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16. Abstracts A Hazard Evaluation and Technical Assistance survey was conducted by NIOSH on July 1 and 6-7, 1977 at the thermometer fabrication, assembly, and shipping and receiving areas of the Jay Instruments and Specialty Company, Cincinnati, Ohio. The survey was requested by the management as a follow-up to a Health Hazard Evaluation conducted April 1976. Employee exposures to mercury were within 80% of the NIOSH recommended standard, but there was evidence of continuous increased absorption of mercury as demonstrated by the fact that 4 of 9 24-hour urine specimens showed mercury levels in the 0.050-0.100 milligrams per liter range. Although this is not generally considered hazardous, it does indicate significant absorption of mercury and points out the need for medical monitoring. The company made significant progress in controlling employee exposure to inorganic mercury, however, additional effort must be made to reduce this exposure by improving ventilation, personal hygiene and work practices, and biological and environmental monitoring.

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CINCINNATI, OHIO 45202

# HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT NO. TA 77-52

# JAY INSTRUMENTS AND SPECIALTY COMPANY
CINCINNATI, OHIO 45215

NOVEMBER 1977

Study Requested By:
Plant Manager of Thermometer Plant
Jay Instruments and Specialty Company

Study Conducted and Report Prepared By:
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Study Dates: July 1, 6, 7, 1977

## SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) conducted an environmental and medical evaluation for inorganic mercury on July 1 and 6-7, 1977 at Jay Instruments. This evaluation was requested by Jay Instruments as a follow-up to a Health Hazard Evaluation (76-49-312) conducted April 1976.

Jay Instruments has made significant progress in controlling employee exposure to inorganic mercury. The company has installed ventilation equipment, made process changes, partitioned the Thermometer Fabrication Area, and instructed employees in proper personal hygiene and work practices. While these improvements have lowered employee exposure to mercury, additional effort must be made to further reduce mercury exposure.

Employee exposures to mercury monitored over 8-hour work shifts ranged from none detectable to 0.04 mg/M$^3$. Glass Blower #3 and the supervisor received the highest exposures (0.04 mg/M$^3$) which were within 80 percent of the NIOSH recommended standard of 0.05 mg/M$^3$. Short-term measurements monitored breathing zone levels of mercury up to 0.5 mg/M$^3$ and area levels up to 0.8 mg/M$^3$.

There continues to be evidence of increased absorption of mercury by employees in the Thermometer Fabrication, Assembly, and Shipping and Receiving Areas. Four of the nine 24-hour urine specimens collected by NIOSH showed urine levels in the 0.050 to 0.100 mg/liter range. Although this is not generally considered to be in a hazardous range, it does indicate significant absorption of mercury and indicates the continued need for careful medical monitoring.

Recommendations are provided in the report suggesting various ventilation improvements, proper personal hygiene and work practices, and biological and environmental monitoring.


## II. INTRODUCTION

The Plant Manager of the Thermometer Plant at Jay Instruments, submitted a request for technical assistance regarding employee exposure to inorganic mercury. The request was for an environmental and medical evaluation to be performed in the Thermometer Plant, as a follow-up to a Health Hazard Evaluation (76-49-312) conducted last year. The technical assistance request was initiated when the recent periodic urine analysis resulted in high mercury levels in some of the employees, indicating systemic absorption of mercury.

An environmental and medical survey was conducted on July 1 and 6-7, 1977, by the Hazard Evaluation and Technical Assistance Branch of the National Institute for Occupational Safety and Health (NIOSH). The environmental evaluation was performed by industrial hygienist, James Price, and the medical evaluation by medical officer, Dr. Charles Wisseman.

## III. EVALUATION

### A. Process Description

Jay Instruments and Specialty Company is primarily engaged in sales; however, it is involved on a small scale in the manufacturing of industrial thermometers. The process is located in the Glass Department (Thermometer Fabrication Area) which covers approximately 1125 square feet of building space with a ceiling height of 16 feet.

In April 1977, the Glass Department was sectioned off by a wall from the Assembly, Shipping, and Receiving Areas.

In the Glass Department, three employees identified as "glass blowers" fabricate the thermometers; this includes: (1) cutting the glass, (2) fire polishing the rod, (3) forming the bubble chamber, (4) filling the thermometer with mercury, and (5) calibration of the thermometer. Under normal conditions each of the glass blowers may conduct any one of the operations, depending on the present needs; however, during the survey, only one of the employees was acquainted with the complete process.

At the time of the Health Hazard Evaluation, local exhaust was not available for any of the above mentioned operations, nor was there any personal protective equipment being used. The company has since installed seven small local exhaust hoods at the workbenches and two larger hoods for housing the calibration tanks and vacuum chamber. Protective clothing and personal protective equipment (respirators) are now furnished to employees.

### B. Evaluation Design and Methods

#### 1. Environmental Sampling

Environmental monitoring for inorganic mercury was conducted using two methods: (1) a direct reading instrument to provide an instantaneous measurement of the existing contaminant concentration, and (2) a long-term sampler to determine the integrated average exposure over the work shift.

The former method employed the dual range J-W Lamaire Mercury Vapor* "sniffer." The range of measurement for the "sniffer" was 0.01 to 1.0 $mg/M^3$ (milligrams per cubic meter), with the scale divided in increments of 0.01 $mg/M^3$. This instrument was used to detect mercury vapor sources and to instantaneously measure mercury levels in the general work area.

For the latter method two long term sampling devices were used to integrate the mercury levels over a four to eight hour sampling period. The two devices used were the 3-M Mercury Vapor Monitoring System* and the MSA* Mercury Vapor Tube System. The 3-M System consisted of a small, lightweight plastic unit which contained a gold collection surface to

*Mention of commercial names or products does not constitute endorsement by NIOSH.

quantitatively absorb mercury vapor. These units were analyzed by the 3-M Company for mercury content. The MSA System consisted of a glass tube containing iodine impregnated charcoal as the collection media; air was drawn through the tube at a flowrate of 50 milliliters per minute using a Sipin pump. Analyses on the tubes were performed by atomic absorption at the Utah Biomedical Test Laboratory. When monitoring personal exposures, the devices were worn by the employees with the collection media positioned near the breathing zone.

Ventilation measurements were taken at the various exhaust hoods in the Thermometer Fabrication Area using a Sierra Thermalanemometer Model 440.

2. Medical

The NIOSH medical officer interviewed and examined the four persons employed in the Thermometer Fabrication Area. Interviews were directed towards revealing occupational history, work practices, and symptoms of mercurialism (constitutional, neurological, dermatologic, oral).

Physical examinations were done on the four persons, including examination for mercury line on gums, gingivitis, tremor of hands, deep tendon reflexes, and coordination tests (finger-to-nose, rapid-alternating movements of hands, heel-toe walk, Romberg sign, and handwriting sample). Blood samples for blood urea nitrogen and serum creatinine, and a 24-hour sample of urine for volume, creatinine, and mercury were collected on these four individuals.

The NIOSH medical officer also collected 24-hour urine specimens from the six workers in the adjacent Assembly and Shipping Areas, which have been separated by a wall from the Thermometer Fabrication Area since the last NIOSH evaluation. Spot urines from two persons without exposure to mercury were collected as controls for the laboratory analysis.

Results of the urinary mercury monitoring done by the Kettering Laboratory and the contents of the OSHA Form 100 for 1976 were reviewed. The hazards associated with mercury were also discussed with the employees interviewed.

C. Toxic Properties of Mercury[1]

The use of mercury should be properly controlled to prevent illness. Avoiding illness requires, among other factors, that each employee be made aware of the potential health hazards associated with mercury exposure. Any person who works with metallic mercury should be aware of the following facts:

1. Mercury is a heavy metal which is liquid and volatile at room temperature; even at room temperature mercury vapor is released into the atmosphere. This vapor is tasteless, odorless, and colorless and is readily absorbed through the lungs into the blood stream if inhaled. While mercury can also enter the body by ingestion and by skin absorption, inhalation is the primary route of entry.

2. Mercury spills should be carefully and quickly cleaned up since sufficient amounts of mercury can accumulate on surfaces to cause a serious health hazard. Mercury has a tendency to lodge into clothing, carpeting, porous surfaces, and cracks and crevices; from there it will vaporize into the surrounding air. Several factors determine how much mercury vapor escapes into the air:

a. Temperature: As the temperature of the mercury increases, the amount of vapor generated increases. For example, when the temperature of the mercury is increased from 68°F to 82°F, the amount of vapor released will approximately double.

b. Surface Area: Mercury vapor escapes from the surface of mercury droplets. Several small droplets of mercury will release more vapor than one large droplet due to more surface area of the mercury being exposed to air.

c. Containers: If mercury is not properly stored, vapor will escape into the atmosphere. A layer of water or other liquid over metallic mercury will decrease vaporization.

d. Chemical Mercury Traps: Only liquid, metallic mercury will produce mercury vapor. Special chemical cleanup solutions will convert mercury metal into salts which will not vaporize at room temperature.

3. Excessive exposures to mercury vapor can produce mercury poisoning, either acute (short-term exposure) or chronic (long-time exposure). Mercury poisoning in industry is more frequently chronic, resulting from mercury accumulating in the body over a period of time. Symptoms of chronic, slow poisoning by low levels of mercury in the workplace include the following:

a. Behavioral Changes: Irritability, depression, short temper, moodiness, nervousness, headache, and insomnia.

b. General Fatigue: Weakness, loss of appetite and weight.

c. Neurologic Changes: Shakiness of hands, poor memory, weakness in arms and legs, unsteady walking, and tingling sensations in tongue or hands.

d. Gastrointestinal Changes: Loose teeth, sore mouth, bleeding gums, upset stomach, black line on gums, excessive salivation, and metallic taste in mouth.

e. Kidney Changes: Abnormalities in blood and urine tests related to kidney function.

Because of improved technology and work practices, it is rare now to find a case of mercury poisoning severe enough to have many of these symptoms. Early signs of mild poisoning, such as changes in kidney function tests or slight shakiness of the hands, are usually looked for. These signs generally disappear if the person is removed from further exposure to mercury.

4. Mercury does not remain in the body indefinitely; it is gradually excreted over a period of time. Most of the mercury is excreted in the urine, with smaller amounts eliminated in feces, sweat, and saliva.

5. Biological monitoring for mercury exposure is generally done by urinalysis. The amount of mercury that is excreted in the urine can vary unpredictably from day to day, and even from hour to hour. While this variability makes interpretation of urine levels difficult, it is still the best available measure of mercury absorption.

Several special collection procedures should be used in order to make urine mercury levels as meaningful as possible. First, a full 24-hour collection of urine is desirable; this helps to avoid some of the variability that may be seen in "spot" samples that are collected at only one time in the day. Second, repeated measurements of urine mercury levels over a period of time will more accurately depict trends in an employee's mercury excretion. Third, averaging the urine mercury levels from several employees working in the area will achieve a more accurate assessment of mercury absorption. The best available procedure is to collect 24-hour urines from all workers in the area, and then to average the results for the entire group.

6. The most accurate guide to interpreting urine mercury levels is as follows[2]:

| | Mercury Levels in Urine | |
|---|---|---|
| | micrograms/liter | milligrams/liter |
| Normal | less than 30 | less than 0.030 |
| Increased absorption | above 50 | above 0.050 |
| Warning | above 100 | above 0.100 |
| Hazardous level | above 200 | above 0.200 |
| Symptoms likely of mercury poisoning | above 300 | above 0.300 |

A normal person who does not work with mercury should have a urine mercury level below 15 ug/l (or 0.015 milligrams/liter). Workers should be removed from exposure at the "Hazardous Level" (above 0.200 milligrams/liter). Because of the variability in urine mercury excretion, it is wise to verify the high level with a repeated 24-hour urine collection before transferring a worker for a prolonged period of time. Ideally, a worker who is transferred to a low-exposure area should not return to the mercury-exposed workplace until his urine mercury level is below 0.050 milligrams/liter to allow an adequate margin of safety when he returns to a mercury exposure area.

7. Since mercury is a naturally-occurring element that may be present in the air, food, and water, everyone has a small amount of it in their body. This small amount does not seem to be harmful to the human body.

8. Good ventilation, proper work practices, and careful personal hygiene can control mercury absorption down to a level where no health effects are known to occur.

D. Environmental Evaluation Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by various sources. These limits represent conditions under which it is believed that nearly all workers may be repeatedly exposed to a substance on an 8-hour per day, 40-hour per week basis without adverse effects. The criteria used in this investigation were taken from the following sources: (1) airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards, (2) Threshold Limit Values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1976, and (3) Occupational Health Standards as promulgated by the U.S. Department of Labor (Federal Register, 29 CFR 1910, pp 509, January 1, 1976). The exposure limits cited by the various sources are presented below:

| Source | Exposure Limits (mg/M$^3$)* |
|---|---|
| NIOSH | 0.05 |
| TLV | 0.05 |
| OSHA | 0.1 |

*mg/M$^3$ - milligrams of mercury per cubic meter of air.

Ventilation criteria applied in the evaluation were taken from the following: (1) Industrial Ventilation - A Manual of Recommended Practices[3], and (2) Recommended Industrial Ventilation Guidelines[4].

E. Evaluation Results and Discussion

1. Environmental Sampling

One (1) area sample and 13 personal samples were collected on July 6, 1977 using both charcoal tubes (MSA tubes) and mercury monitor badges (3-M monitor). The charcoal tubes and monitor badges were positioned next to each other for comparative data collection. As illustrated in Table I, the time-weighted average exposure to mercury over the work shift ranged from none detectable to 0.04 mg/M$^3$. The monitor badges generally indicated lower concentrations of mercury than the charcoal tubes. The results of the monitor badges ranged from none detectable to 0.016 mg/M$^3$ of mercury, whereas the charcoal tubes ranged from less than 0.02 to 0.04 mg/M$^3$ of mercury. Glass Blower #3 (lead woman) and the supervisor received the highest exposure to mercury (0.04 mg/M$^3$) as indicated by the charcoal tube method. The exposures for these two employees were within 80 percent of the NIOSH recommended standard of 0.05 mg/M$^3$.

Eight (8) personal samples were collected on July 7, 1977 using only the mercury badges. Results of the sampling (Table I) indicated personal exposures ranging from none detectable to 0.036 mg/$M^3$ of mercury. The most significant point of these samples was that the "inspector", who worked in the Assembly Area, had the highest mercury exposure. This was somewhat dismaying since the Assembly Area was considered to be mercury-free after construction of the wall between this area and the Thermometer Fabrication Area.

Numerous direct reading measurements were made with the "Mercury Sniffer" throughout the Thermometer Fabrication Area and the Assembly Area. The results presented in Table II denote that a certain amount of mercury contamination existed in the Thermometer Fabrication Area. Breathing zone levels up to 0.5 mg/$M^3$ and area levels up to 0.8 mg/$M^3$ of mercury were monitored. These levels are in excess of the various exposure limits cited in the Environmental Evaluation Criteria Section. It should be noted that the "Mercury Sniffer" is best suited for detecting sources of contamination rather than to provide an accurate assessment of personal exposure.

2. Ventilation

Several deficiencies were observed with the local exhaust and general ventilation systems. These deficiencies are addressed in the Recommendation Section. The primary problems observed with the ventilation systems included: (1) local exhaust hoods were positioned too far from the point of contaminant generation to effectively capture the mercury vapor, (2) ventilation equipment was inadequately maintained, (3) enclosures for the calibration hood and chamber hood were not sufficiently complete, and (4) short-circuiting of the general ventilation system was occurring. Results of the ventilation measurements are presented in Table III.

3. Medical

a. Review of OSHA Form 100

Seven persons were reported as having been transferred from the Thermometer Fabrication, Assembly, and Shipping-Receiving Areas during 1977 (from April 8, 1977 to June 7, 1977). Two persons were transferred permanently to a non-mercury area; two persons were back at work in the assembly area; one person was no longer employed at the company.

b. Urine Mercury Levels Monitored by Kettering Laboratories

Results of the urine mercury determinations done by the Kettering Laboratory since the last NIOSH visit in April 1976 were reviewed. These urines were first-morning voided spot specimens. As shown in Table IV, there was a persistent tendency toward elevation of mercury levels from April 1976 to July 1977.

Improved ventilation, work practices, and personal hygiene, as well as a new wall separating the Thermometer Fabrication and Assembly Areas, were instituted in about April of 1977. There have not been enough urine mercury determinations since then to determine if there has been a downward trend in urine mercury levels.

c. NIOSH Medical Evaluation

The four workers in the Thermometer Fabrication Area were interviewed and examined. There were two males and two females, with a mean age of 26 years (range 22-33). Two workers had been employed three weeks or less; the other two had worked there for two and three years, respectively. One of the long-term employees reported a 10-year past history of exposure to mercury in a similar type of job.

None of these four employees felt that they had a job-related illness, nor did they report any specific symptoms of mercurialism. There was one report of fatigue and irritability that was probably due to working twelve-hour days in the heat-wave weather conditions prevailing at that time.

None of these four employees had any physical signs suggestive of mercurialism, except for one with a questionable tremor of the hands. The four employees had a normal serum creatinine and a normal blood urea nitrogen.

The 24-hour collections for mercury were probably adequate collections, despite the relatively small volume (three of four specimens were below 1 liter in total volume). Since all except one specimen contained over a gram of creatinine per 24-hour specimen, the small total volumes most likely reflected the high fluid loss in sweat during the prevailing hot weather. The concentration of mercury in these 24-hour urine specimens ranged from 0.019 to 0.075 mg/liter, with three of the four specimens in the range from 0.019 to 0.023 mg/liter.

Of the six 24-hour urine specimens collected in the Assembly, Shipping, and Receiving Area, one was lost in transit to the lab. One was of such a low volume and total creatinine as to represent little more than a spot specimen. The other four specimens seemed to be fairly adequate 24-hour collections. Three of the five specimens showed a urine mercury level of over 0.050 mg/liter. This seems unexpectedly high, since the four females and one male in the group have only worked there an average of five months (range one month to 14 months). This area was separated by a wall from the mercury-exposure area approximately two and one half months before the NIOSH visit. Table V summarizes the laboratory data.

F. Conclusions

Subsequent to the Health Hazard Evaluation conducted in April 1976, Jay Instruments has made significant progress in controlling employee exposure to inorganic mercury. For instance, the company has installed ventilation equipment, made process changes, partitioned the Thermometer Fabrication Area, and instructed employees in proper personal hygiene and work practices. While these improvements have lowered employee exposure to mercury, additional effort must be made to further reduce mercury exposure.

1. Environmental

Personal and area samples were collected over 8-hour work shifts to determine the airborne concentration of inorganic mercury. Short-term measurements were also taken to identify various sources of mercury contamination. Employee exposures monitored over the 8-hour work shift ranged from none detectable to 0.04 mg/$M^3$ of mercury. The short-term measurements monitored breathing zone levels of mercury up to 0.5 mg/$M^3$ and area levels up to 0.8 mg/$M^3$. Areas found to be contaminated with mercury included: (1) trash containers, (2) employee clothing and shoes, (3) containers used to store dirty rags, (4) inside of respirator, (5) various work surfaces, (6) inside of plastic containers used for mercury storage (no contamination with lid covering the container), and (7) at face of calibration tank. Operations observed to release excessive mercury vapor included: (1) closing off tubes, and (2) running mercury "out."

Observations of the ventilation system were also noted during the survey. Various deficiencies were found such as improper positioning of local exhaust hoods, inadequate maintenance of ventilation equipment, incomplete hood enclosures, and short-circuiting of the general ventilation system.

2. Medical

There continues to be evidence of increased absorption of mercury by employees in the Thermometer Fabrication, Assembly, and Shipping and Receiving Areas in the Jay Instruments Company. Seven persons had been transferred to low-exposure areas because of elevated urine mercury levels in the three months prior to the NIOSH visit.

Four of the nine 24-hour urine specimens collected by NIOSH showed urine mercury levels in the 0.050 to 0.100 mg/liter range. Although this is not generally considered to be in a hazardous range, it does indicate appreciable absorption of mercury and indicates the continued need for careful medical monitoring.

A disburbing feature of the urine mercury levels is that three of the four specimens showing a level in excess of 0.050 mg/liter were from employees in the Assembly Area. This area is supposed to be mercury-free since the construction of the wall between this area and the Thermometer Fabrication Area two and one-half months prior to the NIOSH visit. Improved clean-up procedures and the practice of changing shoes after leaving the mercury area was supposed to prevent the entry of mercury into the Assembly Area. The building of the partition may have led to a false sense of security and some laxness in dealing with mercury.

## IV. OBSERVATIONS/RECOMMENDATION

A. Environmental

1. Mercury droplets were visible at several locations in the Glass Department. These locations included: (1) the calibration tanks, (2)

the workbenches, (3) the vacuum chamber hood, (4) the sink area, (5) the mercury filtering equipment table, and (6) the floor. Whenever there are spills or droplets of mercury, they must be immediately cleaned up with the proper equipment. Cleanup procedures should entail a vacuum system which is equipped with a mercury absorbent exhaust filter or which is vented directly outside the work environment. Sweeping of mercury with a broom should be prohibited as it facilitates the spreading of the contaminant.

2. Excess mercury from open end thermometers was brushed off onto a cloth strip lining the front of the calibration tank. This practice should be discontinued due to contamination of the cloth with mercury and ready vaporization of the droplets from heat produced by the oil baths.

3. Plastic trash containers which were used for storage of rags and paper waste were found to be contaminated with mercury. These containers should be constructed of non-porous materials and have lids. It is advised that the containers be emptied and washed daily.

4. Mercury droplets were present at several locations where the work surfaces were constructed from formica particle board. All operations involving mercury should be performed over impervious surfaces free of crevices.

5. Consideration should be given to enclosing operations involving mercury to the smallest convenient space to control spills and facilitate cleanup procedures.

6. Mercury should be stored in unbreakable containers and sealed tightly.

7. The process involving the "closing of tubes" was found to produce excessive mercury contamination. The contamination was the result of mercury droplets, which adhered to the outside of the glass, being vaporized when heated in a Bunsen burner. It is imperative that all glass be void of mercury prior to contact with heat.

8. Several adverse work conditions were created from the extremely warm ambient temperatures (85-99$^{o}$F) in the Glass Department. These conditions can lead to the following: (1) possible heat disorders, (2) contamination of street clothing and skin due to employees not wearing their protective clothing, and (3) possible increase in airborne mercury levels resulting from an increase in the vapor pressure of mercury. It is recommended that the air be conditioned to prevent these problems.

9. Provide clean protective clothing daily and when contaminated with mercury; the protective clothing should not be worn outside of this area. Ensure that shoes are of a non-porous material (dispensable shoe covers could be used) and that contaminated shoes are readily identifiable.

10. A formal respirator program should be established in the event that respiratory protection is used. Minimum procedures such as those outlined in the Occupational Safety and Health Standards, 29 CFR 1910.134 (b)(1)-(11), should be followed. All respirators used must be NIOSH-certified. It should be noted that NIOSH has not yet certified any chemical-cartridge respirators for use in a mercury contaminated atmosphere. The cartridge type respirator presently used by Jay Instruments should therefore be replaced with a respirator that is certified.

11. Mercury vapor depressants (e.g.: calcium polysulfides and sulfur) have some success in controlling production of vapors, however, they are limited in application. Such factors as scuffing or vibration (as occurs with foot traffic) could break the coating on the mercury and allow vaporization to continue.

12. Environmental monitoring should be continued on a routine basis. It is imperative that environmental sampling be conducted whenever a change is made in the engineering controls or work practices.

13. The following recommendations pertain to the ventilation system:

a. The flexible duct attached to Hood #2 had a hole approximately one fourth the circumference of the duct. It is recommended that all ventilation equipment be routinely checked and properly maintained to insure optimum performance.

b. The local exhaust system used at the workbenches was virtually ineffective due to the design of the hoods and the distant location which the hoods were positioned from the point of contaminant generation. Minor changes which would sufficiently improve the system would be the addition of flanges to the hoods, and the repositioning of the hoods to a distance at which a capture velocity of 200 feet per minute (fpm) would be maintained. A capture velocity of this magnitude is required due to: (1) the high toxicity of mercury, (2) the turbulent air currents in the Department, and (3) the low volume of air exhausted through the workbench hoods.

c. The enclosures for both the calibration hood and chamber hood should be more complete to prevent air entering from ineffective areas. It was found that large gaps existed at the junction of the hood walls resulting in air being drawn from the bottom, sides and back portions of the hoods. (A minimum capture velocity of 150 fpm should be maintained for these two hoods.)

d. The Glass Department should be kept at a slight negative pressure to preclude escape of mercury vapor into adjacent work areas.

e. Make-up air supplied into the Glass Department entered through a large slot which traversed the wall at a distance of one to two feet from the ceiling. As the make-up air was drawn into the area, the air was pulled towards one of the three exhaust fans installed seven to ten feet above the floor, thus preventing a thorough mixing of air throughout the room. It is recommended that the make-up air be supplied at different heights along the wall to assure a more uniform dispersion.

B. Medical

1. Continue periodic monitoring of mercury-exposed workers for urine mercury levels. The group of workers in this monitoring program should include those persons in the Assembly Area until at least two consecutive monitoring periods show no evidence of excessive absorption of mercury, and environmental levels are proven to be consistently minimal.

2. Employees who work in the Thermometer Fabrication and Assembly Areas should receive more intensive instruction concerning the health hazards of mercury, as well as the work practices and personal hygiene measures necessary to avoid these hazards. This will be difficult, in view of the rapid turnover of employees in some of these jobs. Adequate instruction immediately on beginning work is vitally important to prevent the development of sloppy habits in handling mercury.

3. As recommended in the first NIOSH Health Hazard Evaluation (HHE 76-49) all new employees should receive a pre-employment history, physical examination, and urine mercury. Any person with a urine mercury of 0.200 mg/liter (repeated once to verify the high level) should be removed from exposure until the urine mercury level is below 0.050 mg/liter. Women of reproductive age should be monitored especially closely, since mercury is suspected of being a possible cause of birth defects in high doses.

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3. Industrial Ventilation: A Manual of Recommended Practice, 13th Ed., Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, Lansing, Michigan, 1974.

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Table I

Results of Sampling Conducted for Mercury Vapor

Jay Instruments and Specialty Company
Cincinnati, Ohio

July 6-7, 1977

| | | | Concentration of Mercury (mg/M$^3$)* | |
|---|---|---|---|---|
| Date | Operation/Location | Sample Time | Charcoal Tube Sample | 3-M Monitor |
| 7-6-77 | Glass Blower #1 | 0745-1525 | <0.02 | 0.002 |
| | Glass Blower #2 | 0750-1530 | 0.03 | 0.011 |
| | Glass Blower #3 | 0745-1530 | 0.04 | 0.016 |
| | Supervisor | 0755-1555 | 0.04 | 0.006 |
| | Assembler | 0800-1520 | <0.02 | 0.002 |
| | Inspector | 0810-1600 | <0.02** | <0.001 |
| | Assembler (Lead Woman) | 0810-1535 | | <0.001 |
| | Barometer/Manometer Assembler | 0815-1537 | | <0.001 |
| 7-7-77 | Glass Blower #1 | 0705-1525 | | 0.002 |
| | Glass Blower #2 | 0707-1525 | | 0.005 |
| | Glass Blower #3 | 0707-1525 | | 0.009 |
| | Supervisor | 0807-1535 | | 0.011 |
| | Assembler | 0710-1532 | | <0.001 |
| | Inspector | 0708-1528 | | 0.036 |
| | Assembler (Lead Woman) | 0709-1529 | | <0.001 |
| | Barometer/Manometer Assembler | 0712-1531 | | 0.001 |

*Health Standards
NIOSH: 0.05 milligrams of mercury per cubic meter of air (0.05 mg/M$^3$)
TLV: 0.05 mg/M$^3$
OSHA: 0.1 mg/M$^3$

**Area sample collected two feet from inspector. All other samples were collected at the employee's breathing zone.

# Table II

Mercury Vapor Concentrations Measured With
A Direct Reading J-W Lamaire Mercury Vapor "Sniffer"
Jay Instruments and Specialty Company
Cincinnati, Ohio

July 6-7, 1977

| )ate | Operation/Location | Sample Time | Concentration of Mercury (mg/M$^3$)[1] |
|---|---|---|---|
| '6/77 | Glass Blower #1(BZ)[2]-Putting on Metal Bulbs | 0930 | <0.01 |
| | Glass Blower #2(BZ)-Testing the Bore | 0932 | <0.01 |
| | Glass Blower #3(BZ)-Near Calibration Tank | 0935 | <0.01 |
| | Calibration Tank-At Face of Hood | 0950 | 0.01-0.16 |
| | Aisle between Workbench and Calibration Tank | 0955 | <0.01 |
| | Over Surface of 30 Gallon Container[3] | 1040 | <0.01 |
| | Over Surface of 2 Gallon Buckets[3] | 1045-1055 | 0.01-0.03 |
| | Above Plastic Trash Buckets[4] | 1100 | 0.02-0.7 |
| | Plastic Bucket Used for Storage of Dirty Rags[5] | 1100 | .5 |
| | Face of Hood Used to House Chamber | 1115 | <0.02 |
| | Smock (#3) Glass Blower | 1300 | 0.01-0.8 |
| | Glass Blower's Clothing (#1) | 1300 | 0.01-0.02 |
| | Glass Blower's Clothing (#2) | 1303 | 0.01-0.02 |
| | Glass Blower's Clothing (#3) | 1306 | 0.02-0.09 |
| | Glass Blower's Shoes #1 | 1300 | 0.02-0.06 |
| | Glass Blower's Shoes #2 | 1303 | 0.03-0.09 |
| | Glass Blower's Shoes #3 | 1306 | 0.04-0.20 |
| | Glass Blower #1(BZ)-Putting on Metal Bulbs | 1305 | 0.01 |
| | Glass Blower #2(BZ)-Testing the Bore | 1305 | 0.01-0.02 |
| | Glass Blower #3(BZ)-Closing Off Tubes | 1310 | 0.02-0.3 |
| /7/77 | Glass Blower #1(BZ)-Putting on Metal Bulbs | 0745 | 0.01-0.02 |
| | Glass Blower #2(BZ)-Cutting Metal Bulbs | 0800 | 0.01 |
| | Glass Blower #3(BZ)-Putting on Metal Bulbs | 0755 | 0.01-0.02 |
| | Glass Blower #1(BZ)-Putting on Metal Bulbs | 0845 | <0.01 |
| | Glass Blower #2(BZ)-Cutting Metal Bulbs | 0845 | <0.01 |
| | Glass Blower #3(BZ)-Testing Thermometers | 0845 | <0.01-0.03 |
| | Glass Blower #1(BZ)-Putting on Metal Bulbs | 1145 | <0.01 |
| | Glass Blower #2(BZ)-Grading | 1150 | <0.01 |
| | Glass Blower #3(BZ)-Running Mercury "Out" | 1105 | 0.02-0.08 |
| | Glass Blower #3(BZ)-Closing the Tubes Off | 1130 | 0.03-0.5 |
| | Inspection and Assembly Areas | 1150 | <0.01 |
| | Inside Plastic Container Used for Mercury Storage[6] | 1510 | 0.6 |
| | Outside of Plastic Container (Lid On) | 1510 | <0.01 |
| | Inside of Stored Respirator | | 0.03 |

1. Health Standards
   NIOSH: 0.05 milligrams of mercury per cubic meter of air (0.05 mg/M$^3$).
   TLV : 0.05 mg/M$^3$
   OSHA : 0.1 mg/M$^3$
2. BZ-Sample collected in breathing zone of employee.
3. Contained water to submerge mercury contaminated (waste) glass.
4. Buckets were used as trash containers for paper. The buckets did not have lids or contain water to enhance control of mercury vapor.
5. Bucket did not have a lid or contain water.
6. Contained water to submerge bottles filled with mercury.

Table III

Ventilation Measurements
Jay Instruments and Specialty Company
Cincinnati, Ohio

July 7, 1977

| Location | Air Velocity at Face of Hood(fpm)[1] | Air Velocity 6" From Hood(fpm) | Hood Opening Dimensions(Inches) | Approximate Exhaust Volume(CFM)[2] |
|---|---|---|---|---|
| Calibration Tank Hood | 60 | | 24" x 83" | 830 |
| Chamber Hood | 80 | | 20" x 38" | 420 |
| Chamber Hood (Face Partially Enclosed with Plexiglass) | 90 | | 18" x 38" | 430 |
| Workbench Hood 1 | 225 | 15 | 10" x 4" | 65 |
| Workbench Hood 2 | 145 | 15 | 10" x 4" | 40 |
| Workbench Hood 3 | 245 | 25 | 10" x 4" | 70 |
| Workbench Hood 4 | 300 | 25 | 10" x 4" | 85 |
| Workbench Hood 5 | 245 | 25 | 10" x 4" | 70 |
| Workbench Hood 6 | 210 | 15 | 10" x 4" | 60 |
| Workbench Hood 7 | 230 | 20 | 10" x 4" | 65 |

1. Data have been rounded off to nearest 5 linear feet per minute (fpm).
2. CFM - Cubic feet per minute.

NOTE: A minimum of 12 readings (traverse points) were used to determine the individual averages for the Calibration Tank Hood and the Chamber Hood and 6 readings for the Workbench Hoods.

# Table IV

## Urinary Mercury Levels by Kettering Laboratory
## Jay Instruments and Specialty Company
## Cincinnati, Ohio

| Date | Work Area | Urine Mercury (milligrams/liter) |
|---|---|---|
| 10/76 | TF* | 0.044 |
| | TF | 0.002 |
| | ASR* | 0.080 |
| 12/76 | TF | 0.120 |
| | TF | 0.430 |
| | TF | 0.030 |
| 03/77 | TF | 0.280 |
| | TF | 0.200 |
| | TF | 0.180 |
| | TF | 0.280 |
| 04/77 | TF | 0.190 |
| | TF | 0.470 |
| | TF | 0.600 |
| | ASR | 0.001 |
| | ASR | 0.072 |
| | ASR | 0.180 |
| | ASR | 0.140 |
| 05/77 | TF | 0.068 |
| | TF | 0.130 |
| | ASR | 0.053 |

* TF= Thermometer Fabrication Area
ASR= Assembly, Shipping, Receiving Area

(Note that RF & ASR were part of the same open room until about April 1977, when a wall was installed between the two areas.)

Table V

Laboratory Data (Blood and Urine Specimens)
Jay Instruments and Specialty Company
Cincinnati, Ohio

July 6-7, 1977

| Employee No. | Sex | Urine Volume (ml) | Urine Creatinine (mg/24 hr)* | Urine Mercury (mg/1) | Blood Blood Urea Nitrogen (mg/100 ml)** | Blood Serum Creatinine (mg /100ml)*** |
|---|---|---|---|---|---|---|
| Thermometer Fabrication Area | | | | | | |
| 1 | F | 600 | 1880 | 0.023 | 11 | 1.0 |
| 2 | M | 1230 | 2410 | 0.019 | 19 | 0.9 |
| 3 | F | 840 | 857 | 0.075 | 16 | 0.7 |
| 4 | M | 630 | 1370 | 0.022 | 18 | 0.9 |
| Assembly, Shipping Receiving Area | | | | | | |
| 5 | F | 730 | 752 | (lost) | | |
| 6 | F | 320 | 410 | 0.053 | | |
| 7 | M | 480 | 1360 | 0.019 | | |
| 8 | F | 440 | 1260 | 0.055 | | |
| 9 | F | 580 | 1010 | 0.067 | | |
| 10 | F | 260 | 810 | 0.019 | | |
| Non-Exposed Controls (Spot Specimens) | | | | | | |
| 11 | | | | ****Not Detectable | | |
| 12 | | | | Not Detectable | | |

*Normal values = M 1000-2000 mg/24 hr.
F 800-1800 mg/24 hr.
**Normal values = 5-26 mg/100 ml
***Normal values = 0.5-1.3 mg/100 ml
****Level of Detection = 5 mg/liter (0.005 mg/liter)