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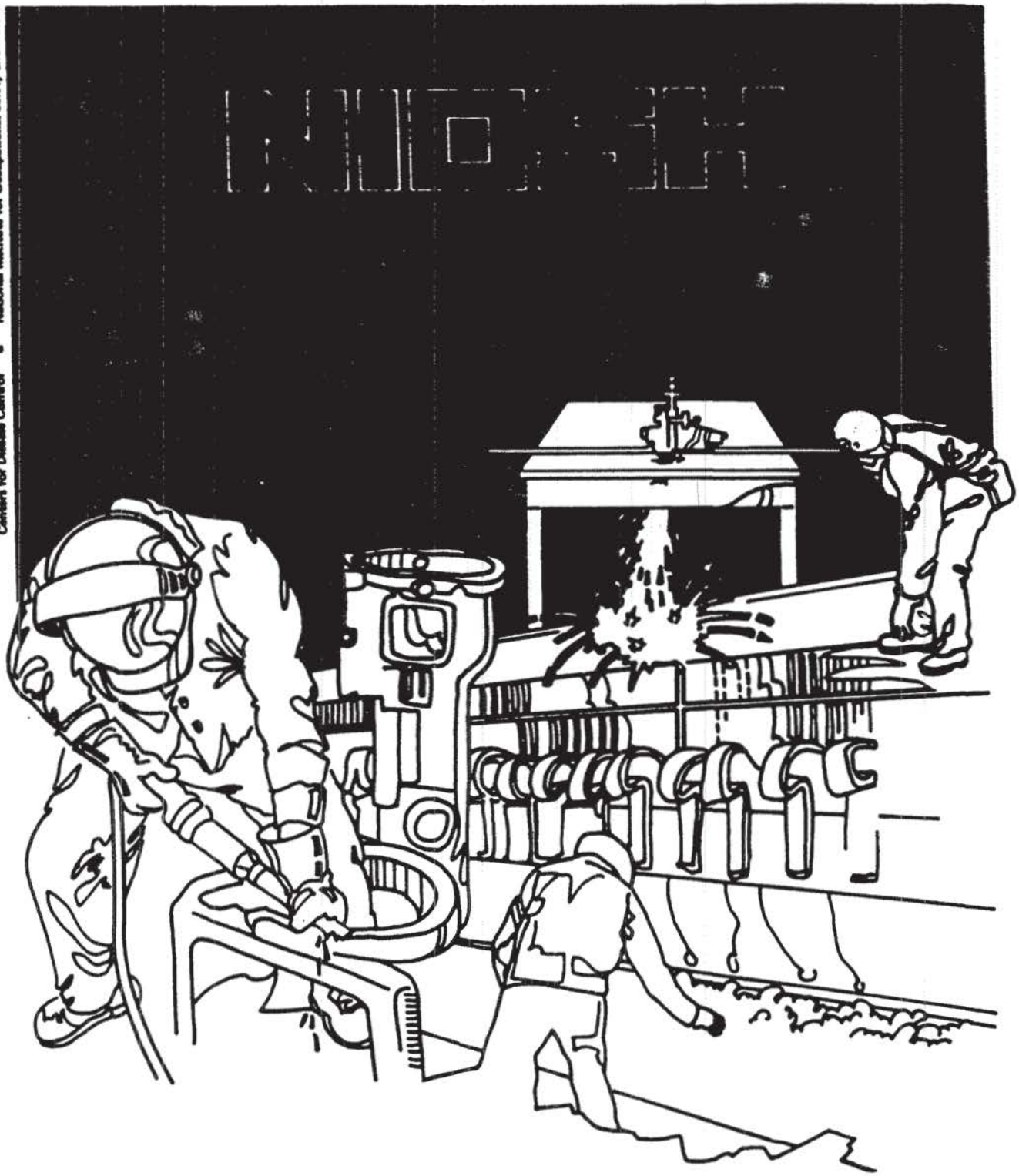

Health Hazard Evaluation Report

HETA 82-255-1193
FIRING RANGE - POLICE DEPT.
CAPE GIRARDEAU, MISSOURI

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 82-255-1193
September 1982
Firing Range - Police Dept.
Cape Girardeau, Missouri

NIOSH INVESTIGATOR:
Ralph J. Bicknell, RPC

I. SUMMARY

In May of 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Police Department at Cape Girardeau, Missouri to evaluate lead exposure in the indoor firing range located in the new police department building in Cape Girardeau, Missouri.

On June 16 and 17, 1982 the NIOSH Investigator collected environmental samples at the range to determine airborne lead concentrations. A total of 11 samples were collected. These consisted of six area samples and five personal samples. All of the area and breathing zone samples contained lead substantially above the U. S. Department of Labor, Occupational Safety and Health Administration (OSHA) current 8-hour time weighted average of 50 micrograms per cubic meter. These samples ranged from 750 to 1520 ug/M^3. The ventilation system is totally inadequate and does not provide sufficient air movement. This is the primary reason for the high airborne lead concentration.

Based on results of environmental samples obtained during this evaluation, NIOSH determined that a substantial hazard of occupational exposure to lead exists at the Cape Girardeau Police Department Firing Range when this range is used.

Recommendations relating to medical surveillance, ventilation, material substitutions, respiratory protection and general operating procedures at the range are presented in Section 7 of the report.

KEYWORDS: SIC 9221 Police Protection - firing range, lead, ventilation.

II. INTRODUCTION

Law enforcement agencies, some private security agencies, and many banks are requiring that their personnel achieve greater accuracy and proficiency in the use of hand guns. This requirement has resulted in the greater use of existing ranges and the construction of new ranges.

Indoor ranges are advantageous from the standpoint of protection from the weather, control of the environment, and use of the facility around the clock. However, many older facilities and even some newer ranges present a health hazard in the form of lead poisoning due to improper ventilation control.

On May 17, 1982 NIOSH received a request from the Cape Girardeau, Missouri Police Department to evaluate potential lead exposure to people using the indoor firing range at the new department building.

III. BACKGROUND

The indoor firing range at the Cape Girardeau, Missouri Police Department is approximately six years old. It was constructed as a part of the new police department building. The range has not been used in the last year.

There are four firing stations on the range. Each station is 4 feet 3 inches wide and 8 feet high. It is 42 feet from the firing line to the bullet trap and 12 feet from the firing line to the back wall.

The ventilation system consists of one small supply duct which is 4 feet behind the firing line located at ceiling height and between station two and three. This duct is 7 inches wide and 13 inches long. The exhaust grill is 8 feet 10 inches in front of the firing line. It is located at ceiling height between station two and three. It is 12 inches wide and 22 inches long. There may be a second exhaust duct behind the bullet trap, but the NIOSH Investigator was unable to locate it.

The training officer is the permanent range officer. Because the police department felt that there was a health problem with this range there is no definitive program for the use of the range. In the past, 10 rounds only had been fired by the officers in order to qualify.

In the conduct of this study, the police department shooters were asked to fire 50 rounds over 30 minutes.

The ammunition was 148 grain Swage Lead Hollow Base Wadcutter from Star Reloading Company.

IV. EVALUATION METHOD

Breathing-zone samples and general area air samples were collected by using Mine Safety Appliance, Model G battery operated pumps with mixed Cellulose Ester Filters at a sampling rate of 1.5 liters per minute.

The samples were analyzed for lead in accordance with NIOSH atomic absorption procedure, Physical and Chemical Analysis Branch Method #S-341. The limit of detection was three micrograms of lead per sample.

A Kurz Portable Air Velocity Meter, Model 440 Thermal Anemometer and an Alnor Jr. swinging vane anemometer were used to measure air velocities at various locations within the firing range.

V. EVALUATION CRITERIA

A. Environmental Standards or Criteria

The current U. S. Department of Labor, Occupational Safety and Health Administration (OSHA) standard for employee exposure to airborne lead permits a time-weighted average exposure of 0.05 milligrams of lead per cubic meter of air (mg/M^3) sampled. This is the same as 50 micrograms per cubic meter (ug/M^3).

B. Biological Monitoring Requirements

The OSHA standard requires that the employer institute a medical surveillance program for all employees who are exposed to an airborne concentration of more than 30 micrograms per cubic meter (ug/M^3) of lead for more than 30 days a year.

Biological monitoring shall consist of blood sampling and analysis for lead and zinc protoporphyrins and shall be provided for each exposed employee at least every 6 months. It shall be provided at least every 2 months for every employee who has a blood level at or above 40 micrograms per 100 grams (ug/100g) of whole blood. This frequency shall continue until two consecutive blood samples indicate a blood level below 40 ug/100g of whole blood.

An employer shall remove an employee from his job when the employee's blood level exceeds 60 ug/100g of whole blood. A second follow-up shall be provided within 2 weeks after the employee receives the first results. The employee shall return to his former job status when two consecutive blood sampling tests are at or below 40 ug/100g of whole blood.

C. Toxic/Health Effects

Lead has been found to have profound adverse effects on the health of workers in the lead industry. Inhalation, the most important source of lead intake, and ingestion result in damage to the nervous, urinary and reproductive systems. The adverse health effects associated with exposure to lead range from acute, relatively mild, perhaps reversible stages such as inhibition of enzyme activity, reduction in motor nerve conduction velocity, behavioral changes, and mild central nervous system (CNS) symptoms, to permanent damage to the body and chronic disease.

The signs and symptoms of severe lead intoxication which occur at blood lead levels of 80 micrograms per 100 grams (ug/g) and above are well documented. The symptoms of severe lead intoxication include loss of appetite, metallic taste in the mouth, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pains, fine tremors, numbness, dizziness, hyperactivity, and colic. In lead colic, there may be severe abdominal pain, such that abdominal surgery mistakenly has occasionally been performed.

Evidence accumulated in both adults and children indicates that toxic effects of lead have both central and peripheral nervous system manifestations. The effects of lead on the nervous system range from acute intoxication, coma and cardiorespiratory arrest to mild symptoms, subtle behavioral changes, and electrophysiologic changes associated with lower level exposures.

With respect to the renal system, it is apparent that kidney disease from exposure to lead is more prevalent than previously believed. The hazard here is compounded by the fact that routine screening is ineffective in early diagnosis. Renal disease may be detected through routine screening only after about two-thirds of kidney function is lost or when manifestation of symptoms of renal failure are present.

Over-exposure to lead has profoundly adverse effects on the course of reproduction in both males and females. In the case of male workers, there is evidence of decreased sexual drive, impotence, decreased ability to produce healthy sperm, and sterility.

VI. EVALUATION OF RESULTS AND DISCUSSION

A. Lead Survey

Air sampling results appearing in Table 1 indicate that lead exposures for the four shooters and the range master were excessive. Assuming that exposures for the remainder of the day (period not sampled) is zero, the 8-hour time weighted averages (TWA) ranged from 940 to 1300 and far exceeded the standard of 50 ug/M^3.

Fortunately, this range was not being used at this time and had not been used for approximately a year.

Four area environmental lead samples were taken at the firing line. The firing booths were numbered one through four going from left to right as you stand at the rear and looked down range. A sample was taken at each firing booth. The height of the filter was approximately 66 to 72 inches. Two additional area samples were taken; one at a desk on the right wall of the range, approximately 5 feet high and one against the back wall behind booth two, approximately 4 feet high.

The 8-hour TWA for the firing line varied from 960 to 1520 ug/M^3. The lowest sample in the survey was the one taken at the back wall and was 750 ug/M^3. This is 15 times the 8-hour TWA concentration of 50 ug/M^3, the Department of Labor, OSHA Standard.

B. Ventilation Survey

The air supply consists of one grill in the ceiling located 4 feet midpoint between station two and three. It supplies air at the rate of 287 cubic feet per minute (cfm).

The air exhaust system consists of one grill located in the ceiling, 8 feet 10 inches from the firing line in a direct line with the supply grill. There is a fan located inside the grill. The duct from the grill feeds to a main duct which runs along the left side of the firing range at ceiling level. There is probably another exhaust grill behind the bullet trap although it could not be located. It may be attached to the main duct. The main duct exhausts to an outside grill. The air exhausted from the grill in front of the firing line is 178 cfm. The air exhausted to the outside is 911 cfm.

Air flow measurements were made at all four firing stations at 1', 3', 5' and 7'. Only two readings were at 50 linear feet per minute (fpm). These were at station two and were at 1' and 3'. All readings at 5' and 7' ranged from 10 to 35 fpm.

Air flows were checked 10 and 20 feet down range. The flow was minimal and so was not recorded.

VII. RECOMMENDATIONS

A. Ventilation

The ventilation in the range is extremely inadequate and is, therefore, exposing anyone who shoots there to high lead levels.

1. Air Supply

The recommended minimum air supply is 50 fpm at all points across the firing line. The optimum is 75 fpm at all points across the firing line.

a. The present air supply is 287 cfm.
b. Air Supply at 50 fpm = 6800 cfm.
c. Air Supply at 75 fpm = 10,200 cfm.

The air supply should be increased a minimum of 6500 cfm and preferably 10,000 cfm.

2. Air Exhaust

In air exhaust systems for firing ranges it is preferable to exhaust a portion of the air at ceiling height 10' to 20' down range from the shooting booths. The exhaust grills should extend across the width of the range for best results. The remaining portions should be exhausted at the target end of the range, preferably behind the bullet trap. The configuration which seems to give the best results is one which exhausts 20-40 percent of the air at the grills in front of the shooters and 60-80 percent at the bullet trap.

The amount of air exhausted from the firing range should exceed the amount of air supplied by 10 percent. This will ensure that the range is at a lower pressure than surrounding areas of the building so that fumes generated in the range will not escape to other parts of the building.

a. Present Quantity of Air Exhausted inside = 178 cfm
outside = 911 cfm.

b. Minimal Exhasut Air = Air Supply + 10% = 7480 cfm.

c. Optimal Exhaust Air = Air Supply + 10% = 11,200 cfm.

For more detailed information it is recommended that you read: HEW Publication No. (NIOSH) 76-130 Technical Document, "Lead Exposure and Design Considerations for Indoor Firing Ranges"; NIOSH Training Publication No. 438, "Safety and Health in the Indoor Firing Range".

B. Substitution

An approach which has been used in other ranges is the elimination or isolation of the major source of emission - the lead bullet. The bullet contains a lead slug plus a primer which contains lead styphnate and lead peroxide. Substituting copper jacketed, nylon jacketed or zinc slugs has been shown to give significant reductions in lead emissions when compared with traditional lead target ammunition. There will still be some lead generated from the primer. Nevertheless, non-lead or jacketed slugs coupled with adequate ventilation should significantly reduce lead contamination.

C. Respirator Selection

Currently 3M disposable half face respirators are used by the range officer and the shooters when the range is in operation. These are inadequate for use in this operation because of the high exposure levels. A full facepiece air purifying respirator with high efficiency filters is recommended at the airborne exposure levels measured at the range. Enclosed in Appendix 1 are the Respiratory Protection Requirements for exposure to airborne lead. This is

taken from Federal Register, Vol. 43, No. 220, Tuesday, November 14, 1978, Part IV, Department of Labor - Occupational Safety and Health Administration, Occupational Exposure to Lead - Final Standard. This installation is not specifically covered by this regulation. Nevertheless, it is an excellent guideline.

D. Biological Monitoring

It is recommended that the current range officer and previous range officers be started on a program of biological monitoring to ascertain what their current blood lead levels are and to determine whether they exceed the current OSHA standard.

VIII. REFERENCES

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4. Occupational Safety and Health Administration, Occupational Exposure to Lead, Federal Register, Volume 43-Number 220, November 14, 1978, pp. 53007-53014

5. Lee, S.A.: An Evaluation of Lead Exposure at an Indoor Firing Range, St. Bernard Police Department, St. Bernard, Ohio, DHHS (NIOSH) Health Hazard Evaluation and Technical Assistance Report No. TA 80-11, April 1980

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X. DISTRIBUTION AND AVAILABILITY

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Copies of this report have been sent to:

1. Cape Girardeau, Missouri Health Department
2. NIOSH Region VII
3. Department of Health, Missouri
4. OSHA, Region VII

Table 1

Lead Survey
Firing Range - Police Department
Cape Girardeau, Missouri

Sample Number	Type of Sample*	Location	Sampling Period	Measured Concentration (mg/M^3)**	8-hr. TWA Concentration (mg/M^3)***
1	Area	Booth 1	9:05-9:45 AM	18.3	1.52
2	Area	Booth 2	9:05-9:45 AM	13.6	1.14
3	Area	Booth 3	9:05-9:45 AM	11.6	0.96
4	Area	Booth 4	9:05-9:45 AM	18.3	1.52
5	Area	At Desk	9:05-9:45 AM	9.8	0.82
6	Area	At Wall Behind Booth 2	9:05-9:45 AM	9.00	0.75
7	BZ*	Shooter 1	9:05-9:36 AM	16.9	1.1
8	BZ	Shooter 2	9:05-9:38 AM	18.5	1.28
9	BZ	Shooter 3	9:05-9:37 AM	19.5	1.3
10	BZ	Shooter 4	9:05-9:35 AM	15.3	1.02
11	BZ	Range Officer	9:05-9:40 AM	12.9	0.94
U. S. Department of Labor Standard					0.05

* BZ = Personal Breathing Zone Sample
** mg/M^3 = Milligrams of lead per cubic meter of air sampled
*** TWA = Time-weighted-average concentration

Note: In calculating the 8-hour TWA concentration(s) for the firing range, consideration was given to actual exposure time of the personnel on the range. For example, an individual receiving a measured exposure of 18.6 milligrams of lead per cubic meter of air sampled (mg/M^3) during a thirty-three (33) minute period would receive an actual time-weighted exposure of 18.6 milligrams per cubic meter x (0.55 hr/8 hr) or 1.28 mg/M^3. In order for this approach to be valid, it is assumed that the applicable person leaves the area following completion of the firing period and does not return to the range area during the remainder of the 8-hour workday.

Appendix 1*

(f) Respiratory protection.

(1) General. Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement engineering or work practice controls except that after the dates for compliance with the interim levels in Table I, no employer shall require an employee to wear a respirator longer than 4.4 hours per day.

(ii) In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit; and

(iii) Whenever an employee requests a respirator.

(2) Respirator selection.

(i) Where respirators are required under this section the employer shall select the appropriate respirator or combination of respirators from Table II attached.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of the respirator specified in Table II whenever:

(A) An employee chooses to use this type of respirator; and

(B) This respirator will provide adequate protection to the employee.

(iii) The employer shall select respirators from among those approved for protection against lead dust, fume, and mist by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) under the provision of 30 CFR Part 11.

(3) Respirator usage.

(i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) Employers shall perform quantitative face fit tests at the time of initial fitting and at least semiannually thereafter for each employee wearing negative-pressure respirators. The test shall be used to select facepieces that provide the required protection as prescribed in Table II.

*Federal Register, Vol. 43, No. 220, November 14, 1978, Part IV, Department of Labor - Occupational Safety and Health Administration, Occupational Exposure to Lead, Final Standard

(iii) If an employee exhibits difficulty in breathing during the fitting test or during use, the employer shall make available to the employee an examination in accordance with paragraph (j)(3)(i)(C) of this section to determine whether the employee can wear a respirator while performing the required duty.

(4) Respirator program. (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134(b), (d), (e) and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator facepiece whenever necessary to prevent skin irritation associated with respirator use.

Table II

Respiratory Protection for Lead Aerosols

Airborne Concentration of Lead or Condition of Use	Required Respirator[1]
Not in excess of 0.5 mg/M^3 (10 x PEL)	Half-mask, air-purifying respirator equipped with high efficiency filters.[2] [3]
Not in excess of 2.5 mg/M^3 (50 x PEL)	Full facepiece, air-purifying respirator with high efficiency filters.
Not in excess of 50 mg/M^3 (1000 x PEL)	(1) Any powered, air-purifying respirator with high efficiency filters; or (2) Half-mask supplied air respirator operated in positive-pressure mode.[2]
Greater than 100 mg/M^3, unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure mode.

[1]Respirators specified for high concentrations can be used at lower concentrations of lead.

[2]Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

[3]A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.