battery powered Mine Safety Appliance (MSA) gravimetric pumps, Type G. The pumps and samples were worn by the police officers. Area samples were also taken using a Research Appliance Corporation (RAC) sequential sampler with the same type of filters. All samples (breathing zone and area) were taken at a rate of 2 liters per minute (lpm). The samples were analyzed at the Cincinnati Laboratory using atomic absorption spectrophotometry.

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

An Alnor thermoanemometer was used to measure the ventilation system. Illumination levels were measured using a General Electric light meter.

TOXICOLOGY AND HYGIENIC STANDARDS

Lead poisoning may occur through the inhalation and/or ingestion of lead fumes or dust. This results in the deposition of lead in the bones and tissues of the body and alterations in normal physiological functions. No single sign or symptom may be considered diagnostic of lead poisoning. Lead poisoning may present such symptoms as a metallic taste in the mouth, loss of appetite, indigestion, nausea, vomiting, constipation, abdominal cramps, nervousness, and insomnia.

Many of the sources of lead poisoning are industrial, but man also absorbs lead in small amounts not normally leading to poisoning from his food and water, and from the air. These sources lead to the "normal" body burden of lead. The normal burden in workmen is 27-30 micrograms of lead per 100 milliliters of blood (µg/100 ml). Thus the lead absorbed in the course of occupational exposure is superimposed on lead absorbed from other sources. Lead poisoning is preceded by a stage of lead absorption, but lead absorption is not always followed by lead poisoning.

The existing standard for inorganic lead exposure (29 CFR 1910.93(b), Table G-2) is 0.2 milligrams of lead per cubic meter of air (mg/M^3) based

on an eight-hour time-weighted average*(TWA). Any exposure above 0.6 mg/M^3 for an eight-hour TWA is considered a serious violation by the U.S. Department of Labor. Although the current standard for inorganic lead is 0.2 mg/M^3, the Threshold Limit Value (TLV) Committee of the American Conference of Governmental Industrial Hygienists (ACGIH) (1973) and the NIOSH criteria for a standard on exposure to organic lead (1972) recommend that the standard be lowered to 0.15 mg/M^3.

VENTILATION

Each firing booth is equipped with an intake and exhaust air supply. The intake grill is located in front of the shooter and is designed with baffles 30° to the horizontal. The exhaust ducts are located approximately four feet down range from the intake. The combined air intake, including the three air conditioning openings, is approximately 6900 cubic feet of air per minute (cfm). The total exhaust including the exhaust opening in the bullet trap area is approximately 4200 cfm. According to the data in Table 3, most of the air is being exhausted up range (85%) and very little down range (15%). To be most effective the down range exhaust should be approximately 80 to 100% of the total.

*A time-weighted average is based upon concentrations for a 7 or 8 hour workday and a 40-hour workweek. They refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects.

To effectively control the lead fumes, an intake or make-up air supply of 45-50 cfm per square feet of cross-sectional area behind the firing line should have an entrance velocity of 400 linear feet per minute (fpm). This suggests that air outlets behind the line should measure approximately four square feet of open area per firing station.

HOUSEKEEPING

The overall housekeeping of the Range was very good with the exception of clean up operations at the end of the day. Clean up operations include the sweeping of the Range using a hand broom. Dry sweeping should be discontinued because of the toxicity of lead and vacuum cleaning should be used instead. Additional care must also be exercised by personnel cleaning the bullet trap. They should use a NIOSH approved respirator during the operation.

ILLUMINATION

Illumination levels were measured at each firing station. The levels were measured while officers were in the standing and prone positions. In the standing position the levels were measured at 30 foot-candles and in the prone position the levels were measured at 5 foot-candles. Since these are the levels that approximate conditions under which officers would fire their weapons, the level of illumination need not be increased.

MEDICAL EVALUATION

In the medical evaluation it was deemed desirable to attempt to assess: 1) the extent of lead absorption by individual officers during the period required to qualify, and 2) the medical status of the current Range Officer and his predecessor, particularly in regard to lead accumulation. Since neither Range Officer had current signs (palsy, Burtonian lines, anemia, etc.) nor symptoms (constipation, colic, encephalitis, etc.) biological testing afforded the only means of possibly determining any previous significant lead accumulation. A collection of various normal and abnormal biologic values is given in Appendix A, and may be referred to in interpreting the results obtained during this study.

While lead has numerous toxic properties, none is more marked than the effects upon porphyrin metabolism (hemoglobin synthesis). In addition, these effects have been carefully studied and form the basis for a number of tests which are of great assistance in establishing the degree of lead absorption. Normally delta-aminolevulinic acid (ALA) is converted to the heme compound porphobilinogin (PBG) by the enzyme delta-aminolevulinic acid dehydratase (ALAD). Lead has an almost immediate and marked inhibitory effect on this enzyme which can be conveniently measured by assaying red blood cells for enzyme content. As might be anticipated, low ALAD levels prevent effective conversion of ALA to PBG and ALA is

accumulated in the blood where excessive levels can be measured. In addition, as the result of its accumulation in the blood, excessive amounts are excreted in the urine, the basis of yet another biologic test.

Once lead is stored in the tissues (mainly bone), blood and urine lead levels may eventually return to normal even though the total body lead burden is increased. This can often be detected by the provocative administration of a chelating agent which combines with tissue lead and leads to its rapid excretion in the urine. The most effective of this class of drugs is calcium disodium versenate (calcium disodium edetate) which can be safely administered in the oral form both for therapeutic and test purposes. The lead content of urine excreted following a test dose of E. D. T. A. (2 grams) can be easily quantitated and provides a crude index indicative of past absorption.

At the time of the first NIOSH visit on March 22-23, the Range had not been in use since the preceding month. This provided an opportunity to obtain blood and urine specimens from the officers under relatively baseline conditions. Officers No. 1 and No. 6 both provided specimens as did the prospective candidate for Range Officer (Officer No. 2). Three other Officers (Nos. 3, 4, and 5) without unusual interest in or exposure to the Range volunteered to serve as controls and contributed specimens. The results of these assays are presented in Table 4. Blood lead levels

ranged from 23 to 31 µg/100 ml (µg%) and urine leads were all less than 1 µg%. Thus these perimeters of exposures are all well within normal limits. Blood ALAD values ranged from 15.2 to 56 units. Only Officer No. 1's values suggest recent exposure although Officer No. 4's values are also slightly depressed. Among the values found for urinary ALA, Officer No. 1 had the highest, but still within the normal range. Thus, from the initial data collected there is nothing to substantiate excessive exposure.

One week later (March 29-30) and during a period in which the Range was again in use (firing having begun on the 26th), blood and urine specimens were again obtained from the same six individuals. Blood was taken after each man completed his qualifying rounds except for Officer No. 1 who was serving as Range Officer during the entire week and his specimen was collected after the completion of firing on the 29th. In addition, each man was given 2.0 grams of oral versinate and instructed to collect all his urine during the succeeding 12-hour period.

The data for these post exposure specimens are also presented in Table 4. All men experienced a rise in blood lead and the difference between pre- and post-exposure values is statistically highly significant ($P=.0017$). However, none of the values exceeded the 60 µg% level generally regarded as safe for men chronically exposed to lead. As

anticipated, a significant increase in urinary lead occurred following versinate provocation. The specimen from Officer No. 1, however, resulted in a level commonly seen in lead workers who have experienced slight absorption. The value from Officer No. 6 was well within the normal range reported for non-exposed persons. This does not eliminate the possibility that he might have had excessive exposure prior to being relieved of his Range Officer duties last July since ample time has passed for his system to have eliminated any excessive accumulation. It is well known that relatively rapidly accumulated lead (weeks to months) is excreted much more rapidly than lead garnered over a longer period of years. None the less, only a positive versenate test could have served to substantiate previous excessive accumulation.

Post exposure ALAD levels were found to be significantly depressed (P=.00014) when compared with pre-exposure values in Officer No. 1's level indicates definite excessive exposure. This test is a very sensitive one and probably signifies excessive exposure prior to significant accumulation i.e., it may become markedly abnormal before excessive levels appear in the tissues, blood or urine and long before lead intoxication occurs. Certainly this is the pattern that would be expected from exposure to episodically excessive environmental lead in which most of the absorbed lead is probably eliminated between exposures. Officer No. 3's ALAD also suggests some excessive exposure, possibly not occupationally related,

since the decrease between pre- and post-exposure levels is of the same general magnitude as noted in all other subjects. As might be anticipated, Officer No. 1's urinary ALA level was the highest of the group and confirms the significance of his depressed blood enzyme (ALAD) level. None the less, this level of urine ALA is far below those seen in lead intoxication and most authorities would regard it as being a high normal value. All the hematocrit values were normal as expected since hemoglobin synthesis is not markedly interferred with except in chronic plumbism.

DISCUSSION OF RESULTS AND RECOMMENDATIONS

At the present time a potential health hazard due to inorganic lead exposure exists at the Orlando, Florida Police Indoor Firing Range. The existing ventilation at the Range is inadequate, since atmospheric lead levels were found to exceed the standard of 0.2 mg/M^3. As can be seen in Tables 1 & 2, all levels of lead in the breathing zone of the Officers and in the general room atmosphere were above the standard. The levels of lead fume varied according to the number of men firing. However, in one instance the concentrations increased although the number firing decreased indicating that the ventilation system is not capable of preventing a build-up of lead fumes.

A properly designed ventilation system for an indoor firing range should maintain the atmospheric lead concentration at or below the existing standard; however it took approximately two to three hours for the existing ventilation system to reduce the lead concentrates to an acceptable level.

At the time of the study it was noted that smoke and lead fumes generated during firing had a tendency to blow back into the area behind the firing line. This was due to the location of the air intake and exhaust. To effectively control lead fumes generated at the Firing Range a sufficient quantity of tempered air should be introduced behind the firing line.

Biological sampling confirmed that excessive atmospheric lead concentrations are present at the Firing Range. All men tested biologically experienced a rise in blood lead, but none of the values exceeded the 60 µg/100 ml generally regarded as safe for men chronically exposed to lead. However, under the present conditions this could change significantly.

To alleviate the conditions existing at the Firing Range and to effectively control lead fumes generated at the firing line, the following recommendations are made.

1. All firing within the Range should cease until proper controls are instituted.

2. A minimum of fifty (50) cubic feet per minute (cfm) of air per square foot (ft^2) of open cross-sectional area at the firing line should be maintained.

3. The air supplied behind the firing line should have an entrance velocity of approximately 400 feet per minute. This suggests that air outlets behind the firing line should measure three to four square feet of open area per firing station (Figure 2).

4. The air supply should be placed as far back of the shooters' position as possible and fitted with movable louvers to permit adjustment of air flow.

5. Most of the air should be exhausted down range. Approximately 35-40% of the exhaust air should be collected by the ceiling ducts approximately ten feet down range of the firing line and the remaining 60-65% down range next to the bullet trap.

6. To be most effective the room should have a slight negative pressure. This would retard any lead fumes from escaping under the doors.

7. To insure adequate air movement through the firing line, the area under the bench at each firing station should be baffled. Hinges may be used on the baffles to allow for prone shooting.

8. The sweeping of the Range with a hand broom should be discontinued and replaced by vacuum cleaning or wet methods.

9. In maintaining, cleaning, and reclaiming lead in the bullet trap, a respirator approved by NIOSH-U.S. Bureau of Mines should be worn by the operator.

10. A rotation system should be instituted for the Range Officer position. It is suggested that one month of duty be followed by three months of alternate activity. This change is suggested not only to alleviate any possible lead absorption and prevent its accumulation, since this is expected to be minimal following the engineering changes, but to prevent undue psychological

and physiological stresses associated with the position. By its very nature this job demands close confinement, constant watchfulness for safety considerations, rote repetition, and exposure to high impact noise which can only be attenuated by existing hearing conservation devices. A rotation system could minimize these stresses and also permit additional numbers of Officers to acquire experience and expertise in this area of police work.

APPENDIX A

Normal and Abnormal Values Reported for some Biologic Assays Utilized in Assessing Exposure to Lead

Blood Lead

Normal Individuals (workmen) 27 ± 3 µg/100 ml (µg%)
(Traffic Officers) 26 ± 6 µg%
Lead workers 60 µg% is usually considered the extreme safe upper limit and 75 ± 4 µg% to indicate impending intoxication.

Blood Delta - Aminolevulinic acid dehydratase (ALAD)

32 ± 11 units corresponds to blood lead levels of <30 µg%
26 ± 9 units corresponds to blood lead levels of 30-44 µg%
18 ± 5 units corresponds to blood levels of 45-59 µg%
12 ± 4 units corresponds to blood lead levels >60 µg%
A value of 14.5 units or less is suggested for screening purposes since it will detect 85% of individuals with blood lead levels of 60 µg% or more.

Hemotocrit

Normal Adult men 47 ± 5%

Urine Lead

Normal Individuals (working men) $3.0\pm.14$ µg/100 ml (µg%)
(traffic officers) $2.8\pm.11$ µg%
Lead Workers $10.8\pm.5$ µg% moderate to severe exposure
$13.0\pm.5$ µg% safe upper limit
$15.2\pm.2$ µg% unsafe (impending intoxication)
Following oral versenate challenge
Normal Individuals (non-exposed) - up to 8.0 µg% (Mean 6.0)
Individuals with slight absorption - up to 70.0 µg% (Mean 33.0)
Individuals with moderate absorption - up to 152 µg% (Mean 90.0)
Indivisuals with excessive absorption - up to 268 µg% (Mean 215.0)

Exposed Individuals - >50.0 µg%

Urine Delta - Aminolevulinic acid (ALA)

Normal unexposed persons - up to 0.6 mg% (Mean .29)
Normal children $0.22\pm.16$ mg% with 95% upper confidence limit of .54 mg%
Normal adults <0.57 mg%
Normal children 1.00 mg% "practical upper limit of normal"
Exposed children 1.00-1.49 mg% corresponds to a blood Pb of 65 ± 17 µg%
1.50-1.99 mg% " " " " 68 ± 16 µg%
2.00-2.99 mg% " " " " 83 ± 23 µg%
3.00-5.99 mg% " " " " 107 ± 46 µg%
6.00-10.00 mg% " " " " 147 ± 65 µg%

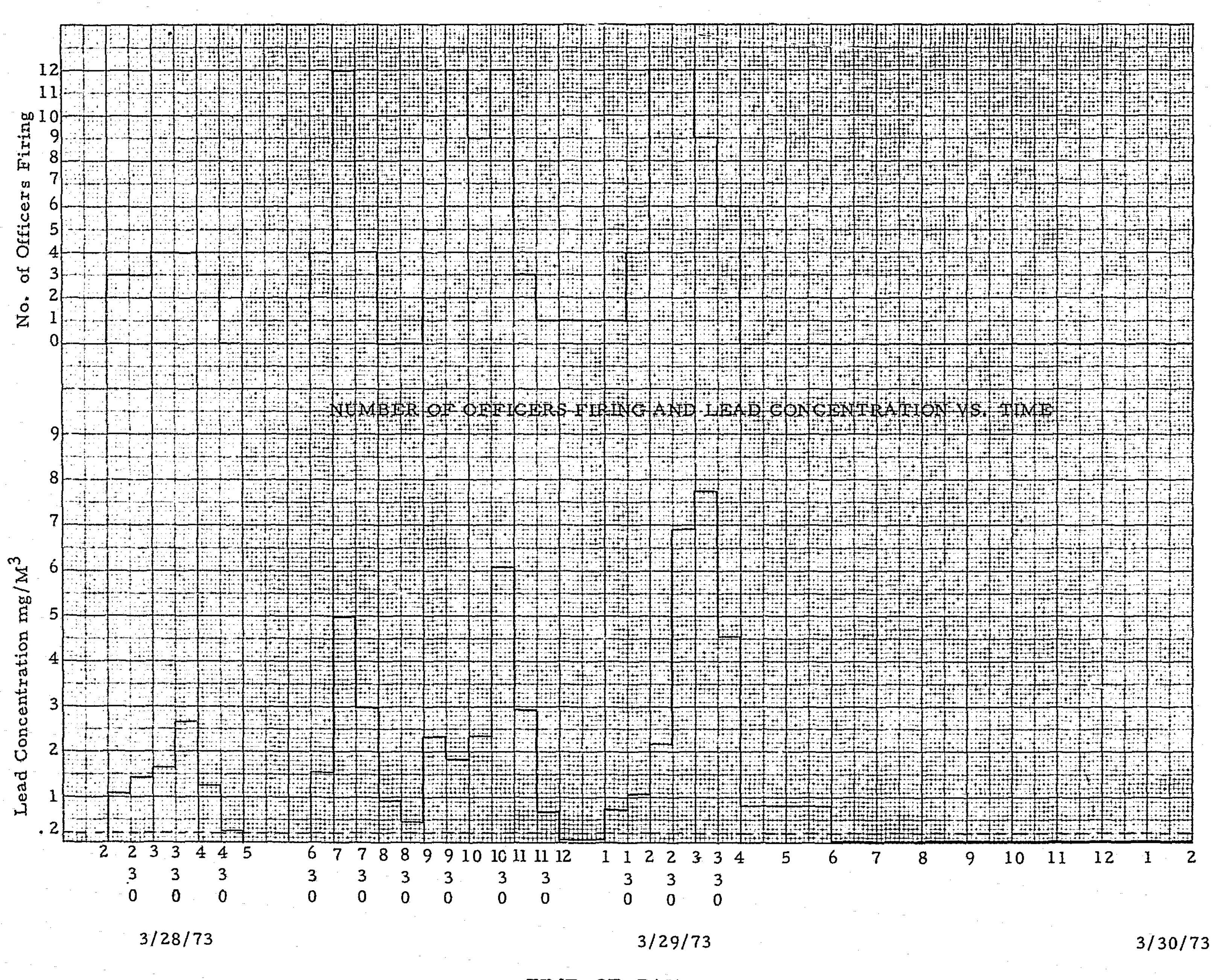
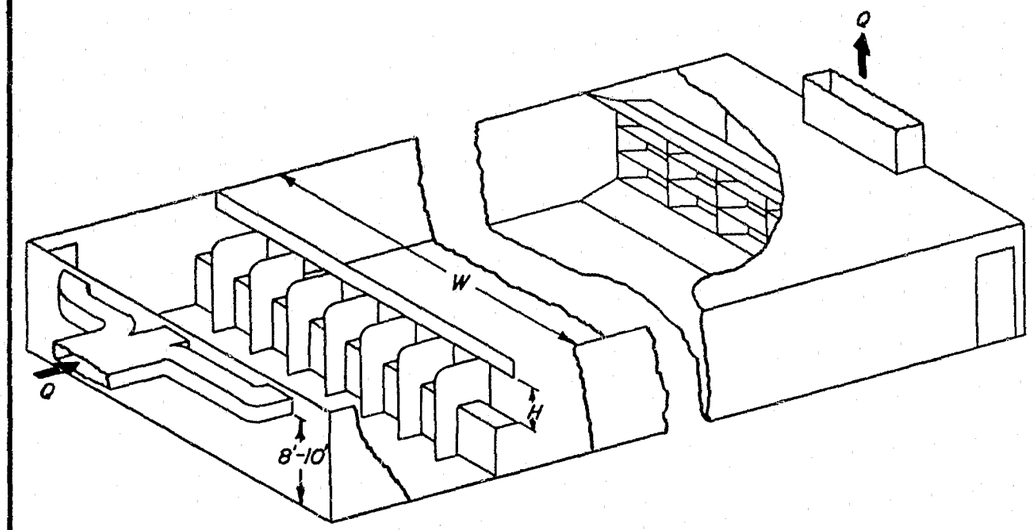

NUMBER OF OFFICERS FIRING AND LEAD CONCENTRATION VS. TIME
No. of Officers Firing
Lead Concentration mg/M³
3/28/73
3/29/73
3/30/73
TIME OF DAY

Figure 2



Q = 50 HW, but not less than 20 cfm/sq ft of room cross sectional area

Notes:

Make-up air:

Minimum temperature = 70 F

Sidewall grilles:

Maximum grille velocity = 400 fpm

Discharge air downward

Ceiling diffusers:

Size for uniform distribution

Bureau of Mines approved lead dust respirator is necessary during clean-up

Acoustical material on walls, ceiling and thick fabric on bench top are recommended

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS	
INDOOR PISTOL AND SMALL BORE RIFLE RANGE VENTILATION	
DATE 1-68	VS-914

TABLE 1

PERSONAL SAMPLES
Sample Rate - 2 lpm

	Sample No.	Time on	Time off	Sample Time (minutes)	Lead Conc. mg/M^3
3/28/73	RO-1-28	3:00 pm	4:30 pm	90	0.82
	P-2767-28	3:12	3:27	15	3.26
	P-3999-28	3:12	3:27	15	5.15
	P-3984-28	3:12	3:27	15	2.38
	P-3992-28	3:12	3:27	15	3.53
3/29/73	P-2777-29	6:48 am	7:00 am	12	4.80
	P-2771-29	6:48	7:00	12	6.65
	P-2761-29	6:48	7:00	12	5.64
	P-2768-29	6:48	7:00	12	12.12
	RO-2765-29	6:45	11:55	310	1.21
	P-2770-29	7:24	7:36	12	4.93
	P-2778-29	7:29	7:36	12	7.12
	P-2779-29	9:02	9:14	12	4.04
	P-2760-29	9:02	9:14	12	3.61
	P-2763-29	9:02	9:14	12	6.27
	SK-2776-29	9:05	11:50	165	1.40
	P-3982-29	10:32	10:44	12	1.90
	P-2756-29	10:32	10:44	12	5.95
	P-2772-29	10:32	10:44	12	6.23
	P-2773-29	10:32	10:44	12	7.40
	RO-2762-29	1:10 pm	3:45 pm	155	0.63
	SK-2775-29	1:10	3:45	155	3.27
	P-3987-29	1:56	2:08	12	2.78
	P-3989-29	1:56	2:08	12	3.18
	P-2755-29	3:07	3:19	12	6.35
	P-2764-29	3:07	3:19	12	6.68
	P-2766-29	4:10	4:20	10	4.99

TABLE 2

AREA SAMPLES

(30 Minute Samples at 2 lpm)

	Sample No.	Time	Number Firing	Lead Conc. mg/M^3
3/28/73	SS-1-28	2:00 - 2:30 pm	3	1.10
	SS-2-28	2:30 - 3:00	3	1.44
	SS-3-28	3:00 - 3:30	4	1.65
	SS-4-28	3:30 - 4:00	4	2.67
	SS-5-28	4:00 - 4:30	3	1.25
	SS-6-28	4:30 - 5:00	0	0.24
				Avg. = 1.39
3/29/73	SS-1-29	6:30 - 7:00 am	4	1.54
	SS-2-29	7:00 - 7:30	12	4.99
	SS-3-29	7:30 - 8:00	4	2.97
	SS-4-29	8:00 - 8:30	0	0.93
	SS-5-29	8:30 - 9:00	0	0.45
	SS-6-29	9:00 - 9:30	5	2.33
	SS-7-29	9:30 -10:00	12	1.83
	SS-8-29	10:00 -10:30	9	2.36
	SS-9-29	10:30 -11:00	12	6.09
	SS-10-29	11:00 -11:30	3	2.94
	SS-11-29	11:30 -12:00 N	1	0.68
	*SS-12-29	12:00 - 1:00 pm	1	0.08
	SS-13-29	1:00 - 1:30	1	0.74
	SS-14-29	1:30 - 2:00	4	1.07
	SS-15-29	2:00 - 2:30	12	2.17
	SS-16-29	2:30 - 3:00	12	6.91
	SS-17-29	3:00 - 3:30	9	7.76
	SS-18-29	3:30 - 4:00	6	4.54
	SS-19-29	4:00 - 6:00	0	0.81
				Avg. = 2.69
	SS-20-29	6:00 - 8:00 pm	0	0.03
	SS-21-29	8:00 -10:00	0	0.03
	SS-22-29	10:00 -12:00 M	0	0.03
3/30/73	SS-23-29	12:00 - 2:00 am	0	0.03

*This is a one-hour sample taken when the Range was closed for lunch break.

TABLE 3

AIR INTAKE

Grill	Total (cfm)	Air Conditioner	Total (cfm
1	500	1	150
2	1100	2	100
3	1700	3	150
4	600		
5	900	Total	400
6	1700		
Total	6500		

Accumulated Total Air Intake - 6900

AIR EXHAUST

Grill	Up Range Total (cfm)	Bullet Trap Exhaust	Down Range Total (cfm)
1	900	1	700
2	600		
3	600	Total	700
4	500		
5	450		
6	450		
	3500		

Accumulated Total Air Exhaust - 4200 cfm

TABLE 4

Officer	PRE-EXPOSURE (3/23/73) BLOOD Pb (µg/100ml)	URINE Pb (µg/100ml)	BLOOD ALAD (units)	URINE ALA (mg%)	POST-EXPOSURE (3/29/73) BLOOD Pb (µg/100ml)	URINE Pb (µg/100ml)	BLOOD ALAD (units)	HEMATOCRIT (%)	URINE ALA (mg%)
1	29	<1	15.2	0.49	51	26	5.2	46.5	0.57
2	27	<1	25.9	0.32	52	5	18.8	43.5	0.40
3	23	<1	56.0	0.39	37	5	51.5	47.0	0.40
4	31	<1	19.0	0.06	43	14	12.3	50.0	0.36
5	24	<1	45.8	0.02	32	8	40.2	46.0	0.40
6	25	<1	35.3	0.30	34	5	27.6	48.5	0.25
AVERAGES	26.5	<1	32.86	0.26	41	10.5	25.93	46.91	0.39

*Probability of a significant change in value =0.0017

Probability of a significant change in value =0.016

Probability of a significant change in value =0.00014

Probability of a significant change in value =0.055

*Probabilities calculated using the student's t test (one tailed)

FOLLOW-UP LEAD EXPOSURE SURVEY

On August 14-15, 1973 a follow-up survey was conducted at the Orlando, Florida Police Department Indoor Firing Range. This survey was made subsequent to ventilation changes recommended by the National Institute for Occupational Safety and Health after the initial survey of March 28-30, 1973. Table 1 shows a comparison between the initial ventilation survey and the follow-up survey. The intake air was increased from 6900 cfm to 9800 cfm, and the exhaust from 7200 cfm to 11,000 cfm. The intake averages out to approximately 45 cfm/ft^2 of cross-sectional area at the firing line. (Recommendations called for 50 cfm/ft^2.) Of the total of 10,100 cfm being exhausted, 7200 cfm or 70% is being exhausted down range as compared to 16% before.

A total of 24 samples for inorganic lead were taken during the survey including six general air samples and 18 personal air samples. All but six of the samples taken were below the existing U.S. Department of Labor standard of 0.2 milligrams of lead per cubic meter of air (mg/M^3)(Tables 1 and 2). The data show that the Range may be used continuously without adverse effects from lead intoxication.

Sample numbers 3794 and 3800 showed a high concentration due to the fact that during the firing sequence the targets become detatched from the holder and the Officers were permitted to enter the Range to replace the targets. Sample numbers 3797, 3795, 3799, and 3773 were above the standard because the door to the exhaust fan located next to the bullet trap was open. This was an oversight on the part of the maintenance

people. This incident emphasizes that during firing operations at the Range the door to the exhaust fan must be kept closed.

The environmental study procedures and instrumentation used in this study were the same as those used in the initial study of March 28-30, 1973.

TABLE 1

Comparison of Initial Ventilation Survey with Follow-Up Survey

AIR INTAKE

Grill	cfm 8/14-15	cfm 3/28-30	cfm from A. C.
1	1800	500	150
2	1800	1100	100
3	1700	1700	150
4	1700	600	400
5	1400	900	
6	1400	1700	
Total	9800	6500 + 400 = 6900	

AIR EXHAUST

Grill	Up Range cfm 8/14-15	Down Range Bullet Trap	Up Range cfm 3/28-30	Down Range Bullet Trap
1	900	7200	900	700
2	825		600	
3	450		600	
4	300		500	
5	300		450	
6	125		450	
Total	2900 + 7200 = 10,100		3500 + 700 = 4200	

TABLE 2

PERSONAL SAMPLES
(Sample Rate - 2 lpm)

	Sample No.	Time on	Time off	Sample Time (minutes)	Lead Conc. mg/M^3
8/14/73	3779	2:30 pm	2:45 pm	15	0.11
	3780	2:30	2:45	15	0.08
	3778	2:30	2:45	15	0.08
	3776	2:30	4:00	90	0.002 (R.O.)
	3777	2:30	4:00	90	0.01 (S.K.)
	3783	3:52	4:07	15	0.06
	3784	3:52	4:07	15	0.11
8/15/73	3792	8:05	8:20	15	0.11
	3791	8:05	8:20	15	0.08
	3788	8:05	8:20	15	0.06
	3786	8:05	10:35	150	0.05 (S.K.)
	3787	8:05	10:35	150	0.02 (R.O.)
	3794	8:55	9:10	15	1.40
	3797	8:55	9:10	15	1.05
	3795	8:55	9:10	15	0.26
	3800	10:17	10:32	15	2.33
	3799	10:17	10:32	15	0.04
	3773	10:17	10:32	15	0.42

TABLE 3

AREA SAMPLES
(Sample Rate - 2 lpm)

8/14/73	3781	2:30 pm	4:00 pm	90	0.03
	3782	2:30	4:00	90	0.02
8/15/73	3789	8:05 am	9:40 am	95	0.11
	3790	8:05	9:40	95	0.10
	3796	9:40	10:40	60	0.04
	3798	9:40	10:40	60	0.13
					Avg. = 0.07

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