FINAL REPORT

MERCURY CONTROL TECHNOLOGY ASSESSMENT STUDY

Leeds and Northrup Company
North Wales, Pennsylvania

Preliminary Survey Report
for the Site Visit of
October 27, 1981

Contract No. 210-81-7107

June 11, 1982

Submitted to:

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REPORT NO.:
ECTB 109-28a

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FOREWORD

A Control Technology Assessment (CTA) team consisting of members of the National Institute for Occupational Safety and Health (NIOSH) and Dynamac Corporation, Enviro Control Division, met with representatives of the Leeds and Northrup Company in North Wales, Pennsylvania, on October 27, 1981, to conduct a preliminary survey on the techniques used to control worker exposure to mercury. Participants in the survey were:

Dynamac Corporation

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

National Institute for Occupational Safety and Health

- Stephanie Spottswood, Associate Project Officer

Leeds and Northrup Company

- Ben Stringer, Manager of Safety and Security
- Rita Schreiner, Industrial Hygienist
- Jay Sensibaugh, Maintenance Manager
- Dennis Gallagher, Standards Lab Manager

The preliminary CTA survey was completed in 1 day. The study included a review of the standards calibration 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 workers from exposure to mercury. The objective is to identify the 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 to control emissions and exposures. This report will be available to companies that handle mercury in order to transfer technology within the major mercury-using industries. The study will also identify areas where additional research is necessary.

JUSTIFICATION FOR SURVEY

Preliminary surveys are intended to generate information about the control strategies used at various facilities and are used to determine where indepth surveys will be conducted. The Leeds and Northrup Company 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 continual effort to maintain control of mercury vapor through the use 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 operation of the Standards Lab, Precision Lab, and Potentiometer Room was obtained, and a detailed process tour was given to the members of the survey team. The plant engineering controls were reviewed, and information was gathered on air and biological monitoring, work practices, and personal protective equipment in effect at the plant.

PLANT DESCRIPTION

The Leeds and Northrup Company, located in North Wales, Pennsylvania, manufactures electronic instrumentation and systems controls. The mercury operation involves the calibration of standards and instruments used for electrical measurement.

The production building occupies a total area of 500,000 square feet (sq ft) (Figure 1). Rooms in which mercury is used occupy 11,800 sq ft. This includes the Standards Lab (5,400 sq ft), the Precision Lab (5,400 sq ft), and the Potentiometer Room (1,000 sq ft). The original building was erected in 1959. The rooms containing mercury operations were built as part of a new addition in the 1960's. Modifications for mercury control were made in these rooms in 1980 following the establishment of the Mercury Task Force Committee at the plant.

A total of 2,700 people are employed at the plant. Of these, 25 people work in the Standards Lab, Precision Lab, and Potentiometer Room. The job classification of these workers is "calibration technician." All of their work is conducted during the first shift.

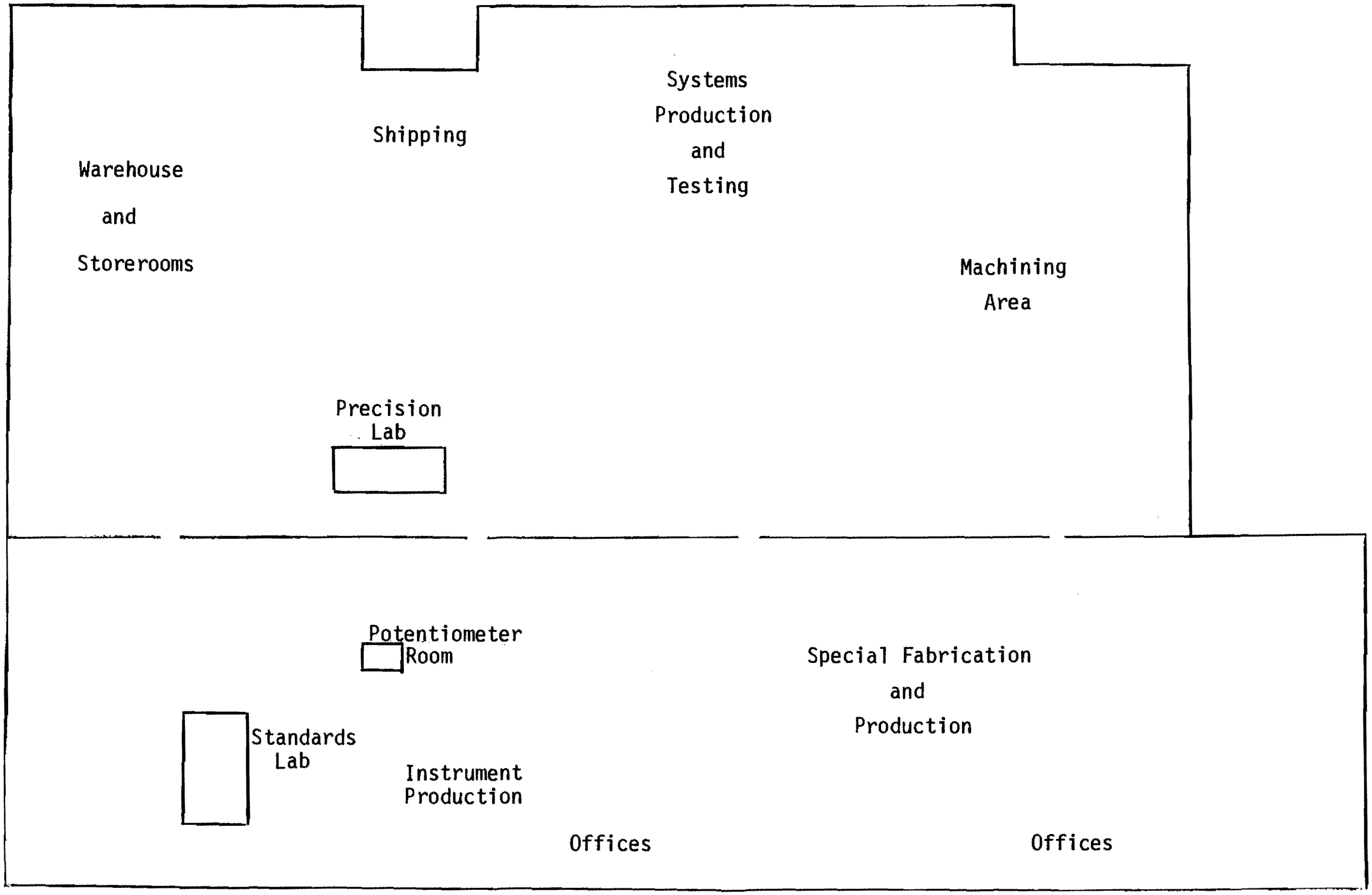

Figure 1. Leeds and Northrup Plant Layout.

PROCESS DESCRIPTION

Mercury is used at Leeds and Northrup as a contact in the calibration of electrical standards. A typical standard is a cylindrical wire-wound resistor, approximately 6 inches high and 2 inches in diameter (Figure 2). The standard has two U-shaped contact bars, each of which has one end attached to the top of the standard and the other end positioned out to the side. The outer ends of these bars are used to contact a box-shaped electrical ratio device. Electrical contact is made by placing the standard between two prongs attached to the side of the ratio device so that the contact bars on the standard rest inside recessed holes on the prongs. These recessed holes contain mercury (approximately 1 milliliter) to provide a low-resistance contact film between the bars and the prongs. Another set of prongs is mounted on the opposite side of the electrical ratio device. This set is used to make contact with a known standard (similar to the other standard). The instrument is used to determine the ratio of resistance of the standard being calibrated to the known standard by adjusting a set of percentage dials until the measured resistances are equal. The dial readings at this point show the ratio between the two standards. The actual resistance of the standard being calibrated is determined by multiplying the ratio by the actual resistance of the known standard. The calibration of standards and equipment is conducted in the Standards Lab, Precision Lab, and Potentiometer Room.

STANDARDS LAB

Standards manufactured at the plant must be calibrated against resistance standards from the National Bureau of Standards (NBS). Standards that are calibrated at NBS are referred to as "primary standards." Primary standards are used to calibrate "secondary standards," or "reference standards." This is done in a hot mineral oil bath in the Standards Lab. The oil bath method of calibration involves the same procedure described above except that the electrical ratio device has a different configuration and the contacts and mercury pools are immersed in an oil bath. The measurement is accurate to within 0.001 percent of the stated resistance in ohms.

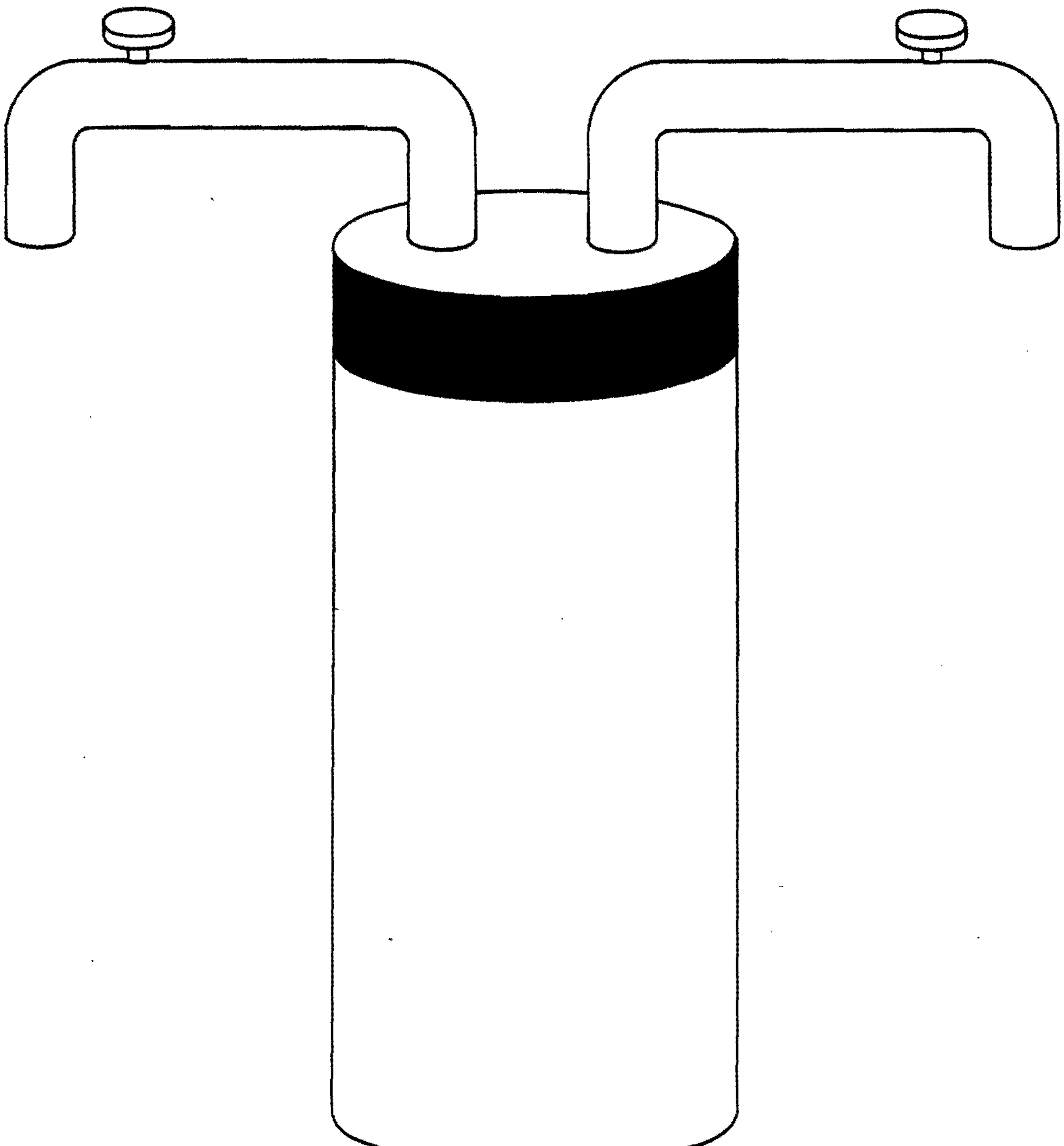

Figure 2. Resistance Standard.

The reference standards are used to calibrate "working standards." This is conducted on the box-shaped electrical ratio device described previously. Temperature in the Standards Lab is maintained at 25 C (77 F).

PRECISION LAB

Working standards are used to calibrate salable NBS-calibrated standards. This calibration is conducted in the Precision Lab using the same type of equipment used in the Standards Lab. Working standards are also used to calibrate the calibration equipment.

POTENTIOMETER ROOM

Working standards are used in the Potentiometer Room to standardize resistor decades. The decades are an integral component of standardizing equipment. This standardization process also involves the use of mercury as a low-resistance contact.

MERCURY CONTROL TECHNIQUES

ENGINEERING CONTROLS

Ventilation

The air supply system for the Standards Lab supplies 3,400 cubic feet per minute (cfm) of air through specially designed strip diffusers along the ceiling. The strip diffusers extend the length of the room. Each strip contains holes for an even diffusion of air. This system was installed to reduce temperature variances in different parts of the room. Air is exhausted through floor level vents located under the workbenches along the walls. The room is kept under a slight positive pressure so that suspended dust is not drawn in.

The airflow in the Standards Lab has been modified by adjusting intake louvers on the air supply system so that the supply air is mostly outside air.

A recirculating air filter unit (Barneby Cheney, Columbus, Ohio), designed to remove mercury vapor from the workplace air, is located in the center of the Standards Lab. This self-contained unit consists of a 1,000 cfm three-speed fan and an activated charcoal filter mounted inside of a casing with approximate dimensions of 1.5 x 1.5 x 4.5 feet. The air intake is at floor level, and the exhaust is at the top of the unit. The filters are arranged in a series of three. The unit is portable and can be moved to any location in the room. The cost of this unit, purchased in August of 1980, was $2,300, including replacement charcoal filters.

The Precision Lab has a 5,000 cfm air supply system and a 5,000 cfm air exhaust system.

Mercury Spill Control Kit

Portable spill cleanup kits (Science Related Materials Products) are used at this facility for cleaning up small mercury spills. Each kit contains a sponge, a suction unit, a 3M 8707 respirator, and mercury-absorbing material. The sponge has a mercury-absorbent material on one side of it. The suction unit is a hand-operated plastic piece with a mercury trap, which is capable of creating enough vacuum to draw a small amount of mercury off of a work surface. The mercury-absorbent material is spread over the spill area to amalgamate the mercury and suppress vapor emission.

Mercury Spill Pump and Filters

Leeds and Northrup has two portable pumps used to clean up larger mercury spills. They are Stokes Model SC2 vacuum pumps mounted on portable carts. Suction is drawn through a flexible rubber hose that has an in-line covered mercury trap. Plant representatives have been using different filters on the discharge of the pumps to reduce mercury vapor emitted during spill cleanup. It was determined that a series of three AMF CUNO Filters (Model 1M1) were needed to keep mercury vapor emissions from exceeding 0.10 milligrams per cubic meter (mg/m^3) during pump operation while cleaning up spills. After further experimentation, it was found that one Koby Senior King 60 filter (NLA Products, West Point, Pennsylvania) controls mercury vapor emissions below 0.10 mg/m^3. Similar filters are employed at the discharge of the pump used to calibrate manometers in the Standards Lab.

Mercury Sink Traps

Two different types of mercury sink traps have been installed in the areas where mercury is used. One is a quart-sized canister, mounted directly under the drain, which has a removable end flange below the pipe elbow. This flange is removed approximately every 6 months to clean out liquid mercury that settles to the bottom of the trap. The second type of trap is a homemade version of the first type. It consists of a covered plastic bottle that is connected to the steel sink trap by an extension pipe. The bottle is maintained full of water. The mercury from the sink trap settles to the bottom and is removed every 6 months.

Bench Top Coverings

Bench tops in areas where mercury is used have been covered with Formica[R] surfacing at a cost of $9,000 (purchased in April of 1980). This was done to prevent mercury from seeping into the cracks and pores of the original wood surfaces.

High Current Supply Substitution

The calibration of current shunts (resistance devices used to measure current) requires the use of a high current supply (approximately 10,000 amperes). Leeds and Northrup presently generates this current using a series of up to 60 batteries called a "battery board." These batteries are kept in a separate room. Varying currents are generated by adjusting contacts in a mercury pool so that the proper number of batteries is connected in series. The battery board is currently being replaced by a new current generator at an equipment and installation cost of approximately $6,000. This will eliminate the use of the mercury pool.

Plastic Trays

The plant has begun to store and transport standards on trays. This has been done to localize and control the accidental spillage of mercury from the contact bars on the standards and from the mercury pools on the ratio devices. The implementation of this control has facilitated the cleanup of mercury in the labs.

Contact Bar Caps

Caps are used to cover the ends of the contact bars to reduce the emission of mercury vapor from the bars after they have been removed from the mercury pools. Pencil erasers are used for caps because they fit snugly over the ends of the bars. In addition, small plastic caps and shrink tubing are used for this purpose.

Storage Cabinet Modifications

The doors on the large cabinets used for long-term storage of the standards in the Precision Lab have been removed to increase airflow across the standards. Plant representatives feel that this helps to remove mercury vapor emitted from the contact bars, thereby preventing workers from being exposed to a high concentration of mercury vapor when they open the cabinets.

Exhaust Hood for Amalgamation

The amalgamation process was relocated under an exhaust hood to reduce the potential for worker exposure to mercury vapor emitted from the process.

PERSONAL PROTECTIVE EQUIPMENT

Calibration technicians, whose routine activities involve use of or contact with mercury, wear the following protective equipment and clothing:

- o Cloth lab coats, which are changed approximately once per week or as needed and are laundered outside of the facility
- o Rubber-soled shoes, which plant representatives claim absorb less mercury than leather
- o Disposable shoe coverings (optional)
- o Disposable rubber surgical gloves.

In the event of a spill of mercury, the following protective equipment is used in the cleanup procedure:

- o Self-contained breathing apparatus (SCBA)
- o Disposable surgical gloves
- o Disposable coveralls or suit
- o Rubber boots
- o Disposable shoe coverings over the boots.

Disposable equipment is placed in plastic bags when the cleanup procedure is completed.

WORK PRACTICES (Including Housekeeping/Decontamination)

Personal hygiene practices that have been implemented to reduce worker exposure to mercury are as follows:

- Smoking, eating, and drinking are not permitted in areas containing mercury so as to minimize accidental ingestion of mercury.
- Employees should wash their hands before breaks, smoking, and meals.
- Rings, watches, and other jewelry should not come in contact with mercury in order to prevent contamination and possible amalgamation.
- In the event that mercury contacts the skin, the worker should wash immediately with soap and water and report the incident to the area supervisor.

The process-related work practices that have been implemented to reduce worker exposure to mercury are as follows:

- Mercury should only be handled on crack- or crevice-free bench tops (Formica[R] tops preferred). Plastic trays are available to serve as catch pans for operations involving mercury.
- When transferring mercury, a suitable pouring technique using a glass or plastic funnel must be employed. If possible, the operation should be performed under a hood using a plastic catch tray.
- When handling items such as resistance standards, the worker must not touch the amalgamated ends. Rubber or plastic coverings are provided to cover amalgamated ends when standards are not in use.
- All amalgamating should be done under an exhaust hood.
- The ambient temperature of areas in which mercury is handled should not exceed 29 C (85 F).
- All work and storage areas should be well ventilated. Storage carts in the Standards Lab should be kept closed when not in use so that they do not become point sources for mercury vapor.

Housekeeping and decontamination procedures employed at the facility are as follows:

- All exposed surfaces should be free of accumulations of mercury. This may be accomplished by cleaning the work area with the mercury spill kit described previously.

- Dry sweeping and the use of compressed air for cleaning floors is prohibited.
- The floors in areas where mercury is used, stored, or handled should be cleaned periodically using HgX^R.
- In the event of a large spill (in excess of 1 tablespoon of mercury), the Decontamination Team is called in to implement cleanup procedures. Personal protective equipment used in this procedure has been described previously. A mercury vacuum pump is used to remove mercury. Monitoring of the workers' personal clothing after they have removed the protective clothing is conducted using a mercury vapor detector (Bacharach MV-2).

MONITORING PROGRAMS

Biological Monitoring

The biological monitoring program consists of yearly urinalysis to determine the concentration of mercury. If the urine-mercury concentration exceeds 25 micrograms per liter (ug/L), the worker is monitored twice a year; and if the concentration exceeds 50 ug/L, monitoring is conducted three times per year. If the concentration remains over 100 ug/L for 1 year, the worker is removed from the exposure area. A 50 ug/L concentration for a 3-year period also warrants removal. Urine-mercury concentrations in excess of 50 ug/L have not been reported at the facility for the last 3 years. Most workers' urine-mercury concentrations are considerably lower than 50 ug/L.

Air Contaminant Monitoring

Mercury vapor levels are monitored weekly using a mercury vapor detector (Bacharach MV-2). Monitoring is conducted in the Standards Lab, Precision Lab, and the Potentiometer Room. Personal monitoring to determine employees' time-weighted average exposure to mercury vapor is conducted twice per year using dosimeters (3M, Mercury Vapor Monitors).

OTHER PROGRAMS

Training Programs

A training session is provided for employees who work in areas where mercury is handled. This includes both new employees and those who transfer into mercury areas. The training includes the following:

- Procedures on good housekeeping, personal hygiene practices, and use of personal protective equipment
- Information on the potential health hazards associated with mercury, including signs and symptoms of overexposure
- Information on the possibility of ingesting mercury by hand-to-mouth contact when good personal hygiene is not practiced.

CONCLUSIONS AND RECOMMENDATIONS

The efforts of the Leeds and Northrup Mercury Task Force Committee established in January of 1980 resulted in an integrated approach to reducing worker exposure to mercury vapor. Based on observation of plant monitoring data, ambient air mercury vapor concentrations have been maintained below the NIOSH recommended standard of 0.05 mg/m^3 since May of 1980. In addition, worker urine-mercury levels have been maintained below 20 ug/L. Many of the controls adopted were inexpensive to implement. These include work practice modifications, minor process modifications, and worker education. This approach to mercury control is highly recommended because significant results can be obtained with very little capital investment.

A significant amount of information was obtained during this preliminary survey. It is recommended that an indepth survey not be made at this facility because the specialized nature of the use of mercury in this operation makes the mercury controls less applicable to other industries.