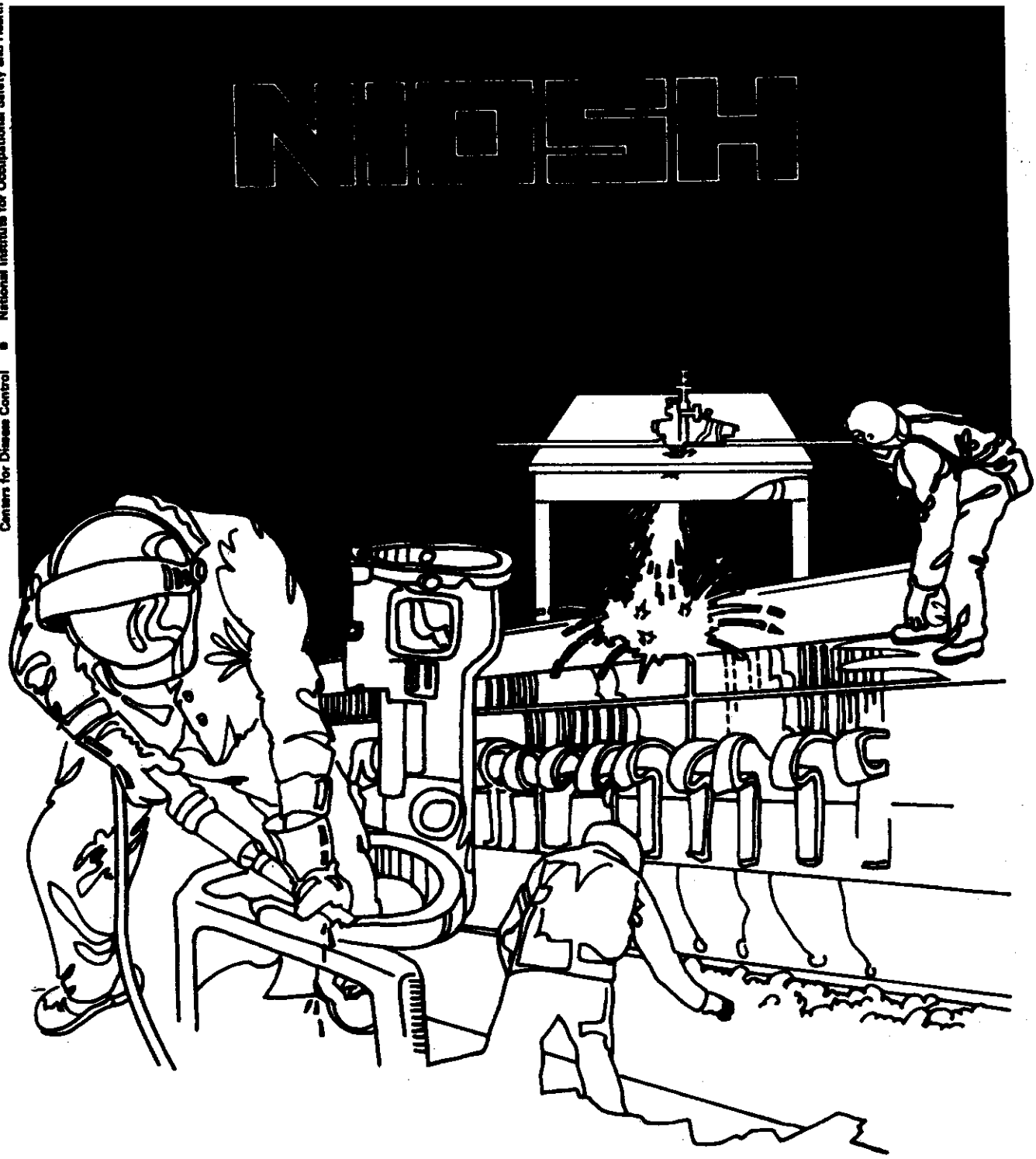
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 87-431-1916
BOLLES OPERA HOUSE
WEST CHICAGO, ILLINOIS

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 87-431-1916
JULY 1988
BOLLES OPERA HOUSE
WEST CHICAGO, ILLINOIS

NIOSH INVESTIGATOR:
Christopher M. Reh

I. SUMMARY

In September 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Environmental Protection Agency to assess the extent of mercury contamination in the Bolles Opera House, West Chicago, Illinois.

NIOSH investigators conducted initial and follow-up surveys at the Bolles Opera House on November 5 and December 17, 1987. During the initial survey, a Jerome Model 411 Gold Film Mercury Vapor Analyzer was used to perform short term, area air sampling in all the rooms of the Bolles Opera House. Fourteen rooms or areas within this building had detectable mercury levels. These levels were mostly under the NIOSH recommended exposure limit of 50 micrograms per cubic meter (ug/m^3), though two readings of 100 and 742 ug/m^3 were found in the basement where the old, mercury contaminated plumbing is stored. The ambient mercury level for the West Chicago Area was below the limit of detection of 1 ug/m^3.

Based on the above data, a follow-up survey was performed utilizing more aggressive, long term air sampling techniques. Mercury in air was collected by drawing air through a solid sorbent (hopcalite) and analyzing this sorbent using cold vapor atomic absorption spectroscopy. This method has a limit of detection (LOD) of 0.02 ug of mercury per sample and a limit of quantitation (LOQ) of 0.036 ug of mercury per sample. Area air sampling was performed in the areas with elevated mercury levels, as indicated by the initial survey. Of the 18 air samples collected, 10 found non-detectable levels of mercury and 5 found levels between the LOD and LOQ. One air sample was above the NIOSH recommend limit of 50 ug/m^3, with this being 82 ug/m^3. This sample was taken in the basement near the old, mercury contaminated pipes. Urine monitoring for mercury was performed on twelve workers in this building, with these samples being corrected for dilution using creatinine. All of these samples were below the LOD of 4 ug/g of creatinine, which are normal urine mercury levels in people who are not exposed to mercury.

On the basis of these results, the NIOSH investigator found no evidence that a health hazard from mercury exposure exists in this building. However, the basement area where the old, mercury contaminated plumbing is stored appears to be contaminated and poses a potential health hazard. Recommendations are made in Section IX to remove the pipes and to clean-up the area.

KEYWORDS: SIC 7399 (Business Services, Not Elsewhere Classified), SIC 7391 (Research and Development Laboratories), mercury, mercury contamination, mercury clean-up and disposal.

II. INTRODUCTION

In September of 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at the Bolles Opera House in West Chicago, Illinois. The request was submitted by the Public Health Advisor for the Environmental Protection Agency (EPA), Region V, on the behalf of the owner of the Bolles Opera House. The request concerned evaluating the extent of mercury contamination by the previous owner of the building.

III. BACKGROUND

Bolles Opera House is a brick building in downtown West Chicago which was formerly owned by Kerr-McGee Chemical Corporation. This three story building (plus basement) was purchased by Kerr-McGee in the early 1940's and used as a sales office and laboratory for producing thorium from thorium ore.

In 1976, the present owner purchased the building from Kerr-McGee with plans of converting the facility into a modern office building. The renovation included the removal of the existing plumbing, which was extensive and consisted of lead pipes. When drain traps and drain pipes on the second floor were broke open, inorganic mercury spilled to the floor. It is not known how much mercury spilled, though the owner anecdotally referred to the amount as being considerable. The owner and his family attempted to clean up the mercury spill, but they were unable to remove the minute amounts lodged in the cracks and crevices of the wood floors. Since this event, the spill areas have been covered with either carpet or linoleum.

Presently, the Bolles Opera House houses the owner's small business which converts hardcopies of files into microfilm and microfiche, with approximately 20 people working in the building. None of the operations performed in this building use mercury or its related compounds.

IV. EVALUATION DESIGN AND METHODS

Since Kerr-McGee performed laboratory activities throughout the Bolles Opera House, the entire building was tested for mercury contamination. On November 4, 1987, an initial survey was conducted by a NIOSH industrial hygienist to determine if the building was possibly contaminated. The survey instrument was a Jerome Instrument Corporation's Model 411 Gold Film Mercury Vapor Analyzer. This instrument contains a thin gold film which selectively absorbs inorganic mercury from an air sample. This phenomenon produces an increase in electrical resistance across the film, which is proportional to the mass of mercury in the sample. The Model 411 was operated in the "sample mode" which collects a 125 milliliter air

sample and has a minimum detectable concentration of 1 microgram of mercury per cubic meter of air (ug Hg/m^3).[1] Sampling was performed in the various rooms on all three floors and in the basement, concentrating on the areas where mercury spills were known to have occurred. Several samples were also taken outside of the Bolles Opera House in order to determine the ambient, environmental mercury levels for the West Chicago area.

After reviewing the data from the initial survey, a second survey was planned in order to use more decisive survey techniques. On December 17, 1987, NIOSH industrial hygienists conducted a follow-up survey consisting of both air sampling and biological monitoring. Area samples for mercury were collected using a solid sorbent tube containing hopcalite (a mixture of manganese and copper oxides) as air was sampled at a nominal flowrate of 0.2 liters per minute (lpm) through a calibrated, battery-powered sampling pump.[2,3] Several rooms in the Bolles Opera House were targeted for sampling based on the data from the initial survey. After sampling, the hopcalite was ashed with nitric and hydrochloric acids. After dissolution was complete, the samples were diluted to volume with deionized water. Aliquots of 25 milliliters were then pipetted into BOD bottles and diluted to 100 milliliters with 10% nitric acid. The mercury was then reduced by the addition of stannous chloride and the samples were analyzed by cold vapor atomic absorption spectroscopy. The limit of detection (LOD) for this method is 0.02 micrograms of mercury per sample. The limit of quantitation (LOQ) is 0.036 micrograms of mercury per sample.

The biological monitoring consisted of spot urine samples which were obtained from 12 of 20 workers in the Bolles Opera House. These samples were collected in specimen containers to which hydrochloric acid had been added as a preservative. All spot samples were corrected for dilution using urinary creatinine levels as the correction factor. The samples were analyzed by MetPath, Inc. in Teterboro, New Jersey. MetPath reported a limit of detection of 4.0 micrograms of mercury per liter of urine.

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).

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 become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Recommended Exposure Limits (RELs),[4] 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[5] and 3) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs)[6] Often, the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH RELs and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA PELs also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily 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 required by the Occupational Safety and Health Act of 1970 (29USC 651, et seq.) to meet 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.

B. Toxic Effects of Inorganic Mercury

Acute or short-term exposure to high concentrations of mercury vapor can cause headaches, cough, chest pains, chest tightness, and difficulty in breathing. In addition to this, mercury may also produce soreness of the mouth and gums, nausea, fever, and diarrhea.[7,8]

Chronic or long-term exposure to mercury is more common, with the central nervous system being the target organ. The clinical manifestation is termed erethism, which is various personality changes associated with mercury intoxication. These changes include increased irritability, depression, paranoia, insomnia, loss of memory and tremors of the limbs (usually the hands). Mercury may remain unsuspected as causing these symptoms since their onset is gradual. Other symptoms of chronic mercury intoxication are inflammation of the mouth and gums, damage to the kidneys (proteinuria, which may lead to nephrosis), allergic skin rash, loss of appetite and weight, fatique, and anemia.[9]

Current scientific literature yields only a limited amount of information on the reproductive effects of inorganic mercury in humans. It has been demonstrated that elemental mercury does pass the placental barrier and appears in fetal blood. At birth, mercury levels in fetal plasma are approximately 30% higher than maternal plasma levels.[10] In animals, exposure to mercury vapor has been associated with litter resorption, growth retardation, and various birth defects (cleft lip and palate, rib fusions, and syndactylia).[11] Presently, no data have demonstrated a risk to pregnant women at exposure levels below the NIOSH recommended standard, though it is prudent to minimize exposure to these members of the working population.

C. Exposure Criteria

NIOSH currently recommends that exposure to mercury vapor be limited to 50 ug/m^3 determined as a TWA exposure for up to an 8-hour workday.[4,8] The ACGIH recommends a 50 ug/m^3 TLV, and a 15 ug/m^3 STEL for mercury vapor.[5] The OSHA PEL for mercury vapor is 100 ug/m^3 which is a ceiling level that should not be exceeded during a workday.[6]

D. Medical Criteria

In persons not occupationally exposed to mercury, the concentration of mercury in urine is usually less than 5 ug/g of creatinine. Since mercury in seafood is normally methylmercury (which is not excreted through the kidney), dietary habits do not influence urine mercury levels. It should be noted that some dental procedures use mercury-based materials and may temporarily increase the excretion of mercury in the urine.[12]

For populations of workers who have chronic exposure to mercury, we recommended using the World Health Organization's biological threshold limit value of 50 ug/g of creatinine for mercury in the urine.[13]

VI. RESULTS

Data from the initial survey using the Jerome Model 411 Mercury Vapor Analyzer are presented in Table I. Mercury levels in all other areas of the building were below the detection limit of this instrument, which subsequently reported the level as zero. Airborne concentrations of mercury in the Bolles Opera House ranged from the non-detectable levels to 742 ug/m^3. The highest levels were found in the first floor "Special Products Room" and in the basement were the old, contaminated plumbing is stored. Only three samples were above the NIOSH REL (one under the sink in the Special Products Room, two in the old plumbing storage area of the basement), while only two of these samples were above the OSHA PEL. Sampling of outside air in West Chicago found ambient mercury concentrations which were non-detectable.

Based on the results of the initial survey, the NIOSH investigator decided to perform general, area sampling for mercury in the following rooms: 306-lobby, 306-right office, 306-middle office, 306-left office, 307, 309, 310, 201, 203, 205-kitchen, 208, furnace room, basement-pipe storage area, and the Special Products Room-under the sink. The locations of these samples in the various rooms of the Bolles Opera House are shown in Figures 1-4. Air samples collected using the solid sorbent/hopcalite method are presented in Table II. Area mercury concentrations range from non-detectable values to 82 ug/m^3. Ten of the eighteen samples showed non-detectable airborne concentrations, while another five of these samples showed airborne concentrations which were between the LOD and the LOQ for the above method. The one sample which showed an 82 ug/m^3 level in the basement was the only sample above the NIOSH REL. This sample was obtained in the area where mercury contaminated plumbing is stored and is an area which is infrequently visited by workers. As before, the sample taken outside the building showed non-detectable ambient levels of mercury.

The data from the urine samples received from 12 employees who work in the Bolles Opera House, are shown in Table III. Several of the workers in this group have been employed in this building for 10 years or more. All urine mercury levels were below the LOD of 4 ug/g of creatinine for this method.

VII. DISCUSSION

For the most part, the airborne mercury levels were either non-detectable or extremely low. Though a level exceeding the NIOSH REL was found in the basement, the amount of mercury collected by this area sample was greatly influenced by the proximity of the old, mercury contaminated plumbing. Removal of these pipes from the building should greatly reduce mercury levels in the basement.

The fact that airborne concentrations of mercury are very low in this building is also supported by the biological monitoring data. All urine samples submitted by 12 employees at the Bolles Opera House showed urine mercury levels below the 5 ug /g of creatinine standard for groups of people not occupationally exposed to mercury.

VIII. CONCLUSION

The airborne mercury concentrations within the Bolles Opera House constitute no long or short term health hazard to the occupants of this building. The old plumbing storage area within the basement is the only area which may have some mercury contamination.

IX. RECOMMENDATIONS

The following recommendations are made per the conditions encountered during the NIOSH surveys:

1. Remove the mercury contaminated pipes from the basement of the Bolles Opera House and dispose of them properly. According to the Resource Conservation and Recovery Act (RCRA), 40 CFR 261, the pipes are considered to be a hazardous waste and must be disposed of in an approved hazardous waste landfill.

2. After removing the pipes, that area of the basement must be cleaned since it may be contaminated with mercury. This can be accomplished using a mercury vacuum cleaner or a mercury cleaning solution (such as HgX).

3. The City of West Chicago should be notified that the previous owner of the building (Kerr-McGee) disposed of unknown amounts of mercury via the City's sewer system. Since the fate of this mercury is unknown, we recommend that testing be performed in the sewer system at points directly under and downstream of the Bolles Opera House.

X. REFERENCES

1. Jerome Instrument Corporation: Model 411 Gold film Mercury Vapor Analyzer: Instruction Manual. Jerome Instrument Corp. Jerome, Arizona, May 1984.

2. National Institute for Occupational Safety and Health: Mercury in hopcalite tubes - draft of method. Cincinnati, Ohio: National Institute for Occupational Safety and Health, September 1982.

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13. World Health Organization: Report of a study group: recommended health-based limits in occupational exposure to heavy metals. Technical Report Series 647. Geneva: WHO, 1980.

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 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. Building Owner, Bolles Opera House
2. EPA, Region V, Radiation Expert
3. EPA, Region V Public Health Advisor
4. NIOSH, Cincinnati Region
5. 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.

Table I

Results from Area Survey with Jerome Model 411
Mercury Vapor Analyzer

Bolles Opera House
West Chicago, Illinois
HETA 87-431

November 4, 1987

SAMPLE LOCATION	CONCENTRATION[1]
Room 205, Kitchen Countertop	15
Room 205, Kitchen Countertop	17
Room 205, Under Sink	5
Room 205, Floor Level	3
Room 201, Floor Level	2
Room 201, Middle of Room	1
Room 203, Middle of Room	4
Room 208, Middle of Room	4
2nd floor, Furnaceroom, Floor Level	2
2nd floor, Furnaceroom, Floor Level	4
Room 306, Lobby	9
Room 306, Right Office	5
Room 306, Right Office	5
Room 306, Middle Office	6
Room 306, Middle Office	4
Room 306, Left Office	3
Room 306, Left Office	3
Room 304, Middle of Room	4
Room 305, Middle of Room	5
3rd Floor Hallway	4
Room 307, Middle of Room	8
Room 307, Floor Level	8
Room 307, Floor Level	20
Room 308, Middle of Room	1
Room 308, Middle of Room	4
Room 309, Floor Level	7
Room 309, Middle of Room	5
Room 309, Floor Level	2
Room 310, Middle of Room	13
Room 310, Floor Level	9
Special Products Room, Under Sink	40
Special Products Room, Under Sink	52
Special Products Room, Under Sink	12
Basement, Bottom of Stairs	12
Basement, Bottom of Stairs	8
Basement, Old Plumbing Storage	30
Basement, Old Plumbing Storage	21
Basement, Old Plumbing Storage	742
Basement, Old Plumbinb Storage	31
Basement, Old Plumbing Storage	100
Outdoors, Ambient West Chicago Air	0
Outdoors, Ambient West Chicago Air	0
Outdoors, Ambient West Chicago Air	0

Limit of Detection: 1 ug Hg per cubic meter of air

[1] Units expressed in micrograms of mercury per cubic meter of air.

Table II

Results From Area Sampling for Mercury

Bolles Opera House
West Chicago, Illinois
HETA 87-431

December 17, 1987

Sample Number	Sample [1] Location	Sample Time	Sample[2] Volume	Concentration[3]
1	Room 306, Lobby Area	8:55 - 15:39	79.2	(0.3)
2	Room 306, Right Office	8:57 - 15:39	76.3	(0.4)
3	Room 306, Middle Office	8:56 - 15:39	78.8	(0.4)
4	Room 306, Left Office	8:57 - 15:39	76.8	0.6
5	Room 307	8:59 - 15:39	81.1	ND
6	Room 309	9:01 - 15:39	78.4	ND
7	Room 310	9:03 - 15:39	77.3	ND
8	Room 205, on floor	9:06 - 15:39	80.4	(0.3)
9	Room 201	9:08 - 15:39	54.8	ND
10	Room 203	9:11 - 15:39	77.3	ND
11	Room 208	9:12 - 15:47	78.1	ND
12	Room 205, Kitchen Counter	9:14 - 15:39	78.4	ND
13	2nd Floor, Furnace Room	9:14 - 15:47	76.6	ND
14	Basement, Pipe Storage, Entrance	9:23 - 15:47	76.6	82.0
15	Basement, Pipe Storage, Backwall	9:24 - 15:47	75.7	0.6
16	1st Floor, Special Products, Under Sink	9:26 - 15:47	78.7	(0.4)
17	2nd Floor, Hallway	9:43 - 15:39	70.9	ND
18	Outdoors, Ambient Air	9:45 - 15:46	69.6	ND
	NIOSH REL			50
	OSHA PEL			100

Limit of Detection: 0.02 ug Hg per sample
Limit of Quantitation: 0.036 ug Hg per sample

1 Location of area samples shown in Figures I, II, III, and IV. Individual samples are identified by the "Sample Number."

2 Units expressed in liters of air.

3 Units expressed in micrograms of mercury per cubic meter of air.

Table III

Results from Urine Sampling for Mercury

Bolles Opera House
West Chicago, Illinois
HETA 87-431

December 17, 1987

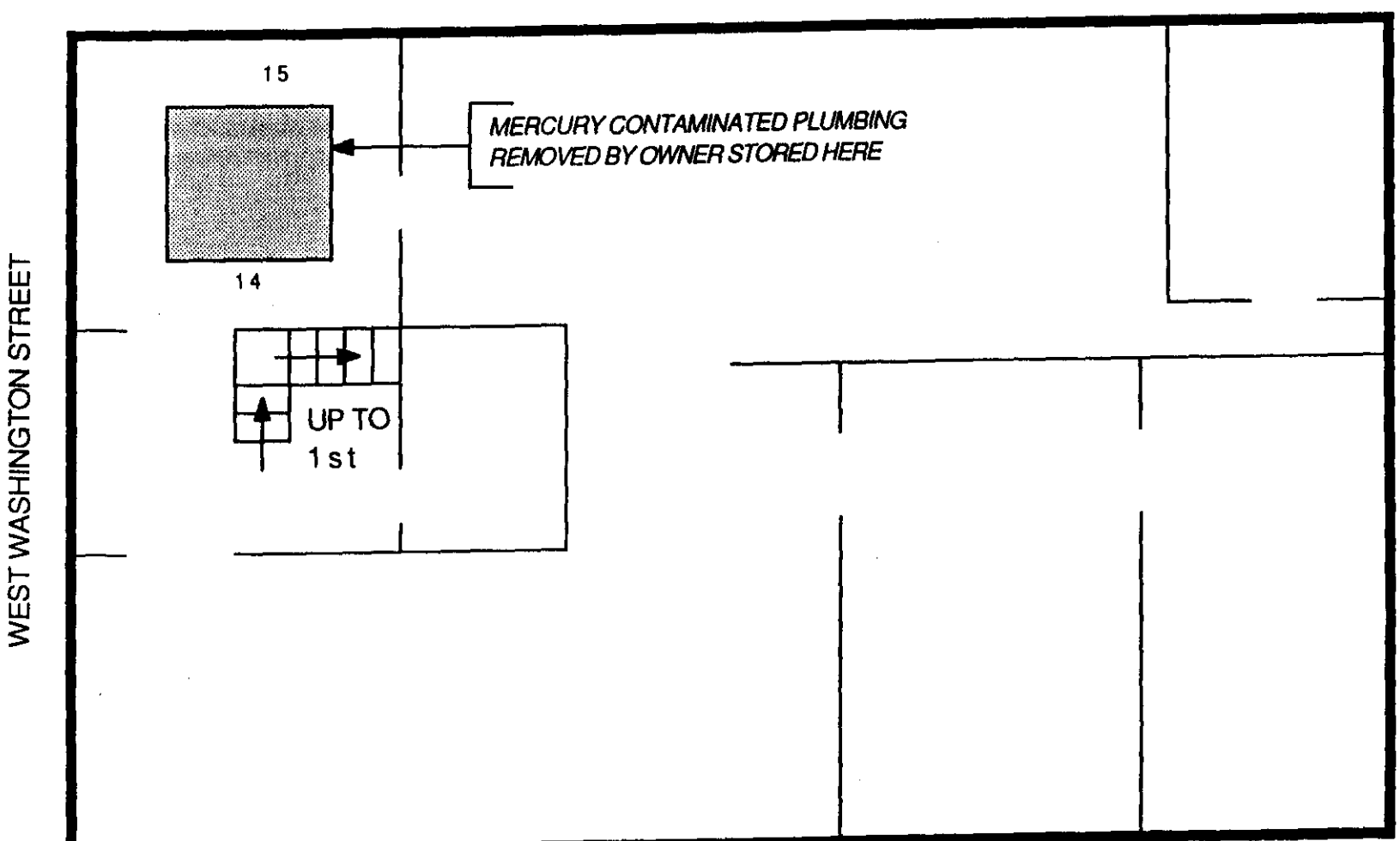
SEX	AGE	YEARS OF[1] SERVICE	URINE Hg[2] LEVELS
Female	45	3	<4.0
Female	18	0.3	<4.0
Female	51	1.5	<4.0
Male	37		<4.0
Male	62	11	<4.0
Male	56	11	<4.0
Male	58	10	<4.0
Female	57	11	<4.0
Male	53		<4.0
Male	34	11	<4.0
Female	54	7	<4.0
Female	48	10	<4.0

Limit of Detection: 4 ug Hg per gram of creatinine

1 Number of years a worker has been employed in the Bolles Opera House.

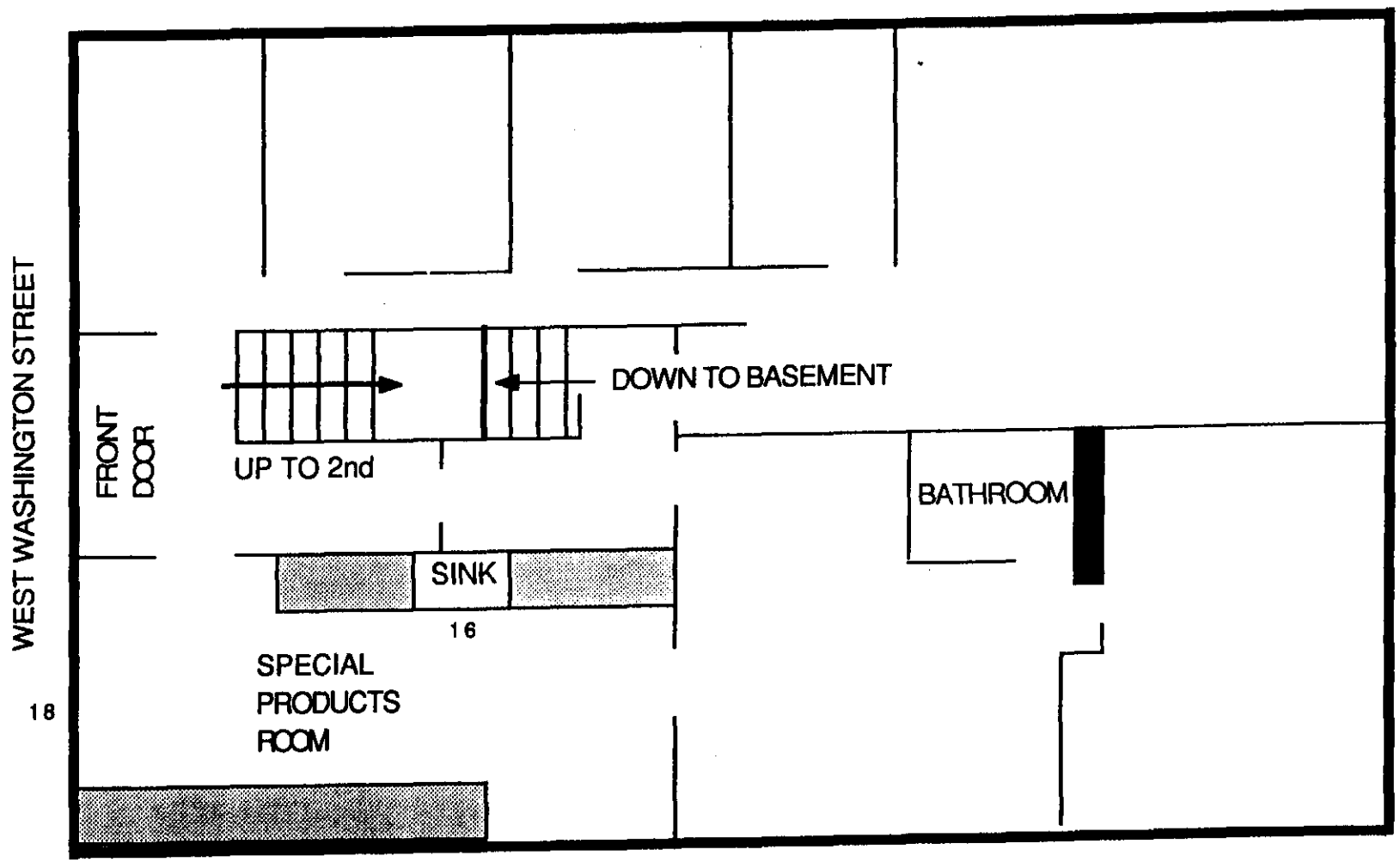
2 Units expressed in micrograms of mercury per gram of creatinine. All urine mercury levels were below the limit of detection.

FIGURE 1 - BASEMENT OF BOLLES OPERA HOUSE



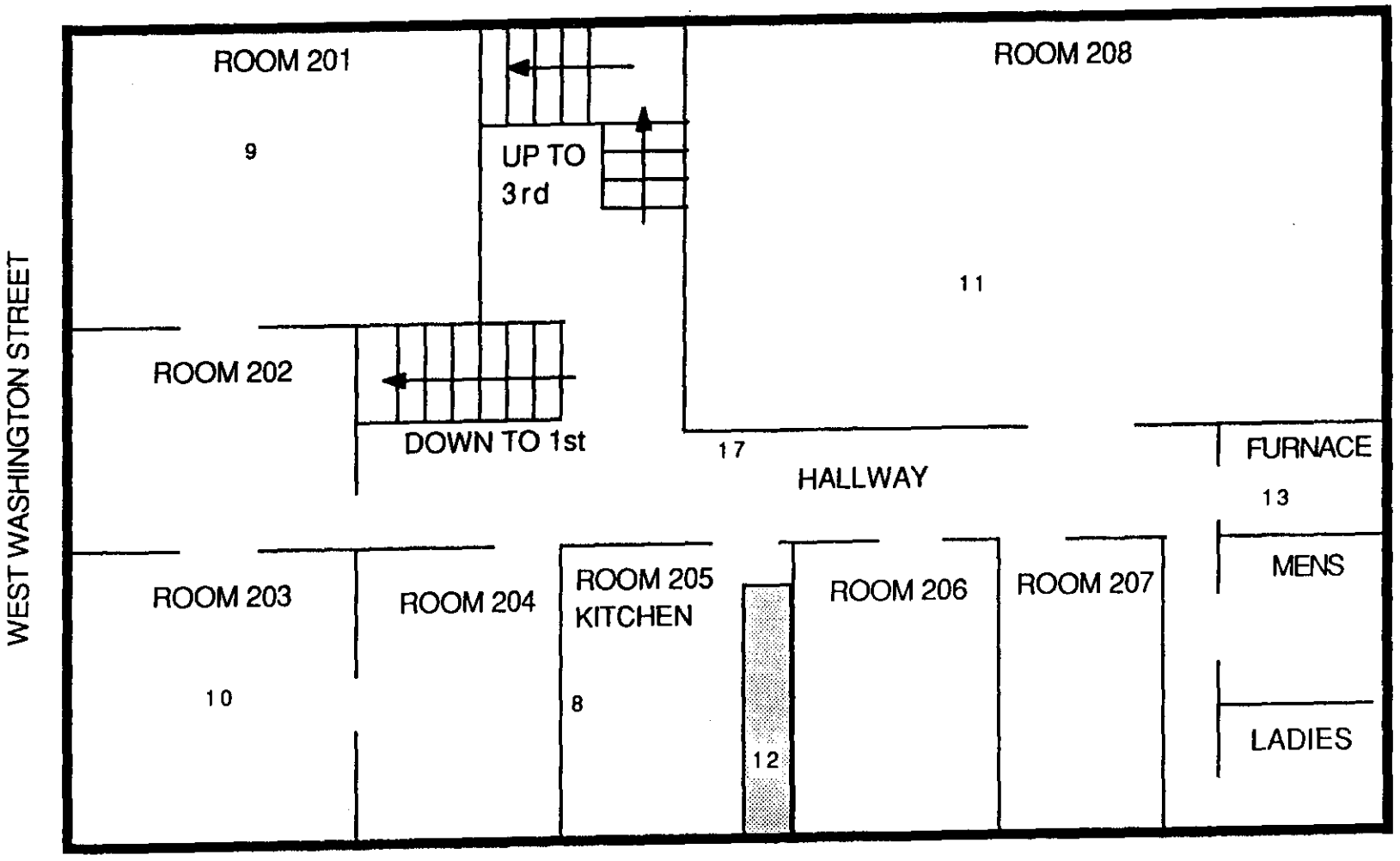
NUMBERS IN ABOVE FLOOR PLAN CORRESPOND TO SAMPLE NUMBERS IN TABLE II

FIGURE 2 - FIRST FLOOR OF BOLLES OPERA HOUSE



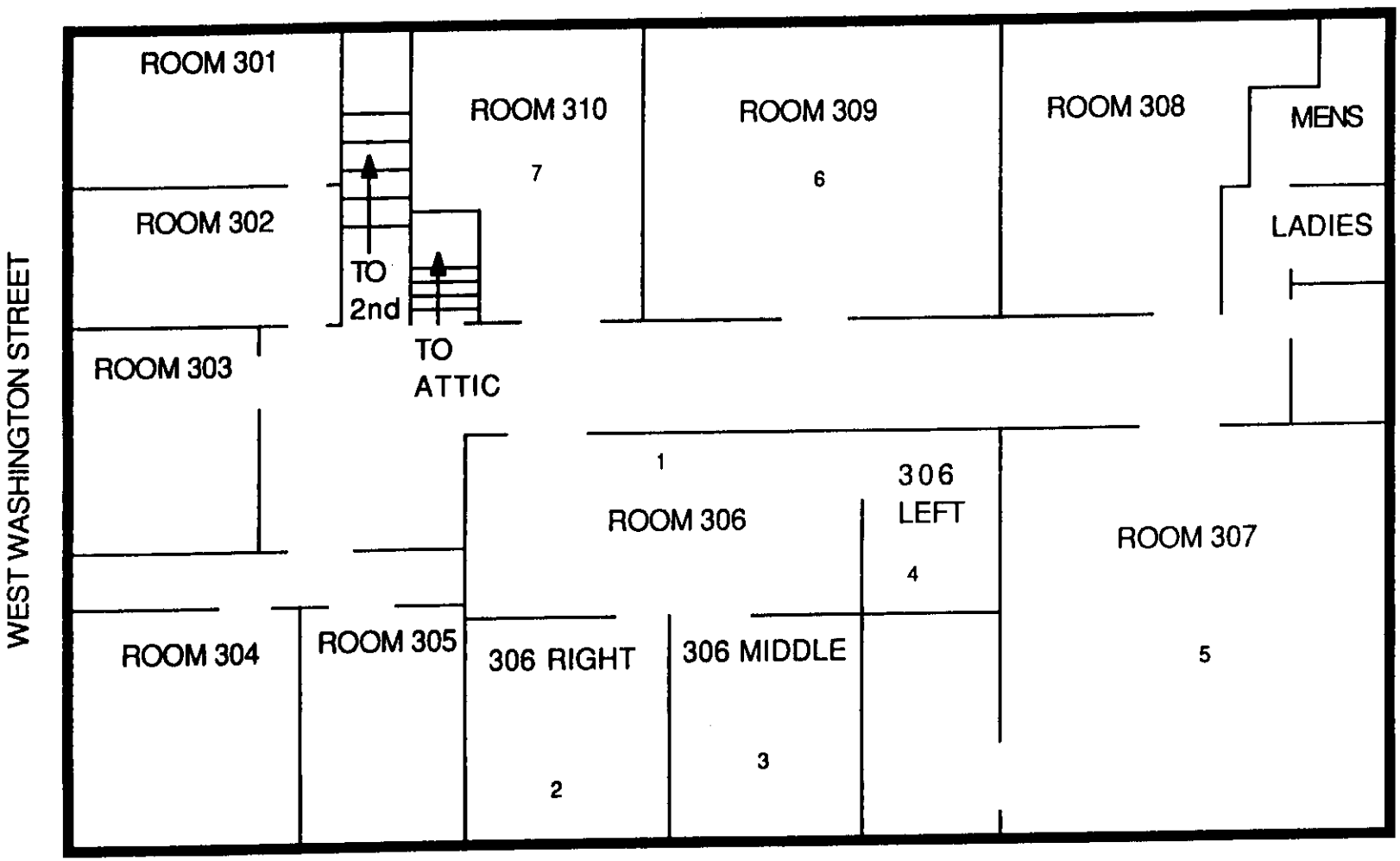
NUMBERS IN ABOVE FLOOR PLAN CORRESPOND TO SAMPLE NUMBERS IN TABLE II

FIGURE 3 - SECOND FLOOR OF BOLLES OPERA HOUSE



NUMBERS IN ABOVE FLOOR PLAN CORRESPOND TO SAMPLE NUMBERS IN TABLE II

FIGURE 4 - THIRD FLOOR OF BOLLES OPERA HOUSE



NUMBERS IN ABOVE FLOOR PLAN CORRESPOND TO SAMPLE NUMBERS TABLE II