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THE CONTROL OF MERCURY VAPOR
IN LABORATORIES

BERKELEY, CALIFORNIA

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C. R. Wintersteen

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The use of mercury in any chemistry laboratory introduces a hazard; the extensive use of vacuum pumps of the mercury diffusion type at the Radiation Laboratory gives rise to an extra hazard because of the quantities of mercury involved.

Some mercury diffusion pumps now in service contain approximately 300 pounds of mercury per pump, and operate at between 180° and 210°C. Figure 1 shows a typical pump installation. No problems have been encountered while pumps are in operation; however, during filling, draining, dismantling, and overhauling procedures, strict precautions must be observed to insure safe working conditions.

The methods of routine control of mercury vapor can be outlined here, and to these can be added the special precautions observed in handling the pump equipment.

General Protective Procedures

The safety of workers who must handle mercury apparatus depends on keeping the mercury confined as much as possible, removing mercury vapor from the air that they breathe, and preventing contact of mercury with their skin. An important link in the safety chain is the detection of mercury vapor in the atmosphere.

Detectors

Two detectors developed at UCRL are being used: Model 3EPS, dc-operated (Figs. 2 and 3), and Model 4EPS, ac-operated. Both detectors utilize the principle of interception of an ultraviolet light beam. The dc unit is preferred because it is battery-operated and no extension cord is required. The ac model works well as a continuous monitoring device, and has an audible alarm which can be set for any given vapor concentration.

Clean-up

Any spilled mercury must be picked up immediately. At UCRL the employees responsible for the spill are furnished a special vacuum cleaner and are required to make the clean-up. "Mervac" vacuum cleaners (Fig. 4) are used to pick up visible droplets of mercury. All mercury recovered in this manner is sent to the Salvage Shop for subsequent cleaning and re-use. Measurements can be made of the air exhausted from the cleaner, so as to check on the filter efficiency. The glass jars originally provided on the trap assembly have been replaced with lucite jars to eliminate danger of breakage.

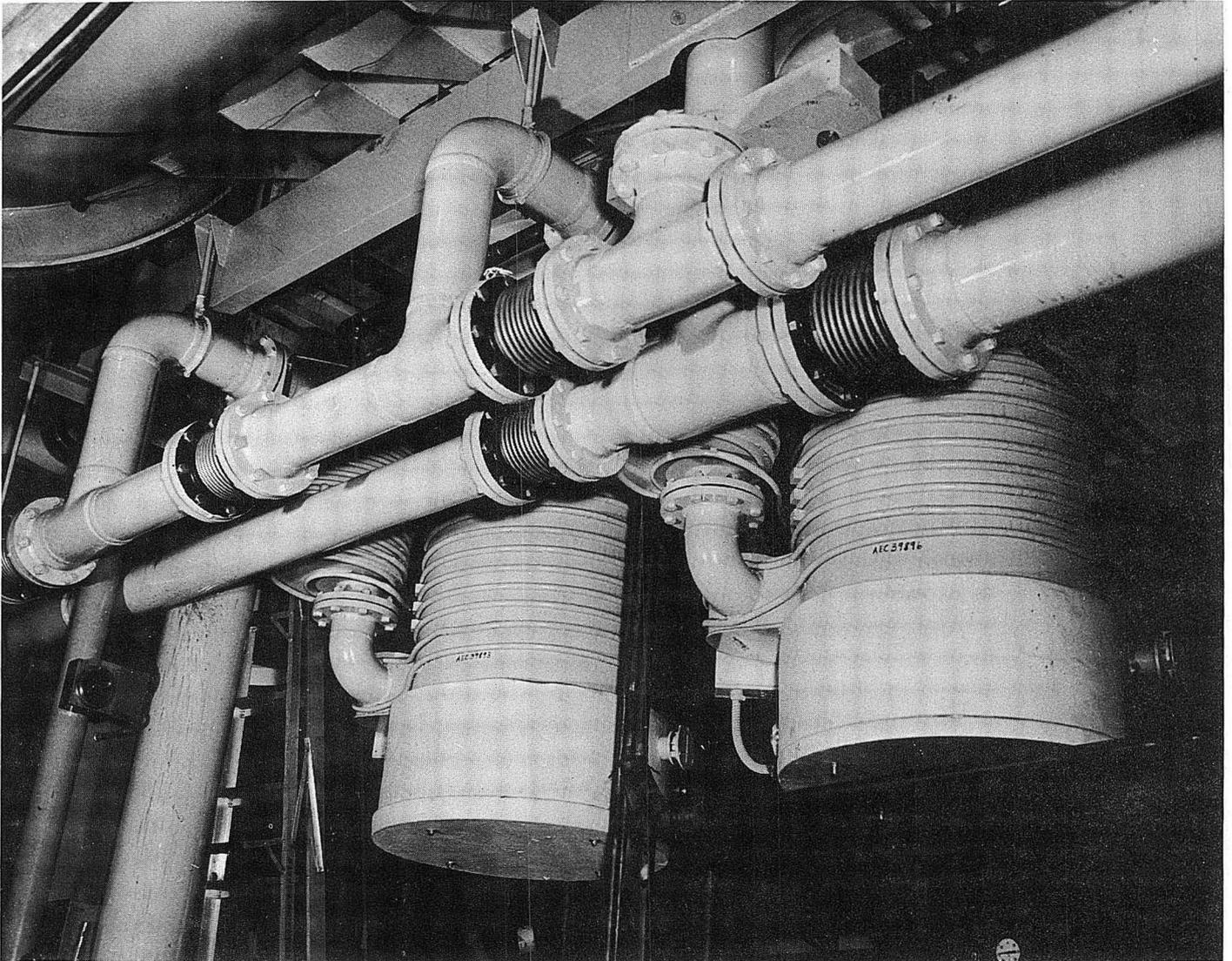


Fig. 1. A typical mercury diffusion-pump installation.

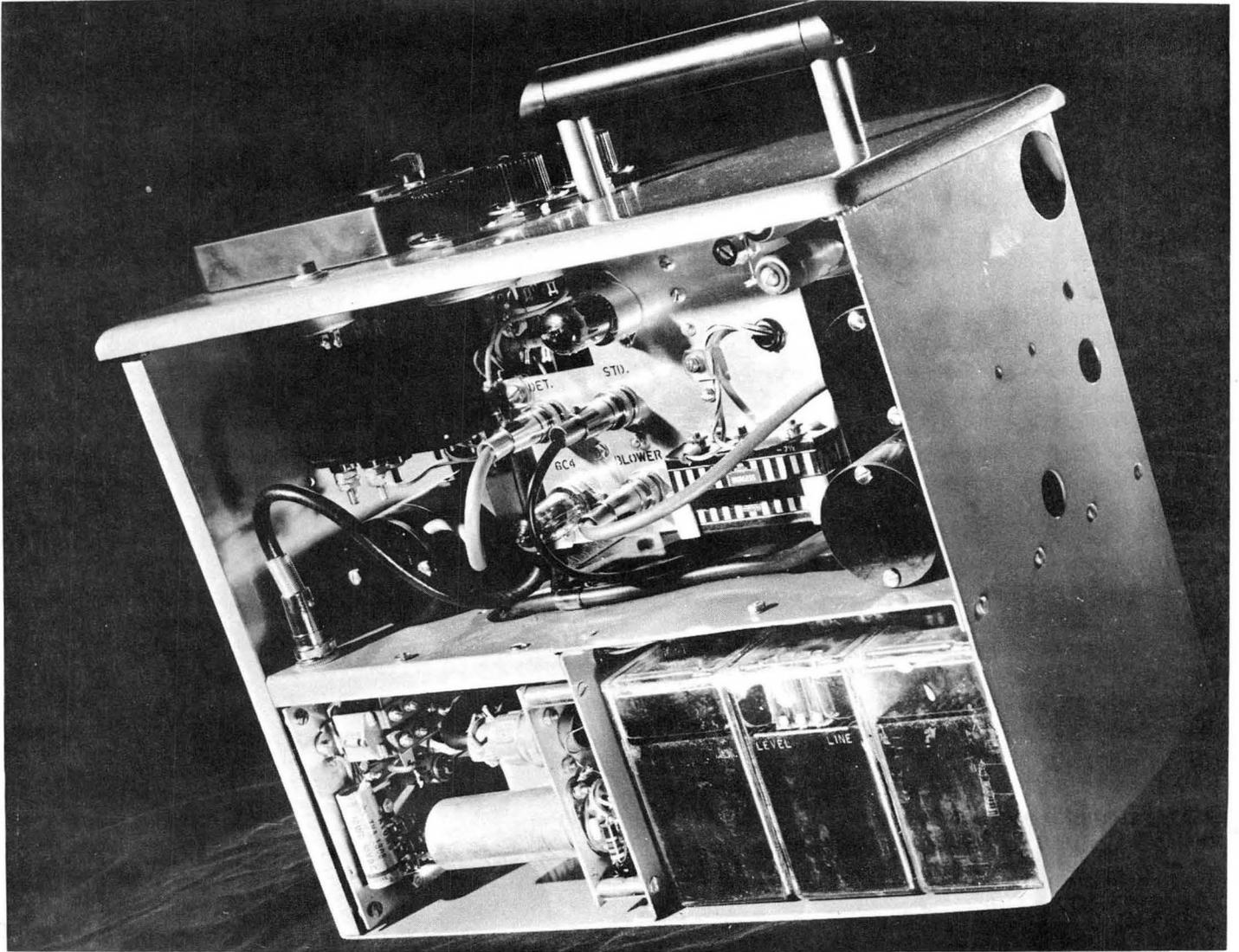


Fig. 2. A dc-operated mercury-vapor detector.



Fig. 3. A dc-operated mercury-vapor detector in use.



Fig. 4. Special vacuum cleaner for picking up spilled mercury.

The activated-charcoal filter material in the mercury vacuum cleaner eventually becomes sufficiently contaminated to warrant replacement with new material. However, the charcoal can be baked over a low-temperature heater in an open area until monitoring indicates that it can be re-used.

If a mercury vacuum cleaner is not available, spilled mercury in quantity can be recovered by freezing. A 3- or 4-inch section of thin-walled pipe is placed in the pool of mercury and liquid nitrogen is poured into the pipe. When solid, the mercury can be picked up with a pair of long-nosed pliers and quickly transferred to a container.

For small droplets a mechanical pipette can be used. Recovery should never be made by use of a mouth pipette.

Vapor Suppression

If a vapor level above the permissible concentration is detected after visible mercury has been cleaned up, Hg-X compound is applied to the contaminated surfaces.

The best results are obtained by dissolving the compound in warm distilled water and then straining the solution through cloth to remove the undissolved particles; application is by use of an ordinary insect-spray gun. (Fig. 5.) The use of this compound in the dry form is wasteful and does not result in the degree of vapor suppression desired.

Respiratory Protection and Skin Protection

The M. S. A. "Mersorb" cartridge in a "Comfoe" facepiece is the standard equipment at UCRL for respiratory protection. Because of the affinity of mercury for rubber it is desirable to monitor the facepiece to make sure that absorption has not taken place. By the same token, neoprene gloves rather than rubber gloves should be worn.

The "all-service gas mask" for respiratory protection was not found satisfactory. It was our experience that the somewhat expensive rubber parts of the equipment eventually became heavily contaminated. It was not economically feasible to decontaminate these parts, and they had to be scrapped.

Ventilation

Ideally, all work with mercury should be done outdoors or in hoods; however, this is not always possible. It has been our experience that if a room has good cross ventilation the maximum allowable concentration (MAC) of 0.1 mg/m^3 of air is not attained. As an example, one chemistry area had become badly contaminated with spilled mercury. Two standard hoods were in operation with the faces partly open. Monitoring at the breathing level did not indicate a MAC. The hood exhausts were then turned off and the hallway door was closed. Within a very short period of time the concentration increased well over the MAC.



Fig. 5. Application of Hg X solution.

Miscellaneous Precautions

Filling pumps by the gravity method is preferred; however, in some cases it is necessary to use a suction method. The roughing pump connected to the diffusion pump is utilized to draw the mercury from an open container through a siphon tube (both of stainless steel) into the pump. The container must be open in order that the receding level of mercury can be observed; then the pump can be valved off before air is drawn into the tube. During such operations approved respirators should be worn.

To maintain good housekeeping in chemistry laboratories having glass vacuum racks it is advisable to have a stainless steel catch pan at the base of the glass array. The pan should be sloped and provided with an outlet and drain tube which can be inserted into a metal flask located on the floor.

As it is possible for a person to be accidentally exposed to high concentrations of mercury vapor as a result of equipment failure or explosion, any known or suspected cases of exposure should be referred to a physician for a series of urinary analyses.

Safe Practices Recommended at UCRL

These are the rules in effect at UCRL.

1. General Precautions for Handling Mercury

- A. Always work in a cool ventilated area; never in a closed room. Keep work area as free of dust as possible. Dry sweeping of floors should not be permitted.
- B. Clean up mercury spills as soon as possible. A mercury vacuum cleaner can be obtained by calling the Inspection Technicians. Hg X Compound in water solution should be applied by use of a spray gun for vapor suppression when necessary.
- C. Keep the Safety Office advised as to spills or large-scale usage of mercury in your area. This department is equipped to make surveys when necessary to determine the vapor level.
- D. All mercury picked up should be put in labeled flasks obtainable from the Salvage Group. Return the container and dirty mercury to this group for future salvaging. Do not dispose of mercury in any other manner, unless it is suspected that it has become radioactive, in which case dispose of it through Health Chemistry.
- E. Keep mercury in closed containers and always store on the lowest shelves. A light film of oil will prevent vapor from being given off on containers which of necessity must be open to the air.
- F. Do all transfer work over steel or glass trays. A small amount of water in the tray will keep the droplets from splashing. Do not transfer over sinks or allow the mercury to get into sanitary drains.

2. Personal Safety

A few common-sense rules must be followed to eliminate the possibility of mercury absorption, either by inhalation or through the skin.

- A. Wear neoprene gloves, but remove them before handling the respirator, so as to avoid contaminating it. Gloves of porous material, such as cotton, become easily contaminated. Avoid the use of rubber-soled shoes, particularly those having crepe-rubber soles.
- B. The standard respiratory protection is the "Mersorb" cartridge in the standard chemical facepiece. These are available at the Storeroom. This respirator is rated for protection against a vapor concentration of 37 mg/m^3 for 70 hours. Label the respirator with your name and always store it away from the area in which mercury is used. Use the container furnished with the respirator. Have the facepiece monitored at frequent intervals.
- C. Wash your hands thoroughly before smoking or eating. Food must not be kept or eaten in mercury work areas. Do not tap the ends of cigarettes on bench tops in areas where mercury is used.
- D. Do not wear gold watches or rings when working with mercury, as the gold may become coated and hold mercury in contact with the skin.

3. Vacuum-Pump Operation

- A. Diffusion pumps must be cooled down before any overhaul work is done. All welding or burning operations on dismantled diffusion pumps shall be done outside the shops and only when a strong breeze prevails. The worker shall wear a respirator and neoprene gloves inside plastic-coated work gloves. Gloves must be disposed of when the job is completed.
- B. All equipment containing mercury must be placed over suitable catch pans when work is being done. The pans should be of steel, with "4-A" plastic coating, and should have rounded corners.
- C. All mechanical pumps used on mercury work must be exhausted by vent piping to the outside atmosphere above the breathing zone.
- D. Diffusion pumps or component parts must not be returned to stock until properly sealed and labeled. (Adhesive labels are available at the Safety Office for the purpose of marking contaminated objects.)

- E. Contaminated equipment not in use shall be stored outdoors, sealed and properly labeled.
- F. Piping removed from any mercury pump system shall not be re-used for other purposes.
- G. Waste oil from mechanical pumps used on mercury systems must be collected in separate marked drums. Do not dispose of this oil in the regular waste-oil tank.

Conclusions

The problem of mercury vapor in laboratories need not be a serious one if the basic precautions are taken. We recommend the following program as adequate and practical for the typical research laboratory:

1. Make sure that good ventilation is available at all times.
2. Clean up spills as soon as possible, preferably by use of an approved vacuum cleaner.
3. Use an electronic detection device for monitoring work areas and equipment.
4. Use vapor-suppressive chemicals when necessary.
5. Make sure that the correct personal protective equipment is available.
6. Establish a safety procedure and stress the importance of mercury vapor control by the use of safety bulletins and other printed material.

This work was done under the auspices of the U. S. Atomic Energy Commission.