U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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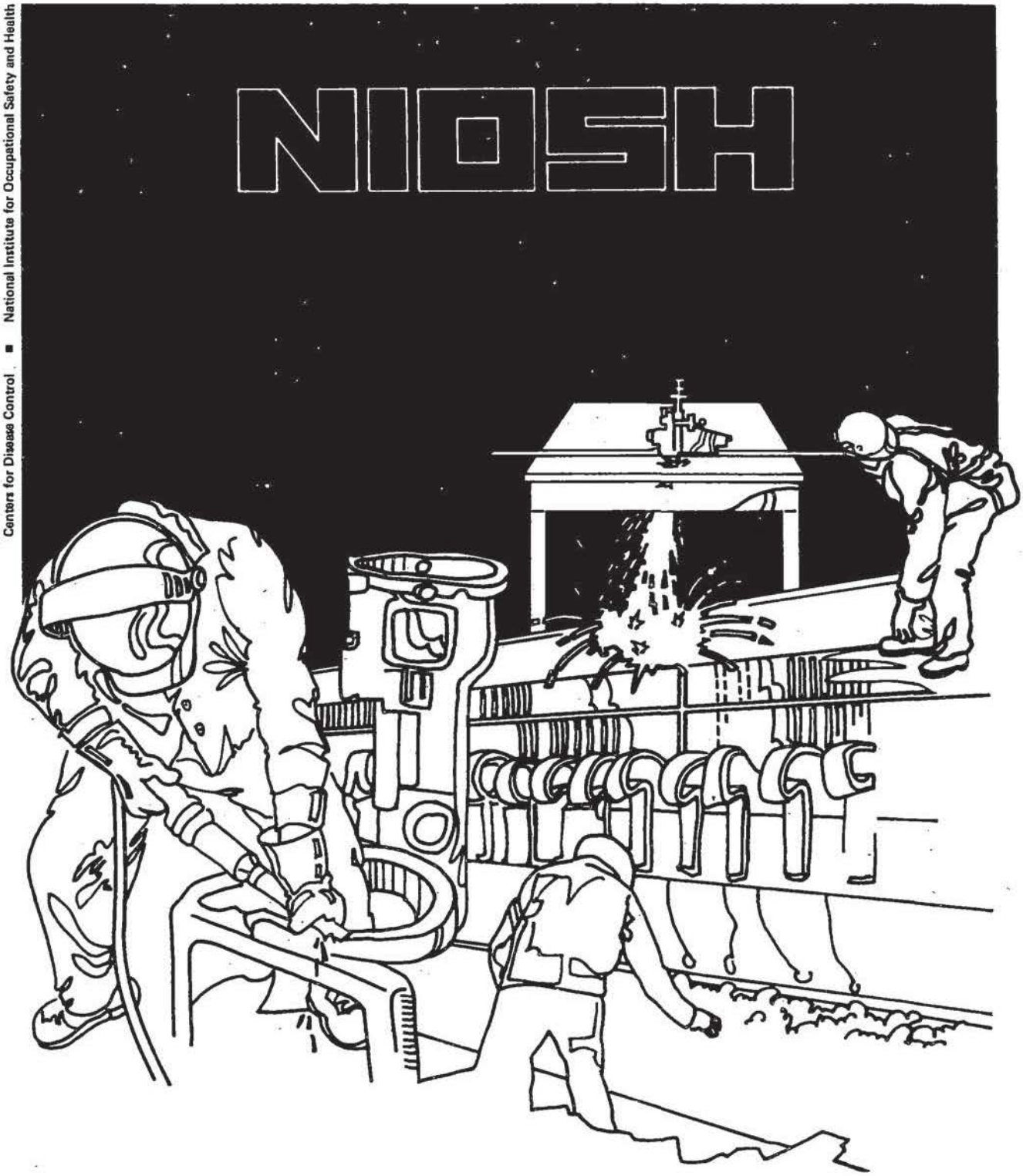

Health Hazard Evaluation Report

HETA 83-012-1354
ROBERT J. GOETZ, D.D.S.
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.

HETA 83-012-1354
AUGUST 1983
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I. SUMMARY

On October 19, 1982, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate the mercury exposure at Robert J. Goetz, D.D.S., dental clinic in Cincinnati, Ohio. Mercury was used during the preparation of dental amalgams for tooth fillings.

NIOSH conducted a preliminary site visit on December 14, 1982, and a follow-up visit on January 20, 1983. During the preliminary visit, a direct reading instrument was used to screen the clinic for mercury contamination. Personal and area environmental air samples were collected during the follow-up survey, along with urine, and hair samples for mercury determination.

Sampling results from the January follow-up visit revealed that the time weighted average (TWA) exposures for the dentist and his employees ranged from 0.010 to 0.014 mg/m^3. NIOSH recommends that TWA exposures to mercury vapor not exceed 0.05 mg/m^3. The maximum breathing zone exposure recorded in the amalgam preparation area was 0.07 mg/m^3. The OSHA permissible exposure limit restricts mercury exposure to a 0.10 mg/m^3 ceiling. Area sampling showed that mercury vapor levels in the laboratory averaged 0.01mg/m^3 for the full work shift. Six amalgams were prepared on the date of this survey, which was normal for this clinic.

The 24-hour urinary mercury excretion levels for the dentist and the dental assistant ranged from 8.0 to 9.6 micrograms of mercury per liter of urine (ug/l) when corrected to a specific gravity of 1.024. A conservative upper limit of normal urine mercury content is 30 ug/l. The hair sample mercury level was 8.7 parts per million (ppm). This is slightly higher than the range of normal concentrations reported by analytical laboratories of 2.0-6.0 ppm. However, urine mercury levels are the best guide to mercury absorption during exposure to mercury vapor.

A single direct reading result (0.07 mg/m^3) approached the OSHA ceiling standard of 0.10 mg/m^3. However, based upon the remaining environmental sampling results, and the biological sampling results, NIOSH concluded that there was no health hazard from overexposure to mercury at the Robert J. Goetz, D.D.S. dental clinic. Recommendations are included which may help to reduce peak exposures and to further reduce the low TWA mercury exposure levels.

KEYWORDS: SIC 8021 (Offices of Dentists), amalgam preparation, mercury

II. INTRODUCTION

In October 1982, NIOSH received a request for a health hazard evaluation at the dental clinic of Robert J. Goetz, D.D.S., in Cincinnati, Ohio. The request was initiated by Dr. Goetz. In March 1982, a person working in the dental clinic was diagnosed by a private physician as having a higher than normal mercury body burden following an elemental analysis of a sample of pubic hair. Dr. Goetz requested that NIOSH determine the possible health hazards of mercury exposure in his clinic. Mercury is a component of the amalgam used for fillings in teeth.

III. BACKGROUND

The Robert J. Goetz Dental Clinic is currently staffed with a dentist, a dental assistant, and a receptionist. The clinic contains a waiting room, receptionist area, employee lounge, three operatories (only two in use at the time), an x-ray room, and a laboratory. The operatories, x-ray room, and laboratory are tiled, while the remainder of the clinic is carpeted.

The mercury handling procedure is similar to that found in many dental offices. The mercury is purchased in one pound bottles. The amalgam preparation process consists of putting a six gram alloy tablet into a plastic capsule and adding a drop of mercury. The capsule is agitated on an amalgamator after which the amalgam is removed from the capsule and used for tooth filling purposes. During this process, it is possible for mercury contamination to occur. About three pounds of mercury are used per year at this clinic.

IV. METHODS AND MATERIALS

A. Environmental

A Bacharach Instrument Company, Mercury Sniffer®, Model MV2 was used on December 14, 1982, to screen the dental clinic for mercury contamination. This instrument works on the principle of atomic absorption of light at a wavelength of 253.7 nanometers. The Mercury Sniffer was used again on January 20, 1983, while connected to a strip chart-recorder, to monitor the laboratory amalgam preparation area. This provided mercury vapor air concentrations in the vicinity of the source in real time.

NIOSH also collected three personal breathing zone air samples and one area air sample on the January follow-up survey to evaluate elemental mercury vapor exposure during the preparation and use of the dental amalgams. The samples were collected using 3M #3600 Mercury Vapor Monitors. This device collects mercury vapor via diffusion onto a gold collection surface. Conductometric analysis of the gold-mercury amalgam was provided by the 3-M Company Analytical Service, St. Paul, Minnesota.

B. Medical

On January 20-21, 1983, 24-hour urine samples were obtained from the dentist and dental assistant. These samples were collected in 2500 ml specimen containers to which nitric acid had been added as a preservative. These were analyzed for mercury using flameless atomic absorption spectrometry (AAS) at UBTL, Salt Lake City, Utah.

Also, a pubic hair sample was obtained from one employee. This was analyzed for mercury via flameless AAS (UBTL).

V. EVALUATION CRITERIA

A. Environmental Criteria

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 are intended to 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, however, 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). Evaluation criteria may change over the years as new information on the toxic effects of an agent become 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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

NIOSH currently recommends that exposure to mercury vapor be limited to 0.05 mg/m^3 determined as a TWA exposure for an 8-hour workday.[2] The ACGIH recommends a 0.05 mg/m^3 TLV, and a 0.15 mg/m^3 STEL for mercury vapor.[3] The current OSHA standard for mercury is 0.10 mg/m^3 as a ceiling not to be exceeded in an 8-hour shift.[4]

B. Toxic Effects of Elemental Mercury:

Inhalation of high concentrations of mercury vapor for relatively brief periods can cause headaches, cough, chest pains, chest tightness, and difficulty in breathing. It may also cause chemical pneumonitis. In addition it may cause soreness of the mouth, loss of teeth, nausea, and diarrhea. Liquid mercury may irritate the skin.[1]

Repeated or prolonged exposure to mercury liquid or vapor causes effects which develop gradually. The first effects to occur are often fine shaking of the hands, eyelids, lips, tongue, or jaw. Erethism, a syndrome which may be ignored by the individual, or attributed to other causes, is characterized by irritability, outbursts of temper, excitability, shyness, resentment of criticism, and indecision. Other symptoms of mercurialism are headache, fatigue, allergic skin rash, sores in the mouth, sore and swollen gums, black line on gums, loose teeth and excess salivation.[1,2]

C. Medical Criteria

The complexities of renal excretory mechanisms for mercury make it difficult to correlate urine mercury levels with environmental exposures. However, the normal urine mercury level for persons non-occupationally exposed is nearly always less than 10 micrograms of mercury per liter of urine (ug/1).[5] A suggested guide for the interpretation of urine mercury levels in those occupationally exposed is as follows:[6]

Guide for Workers Exposed to Inorganic Mercury	Level of Mercury in Urine Micrograms/Liter
Normal Limits	Less than 30
Increased Absorption	Above 50
Warning	Above 100
Hazardous Level-remove from further exposure	Above 200
Symptoms of Mercury Poisoning May Occur	Above 300

Laboratories performing analyses of hair samples for mercury content have reported that upper levels of normal for mercury in hair ranges from 2.0 to 6.0 ppm by weight.[7,8]

VI. RESULTS AND DISCUSSION

A. Air Samples

Airborne mercury vapor was detected but at concentrations below current exposure criteria.

Figure 1 presents tracings from the strip chart-recorder connected to the Mercury Sniffer during the follow-up survey. Indicated are the mercury vapor peak breathing zone exposures experienced while preparing dental amalgams. The maximum exposure was 0.07 mg/m^3. The instrument was fairly steady at 0.01 mg/m^3 at other times. These results show that the OSHA ceiling concentration of 0.10 mg/m^3 was approached during this operation, but was not exceeded. (Figure 2).

The Mercury Vapor Monitor sampling results revealed that full shift TWA exposures for the dentist, dental assistant, and receptionist were 0.014, 0.013, and 0.010 mg/m^3 respectively. It can be seen graphically in Figure 2 that these exposures were below accepted TWA exposure criteria for mercury vapor. The single area sample result was 0.009 mg/m^3 which was in close agreement with Mercury Sniffer® indications.

B. Urine Samples

The two urine mercury analyses on clinic personnel were within the normal occupational exposure range of less than 30 ug/l. At 8.0 and 9.6 ug/l respectively (corrected to specific gravity of 1.024) the dentist and dental assistant mercury in urine results were inside the range of those not occupationally exposed, which is less than 10 ug/l. A control sample submitted showed a urine mercury level of 0.9 ug/l. Urine mercury levels are stated to be the best guide to blood mercury levels during exposure to inorganic or metallic mercury.[5] Therefore these levels are the best biological indicators of exposure for this evaluation.

C. Hair Samples

The mercury concentration in the hair sample from the dentist was 8.7 ppm. This level is in agreement with his previously reported level of 7.8 ppm. Both levels are slightly higher than the upper range of normal reported by analytical laboratories of 6.0 ppm.

Interpretation of this result may not be relevant in this evaluation since hair mercury concentrations correlate well with blood mercury concentrations during exposure to methylmercury, but not to elemental mercury vapor, as is the case in dental operations.[5]

VII. CONCLUSION

A single direct reading breathing zone result (0.07 mg/m^3) approached the OSHA ceiling standard. However, based upon the remaining air sample results, and urine sample results, it is concluded that exposures to mercury in this clinic are such that they should not present a health hazard to clinic personnel.

VIII. RECOMMENDATIONS

The following recommendations should help to reduce peak exposures and further reduce the already low TWA exposures:

1. Store mercury in unbreakable, tightly sealed containers.
2. Perform all operations involving mercury over areas that have impervious and suitably lipped surfaces so as to confine and facilitate recovery of spilled mercury or amalgam.
3. Clean up any spilled mercury immediately. Droplets may be picked up with narrow bore tubing connected (via a wash-bottle trap) to the low-volume aspirator of the dental unit.
4. Use tightly closed capsules during amalgamation.
5. Use a no-touch technique for handling the amalgam.
6. Salvage all amalgam scrap and store it under water.
7. Work in well-ventilated spaces.
8. Avoid carpeting dental operatories as decontamination is not possible.
9. Avoid heating mercury or amalgam.

10. Alert all personnel involved in handling of mercury, especially during training or indoctrination periods, of the potential hazard of mercury vapor and the necessity for observing good mercury hygiene practices.

IX. REFERENCES

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7. ACTUS Environmental Laboratory, Florence, Kentucky

8. Community Health Center, 375 Glensprings Drive, Cincinnati, Ohio

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XI. 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. Robert J. Goetz, D.D.S.
2. NIOSH, Region V
3. OSHA, Region V

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.

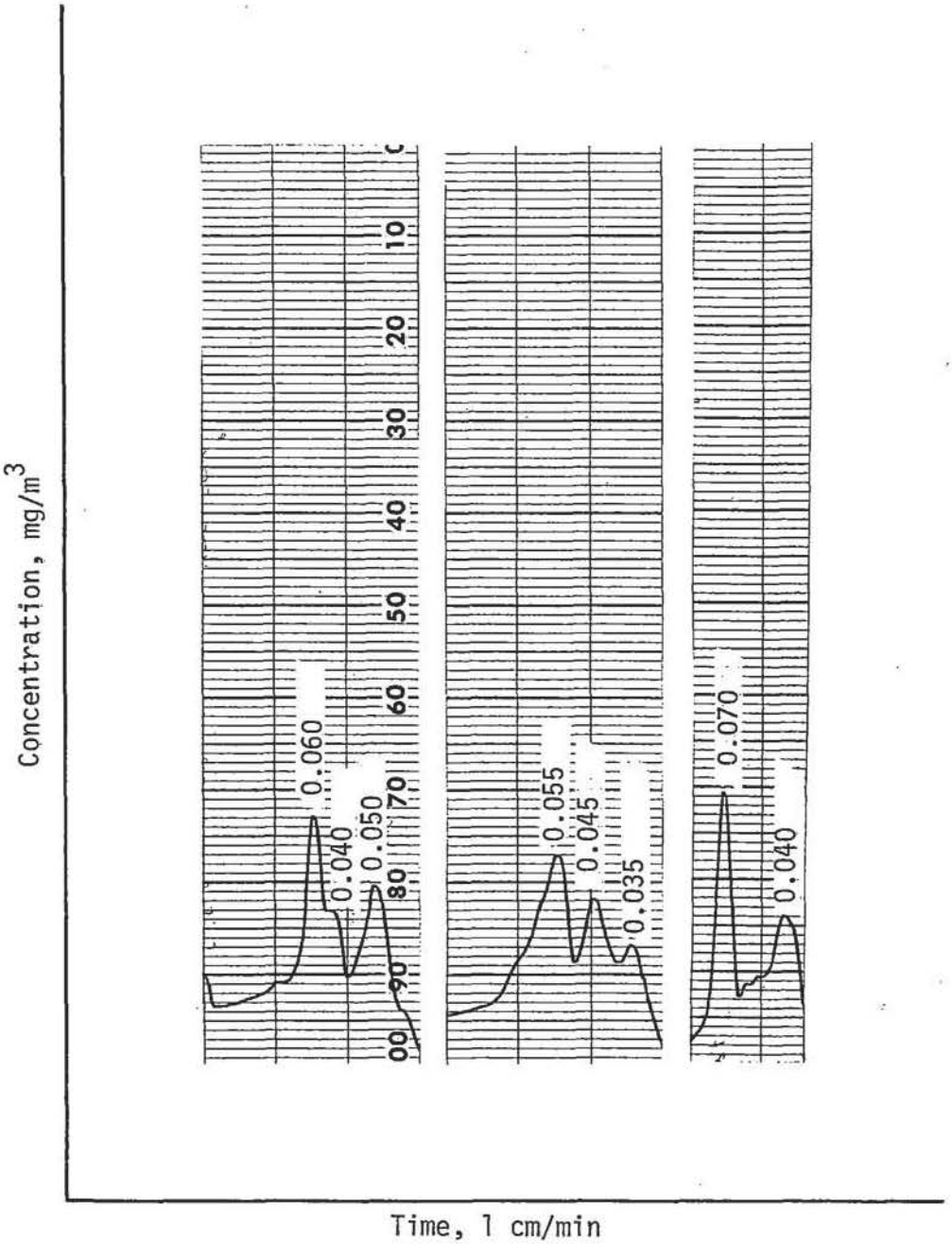
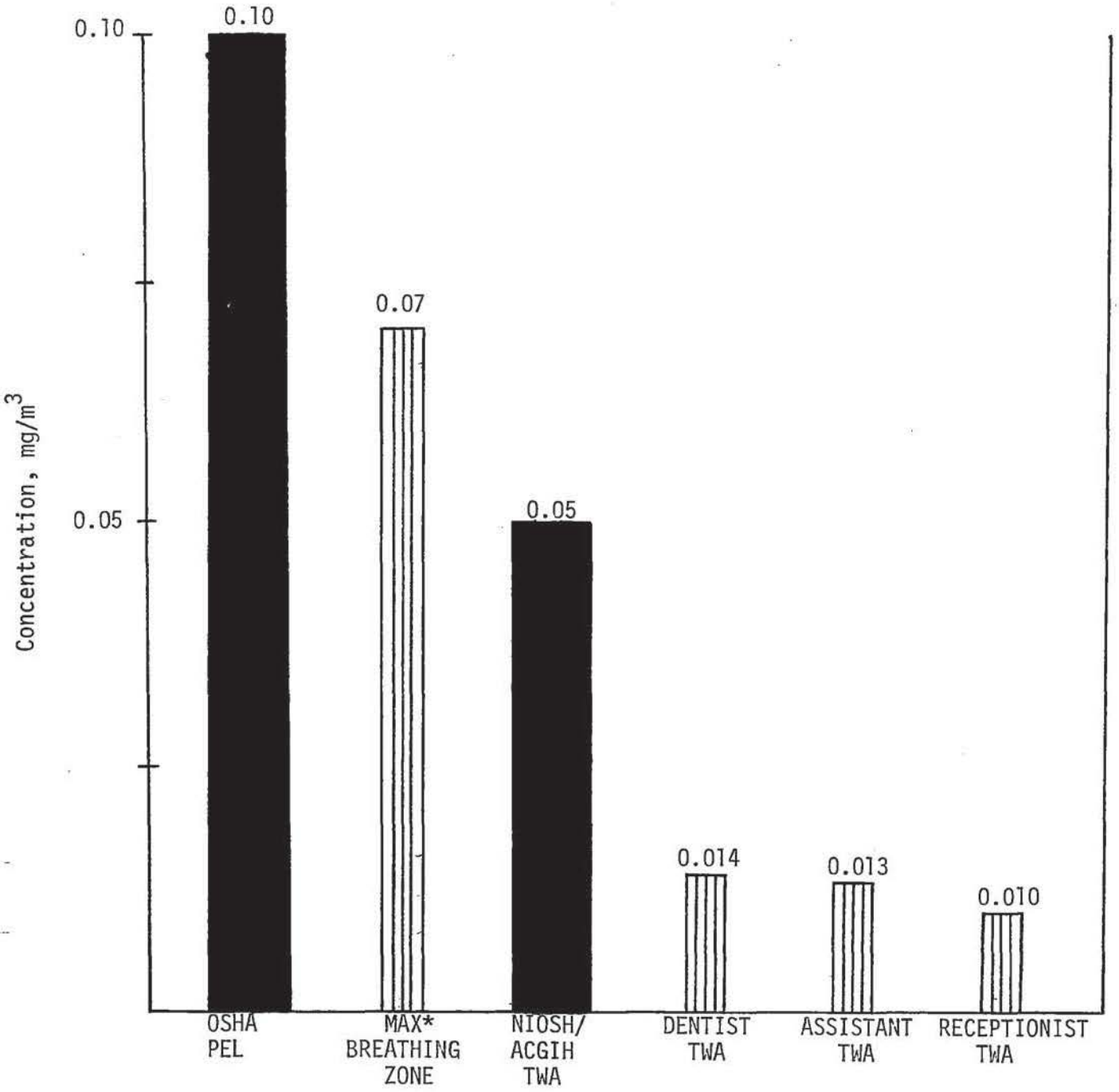


Figure 1. Mercury Vapor Exposure Experienced During Amalgam Preparation



*Highest Direct Reading Instrument Breathing Zone Data Point While Preparing Amalgam

Figure 2. Comparison of Mercury Results With Standards.