FINAL REPORT

MERCURY CONTROL TECHNOLOGY ASSESSMENT STUDY

GTE Products Corporation
Fluorescent Lamp Plant
Danvers, Massachusetts

Preliminary Survey Report
for the Site Visit of
December 1, 1981

Contract No. 210-81-7107

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Submitted to:

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FOREWORD

A Control Technology Assessment (CTA) team consisting of members of Enviro Control, Inc. (ECI) met with representatives of the GTE Products Corporation in Danvers, Massachusetts on December 1, 1981 to conduct a preliminary survey on the techniques used to control worker exposure to mercury. Participants in the survey were:

Enviro Control, Inc.

Donato Telesca, Program Manager
David D'Orlando, Environmental Engineer
Robert Reisdorf, Industrial Hygienist

GTE Products Corporation

Robert Wood, Industrial Engineer
Charles O'Donnell, Supervisor of Industrial Engineering
Milton Davis, Plant Engineer
Paul Robinson, Plant Manager

The CTA team also met with representatives of the Teamsters Union who worked at the plant in order to explain the purpose of the visit. These representatives are:

Karen Griffith, Senior Steward
Jesse Barton, Maintenance Shop Steward

The preliminary CTA was completed in one day. The study included a review of the fluorescent lamp manufacturing process, a tour of the production facility, and an investigation of engineering controls, work practices, and monitoring programs.

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INTRODUCTION

CONTRACT BACKGROUND

The Mercury Control Technology Assessment Study has been initiated to assess the current technology used to protect the worker from exposure to hazardous levels of mercury. The objective is to identify and evaluate the exemplary methods employed by industries in controlling worker exposure to elemental mercury and mercury compounds. A result of the study will be the publication of a comprehensive document describing the most effective means of controlling emissions and exposures. This report will be available to companies which handle mercury in order to transfer technology within the major mercury using industries. The study will also identify directions where additional research is necessary.

JUSTIFICATION FOR PRELIMINARY SURVEY

Preliminary surveys are intended to generate information about the control strategies used at various facilities and they will be used to determine where in-depth surveys will be conducted. The GTE Products Corporation Fluorescent Lamp Plant was selected for a preliminary survey because of the controls in effect to protect the worker from exposure to mercury vapor. The concern for worker protection at this plant has resulted in a continuous effort to control mercury vapor through a combination of ventilation and process equipment modifications.

SUMMARY OF INFORMATION OBTAINED

An opening meeting was held during which the objectives of the program were discussed with plant representatives. Information on the construction and operation of fluorescent lamps was obtained and a process tour was given to the members of the survey team. The plant engineering controls were reviewed and discussions were held on air and health monitoring, work practices and personal protective equipment in effect at the plant.

PROCESS DESCRIPTION

MERCURY HANDLING

Mercury arrives at the plant in 76-pound metal flasks. It is transferred to smaller glass bottles using a specially designed pouring apparatus described in the control section. All mercury is stored in a locked safe.

The mercury is purified using an oxifier and gold filter. The glass bottle of mercury is emptied into the top of the oxifier where it is agitated in the presence of oxygen. Mercury is allowed to flow from the oxifier into another glass bottle. This bottle is then emptied into a container which has a gold filter on the bottom for the removal of impurities. Mercury flows through this filter into a polyurethane bottle. Each bottle holds 8 pounds of mercury. The bottles are stored and eventually used to fill the mercury dosers in the fluorescent lamp production machinery.

LAMP PRODUCTION

Pre-cut glass tubes for the fluorescent lamps arrive at the plant. The inner surface of the tube is coated with a phosphor solution. The lamp is heated to evaporate the liquid, and a phosphor coating remains on the inside of the tube.

Mount assemblies are fused to the ends of the glass tube. Each assembly consists of a funnel-shaped piece of glass with an "exhaust tube" through the middle of it. The lead wires and spiral wound cathode wire (tungsten coil) which make up the hot cathode are set into this mount assembly.

The tubes are heated, evacuated through the exhaust tube, and a small amount of mercury and an inert gas are injected into them. The details of the mercury injection procedure are proprietary. The "exhaust tubes" are then sealed closed, and the tips of these tubes are discarded. A metal base is attached to each end of the lamp and the lamp is treated with a coating, test lit (aging), and inspected in preparation for packaging.

The function of mercury vapor in the fluorescent lamp is to emit ultra-violet light (at a wavelength of 2537 Å) when excited by an arc developed between the hot cathodes as current passes between them. The tungsten coil is coated with an electron emitting substance which initiates the arc across the length of the tube. The electron stream from this arc strikes the mercury atoms resulting in the emission of ultra-violet light. The ultra-violet light strikes the phosphor coating on the inside of the tube thereby giving off visible light.

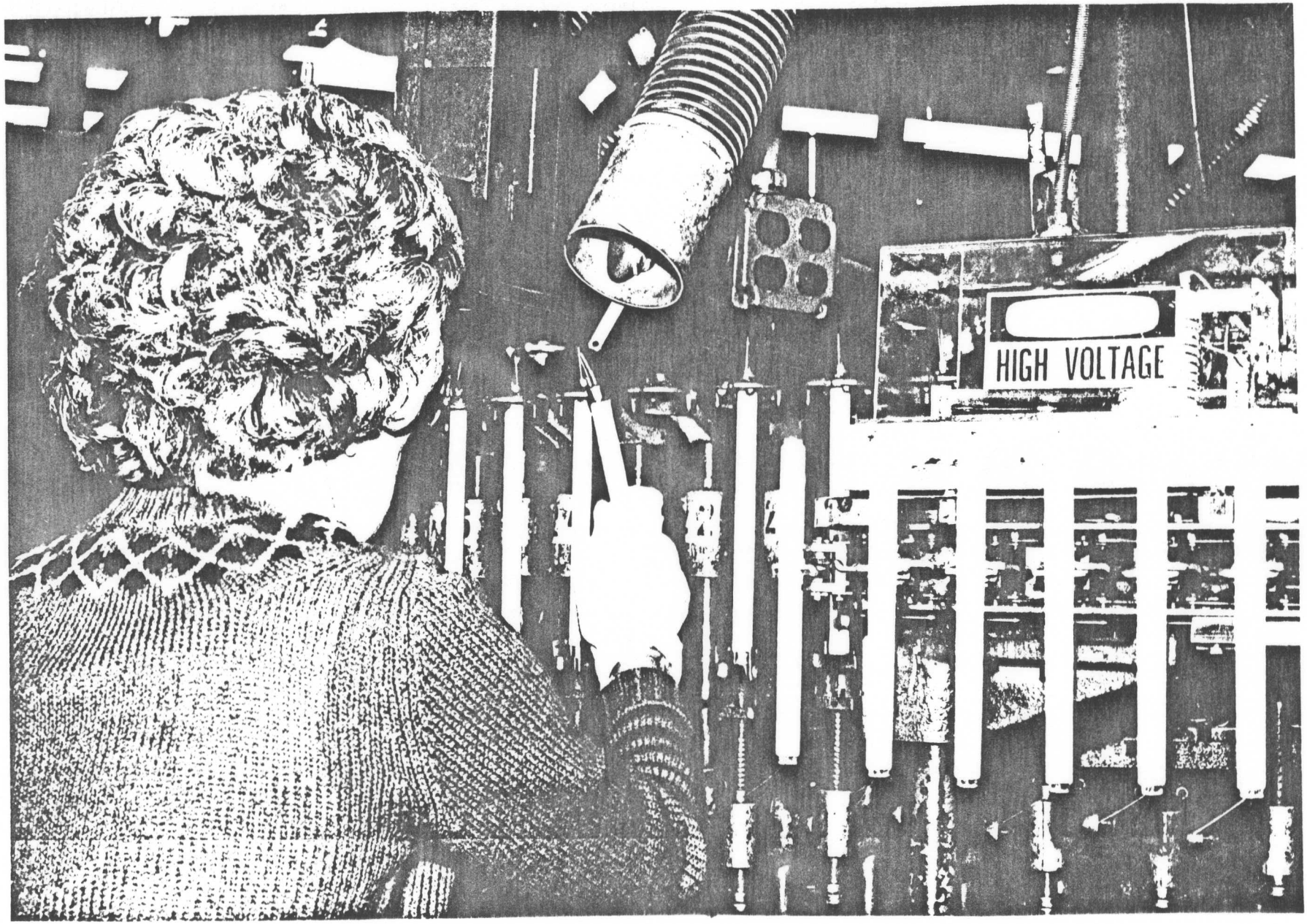

Figure 3. Local Air Supply in Front of Worker

The first type is a vacuum system in which a 4500 cfm blower draws the tube tips through a 4-inch collection pipe to a cyclone separator. The tubes enter the collection pipe by falling into discharge chutes located on each end of the lamp at the tube sealing station of the lamp manufacturing machine. As the tubes enter the cyclone, they are separated from the air stream and fall into a 55-gallon drum (Figure 4). The exhaust air stream from the blower (which is mounted on top of the cyclone) flows through a dust separator before being vented to the roof. The cyclone has a flexible discharge duct which connects to a cover clamped onto the 55-gallon drum. The system is entirely enclosed. When the drum is filled to capacity, the cover is unclamped and the drum is transported to a central refuse collection point.

The second type of tube catcher is a gravity system. Exhaust tube tips fall into a discharge chute which leads to a covered bucket on the floor below. The bucket is connected to its cover by a seal-tight clamp. Buckets are emptied every 2 or 3 days.

Mercury Spill Vacuum Pumps

GTE has two cart-mounted mercury vacuum pumps which are used to pick up mercury spills. The pumps are manufactured by Cenco Megavacs (Central Scientific Company) and operated by 1-horsepower motors. A rubber hose with an in-line mercury trap and a 1/8-inch copper tube tip is used to draw in the mercury. The narrow diameter copper tip is used to increase the vacuum velocity thereby facilitating the mercury clean-up. The mercury trap has a tap at the bottom through which the mercury is drained. A fan can be mounted on the pump cart in order to provide dilution air to the worker cleaning up the spill. Smaller mercury spills are cleaned using a Mervac charcoal-filtered vacuum cleaner with an in-line trap on the suction hose.

ISOLATION

Mercury Maintenance Area

GTE has a designated mercury maintenance area which is used for repairing and cleaning any parts which may have come in contact with mercury. The

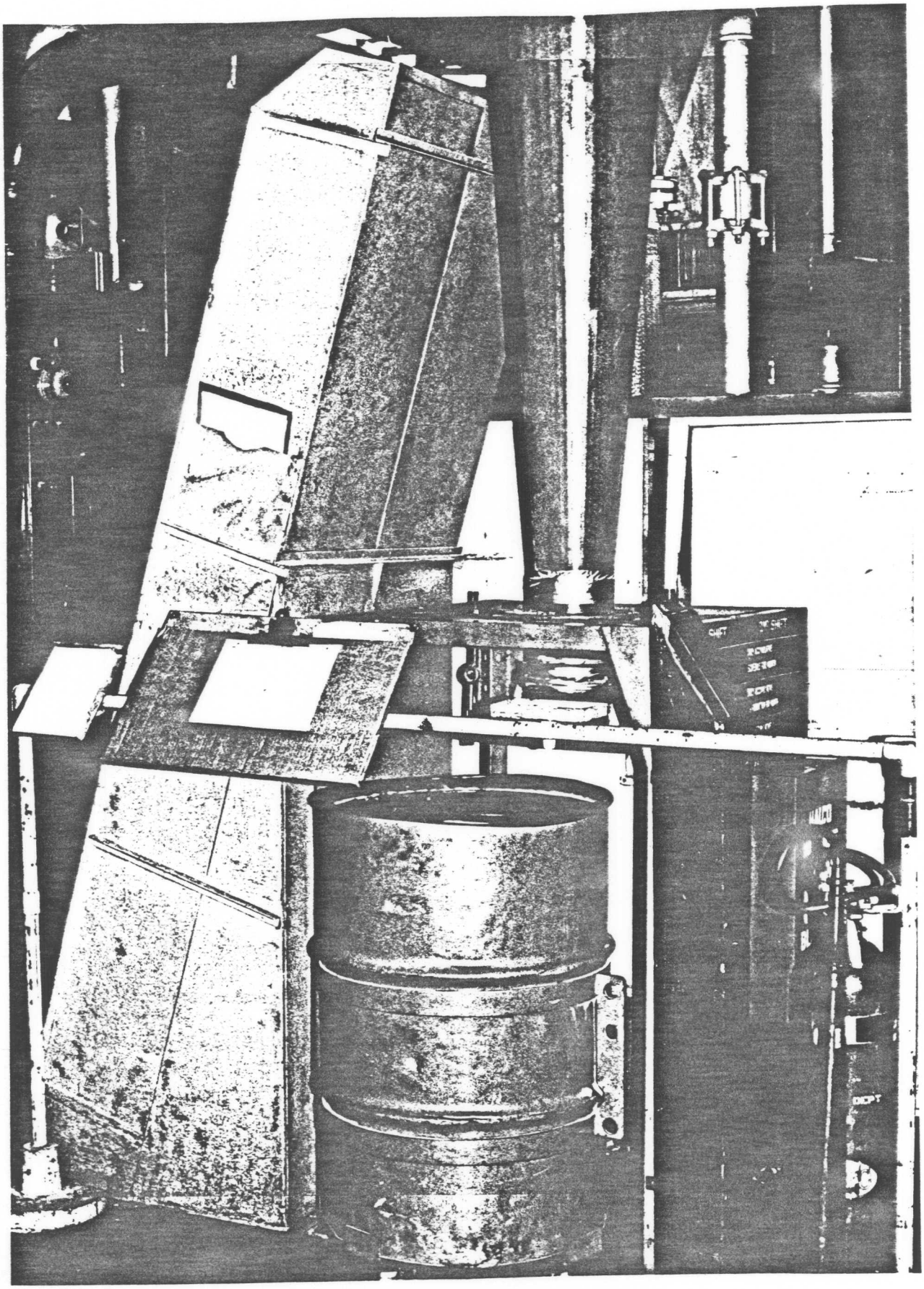

Figure 4. 55-Gallon Drum Below Cyclone Chute

area is restricted to maintenance workers. There are four 3-sided exhaust hoods in the area. They are used for part storage, part repair, part cleaning, and waste oil storage. Parts containing mercury are kept on a rack underneath an exhaust hood. Galvanized black sheet metal pans with 1-inch lips are kept under all mercury contaminated parts in order to contain spilled mercury. Both the part storage and part repair hoods are back draft slot hoods (Figure 5).

The part cleaning booth is used for solvent cleaning with Chlorothane. It consists of a 3-sided hood with a grated work surface. Bottom exhaust is provided by a blower mounted adjacent to the work bench. The system operates at a static pressure of 6 to 7 inches of water and it exhausts to the roof. Mercury which falls through the grating collects in an oil bath which is replaced on a monthly basis. The hood has a polyethylene door which can be lowered over half of the face of the hood in order to increase air velocity past the worker's breathing zone.

Buckets of waste oil containing mercury are kept under a separate exhaust hood. These buckets are emptied daily into a 275-gallon hold tank. Mercury which settles to the bottom of the tank is removed through a tap. The oil is then re-used in the manufacturing process.

The cleaning booth is steam-cleaned and painted on a monthly basis or as needed. The floors in the mercury maintenance area are coated monthly with a concrete sealer. Walls in the area are washed and painted as needed.

Mercury Handling Station

The preparation of mercury for use in the process is conducted in a designated work area. Special features in this area include the three wall fans mentioned previously, a mercury storage safe, an exhausted mercury storage cabinet, and a mercury transfer device. The exhausted storage cabinet is used for storing the 8-pound capacity polyurethane bottles containing mercury. The mercury transfer device is an A-framed structure (approximately 2 1/2 ft. high) which sets on wheels on the floor (Figure 6). The structure has a pivotted ring into which the 76-pound mercury flask is clamped. This

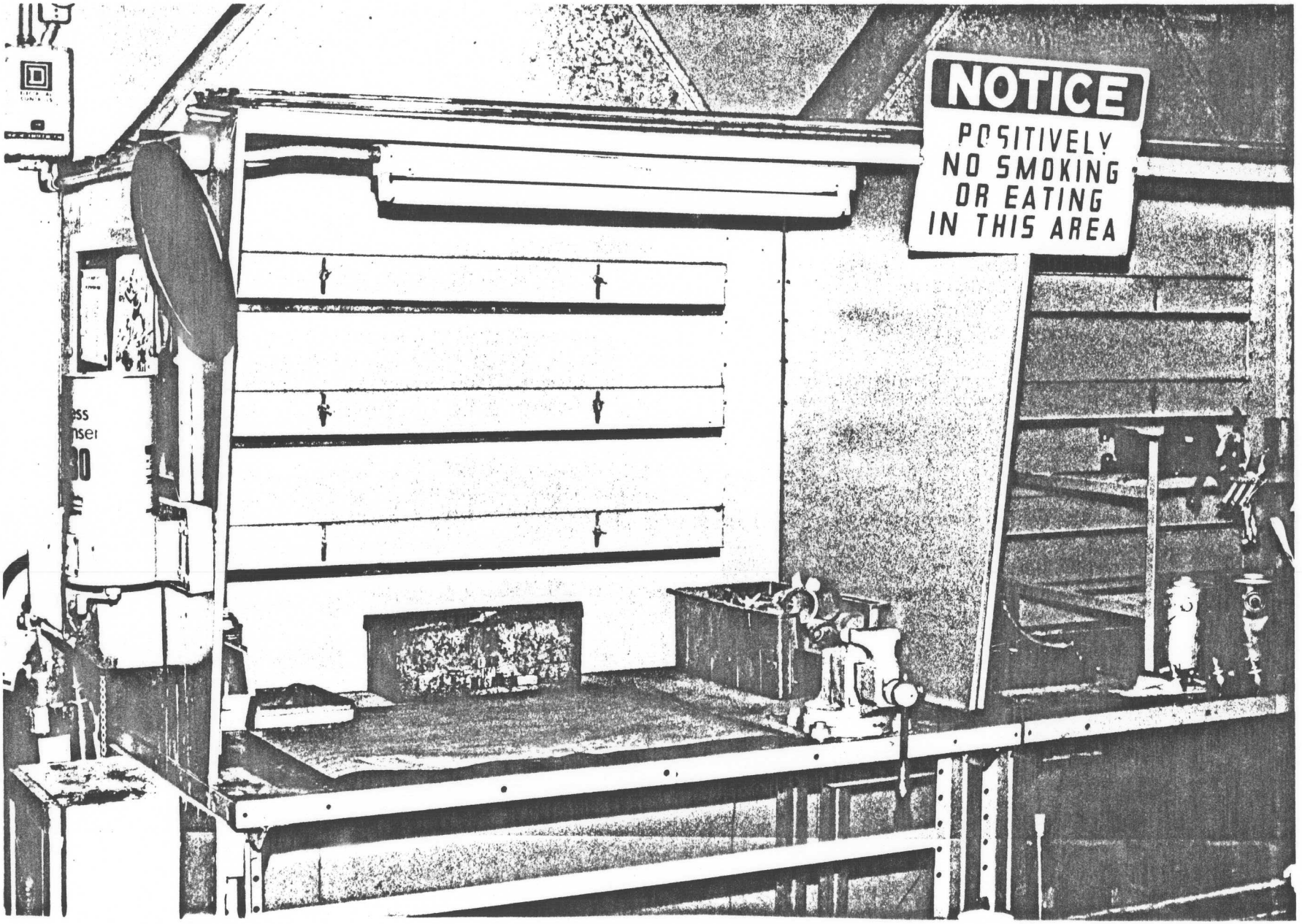

Figure 5. Part Repair and Part Storage Booths with Backdraft Slot Hoods

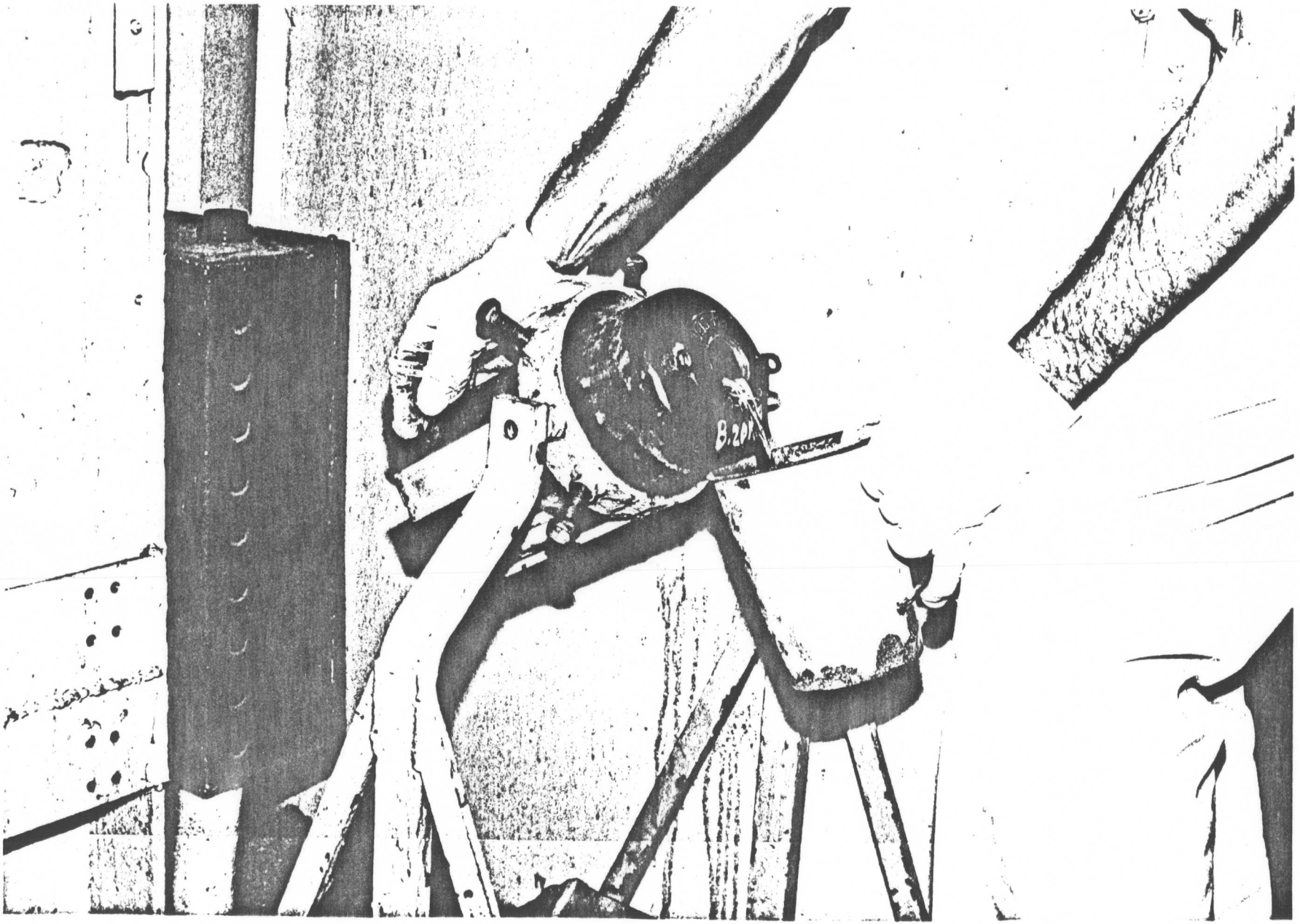

Figure 6. Mercury Transfer Device

pivotted ring enables the flasks to be easily tipped in order to fill the smaller containers with mercury. This control helps to prevent mercury spills which are often associated with mercury transfer.

PERSONAL PROTECTIVE EQUIPMENT

Maintenance workers whose routine activities involve use of or contact with mercury wear cloth work gloves. In addition, they may wear cloth coveralls if greasy work is anticipated. Respirators (American Optical, half-face-piece, with dual mercury vapor cartridge) are available, however, use of respirators is optional on the part of the employee. Production workers, whose potential for exposure to mercury is less than that of maintenance workers, do not wear personal protective equipment on a routine basis.

Work Practices

Personal hygiene practices have been implemented to control worker exposure to mercury. These consist of the following:

- Employees must wash their hands (including fingernails) before breaks and after direct contact with liquid mercury.
- Smoking is not permitted in production areas.
- Employees must keep their work clothes clean (work clothes are not supplied by the company).

Other practices which have been implemented to control worker exposure to mercury include the following:

- Whenever possible, mercury transfer from container to container is conducted over a steel tray to contain mercury spills which may accidently occur.
- Stored mercury is kept in a safe.
- Work on mercury contaminated machine parts is conducted at a ventilated hood.
- Oil removed from the numerous vacuum pumps throughout the plant is collected and deposited into a fifty-five gallon drum which is used only for this purpose.

- The amount of mercury allocated to maintenance workers is controlled so as to minimize the chance of a large spill occurring.
- Dry sweeping of floors is not permitted since this may produce an additional mercury vapor hazard.
- In the event of a major mercury spill, the maintenance department is notified and a "Megavac" vacuum pump is used to clean it up. If the spill consists of small mercury beads and covers a large surface area, Mervac Mercury Vacuum Cleaner is used for cleanup.
- Work benches and maintenance workers tool carts are cleaned on a regular basis using the Mervac Vacuum Cleaner.
- Floors in production and maintenance areas are washed approximately twice per year using HgX®, a mercury vapor suppressant.
- When performing maintenance on exhaust machines, workers must leave the ventilation fan on.
- Maintenance workers place a layer of kraft paper on the surface of the mercury parts cleaning station to help contain mercury which may be released in the cleaning process. The paper is rolled up and disposed of at the end of the shift.
- Fresh air ducts at the work stations are positioned so that air flows across the employee's breathing zone.

Monitoring Programs

The biological monitoring program consists of monthly urinalysis of selected employees to determine the concentration of mercury. All persons working where there is potential for exposure to mercury for any extended period of time take part in the monitoring program. The following employee groups are usually monitored at least semi-annually:

- all third shift lamp manufacturing machine cleaning personnel
- maintenance workers who fill mercury dispensers
- mercury purification area worker
- unit supervisors and attendants
- mechanics and electricians
- exhaust machine loaders and unloaders
- cleaning personnel

Plant representatives follow guidelines published by the Commonwealth of Massachusetts which outline the significance of urinary mercury concentrations with regard to mercury vapor workplace concentrations. These guidelines are described in Table 1.

TABLE 1

Significance of Urinary Mercury Concentrations

Urinary Mercury Concentration (mg/L)	Condition	Action
0.00 to 0.15	No or safe exposure	None
0.15 to 0.30	Undesirable exposure	Reduce exposure
0.30 to 0.60	Significant exposure	Medical Exam
0.60 to 1.00	Definitely harmful exposure	Medical Exam
Over 1.0	Hazardous condition	Remove from exposure

If an employee's urine-mercury concentration remains in excess of 0.15 mg/L for two consecutive months, the employee is relocated to a "low" exposure area until the concentration falls to below 0.15 mg/L.

During the plant visit, the results of the Biological Monitoring Program were reviewed. The number of employees whose urine-mercury concentration exceeded 0.15 mg/L has been decreasing steadily over the last 10 years. Currently, no employee's urine-mercury concentration is in excess of 0.15 mg/L.

Air Contaminant Monitoring

Mercury vapor levels are monitored every 6 months using a Beckman 23-A Mercury Vapor Detector. The monitoring is conducted in selected areas. Emphasis is placed on measuring the concentration of mercury vapor in the exhaust machine areas and the maintenance department; two areas which plant representatives have determined to have a higher potential for exposure than

the rest of the plant. Personal monitoring to determine the employee's time-weighted-average exposure to mercury vapor is not conducted.

OTHER PROGRAMS

Training Program

Employees are taught proper procedures for handling mercury and made aware of the potential health hazards associated with exposure to mercury vapor. The program involves group training sessions for new employees and individual training sessions if an employee's urine-mercury concentration is in excess of 0.15 mg/L.

CONCLUSIONS AND RECOMMENDATIONS

Based on a review of plant biological monitoring data, existing control strategies at the GTE Products Fluorescent Lamp Plant appear to be adequate in controlling worker exposure to mercury vapor. This is achieved through a program of engineering control and maintenance coupled with good work practices involving the handling of mercury.

The two controls which probably contribute the most towards achieving the low mercury vapor concentrations are dilution ventilation and isolation of the mercury work areas. Dilution ventilation is applicable to all industries which use mercury, however, it should not be solely relied upon for contaminant control unless local exhaust is not feasible.

At the GTE plant there are numerous mercury vapor emission points and several major heat sources associated with the process. In addition, the process is spread out over a large area. Consequently, dilution ventilation would probably provide a better means of control than local exhaust ventilation at this facility.

GTE's mercury work stations, such as the mercury handling station and mercury maintenance area, are examples of isolated work areas where mercury vapor concentrations would be expected to be greater than on the production floor. By isolating these areas and providing local exhaust ventilation, mercury vapor generated here can be controlled.