

OSHA Directives

CPL 2-2.6 - Inorganic Mercury and its Compounds

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CPL 2-2.6
OSHA Instruction
October 30, 1978
OSHA PROGRAM DIRECTIVE #300-2

TO: Field and National Offices/OSH

SUBJECT: Inorganic Mercury and Its Compounds

1. PURPOSE

This directive provides guidelines to be followed in inspection, and where necessary, the issuance of citations, regarding exposure to mercury in the workplace.

2. DOCUMENTATION AFFECTED

None

3. DOCUMENTATION REFERENCED

a. Field Operations Manual, Chapter XIII. b. OSHA Standard Methods for Sampling Total Dust, Metal Fumes, and Liquid Aerosols. c. Guidelines for Controlling Occupational Exposure to Mercury or its Inorganic Compounds.

4. BACKGROUND

a. Chemical Data. On the following page is a table of properties of some commonly encountered mercury compounds. A vapor pressure curve for mercury follows the table. b. Fire, Explosion Potential, and Reactivity. Although elemental mercury presents little danger of fire or explosion, several mercurial compounds do pose such a threat. Some organic mercurial compounds (e.g. mercury fulminate) pose a serious threat, however, they are not the concern of this directive. Among the inorganic mercurial compounds, several are reported as being physical hazards. Mercury nitride poses an explosion hazard when exposed to heat. Upon contact with acids or

moisture, mercuric selenide readily liberates flammable gas. Mercurous chromate, mercurous chloride, mercurous oxide, and mercury ore (cinnabar) are also reported to be flammable under certain conditions and potential physical hazards. c. Other relevant Information. This section is for information purposes only, not for compliance action.

(1) Common Processes. A brief description of the common processes involved in the production, use, and handling of mercury and its inorganic compounds is impossible due to its numerous industrial applications. There are over 600 major industrial plants currently using mercury in its elemental form. Listed below are several broad industrial areas in which mercury is used.

PROPERTIES OF SOME MERCURY COMPOUNDS

Vapor Melting Pt. Boiling Pt. Compound Appearance Pressure C C -----

----- Mercury Silver-White 1mm Hg -38.87 deg 356.58 deg (elemental)

heavy, mobile, at 126.2 C Hg liquid metal -----

--- Mercury Ore Bright scarlet- Sublimes (Cinnabar, red powder or at 583.5 deg Mercuric lumps; blackens Sulfide) on exposure to HgS light -----

----- Mercuric White powder 1 mm Hg 277 deg. 302 Chloride or crystals at 136.2C HgCl₂

----- Mercurous White crystals, Sublimes Chloride or crystalline at 400 deg. HgCl₂ powder; taste- less, odorless

Mercurous Black to Decomposes Oxide grayish-black at 100 deg C Hg₂₀ powder -----

----- Mercury Brown powder Explodes Nitride Hg₂N₂ -----

----- Mercurous Red needles Decomposes

Chromate or powder Hg₂CrO₄ -----

Mercuric Gray plates Sublimes Selenide HgSe -----

----- - - - - - Continued From Above -----

Mol. Solubility Flammability Compound Weight In H₂O -----

----- Mercury 200.59 Insoluble (elemental) Hg -----

----- Mercury Ore 232.68 10 mg/1 When ignited in (Cinnabar, at 18 C air, decomposes Mercuric to metal and sulfur Sulfide) which burns to SO₂. HgS -----

----- Mercuric 271.52 1 gm/13.5 ml Chloride HgCl₂ -----

----- Mercurous 472.14 Practically Chloride Insoluble

Hg₂Cl₂ ----- Mercurous 417.22 Insoluble

Moderate Oxide Hg₂₀ ----- Mercury 629.85

Severe explosion Nitride hazard when Hg₂N₂ exposed to heat. -----

----- Mercurous 517.23 Moderate, by Chromate chemical reaction; Hg₂CrO₄ an oxidizer ----- Mercuric 279.57 Readily liberates Selenide flammable gas upon HgSe contact with acids or moisture -----

For Graph entitled "Elemental Mercury Vapor Pressures at Various Temperatures", see printed copy.

(a) Mechanical. Because mercury is a liquid at low temperatures with no tendency to wet glass, it is widely used in scientific instruments such as thermometers and barometers. Mercury is also used in the pressure gauges of vacuum pumps. Potential mercury exposure is a problem not only in the production of such instruments, but also in research institutions where such instruments are used extensively.

(b) Electrical. Mercury's very high level of electrical conductivity lends itself to use in electrical appliances. The principal use of mercury in this category is for batteries. Mercury is also used in rectifiers, oscillators, power control switches, and vapor lamps.

Mercuric oxide is used extensively in dry cells. In such a battery, the depolarizer is composed of mercuric oxide, the electrolyte is a strongly alkaline solution of potassium hydroxide saturated with potassium zincate, and the anode is of zinc. In the manufacture of these cells, processes such as mixing, blending, and tabletting of the mercury present potential exposure problems. The exposure may be to mercury dust or vapor.

(c) Chlorine. The chlor alkali process uses saturated and heated salt brine (25% NaCl in water) to produce Cl₂ (chlorine gas), H₂ (hydrogen); and NaOH (sodium hydroxide) by electrolysis. The two basic cell types are diaphragm cells and the mercury cells. Several different designs in each cell type can be found. Low-voltage, high-amperage power is used in both types. The cells are usually hooked up in series. Diaphragm cell construction materials include asbestos, lead, concrete, stoneware, and possibly fiberglass. Diaphragm cells do not contain mercury. The mercury cell uses mercury in a two-chamber system; in the first (electrolyzing) chamber, chlorine gas is produced and the sodium ion is amalgamated in the mercury. In the second (denuding) chamber, hydrogen is formed when the amalgam contacts water and the sodium ions combine with the remaining hydroxyl ion (OH⁻) to form NaOH. The basic process reaction for the electrolytic cells is



In this process the NaOH is extremely corrosive and mercury leaks, spillage, and recovery are always a problem. As the cells age and become inefficient, they have to be rebuilt. Rebuilding is a routine operation in chlor alkali plants, where cells are operated in batteries of tens and even hundreds. During the rebuilding process, the cells are leveled off, exposing the mercury surface, creating a potential exposure problem.

(d) Paint. In the paint industry, mercury is commonly used in its organic form. In the primary paint industry, however, mercury may initially be in its elemental form, even though the final product may be organic. In such primary manufacture, there may be some potential mercury exposure.

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(e) Medicinals. Mercury is used primarily in dental supply and equipment. Dentists have a variety of uses for mercury, the primary one being a filler for cavities. Due to mercury's use in

medical equipment and supplies, dental schools and offices and hospitals are sites of potential exposure.

(2) Signs and Symptoms of Intoxication. Intoxication may occur in workers excessively exposed to mercury or to its compounds. The exposure may be due to mercury vapor, mist, dust, or fume, by inhalation, ingestion, or through skin. Two general types of mercury intoxication exist, chronic and acute. Chronic mercury intoxication is caused by exposure to a low concentration of mercury over an extended period of time. Acute mercury intoxication is due to a greater exposure and is unrelated to time factors. Definite symptoms of chronic mercurialism may not appear until after six months of exposure, or longer. The symptoms are primarily of the nervous and digestive systems. The symptoms of overexposure to mercury may include such personality manifestations as: irritability, excitability, or excessive timidity. Other symptoms include: headaches, drowsiness or insomnia, and weakness. Many cases also include reports of sore mouths, excessive salivation, and perspiration. In mercury intoxication, a common symptom is a tremor which is aggravated by emotion or excitement. Also included in the literature as symptoms of mercury intoxication are: loss of appetite, weakness, digestive disorders, kidney damage, and bleeding gums. If an inspector is unfamiliar with biological monitoring methods used for mercury, he or she should check with his Senior Industrial Hygienist. When evaluating biological symptoms, trends within groups of employees should be noted. Elevation in mercury levels within a group is often a more significant finding than elevations in an individual because it indicates a common source.

PARAGRAPH DELETED

This page replaces deleted pages 6-14.

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Dear Sir:

The nature of work at your establishment indicates to the Occupational Safety and Health Administration (OSHA) that mercury in various forms may be used in your manufacturing process. As you know, the present permissible exposure limit to mercury is 1 mg/10 M3 (.1 mg/M3) expressed as a time-weighted average concentration for an 8-hour period. In order to achieve compliance with this mandatory airborne mercury level, you must implement feasible engineering or administrative controls or maintain an effective respiratory protection program should such controls be found infeasible. The National Institute of Occupational Safety and Health has recommended that the permissible exposure limit for mercury be lowered to .05 mg/M3. This recommendation is currently being considered by OSHA.

As an interim measure until such time as a complete standard is promulgated we are forwarding herewith recommended guidelines for protection of your employees against the risk of illness resulting from exposure to inorganic mercury and its compounds. These recommendations involve preventive steps of good housekeeping, personal hygiene, medical surveillance, monitoring and measuring of exposure levels, employee training, and respirator information which should ensure a healthful workplace for those of your employees who are involved in such

manufacturing processes. The issuance of these guidelines does not alter our intention to continue our compliance activities.

The threat of mercury poisoning is ever present if mercury and its compounds are not treated with utmost care in the manufacturing process. Therefore, voluntary compliance with the enclosed nonmandatory guidelines would further the overall objective of the Occupational Safety and Health Act - to assure so far as possible, safe and healthful working conditions.

Your cooperation in this matter is greatly appreciated. Protection of your employees from overexposure to mercury is, I am confident, our common goal.

Bert M. Concklin Deputy Assistant Secretary

Guidelines for Controlling Occupational Exposure to Mercury or Its Inorganic Compounds

In accordance with the Occupational Safety and Health Administration's (OSHA) standard for air contaminants (29 CFR 1910.1000), employee exposure to airborne mercury or its inorganic compounds shall not exceed an 8-hour time-weighted average limit of 1 mg/10 M3 (0.1 mg/M3) or a limit set by a state agency whenever a state-administered Occupational Safety and Health Plan is in effect. It should be emphasized that the permissible exposure limit is a time-weighted average. The first mandatory requirement is that employee exposure be eliminated through the implementation of feasible engineering controls. After all such controls are

implemented and do not fully control to permissible exposure limits, each employer must rotate its employees to the extent possible in order to reduce exposure. Only when all engineering or administrative controls have been implemented, and the level of mercury still exceeds permissible exposure limits, may an employer rely on a respirator program pursuant to the mandatory requirements of 1910.134. In addition it is mandatory that no employee be allowed to consume food or beverages in an area exposed to mercury (29 CFR 1910.141(g)(2)). Generally, where working conditions or other practices constitute recognized hazards likely to cause death or serious physical harm, they must be corrected pursuant to Section 5(a)(1) of the Occupational Safety and Health Act. In addition to these mandatory requirements, the National Institute of Occupational Safety and Health has recommended that the limit be lowered to 0.05 mg/M3; this recommendation is currently being considered by OSHA. Pending such consideration, the following recommendations are made to ensure that employee exposure to mercury and its inorganic compounds is controlled to the permissible exposure limit.

1. MONITORING

a. Initial Evaluation Each employer who has a place of employment in which mercury or its inorganic compounds are occupationally produced, reacted, released, packaged, repackaged, transported, stored, handled, or used should inspect each workplace and work operation to determine if any employee may be exposed to mercury or its inorganic compounds. Indicators that an evaluation of employee exposure should be undertaken would include:

(i) Any information or observations which would indicate employee exposure to mercury or its inorganic compounds; (ii) Any measurement of airborne mercury vapor or the dust of its inorganic compounds; (iii) Any employee complaints of symptoms which may be attributable to exposure to mercury or its inorganic compounds; (iv) Whenever there has been a production, process, or control change which may result in an increase in the airborne concentration of mercury vapor or the dust of its inorganic compounds, or whenever the employer has any other reason to suspect an increase in the airborne concentrations of mercury vapor or the dust of its inorganic compounds.

b. Air Monitoring

(i) Employee exposure measurements should represent the actual breathing zone exposure conditions for each employee. Any appropriate combination of long-term or short-term samples would be acceptable, but all exposures should be calculated on an 8-hour time-weighted average, assuming a 40-hour work week, to arrive at the permissible exposure limit. (ii) Accuracy of Measurement. The method of monitoring and analysis should have an accuracy of not less than plus or minus 20% for concentrations of airborne mercury vapor or the dust of its inorganic compounds equal to or greater than the permissible exposure limit. (One method meeting this accuracy requirement is available in the "NIOSH Manual of Analytical Methods," Government Printing Office Stock No. 1733-00041.) (iii) Frequency of Monitoring. Where the employer has determined that employees are exposed to mercury or its inorganic compounds in excess of the permissible exposure limit, monitoring should be repeated quarterly.

2. MEDICAL SURVEILLANCE

Each employer should institute a medical surveillance program for all employees who are or will be exposed to airborne concentrations of mercury vapor or the dust of its inorganic compounds above the permissible exposure limit. The program should provide each employee with an opportunity for biological monitoring and medical examination performed by or under the supervision of a licensed physician and provided during the employee's normal working hours without cost to the employee.

a. Medical Examination

(i) Each employer should provide a medical examination which includes a complete medical history and physical examination, complete blood count, routine urinalysis (specific gravity, sugar, protein determinations, and microscopic examination), and voluntary pregnancy test, where appropriate, to each employee exposed to mercury or its inorganic compounds in excess of the permissible exposure limit. (ii) Medical examinations should also be made available:

(a) To employees prior to their assignment to areas in which airborne concentrations of mercury or its inorganic compounds are above the permissible exposure limit; (b) At least annually for each employee exposed to airborne concentrations of mercury or its inorganic compounds above the permissible exposure limit at any time during the preceding six months; (c) For each employee whose urine analysis sampling series indicates elemental mercury level at or above 0.02 mg per liter of urine or total mercury level in excess of .200 mg per liter of urine,

which is not receding; (d) Immediately upon notification by the employee that the employee has developed signs or symptoms commonly associated with toxic exposure to inorganic mercury or its compounds.

(iii) Where medical examinations are performed, the employer should provide the examining physician with the following information:

(a) The reason for the medical examination requested; (b) A description of the affected employee's duties as they relate to the employee's exposure; (c) A description of any personal protective equipment used or to be used; (d) The results of the employee's exposure measurements, if available; (e) The employee's anticipated or estimated exposure level; (f) The results of the employee's biological monitoring; and (g) Upon request of the physician, information concerning previous medical examination of the affected employee.

b. Biological Monitoring

(i) Urine sampling and analysis should be the biological monitoring method used. The method of analysis for total, ionic and elemental mercury in urine is described in the American Industrial Hygiene Association Journal, September 1974, pp. 576-580. For the analysis at least 100 ml of urine should be collected during a work day when sampling is scheduled. (ii) Accuracy of Measurement. Sample analysis should have an accuracy to a confidence level of 95% as it pertains to the repeatability of several analyses from any given urine sample. (iii) Frequency of Monitoring

(a) If possible, a urine sample should be obtained of all employees who will be assigned to work with mercury or its inorganic compounds prior to exposure to the work area. (b) For employees exposed to less than permissible levels of airborne mercury, urine sampling and analysis should be done every six months. (c) For employees exposed to airborne mercury vapor or inorganic mercury compounds above the permissible exposure limit, urine sampling and analysis should be performed every three months for each employee. It should continue at least six months after the last known exposure above the permissible exposure limit if the employee is available for sampling. (d) Where the total mercury level exceeds .200 mg of mercury per liter of urine, or 0.02 mg of elemental mercury per liter of urine, sampling should be accelerated to a weekly basis. The activities of the employees should be observed to detect the potential source of mercury intake.

(e) If the total mercury level in urine does not decrease during the one month sampling period, or if the elemental mercury level in urine does not decrease in two weeks, a physician should be consulted.

(iv) (a) The results of employee urine sampling should also be considered as a group exposure by area of assignment and/or by job description. Elevated group urine mercury levels should be a cause for review of operational practices, process controls, and a change in either or both to reduce employee exposures. (b) If several employee urine samples from the same area of

assignment indicate excessive elemental mercury urine levels, corrective action in the area should be started by the employer immediately.

c. Physician's Written Opinion

(i) The employer should obtain and furnish the employee with a written opinion from the examining physician containing the following:

(a) The signs or symptoms of mercury exposure manifested by the employee, if any; (b) A laboratory report of the mercury content in blood or urine if such analysis is performed by or under the supervision of the physician, or reported to the physician by a laboratory to which such samples have been submitted for analysis; (c) The physician's opinion as to whether the employee has any detected risk of material impairment to the employee's health from exposure to mercury or its inorganic compounds or would directly or indirectly aggravate any detected medical condition; (d) Any recommended limitation upon the employee's exposure to mercury or its inorganic compounds or upon the use of personal protective equipment and respirators; and (e) A statement that the employee has been informed by the physician of any medical condition which requires further examination or treatment.

(ii) The written opinion obtained by the employer should not reveal specific findings or diagnoses unrelated to occupational exposure to mercury or its inorganic compounds.

(iii) If the employer determines, on the basis of the physician's written opinion, that any employee's health would be materially impaired by maintaining the existing exposure to mercury or its inorganic compounds, the employer should place specific limitations, based on the physician's written opinion, on the employee's continued exposure to mercury or its inorganic compounds.

3. TRAINING

a. Each employer who has a workplace in which elemental mercury or its inorganic compounds are stored and used occasionally in small quantities, and where airborne mists, fumes, vapors, or dusts may be accidentally or intentionally produced and released in the work environment due to handling, storage, or use should:

(i) Inform employees who work or will be working with mercury or its inorganic compounds occasionally of potential health hazards; (ii) Inform employees of the correct work and storage practices, written emergency procedures to be followed in case of spills or leaks, and personal protective equipment necessary in emergencies; (iii) Provide equipment and/or materials necessary to control mercury-containing spills or leaks in quantity sufficient to control the entire amount of mercury or compound used; (iv) Provide written procedures and means for removal of mercury or its compounds from body surfaces and working surfaces, machinery, or tools to be used later for other work activities; (v) Establish limited areas within the workplace where mercury or its compounds can be used; (vi) Inform and local fire department of the exact

location of storage and the hazards in case of fire; (vii) Assure that the permissible exposure limit is not exceeded in the work environment during the occasional uses.

b. A training program for all new employees prior to work assignment and for all affected employees at least annually should be provided by employers:

(i) Who have a workplace in which mercury metal, its vapors, fumes, solutions, or inorganic mercury compound dusts, mists, solutions or vapors are routinely produced, reacted, used, stored, handled in the open work environment, and where the possibility of exceeding the permissible exposure limit exists; or (ii) Whose employees may have the opportunity for routine significant contacts with mercury metal or its inorganic compounds as solutions, dusts, or mists because such materials are the ingredients or byproducts of a handling, use, or production process.

c. The training program should:

(i) Advise affected employees of the signs and symptoms of over-exposure to mercury; (ii) Instruct affected employees to advise the employer of the development of the signs and symptoms of overexposure to mercury; (iii) Inform employees of the specific nature of operations which could result in exposure to mercury above the permissible exposure limit, as well as safe work practices for the handling, use, release, storage, or disposal of the mercury or its compounds in normal operations; (iv) Instruct employees in proper housekeeping practices, decontamination procedures in the event of a mercury or mercury compound spill, and fire emergency procedures; (v) Emphasize the possibility of ingesting mercury by hand-to-mouth contact when good personal hygiene is not practiced; (vi) Inform employees of measures necessary to protect them from exposures in excess of the permissible exposure limit. The wearing and turning-in of protective clothing should be stressed; (vii) Instruct employees as to the purpose, proper use, and limitations of respirators; (viii) Provide employees with a description of, and explain the purposes for, the medical surveillance program; (ix) Inform employees where written procedures and hazard information are available on the premises.

4. PERSONAL PROTECTIVE EQUIPMENT

a. Where respirators are required under 1910.1000(e) and 1910.134, the employer should select and provide an appropriate respirator from the table below.

b. Recommendations for Respirator Usage at Mercury Concentrations Above Permissible Exposure Limit

Recommended Respirator	Airborne Concentration of Mercury	1. Fume, dust, vapor	1. Fume, dust, vapor
(A) A type C supplied-air or mist in excess respirator with a full of 5 mg/M3 facepiece operated in pressure-demand or other positive pressure mode, or (B) A self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. 2. Fume, dust, vapor (A) A type C supplied-air or mist less than respirator with a full 5 mg/M3 facepiece operated in pressure-demand or other			

|| positive pressure mode, ||| or ||| (B) A self-contained breathing|| apparatus with a full ||| facepiece operated in ||| pressure-demand or other ||| positive pressure mode, ||| or ||| (C) Cartridge type respirator,||| when approved (TC) and ||| available. | -----

c. Only those respiratory protection devices which have been approved by the National Institute of Occupational Safety and Health under the provisions of 30 CFR Part 11 should be used. d. There should be an established in-plant procedure and means and facilities provided to issue respiratory protective equipment, to return used contaminated equipment, to decontaminate and disinfect the equipment, and to repair or exchange damaged equipment. Record keeping of these activities should be considered, especially on recharge of self-contained breathing apparatus air cylinders.

5. PROTECTIVE CLOTHING

a. Where protective clothing is required under 1910.132, the employer should provide and ensure that employees wear appropriate, clean, protective clothing, such as, but not limited to, coveralls, smocks, aprons, gloves, shoes, hair covers or hats, in the following situations:

- (i) Where employees may be exposed to concentrations of mercury above the permissible exposure limit; or
- (ii) Where the skin, hair, or clothing of employees may have repeated contact with accumulations of mercury fume, dust, mist, or solutions.

b. The employer should launder, maintain, and/or dispose of all contaminated personal clothing discarded by employees. c. The removal of mercury fume or dust from protective clothing by blowing or shaking should be prohibited. d. The employer should ensure that all protective clothing is removed in change rooms and deposited in marked laundry bags. e. The employer should inform any person who launders or cleans mercury-contaminated protective clothing of the potentially harmful effects of exposure to mercury and of precautions to take, such as not airing or shaking the clothing to remove mercury fume or dust. f. Street clothing and street footwear should not be permitted in the workplace whenever airborne mercury concentrations exceed the permissible exposure limit or potential contacts with mercury or its inorganic compounds exist. Contaminated clothing or footwear should not leave the plant except in packages for laundering, decontamination, or disposal. g. Employees who work with elemental mercury should turn in all protective clothing used after each shift of use. h. If protective clothing and plant footwear is provided for a longer period of use, they should be stored separately from personal street clothing, street footwear, food, tobacco products, and other personal effects.

6. HOUSEKEEPING

- a. All exposed surfaces should be maintained free of accumulation of mercury which, if dispersed, would result in airborne concentrations in excess of the permissible exposure limit or in a visible dust cloud.
- b. Dry sweeping and the use of compressed air for the cleaning of floors and other surfaces should be prohibited. If vacuuming is used, the exhaust air should be properly filtered to prevent generation of airborne mercury concentrations. c. Persons not wearing respiratory protective equipment should be excluded from areas where spills or leaks of mercury or inorganic mercury compounds have occurred until cleanup has been completed. d. All hand contact points (such as tools, door knobs, table tops, etc.) should be maintained free of mercury contamination. If this is impossible, gloves should be provided. e. Carpeting should not be used anywhere within the workplace. Doormats should be treated as mercury-contaminated objects. f. Used industrial wipe rags, floor cleaning mops, or paper towels used on mercury contaminated surfaces should be treated as potentially contaminated. They should not be rehandled, reused, compressed and stuffed, or dried on in-plant uncontrolled heaters.

7. PERSONAL HYGIENE FACILITIES AND PRACTICES

- a. All food, beverages, tobacco products, nonfood chewing products, and unapplied cosmetics should be prohibited in areas where there is a likelihood that skin or clothing may come in contact with fume, dust, mist, or solutions of mercury or where the airborne concentrations of mercury are above the permissible exposure limit. See the mandatory portion (page 1) of this Guideline. b. The employer should ensure that employees or visitors who work in or need access to areas specified in paragraph 5.a. wash their hands, forearms, face, and neck before each occasion of eating, drinking, smoking, or applying cosmetics and at the end of each work shift. All other employees should be encouraged in this practice. c. Employers should provide an adequate number of lavatories, maintained and provided with soap, hand brushes, and towels. Employees should be instructed in using the handbrushes on fingernails submerged in washwater. Used paper or fabric towels should be considered and treated as contaminated. d. Where employees wear protective clothing or equipment, or both, change rooms shall be provided in accordance with 1910.141(e). e. Rings, watches, wallets, combs, and other personal items usually carried on a person should not be brought in contact with mercury or its compounds if at all possible. The frames of safety glasses or personal glasses should be carefully cleaned after each shift of work. f. Contact lenses should not be used in areas where eyes may be exposed to vapors, dusts, or mists containing mercury.
