

IV. ENVIRONMENTAL DATA

Sampling and Analytical Methods

Various methods of sampling for mercury in air and analysis of these samples have been considered and the recommended methods are described in Appendix I and II.

The recommended methods for sampling air involve the use of scrubbers to remove mercury vapor and mercury compounds. [120,121] More specifically, the recommended method incorporates two bubblers, each containing a solution of sulfuric acid and potassium permanganate as the collecting media. Although there is some inconvenience involved in the use of bubblers, their use is justified because of uncertainties in sampling and analysis of nonelemental mercury by other methods as discussed below.

The recommended method for analysis of the sample is flameless atomic absorption spectrophotometry. Both colorimetric dithizone methods and atomic absorption methods give similar results in parts added/parts found studies [122-124] and comparison studies. [124-126] However, the speed in analysis which atomic absorption spectrophotometry affords, without any loss in accuracy and precision, makes it the method of choice as a reference method for analysis of mercury in bubbler solutions when properly standardized and calibrated.

It is imperative that calibration curves be constructed using conditions as close as possible to the actual samples. For example, when flameless atomic absorption is selected, the acid permanganate solutions must be used in the bubblers used for calibration. Calibration curves that are constructed for the dithizone method must also be obtained from acid-permanganate solutions spiked with appropriate mercury compounds.

No single detailed method of analyzing for mercury compounds has been collaboratively tested by numerous laboratories, but the atomic absorption method described in Appendix II represents a culmination of several flameless atomic absorption methods developed and used by various investigators. [126-131]

The sampling and analysis of mercury are particularly complex because of the numerous forms in which mercury may exist in the air. The interconvertibility of the various forms of mercury further complicates sampling and analysis. Mercury metal is not highly reactive but does form numerous compounds of varying thermal and chemical stabilities. Mercury reacts to form inorganic and organic compounds. Common oxidation states of mercury are Hg(I) and Hg(II), although only Hg(II) forms organic mercurials. The compounds of mercury generally have very high volatility compared to those of the alkaline earth metals, and collection of mercury compounds is complicated by their high vapor pressures. Accordingly, it is questionable whether particulates of certain mercurials will remain

unvolatilized if collected on simple filters because of the large volumes of unsaturated air which are drawn over the filters.

The chemical stabilities of mercury compounds after collection are important considerations because the relatively easy conversion of one mercurial to another may have a significant effect on the volatility and method of analysis.

The volume of literature regarding the sampling and analysis of mercury attests to the difficulties which are encountered in sampling for mercury. Only in recent years has it been possible to determine, with reasonable accuracy, the form in which mercury exists in the environment. This determination is possible, in part, because of such developments as chromatography and mass spectrometry. These forms of analysis may soon make it possible to clearly and routinely differentiate among the different forms of mercury.

Many analytical methods have been used for the determination of mercury and a review of the literature on this subject has been completed by Smith.[132] Sampling for mercury in air is much more difficult than the subsequent analysis. For best results, sampling and analysis must be considered simultaneously, covering the whole range of types and concentrations of mercury hazards which may be present in the occupational environment.

The choice of method of analysis is largely dependent upon what method of sampling is employed. In addition, the degree to which the

sampling method collects the different forms of mercury provides the basis for the usefulness of the entire procedure.

The methods which have been reported for sampling of mercury in air are many but are separable into two basic categories, a) those methods which remove mercury and mercury compounds from air by scrubbing, and b) those methods which collect an air sample. [133]

The scrubber type of sampling utilizes bubblers, filters, adsorbants, and amalgamable collectors.

The category of bubblers may include impingers, bead-packed towers, and a wide variety of scrubbing solutions. These scrubbing solutions are used to collect the mercury either discriminately or indiscriminately, and frequently to convert the mercury to an easily determinable form such as Hg(II). The most popular scrubbing solutions are acidic permanganate, iodine-potassium iodide, and iodine-HCl with acidic permanganate being used the most frequently in industrial hygiene surveys. Collection efficiencies for all mercury contaminants have not been reported for all of these scrubbing solutions. However, for mercury vapor and inorganic compounds of mercury, efficiencies greater than 90% have been reported. For organic mercurials, except short chain alkyl mercurials, [122,134,135] collection efficiencies for these solutions appear to be greater than 80%.

Uncertainties which still exist in the collection efficiencies for organic and inorganic compounds stem primarily from inadequate

methods of standardization and uncertainties in methods of analysis. With a very few exceptions, experimenters have not prepared standard dust chambers of mercury compounds and tested collection efficiencies of scrubbing solutions with these chambers. [134]

Filters have been used with scrubbers to collect various mercury contaminants in air. Elemental mercury vapor has been determined by filtering through papers impregnated with selenium, selenium sulfide and potassium iodide. [130,136,137] Particulates have been filtered by cellulose filter papers, fibrous glass filters, asbestos wool and quartz wool. [138,139] However, collection efficiencies of all of these media have not been determined and may be highly variable.

Adsorbants are among the most popular collectors and range from charcoal to sea sand. Evaluation of the collection efficiencies of these devices for compounds of mercury are also lacking. Also lacking are evaluations of collection efficiencies for particulates or dust which contain mercury.

Amalgamable collectors are also very popular but have been demonstrated to be efficient only for the collection of elemental mercury vapor. If compounds and dust are collected in a separate pyrolysis tube, presumably the mercury in compounds and dust can also be determined. Some work has been done on this method, [138] but a thorough documentation is lacking at this time. Amalgamable collectors, which have been reported to collect mercury, include gold

and silver in various forms. [138,139] The efficiencies of these methods of collection are not well documented.

The second category of sampling involves collection of a direct air sample. There are two general methods of direct air sampling. The first involves a static sample, commonly known as a grab sample, which may be collected in a plastic bag or syringe. This method has not been used or documented extensively for collection of mercury and mercury compounds. [140] The second method is a dynamic monitoring method in which air containing mercury is drawn directly through monitoring instruments called mercury vapor meters. Both hand-held portable units and remote units have been used. To date, these instruments have been designed to monitor only elemental mercury vapor.

Of all the methods for monitoring of mercury, hand-held mercury vapor meters have been used the most extensively. Of all methods used, these are probably the least foolproof. There are a number of major difficulties which may be encountered with mercury vapor meters: 1) standardization must be done prior to monitoring mercury with mercury vapor meters, and this is easily overlooked; 2) they respond to many other substances in the air such as dust, cigarette smoke, humidity, ozone, and sulfur dioxide and common organic solvents such as acetone, [31] the presence of which may not be known; 3) some types of mercury vapor meters reverse in response to high concentrations of mercury vapor, indicating meter readings much lower than true mercury

vapor concentrations [135]; 4) they may be affected by high magnetic fields that may exist in chlor-alkali plants; 5) the volume of air sampled by a hand-held mercury vapor meter is small and usually gives a poorly representative sample of the environment. Typically, the volume of air sampled may be 100 ml or less.

Mercury vapor monitors with remote sensors have been used and have problems similar to those of the hand-held type except that 1) problems due to magnetic fields are alleviated, and 2) a large volume of air is sampled and thus provides more representative sampling. With these remote monitors, samples of air are conveyed via Teflon or PVC tubes from sampling ports in the contaminated environment to the monitor. Generally, the sampling points are located in the breathing zone of workers on a grid system, whereby the various parts of the work environment are sampled sequentially. However, the influence that contamination which may enter and contaminate tubing may have upon subsequent instrument reading does not appear to have been evaluated, and the reliability of these sampling systems has not been documented. Tubing which would be required in a remote sampling system could introduce unknown contaminants and make such a system impractical. In summary, there are many problems associated with the use of mercury vapor meters for determining air concentrations of elemental mercury vapor. In addition, mercury vapor meters do not monitor for compounds of mercury which may be present in the environment.

From the above, it can be seen that for accurately determining concentrations of mercury in air, one must consider not only the form in which the mercury may be present but a multitude of other factors which can have major influence upon the results. The sampling and analytical methods recommended in Appendices I and II have been selected to minimize these factors.

Environmental Levels and Engineering Controls

Numerous studies can be cited to identify environmental levels of mercury found in the work environment of various mercury-using industries. [25,26,28,49,116] A review of these studies shows there have been wide ranges of mercury exposures encountered by workers at their places of employment.

Benning [26] reported levels of total mercury, ranging from 0.20-0.75 mg Hg/cu m, in the workroom atmosphere of a company using copper amalgam compound in manufacturing carbon brushes for electric motors. No industrial hygiene practices, from either an engineering or sanitation standpoint, were in effect at this plant, so that there were most likely multiple exposures of workers to mercury at the plant through inhalation, skin absorption, and ingestion. In addition, mercury-contaminated work clothing was worn home, permitting a certain amount of mercury to be carried into the home. The installation of ventilation control measures reduced the air concentrations to a range of 0.05-0.07 mg Hg/cu m of total mercury. Even with this reduction of airborne concentration, high levels of mercury in worker urine samples

continued. They were reduced, however, upon institution of strict sanitation requirements for plant housekeeping, handwashing, eating arrangements, and initiation of health orientation programs for employees. For example, one worker showed a reduction from 1,810 to 330 μg Hg/liter of urine after these measures were introduced. This experience indicates the need for evaluation of the total environment for effective control of the hazards associated with exposure to mercury. Reliance on the control of the atmospheric levels of mercury will not, by itself, necessarily assure that absorption of mercury by the worker will be sufficiently reduced if workers have poor personal hygiene or work practices which permit them to be exposed through routes other than inhalation.

Copplestone and McArthur [116] reported effective reductions of airborne mercury levels after installation of ventilation control measures in a company manufacturing jewelry. The peak reading in the general air of this plant reached a high of 0.35 mg Hg/cu m during the summer months. Almost immediately after installation of an improved ventilation system, these levels dropped to 0.03 mg Hg/cu m.

An investigation of the environment of workshops repairing direct current electric meters by Bidstrup et al [25] showed the significance an "enclosed" environment may have upon the concentration of mercury in air. Air levels of mercury vapor were measured during the summer months when the workshops were open to outside ventilation

through windows and again during winter months when the windows were closed.

In two workshops the concentration of mercury in the general atmosphere during the summer reached 0.223 mg Hg/cu m and 0.23 mg Hg/cu m, respectively. At work stations, levels as high as 1.6 mg Hg/cu m were recorded. In the other workshops studied the general atmosphere concentrations during the summer ranged from 0.005 to 0.067 mg Hg/cu m. Sampling in these other workshops during the winter months with the windows closed showed that the general atmosphere in most of the shops exceeded levels of 0.2 mg Hg/cu m, while at work stations, levels significantly above this were frequently recorded.

In the one shop which had mercury vapor concentrations of 0.223 mg Hg/cu m in the general atmosphere (range for all locations sampled was 0.08-1.6 mg Hg/cu m) during the summer months, ventilation equipment was installed prior to winter sampling. The winter samples in that shop ranged from 0.003-0.1 mg Hg/cu m. The environmental conditions observed in this study emphasize the effectiveness of ventilation for reducing airborne concentrations of mercury. In addition, it illustrates the impact which changes brought about by seasonal conditions may have upon concentrations of mercury in the atmosphere of the workplace.

One of the largest users of metallic mercury is the chlor-alkali industry in which brine is electrolyzed in large cells with mercury as the cathode. Although the mercury is totally enclosed most of the

time, many tons of the metal are present and, inevitably, mercury vapor enters the ambient air during overhaul or cleaning of equipment and from accidental leaks; thus, exposure to elemental mercury vapor is potentially a major hazard to chlor-alkali workers. Because chlorine gas is frequently present in the atmosphere and reacts with mercury vapor to produce chlorides of mercury, the potential exposure to mercury chlorides also exists. [28]

Smith et al [28] reported on the results of numerous mercury in air determinations in 21 chlor-alkali plants in the U. S. and Canada. The actual range of the time-weighted average of samples collected was 0.001 to 2.64 mg Hg/cu m, with the highest reading in the cell bed grinding operations. The average air concentration was 0.065 mg Hg/cu m with more than half (59%) having exposure at or below 0.05 mg Hg/cu m. These results would indicate that engineering controls can limit airborne concentrations of mercury in chlor-alkali plants to the standard recommended in this document.

The above studies illustrate that effective control of the work environment to limit airborne concentrations of mercury to 0.05 mg Hg/cu m is feasible. In those instances where ventilation systems were installed or improved, [25,26,116] the reduction of airborne levels of mercury to or below a level of 0.05 mg Hg/cu m of air was prompt. In addition, the study of Benning [26] is significant for showing that the worker plays an important role in controlling his own

exposure to mercury by being aware of the hazards inherent in mercury and having good work and personal hygiene practices.

V. DEVELOPMENT OF STANDARD

Basis of Previous Standard

Among the first hygienic guides for controlling exposure to mercury in the United States was the Threshold Limit Value (TLV) of 0.1 mg Hg/cu m recommended by the American Conference of Governmental Industrial Hygienists. [141] This TLV was based primarily on the results of the studies by Neal et al [18,19] of workers in the felt-hat and fur-cutting industries in 1937 and 1941. [8] Neal's [19] report concluded that no cases of mercury poisoning were found among workers exposed to less than 0.1 mg Hg/cu m, but that cases did occur at all ranges of exposure above this level. In addition, the incidence of mercury poisoning increased with the length of occupational exposure. "Borderline" cases of mercury intoxication at levels below 0.1, ie, at 0.08 mg Hg/cu m; a 20% of incidence of tremors was reported in workers exposed at 0.08 mg Hg/cu m for 20 years. However, this recommendation has been in effect for almost 30 years in this country.

In a large scale study of workers exposed to concentrations of mercury vapor from less than 0.01 to 0.27 mg Hg/cu m in chlor-alkali plants in North America and Canada, Smith et al [28] concluded, "The data presented here show no significant signs or symptoms in persons exposed to mercury vapor at or below a level of 0.1 mg/m³. However, the data do raise a question regarding the adequacy of the safety

factor provided by a TLV of this magnitude." Following publication of the Smith study and a review of prior documentation, the American Conference of Governmental Industrial Hygienists recommended a reduction in the TLV to 0.05 mg Hg/cu m for inorganic elemental mercury, inorganic mercury, and nonalkyl organomercury compounds. [142]

The American National Standards Institute (ANSI) [143] recommended in 1943 as a mercury standard (Z37.8-1943) a level of 0.1 mg Hg/cu m based on the studies of Neal et al, [18,19] and subsequently reconfirmed this level in 1971. [144] However, in 1972, ANSI Z37.8-1972 [145] lowered this standard to 0.05 mg Hg/cu m based upon the studies of Smith et al [28] and made it applicable to mercury vapor and all mercury compounds except alkyl mercury compounds, even though the authors [28] concluded, "The implications of the results of this study on the current threshold limit value of 0.1 mg Hg/cu m are to some extent dependent on matters of judgment rather than fact. The data indicate that with respect to most of the symptoms [complaints reported by workers], the dose-response relationship does not exhibit sufficiently high incidence to warrant concern until the present threshold limit value is exceeded... The data presented here show no signs or symptoms in persons exposed to mercury vapor at or below a level of 0.1 mg Hg/cu m. However, the data do raise a question regarding the adequacy of the safety factor provided by a TLV of this magnitude."

A committee of the International Symposium on Maximum Allowable Concentrations of Toxic Substances in Industrial Environments held in Stockholm (1968) reviewed the available evidence on mercury toxicity and recommended the subdivision of mercury and its compounds into three categories based primarily upon toxicological properties. [68]

The committee's recommendations for Maximum Allowable Concentration (MAC) for mercury vapor in the industrial environment was 0.05 mg Hg/cu m. For inorganic mercury compounds and phenyl and methoxyethyl mercury compounds, a level of 0.10 mg Hg/cu m was suggested. The greater toxicity of alkyl mercury compounds (methyl and ethyl mercury salts) was recognized and no air level was recommended, but the committee concluded that with a continuous eight-hour exposure to 0.01 mg Hg/cu m of alkyl mercury compounds in air, the total level of mercury in blood would not usually exceed 10 µg Hg/100 ml of blood.

The maximum allowable concentration for metallic mercury in the USSR is 0.01 mg Hg/cu m. [146] This standard was established more than 30 years ago and was based upon observations in mercury-using industries and of exposed workers. [147] The data upon which this standard is based are not available, however, the level is in keeping with the philosophy in Russia that occupational health standards be established at levels at which no detectable effects will be observed in workers. [148]

The workroom air standard for inorganic mercury established under the Occupational Safety and Health Act of 1970 (part 1910.93 of Title 29 published in the Federal Register, Volume 37, Number 202, pages 22139-22144, dated October 18, 1972) is 0.1 mg Hg/cu m. This ceiling limit is based on the ANSI Z37.8-1943 (R-1971) standard. [144]

Basis for Recommended Environmental Standard

Two approaches can be taken for deriving an environmental standard for mercury: establish a direct relationship between environmental exposure and worker response or establish an indirect relationship between mercury excretion, signs and symptoms of mercury poisoning, and environmental levels.

Studies have indicated the lack of substantiating evidence for the second approach. Several investigators [7,8,20,21,26,28,50,54,56,115,116,119] have attempted to measure the amount of mercury in urine or blood as an index of worker exposure. These attempts demonstrate that there is a lack of reliability in correlation between levels of mercury in the urine or blood of a worker and the extent of his exposure or the appearance of symptoms. The disagreement of correlation of average ratios between urinary mercury and atmospheric mercury has been and continues to be unresolved. Earlier reports [54,118] suggested ratios of about 2.0 and 2.6. A recent paper by Bell and his co-workers [149] indicates that the ratio is 1.

The derivation of an environmental limit for worker exposure to mercury vapor and inorganic and organic (nonalkyl) compounds of

mercury is complicated by the lack of specificity of effects seen at the lowest doses. Such effects as loss of appetite, insomnia, and those of nervous system involvement including tremor, psychic disturbances, and "nervousness" are manifested in other diseases, but may occur with significant frequency among workers exposed to mercury. Thus, the demonstrations of a higher incidence of effects with increasing levels of mercury exposure could be a basis for deriving an environmental limit.

The study by Smith and co-workers [28] in chlor-alkali plants of workers exposed primarily to mercury vapor showed a positive correlation between exposure levels and symptoms of neurologic involvement (tremor, "shyness", and "nervousness"), loss of weight, and loss of appetite. The workers studied were exposed at TWA levels ranging from less than 0.01 mg Hg/cu m to 0.27 mg Hg/cu m, with most (84.5%) exposed at less than 0.1 mg Hg/cu m; approximately 60% of the total were exposed to less than 0.05 mg Hg/cu m. Significances of correlations were reported as probability (P) levels. The correlation between tremors involving the fingers, eyelids, and tongue and air levels from 0.1 to 0.27 mg/cu m was significant at $P = 0.001$. There was a significantly higher incidence of abnormal reflexes at exposure levels above 0.1 mg Hg/cu m. Thus, it was shown that there was a dose-response relationship among these workers, with the incidence of signs and symptoms of neurologic involvement increasing with exposure level.

A review of the data of Smith et al [28] shows there were effects in workers exposed at levels under 0.1 mg Hg/cu m. See Figure XII-4.

There was a high incidence of effects in workers exposed at 0.24 mg Hg/cu m and above (Figure XII-4). In the 0.11 to 0.14 mg Hg/cu m exposure group, there was incidence of weight loss and objective tremor; at lower levels the incidence of these signs was similar to that of the control group. Other effects observed or complaints reported (loss of appetite, insomnia, shyness, decrease in diastolic blood pressure, frequency of colds, history of nervousness, and diarrhea) were not markedly different in the three lower exposure groups (controls, 0.01 to 0.05 and 0.06 to 0.10 mg Hg/cu m) but there was a slight increase in complaints of appetite loss and insomnia in the 0.06 to 0.10 mg Hg/cu m exposure group compared to the two lower exposure groups.

Symptoms (subjective effects) as a rule are generally more sensitive than signs (objective effects) in the appearance of effects and thus the appearance of such symptoms as loss of weight and insomnia are indicative that evidence of toxicity is occurring between 0.06 and 0.1 mg Hg/cu m exposure level.

Bidstrup and co-workers [25] have reported signs of mercury intoxication (tremor, psychic disturbances) in 1 of 16 workers exposed to mercury vapor between 0.005 and 0.06 mg Hg/cu m. Duration of exposure was 19 years. Turrian and associates [114] noted signs and

symptoms of tremor and erethism in 5 of 26 workers exposed to levels between 0.01 and 0.06 mg Hg/cu m (see Table XII-7). At least 15 workers in this same exposure group exhibited symptoms of central nervous system involvement (headache, low concentrating ability, mental irritability). The average length of exposure was 9 years but minimum duration of exposure for the workers cannot be estimated. Other workers, Smith and Moskowitz, [20], Smith et al, [21] and Moskowitz, [56] concluded that mercury intoxication occurred in workers exposed at less than 0.1 mg Hg/cu m but did not report the lower exposure levels at which these effects occurred.

McGill et al [50] found no evidence of dangerous absorption of mercury in workers in one chlor-alkali plant study. Air levels over a period of 6 years varied between 0.08 and 0.13 mg Hg/cu m as measured by a mercury vapor meter. Information concerning the extent of the medical examination and the number and location of environmental samples was not reported. The range of environmental levels is small in comparison to the levels (less than 0.01 to 0.27 mg Hg/cu m) reported by Smith et al [28] in a study of 21 chlor-alkali plants. The reported findings in this paper do not parallel the findings of other investigators. [20,21,26,28,56]

The demonstration by Smith et al [28] of a significant occurrence of signs of toxicity at a level below 0.1 mg Hg/cu m and the occurrence of cases of toxicity between 0.005 and 0.06 mg Hg/cu m by Bidstrup et al [25] and Turrian et al [114] between 0.01 and 0.06

mg Hg/cu m indicate the need for an environmental standard for protecting the health of exposed workers of 0.05 mg Hg/cu m. With regard to the Trachtenberg [52] findings among the workers in Kiev, exposed to low concentrations (0.01-0.05 mg Hg/cu m), it is concluded that his report of hyperthyroidism should be investigated and confirmed before being used as a criterion for establishing an environmental standard for mercury.

Because of the prevalence in the general population of nonspecific signs and symptoms which can be associated with mercury, it is difficult, if not impossible, to establish a level at which no effects are observed. This is illustrated by the studies of Smith and his co-workers [28], Bidstrup and her associates [25], Turrian et al [114] and of Trachtenberg. [52] Effects between 0.005 and 0.06 mg Hg/cu m were found in these studies. The problem is further complicated because the validity of sampling and analytical methods on which the air levels are based cannot be determined conclusively; thus effects cannot be correlated with a high degree of confidence. Until better methods are established that will permit more specific identification of the effects of exposure to low levels of mercury, a specific level at which a standard should be established cannot be identified; but it is concluded that the standard should be at least as low as 0.05 mg Hg/cu m.

The possibility that mercury-contaminated clothing or hands are sources of increased worker exposure to mercury has been suggested by

several investigators [26,49,64,149] especially when work clothing is worn for much longer than the normal workday. According to Bell and his co-workers [149] this may result in excessively long exposure to mercury. This possibility has not been proved but if true, it can be controlled by change of clothing after exposure. For this reason, a strong recommendation for a daily change of work clothes is made by NIOSH.

VI. WORK PRACTICES AND SANITATION

The unusual physical properties of mercury make it difficult to control the potential hazards which are inherent in its use. A recognition of these hazards by workers is one of the most important aspects of its control. [26]

In addition to the management of the environment by process controls, administrative controls should also be instituted for regular and emergency work practices to avoid unnecessary contact with mercury. Several investigators [16,26,29,150-153] have stressed the importance of cleanliness of the work environment and the need for workers to give scrupulous attention to personal hygiene for the control of exposure to mercury. Their recommendations and conclusions are applicable to most situations where exposure to mercury may occur.

Work clothes which are to be worn during working hours only should be provided for all workers exposed to mercury. [26]

Workmen should shower before changing into street clothes. Because mercury is difficult to remove from the skin, it is essential that warm showers and soap be provided and used.

Work clothing should take the form of coveralls, as opposed to shirts and trousers, and have a minimum of seams, with no cuffs or pleats. Clothing should also be of a nonwoven or tightly woven fabric, which exhibits a minimum tendency to absorb mercury. [64]

Shoe covers, rubber boots or shoes which can be washed should be provided where floor contamination is a problem.

Work clothing should be changed daily, and separate lockers must be provided for work clothes and street clothes. Contaminated clothing should be stored in covered containers or vaporproof bags pending laundering.

Laundering of such work clothes should be provided by the employer, and precautions taken to minimize exposure of laundry workers to mercury.

All spills of mercury should be cleaned up immediately. Vacuum cleaning is an effective method for removal of mercury. However, vacuum cleaners should be equipped with charcoal filters so that mercury vapor will not be discharged into the workroom air. Sweeping should be avoided as it creates dust and tends to break up any elemental mercury into even smaller particles, thereby increasing the rate of vaporization. Mercury vapor depressants, such as calcium polysulfide, have proved successful in controlling production of mercury vapor from spills. [153] The use of compressed air to blow elemental mercury or dust off equipment or clothes must be avoided, as blowing will increase the airborne level of mercury vapor and disperse mercury even more widely in the workplace.

Containers of elemental mercury must be kept covered with vapor tight covers when not in use. This may be accomplished by a tight

fitting cover or by covering the surface of the mercury by an aqueous layer to prevent vaporization.

The floor and work surfaces of all areas where mercury is used should be made nonporous and free from cracks or joints. Floors should be sloped to drains equipped with water traps which will store the mercury under water until collected and reclaimed. [151]

Waste mercury or waste material contaminated with mercury should be placed in tightly covered or vaporproof containers, pending removal or disposal. Disposal or reclamation of mercury should be undertaken only by those adequately trained in handling these types of contaminated materials.

All food and tobacco must be excluded from mercury work areas, and workers should be required to thoroughly wash their hands before eating or smoking. [26] Handwashing facilities for use by workers should be near the work location.

Only those persons having a need to be there should be permitted in mercury work areas, and each mercury processing area should be separate from other areas where possible.