WOMEN'S OCCUPATIONAL HEALTH RESOURCE CENTER

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# WOMEN AND CHEMICALS AT WORK

Materials are assembled in the following order:

* Women's Occupations, Smoking, and Cancer and Other Diseases
* Danger: Lungs at Work
* Formaldehyde Risks in the Workplace
* New OSHA Formaldehyde Standard
* Methylene Chloride: Cosmetology Risks and Toxicology Guide
* Ethylene Oxide: How to Use It Safely
* Ethylene Oxide: Risks Grow; Court Orders
* Pointing the Finger at Nail Salons
* Handling Chemotherapeutic Drugs
* Anti-Cancer Drugs
* Nitrosamines
* Asbestos: What to Do; When to Act
* A Guide to Chemicals Used in Jobs with Large Numbers of Women Workers
  (adapted from *Work Is Dangerous to Your Health*, 2nd edition)



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# Women's Occupations, Smoking, and Cancer and Other Diseases

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During the past decade, two remarkable trends have occurred that are greatly influencing women's health: the proportion of women who work in the paid labor force has risen sharply, and the number of women smokers who work is escalating. The rapid increase in the rate of lung cancer in women has attracted considerable attention recently, with the entire 1980 Surgeon General's report focusing on the health consequences of cigarette smoking in women.[1] An important aspect of this problem that has not received much attention, however, is the relationship of women's employment in hazardous occupations to their cancer risks, particularly those risks resulting from the combination of exposure to occupational carcinogens and cigarette smoke.

This article will address three major questions: (1) What jobs do women hold, and in what industries do they work? (2) How much do women smoke, and how is their smoking related to their jobs and to other social factors? (3) How does the combination of occupation and smoking influence women's risk for developing cancer and other diseases?

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## Patterns of Female Employment

In 1978, 41 percent of the United States work force was female, representing 39 million women, compared to 38 percent in 1973. The proportion is still rising. It is estimated that of the additional 42 million women who are currently unemployed, at least 3.5 million want jobs now, and another eight million are now in school but will soon enter the job market.

In spite of some social gains and increased opportunities, about one third of all female workers are still employed in the ten traditionally female professions listed in Table 1. Even though one may be tempted to stereotype women as working in relatively harmless occupations, millions of working women do face unrecognized occupational hazards, while tens of thousands of women are employed in high-risk industries, involving exposure to numerous dusts, chemicals, radiation, and other toxicants. As many practitioners are probably unfamiliar with the everyday workplaces of these women, Table 2 provides a more detailed breakdown of current industrial occupational patterns of women workers.

## Patterns of Smoking Among Women

Men's smoking habits tend to reflect their socioeconomic levels: men in higher income and educational groups smoke less; men in lower groups smoke more. This long-standing pattern is becoming even more pronounced as men in the middle and upper socioeconomic classes continue to give up cigarette smoking.

No such generalizations, however, can be made for women.[2] Table 3 shows the distribution of female smokers, ex-smokers, and nonsmokers according to occupation and industry of employment. Women least likely to smoke are teachers and household workers, two groups which are at opposite ends of the social spectrum. Women most likely to smoke are waitresses and women in managerial, sales, and craft positions, especially workers involved with the manufacture of electrical machinery, of whom 45.1 percent smoke cigarettes and who comprise over two percent of the female labor force.

A definitive explanation for these obvious differences in the smoking patterns of men and women has not yet been formulated. Stress is probably involved, related to the working woman's dual role as homemaker and income producer and to dissatisfaction with lower paying, less satisfying jobs than men.[3] When compared with men, women suffer from job discrimination, slower advancement, lower pay, and exclusion from decision-making processes. Many women smoke to relieve external stress, whatever the source, and women as a group have a more difficult time quitting than do men.[4] An American Cancer Society survey shows a greater decline in the number of doctors who smoke than that of nurses, over a 13-year period,[5] and reveals a much higher smoking rate among nurses than among other women, even though nursing is one of the most professional of the "female" occupations.[6]

**"Many women smoke to relieve external stress, whatever the source, and women as a group have a more difficult time quitting than do men."**

## Female Workers at Risk for Cancer and Other Diseases

While there have been many studies on the risks for occupationally induced cancer among men, little data are available for women. Table 4 lists some of the more populous female occupations and typical agents that women who hold these jobs are likely to be exposed to. There is considerable disagreement over the likelihood of increased cancer risk due to specific agents (e.g., for hairdressers who use hair dyes), and these uncertainties are noted. This section reviews some of the cancers linked to occupational exposure in men. There is reason to assume that women holding similar jobs will experience similar risks.

The study of occupational causes of lung cancer has been one of the main methods of identifying specific agents that cause human lung cancer. The most notorious of these is asbestos, which causes cancer of the lung, pleura, peritoneum, and other sites in asbestos miners and in factory and insulation workers.[7,8]

Asbestos is used in the manufacture of certain textiles, in a predominantly female industry. While data on cancer in American women textile workers have yet to be published, a British study of a London factory that manufactured asbestos insulation materials and textiles found an elevenfold increase in lung cancer risk in female workers after allowing for smoking habits.[9] There was also evidence that the joint effect of cigarette smoking and asbestos exposure was synergistic (one exposure multiplied the effects of the other), as it is known to be for men.[10] Pleural and peritoneal mesothelioma, although not definitely linked to cigarette smoking, have been documented in female family members of asbestos workers whose only known exposure was through handling the male workers' clothes.[11] Other studies have also linked mesothelioma with nonoccupational asbestos exposure in female relatives of asbestos workers and in those women who live near asbestos industries.[12] Therefore, it must be presumed that widespread nonoccupational exposure to asbestos does exist for women, and that smoking increases this risk.

There is a growing concern that occupants of school buildings, including 2.1 million female teachers in primary and secondary schools, may be exposed to small but toxicologically significant levels of asbestos fibers, especially in older buildings where maintenance has declined. Many state agencies are now investigating this problem. In 1980, the Massachusetts Division of Occupational Hygiene reported that at least 12 percent of 1,425 schools built between 1946 and 1973 contained sprayed-on asbestos, and that 49, or one-fourth, of these latter schools required long-term asbestos control.[13]

Arsenic is also considered to be an established lung and skin carcinogen for humans. Large numbers of women employees may be at occupational risk for arsenic-induced cancers. Of particular concern are the many artists, jewelers, and craftswomen who make ceramics and ceramic enamel. Because this is a major cottage industry, many of these workers are never included in official employment statistics, particularly those women who work at home or on a part-time basis, and the majority of them have families. Furthermore, many home hobbyists use these materials without proper education about possible hazards. Several good reviews of occupational health hazards of the arts and crafts industry are now available.[14] Also at risk for arsenic-induced diseases are insecticide and herbicide makers and packagers, and cotton-gin workers exposed to arsenic-containing residues on the cotton.

One of the most powerful lung carcinogens known is the chemical bischloromethyl ether (BCME), generated in the manufacture of certain ion exchange resins.[15] Trace amounts of BCME can form in many industrial environments. Small amounts of BCME spontaneously occur during the reaction of formaldehyde with acid chloride, a combination readily found in many industries, including textile finishing, fertilizer and dye manufacturing, in the production of some bactericides, and possibly in reactions commonly encountered by laboratory and industrial chemists.[16]

Vinyl chloride monomer (VCM), one of the most widely used chemicals in the United States, is a proven human carcinogen, causing angiosarcoma of the liver;[17] it may cause lung cancer in humans[18] as it does in animals at very low doses.[19] Until recently, VCM was used as a propellant for hundreds of household and cosmetic products.[20] Users of these products, mostly women, may have been exposed to the agent in closed rooms, such as bathrooms and laundry rooms, even when well ventilated. Groups of female workers who were highly exposed in the past included

**TABLE 1**
**TEN LARGEST "TRADITIONALLY FEMALE" OCCUPATIONS**

| Occupation | Percent of female work force |
|---|---|
| Secretary | 8.5 |
| Retail sales clerk | 4.3 |
| Bookkeeper | 4.3 |
| Waitress | 3.2 |
| Cashier | 3.1 |
| Private household worker | 2.9 |
| Registered nurse | 2.8 |
| Elementary school teacher | 2.8 |
| Typist | 2.6 |
| Sewer and stitcher | 2.0 |

beauticians and cosmetologists, who use hairsprays extensively, and household workers, who use cleaning and furniture-polishing products. Trace amounts of VCM are also found in cigarette smoke.

Many women are occupationally exposed to ionizing radiation, especially from medical and dental x-rays and radioisotopes. Most exposures take place in health care institutions, where the majority of nurses, health technologists and technicians, and medical and dental health service workers are women. Smaller numbers of women are employed in industries that manufacture radioisotopes for medicine and industry, for nuclear materials and devices, and for the physical sciences. Table 5 gives estimates of the average annual doses of ionizing radiation received by various workers, based on data from the 1980 Biological Effects of Ionizing Radiations (BEIR) Report.[21]

Medical institutions are expected to follow established standards and guidelines for radiation protection of personnel (e.g., radiologists and x-ray technicians) and most have good monitoring records. However, little data are available on exposure patterns among non-radiation personnel, such as surgery room or floor nurses, technicians, nursing aides, anesthesiologists, gynecologists, and other specialists, many of whom care for patients undergoing radium or iodine therapy or treatments requiring implants of radioisotope emitters. Furthermore, accidents happen even in the most scrupulously monitored institutions: "Attendants who transport children to the x-ray department may routinely hold them while they are x-rayed; a nursing aide may change bedding contaminated with "hot" emesis; an orderly may accidentally spill a container of radioactive urine, fail to report the incident, mop the floor, and return the mop to the cleaning closet . . . ; nurses may write their notes in an unshielded chart-room adjacent to a radiation area."[22] In contrast to standard hospital practices, personal monitoring of dentists, dental technicians, and hygienists is almost nonexistent, despite their almost daily use of x-ray equipment.

Strict adherence to radiation safety measures in some nuclear medicine departments has resulted in a long-term decline in average personnel exposure to radiopharmaceuticals, even with continuous increases in patient workload.[23] Nevertheless, the few limited surveys available indicate that radioisotope workers routinely accumulate average annual exposures that are appreciable fractions of the current occupational guideline of five rems per year. For instance, radionuclide workers receive approximately 260 mrems per year, while radium workers receive about 540 mrems per year.[24]

Approximately 1,500 female electron microscopists are exposed to low levels of scattered radiation generated by their equipment;[25] several thousand female physicists and research technicians work with high voltage x-ray machines and diffractometers. The average dose received by this group is estimated at 50 to 200 mrems per year.[24]

The major neoplastic sequelae of exposure to ionizing radiation are cancers of the breast, thyroid, lung, and hematopoietic system.[21] Despite the substantial epidemiologic evidence linking radiation to cancer, there are only limited data to show whether cigarette smoking enhances its carcinogenic properties. Most classic studies about ionizing radiation exposure and cancer contain little or no data on the subjects' smoking habits. In the single study on male and female victims of the atomic bombs dropped on Hiroshima and Nagasaki in which smoking data were available, it was possible to establish that both exposures contributed to the incidence of lung cancer among bombing victims, but not whether there was any interaction between the two exposures.[26]

The data of Archer and colleagues on lung cancer risks in uranium miners (exposed to radon daughters) demonstrate that the risks from this type of ionizing radiation are greatly enhanced in smokers.[27] Hoffmann and Wynder[28] and Doll et al[29] believe this interaction is probably true of other forms of ionizing radiation. The 1980 BEIR Report concluded that smoking cigarettes reduced the latency period of

TABLE 2
NUMBER OF WOMEN IN CURRENT WORK FORCE
CLASSIFIED BY OCCUPATION (1978)

| Occupation | Women employed (in thousands) |
|---|---|
| **White-collar workers** | **24,594** |
| Professional and technical | 6,083 |
| Nurses, dieticians, and therapists | 1,255 |
| Health technologists and technicians | 353 |
| Engineering and science technicians | 132 |
| Painters and sculptors | 83 |
| Managers and administrators, except farm | 2,365 |
| Sales workers | 2,666 |
| Sales clerks, retail trade | 1,672 |
| Clerical workers | 13,456 |
| Bookkeepers | 1,660 |
| Cashiers | 1,222 |
| Secretaries | 3,561 |
| Typists | 1,009 |
| **Blue-collar workers** | **5,770** |
| Craft and kindred workers | 694 |
| Operatives, except transport | 4,317 |
| Assemblers | 606 |
| Checkers, examiners, and inspectors, manufacturing | 359 |
| Clothing ironers and pressers | 101 |
| Dressmakers, except factory | 113 |
| Filers, polishers, sanders, and buffers | 38 |
| Garage workers and gas station attendants | 20 |
| Laundry and dry cleaning operatives | 118 |
| Meat cutters and butchers, except manufacturing | 13 |
| Meat cutters and butchers, manufacturing | 33 |
| Packing and wrappers, excluding meat and produce | 422 |
| Photographic process workers | 48 |
| Precision machine operatives | 43 |
| Punch and stamping press operatives | 47 |
| Sewers and stitchers | 772 |
| Shoemaking machine operatives | 60 |
| Textile operatives | 224 |
| Spinners, twisters, and winders | 100 |
| Welders and flame cutters | 41 |
| Transport equipment operatives | 258 |
| Nonfarm laborers | 492 |
| **Service workers** | **8,037** |
| Private households | 1,135 |
| Child care workers | 447 |
| Cleaners and servants | 514 |
| Housekeepers | 117 |
| Service workers, except households | 6,901 |
| Cleaning workers | 858 |
| Food service workers | 2,951 |
| Bartenders | 111 |
| Cooks | 678 |
| Dishwashers | 82 |
| Food counter and fountain workers | 397 |
| Waitresses | 1,297 |
| Health service workers | 1,660 |
| Dental assistants | 128 |
| Health aides, excluding nursing | 238 |
| Nursing aides, orderlies and attendants | 902 |
| Practical nurses | 390 |
| Personal service workers | 1,302 |
| Attendants | 175 |
| Child care workers | 403 |
| Hairdressers and cosmetologists | 483 |
| Housekeepers, excluding private households | 92 |
| Welfare service aides | 84 |
| Protective service workers | 115 |
| Guards | 53 |
| Police and detectives | 28 |
| **Farm Workers** | **509** |

Source: Employment and Unemployment During 1978: An Analysis. Special Labor Force Report 218. US Department of Labor, Bureau of Labor Statistics, 1979, pp A-22–23.

## TABLE 3A
## SMOKING HABITS OF WORKING WOMEN, BY OCCUPATIONAL CLASSIFICATION

| Occupation | Percent of current female labor force[a] | Percent | | | |
|---|---|---|---|---|---|
| | | Non-smokers | Ex-smokers | Present Smokers | |
| | | | | ≤1 pack/day | >1 pack/day |
| Professionals | | | | | |
| Health | 4.4 | 51.2 | 16.6 | 25.2 | 6.9 |
| Teachers | 6.8 | 63.5 | 14.0 | 19.8 | 2.7 |
| Other | 4.6 | 53.4 | 15.1 | 24.0 | 7.5 |
| Managerial, including office, restaurant, sales, and administrators | 6.7 | 42.7 | 16.4 | 28.0 | 12.1 |
| Sales | 6.2 | 46.0 | 16.2 | 30.0 | 8.0 |
| Clerical | | | | | |
| Bookkeepers | 4.6 | 53.1 | 12.2 | 26.5 | 8.2 |
| Office machine operators | 1.3 | 52.8 | 15.7 | 23.1 | 8.4 |
| Secretaries | 13.3 | 52.0 | 14.7 | 26.3 | 7.0 |
| All other | 14.2 | 50.6 | 13.6 | 27.5 | 8.3 |
| Crafts | 2.4 | 46.4 | 13.1 | 31.8 | 8.6 |
| Operatives | 11.8 | 52.8 | 10.1 | 31.6 | 5.5 |
| Service | | | | | |
| Cleaning | 2.5 | 51.9 | 12.8 | 31.2 | 4.1 |
| Food | 6.6 | 40.0 | 13.4 | 39.8 | 6.8 |
| Health | 6.9 | 52.1 | 10.5 | 32.2 | 5.2 |
| Private Household Workers | 2.8 | 62.4 | 10.1 | 24.7 | 2.8 |

[a]Figures are subject to sampling errors and therefore may not agree with those in other tables.
Source: Unpublished data, Health Interview Survey, 1976, National Center for Health Statistics

## TABLE 3B
## SMOKING HABITS OF WORKING WOMEN BY INDUSTRY OF EMPLOYMENT

| Industry | Percent of current female labor force[a] | Percent | | | |
|---|---|---|---|---|---|
| | | Non-smokers | Ex-smokers | Present Smokers | |
| | | | | ≤1 pack/day | >1 pack/day |
| **Manufacturing** | | | | | |
| Machinery, excluding electrical | 1.1 | 48.9 | 13.8 | 32.7 | 4.5 |
| Electrical machinery | 2.3 | 45.9 | 9.0 | 34.5 | 10.6 |
| Transport equipment | 1.1 | 52.7 | 5.9 | 30.3 | 11.1 |
| All other | 3.6 | 49.8 | 11.7 | 31.2 | 7.3 |
| **Transport and communication** | 3.5 | 46.4 | 10.7 | 32.1 | 10.9 |
| **Wholesale trade** | 2.3 | 52.4 | 9.0 | 28.4 | 10.2 |
| **Retail trade** | | | | | |
| Food | 5.1 | 36.2 | 12.2 | 41.9 | 9.6 |
| Other | 12.5 | 48.4 | 15.2 | 29.5 | 6.9 |
| **Finance, insurance, real estate** | 7.8 | 50.5 | 14.3 | 25.2 | 10.1 |
| **Service** | | | | | |
| Personal, cleaning | 2.5 | 54.6 | 11.8 | 31.2 | 2.3 |
| Business | 2.2 | 41.5 | 16.7 | 32.1 | 9.6 |
| Medical | 12.7 | 51.9 | 12.8 | 29.5 | 5.8 |
| Education | 14.5 | 60.3 | 15.2 | 21.7 | 2.8 |
| Household | 3.1 | 62.0 | 10.9 | 23.4 | 3.7 |
| Other | 5.7 | 52.7 | 16.3 | 23.8 | 7.3 |
| **Government** | 5.0 | 47.4 | 14.5 | 29.6 | 8.5 |

[a]Figures are subject to sampling errors and therefore may not agree with those in other tables.
Source: Unpublished data, Health Interview Survey, 1976, National Center for Health Statistics

**TABLE 4**
**POTENTIAL OCCUPATIONAL HEALTH HAZARDS IN SELECTED "TRADITIONALLY FEMALE" OCCUPATIONS**

| Occupation | Women employed (in thousands) | Known or suspected Cancer risk factors[a] | Other health hazards |
|---|---|---|---|
| Health care professions (e.g. nurses, nursing aides, dental assistants, and laboratory workers) | 3,268 | Sterilizing agents and disinfectants (ethylene oxide, ultraviolet light)<br>Anesthetic gases (halothane)<br>Ionizing radiation<br>Radioisotopes<br>Cancer drugs, carcinogenic chemicals<br>Hepatitis B | Infections (e.g. serum hepatitis)<br>Dermatitis<br>Mercury vapor<br>Back injuries<br>Puncture wounds and lacerations<br>Phenolic compounds |
| Clothing and textile workers | 1,109 | Benzidine-type dyes<br>Asbestos<br>Formaldehyde finishes (BCME)<br>Flame retardants (TRIS) | Noise, vibration, cotton dust, and other respirable fibers<br>Various solvents<br>Carbon disulfide (in viscose rayon manufacture) |
| Laundry workers | 219 | Dry cleaning solvents (TCE,* perchloroethylene)<br>Contaminant asbestos dust | Heat, noise, and vibration<br>Back injuries, falls, and sprains<br>Infection<br>Electrical shock |
| Meat wrappers and cutters | 46 | Wrap decomposition fumes (vinyl chloride, PVC,** hydrogen chloride, CO) | Cold, humidity<br>Infection (e.g., Salmonella) |

| | | | |
|---|---|---|---|
| Hairdressers and cosmetologists | 483 | Hair dyes<br>Asbestos from dryers<br>Ultraviolet light<br>Solvents<br>Vinyl chloride spray-can propellants | Bleaches<br>Diethanolamine<br>Noise, heat, and vibration<br>Talc<br>Nail varnishes (e.g., acetone, toluene, xylene, plasticizers) |
| Artists and crafts-persons | 250 | Arsenic and alloys<br>Beryllium, cadmium, and chromium<br>Nickel oxides and carbonyl<br>Asbestos<br>Wood dust and glues<br>Cleaning solvents: "benzine" (petroleum distillates), carbon tetrachloride, trichloroethylene, formaldehyde<br>Vinyl chloride, PVC**<br>Dyes and pigments | Lead and other heavy metals<br>Glazes and finishes<br>Lacquers and paint thinners<br>Plastics, resins<br>Silica-containing dusts and clays<br>Adhesives |
| Agricultural workers | 509 | Organochlorine pesticides: aldrin/dieldrin, endrin, Kepone, methoxychlor, Mirex, DDT, lindane, chlordane/heptachlor, and toxaphene<br>Arsenic pesticides and herbicides<br>Phenoxy herbicides: 2,4-D, 2,4,5-T ("Agent Orange") | Heat and cold<br>Injuries from machinery |
| Electrical machinery manufacturers | 1,000 | PCBs***, TCE,* cadmium, and other metals | Plastics, resins |

[a] For a complete discussion of the epidemiologic and experimental evidence for these and other suspected occupational carcinogens, see Schottenfeld D, Haas JF: Carcinogens in the workplace. Ca 29: 144—168, 1979.

* trichloroethylene
** polyvinyl chloride
*** polychlorinated biphenyls

radiation-induced cancers, but did not indicate whether the effect was multiplicative or synergistic.

Epidemiologic studies have firmly linked cancer of the oral cavity in women with cigarette smoking and heavy alcohol consumption,[30] and with employment in the textile industry among men.[31] Geographical studies have correlated oral-cavity cancer death rates with apparel and textile industry concentrations, especially in the southeastern United States. The correlations were strongest in those countries where at least one percent of the population was employed in these major female occupations.[32] It remains to be determined whether this purely statistical correlation is directly related to occupational exposures in the textile industry, to smoking habits of women employed in that industry, or to some interaction between the two exposures. Also many women in rural areas of the South use oral snuff, a practice that increases the risk of mouth cancer,[33] but which is a culturally acceptable tobacco substitute in industries where smoking is not permitted.

## Other Occupational Diseases

The role of cigarette smoking in cardiovascular diseases (CVD) is well known, as are the influences of risk factors such as hypertension, blood lipids, age, and glucose tolerance. The relationship between CVD and occupation has received relatively little attention, especially compared with studies of occupational carcinogenesis. Studies involving women workers are practically nonexistent. Any excess risk for CVD in a woman worker who smokes is probably exacerbated by exposure to cardiopathogenic chemicals such as carbon disulfide, nitroglycerin, and synthetic estrogens. These chemicals are handled by a large number of women in the manufacture of viscose rayon, explosives, and drugs.

Studies have shown that in women who use oral contraceptives, smoking is a powerful synergistic risk factor for myocardial infarction and possibly subarachnoid hemorrhage.[34] Thus, women who smoke, use oral contraceptives, and work in these industries may be at even higher risk for CVD.

Just as cigarette smoking causes pulmonary diseases other than cancer, there is a higher risk for many occupational lung diseases in women who smoke than in those who do not. Textile workers in cotton mills have increased risks for chronic bronchitis, airway obstruction, and pulmonary impairment,[35] and cigarette smoking produces a multiplicative effect on these conditions. Workers employed in synthetic fiber, wool, soft hemp, and flax mills, and in sisal, jute, and kapok processing, may develop pulmonary hypersensitivity leading to the onset of chronic lung disease, although these fibers appear to be less potent than is cotton dust.[36]

Thousands of women work in industries in which they are routinely exposed to potent pulmonary sensitizers that may greatly increase their risk for smoking-related chronic lung disease. For example, about 35,000 women use a meat-wrapping process in which a hot wire melts the plastic wrap, sealing the meat package. This process gives rise to such fumes as hydrochloric acid and phosgene, which produce a short-term asthma-like response, as well as recurrent respiratory illness.[37] Other potent pulmonary sensitizers are toluene diisocyanate (TDI) and other isocyanate-starting materials for polyurethane foam, and talc dust and carbon black, used in the rubber industry.[38] There are at least 500,000 women employed in the plastics and rubber manufacturing industries.

A variety of organic and inorganic dusts are capable of producing diffuse pulmonary interstitial fibrosis or pneumoconioses. Berylliosis, an extremely debilitating beryllium-induced systemic granulomatous disease that often progresses to a diffuse interstitial fibrosis, was first observed among women employed in the manufacture of fluorescent light bulbs.[39] Female laundry workers have been found to be at risk for pneumoconiosis from the contaminants of clothes they laundered, e.g., in pottery laundries where clothes are laden with silica dust.[40] There are at least 219,000 female laundry workers in the

**TABLE 5**
**ESTIMATED ANNUAL WHOLE-BODY DOSE RATES FROM SIGNIFICANT SOURCES OF OCCUPATIONAL RADIATION EXPOSURE**

| Source | Number of workers exposed | Percent Women | Average dose rate (mrems/year) |
|---|---|---|---|
| Medical x-rays | 195,000 | 80 | 300-350[a] |
| Dental x-rays | 171,000 | 85 | 50-125[a] |
| Radiopharmaceuticals | 100,000 | 20 | 260-350 |
| Commercial nuclear power plants | 67,000 | 5 | 400 |
| Fuel processing and fabrication | 11,250 | 10 | 160 |
| Particle accelerators | 10,000 | — | Unknown |
| X-ray diffraction units | 10,000–20,000 | — | Unknown |
| Electron microscopes | 4,400 | 60 | 50-200 |
| Airline crew and flight attendants | 40,000 | 90 | 160 |

[a]Based on personal dosimetry. True whole-body exposure is somewhat lower.

United States and tens of thousands of employed household workers with laundry responsibilities (to say nothing of housewives with the same responsibility for cleaning their husbands' work clothes). Pneumoconiosis has also been reported in women employed in the manufacture of porcelain electrical parts, where they are exposed to silica.[41]

Organic dusts other than those connected with textile manufacture can induce occupational lung disease, chiefly through allergic responses. Among these conditions significant to women workers are: farmer's lung (moldy hay); mushroom worker's lung (mushroom compost); bird fancier's lung (pigeon, parrot, and other droppings); turkey raiser's disease; chicken raiser's disease; and allergic responses arising from contaminated humidifiers, air conditioners, and heating systems.[42,43] The number of women exposed to these risks is estimated to be in the tens of thousands.

## Passive Smoking

The possible health consequences of breathing the cigarette smoke produced by others (sidestream smoke or "secondhand smoke") have recently received attention. In poorly ventilated areas, the ambient concentration of noxious components of sidestream smoke, such as carbon monoxide and nicotine, can exceed occupational exposure standards;[44] added to this may be an appreciable concentration of carcinogenic nitrosamines.[45] While such exposure is obviously not beneficial, epidemiologic assessment of risks for cancer and other diseases has not yet been published. Limited data are available that address other possible harmful effects, such as functional lung impairment in individuals chronically exposed to secondhand cigarette smoke,[46] including waitresses and bartenders, airline cabin attendants, hospital nursing staff, and women who work in offices where smoking is not restricted.

## Comment

The 1979 Surgeon General's report lists six ways in which cigarette smoking can interact with the occupational environment to increase risk of illness or injury:[47]

- A working environment may facilitate body absorption of the toxic components of cigarette smoke;
- Cigarette smoking can transform workplace chemicals into more toxic substances;
- A worker can be doubly exposed to the toxic constituents of tobacco smoke and to the same constituents in the workplace;
- The health effects from environmental exposure can be concurrent with similar health effects from smoking;
- The synergistic effects of all agents can pose a grave health problem to workers;
- Accidents can be caused by smoking in an industrial environment.[46]

The few studies on the relationship between occupational exposures and cancer mostly involve male subjects, and conclusions regarding risks for women must be inferred from these data and from the six risk factors cited. While these inferences are probably valid, they are no substitutes for hard data, which we hope will be developed in future studies.

In the meantime, the practitioner should be aware of the many potential and real cancer risks faced by millions of smoking and nonsmoking women at their jobs. The following recommendations are made to help clinicians make the most of their contact with women workers who are their patients:

- Become familiar with the occupations in which women are employed (Table 2), and try to learn what specialty industries employing women may be located near your practice.
- Make a habit of obtaining a thorough occupational history of both men and women. Such a history need not be time-consuming, and may provide valuable information for establishing a diagnosis. An occupational history should include at least the patient's current job title, the name and address of the current employer, dates of employment, and the type of industry involved (e.g., food processing, health care, electronics assembly). Find out if the patient has had specific contacts with chemicals, dusts, vapors, fumes, ionizing or nonionizing radiation, noise, vibration, or extremes of hot and cold. Inquire about previous jobs and the occupations of family members.
- Discuss with the patient any concerns you may have about possible occupationally related problems, and find out whether the patient suspects certain environmental agents. Often, no one knows the hazards of the workplace better than the worker herself.
- Be alert for illness patterns that may indicate occupational hazards not previously suspected or reported. The majority of established occupational carcinogens were first detected by observant practitioners, and only afterward confirmed by epidemiologists.
- Keep the patient fully informed of any findings relating her illness to her workplace, as there may be many other workers—male and female—who will benefit from this knowledge.
- Set an example for your patients and your staff: don't smoke. Encourage others not to smoke, and see that occupational health regulations and guidelines for limiting exposure to radiation, chemicals, radioisotopes, and other health hazards are rigorously enforced.
- Learn what public and private resources are available to assist both lay persons and health professionals in dealing with all aspects of occupational health. Some agency names and addresses accompany this article.

# FURTHER SOURCES OF INFORMATION

There are many resources that physicians and other health professionals can turn to for information on occupational cancer. Federal agencies provide the most information, particularly the National Cancer Institute (NCI), the National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA). Other sources include numerous university, trade, labor union, and nonprofit organizations, including the American Cancer Society (ACS).

## GOVERNMENT AGENCIES:

**The National Cancer Institute (NCI)** The NCI's Office of Cancer Communications maintains a Cancer Information Clearinghouse, which produces such valuable materials as *Cancer Information in the Workplace,* an annotated bibliography of educational materials for the public and for health professionals.

*Write to: Cancer Information Clearinghouse, Office of Cancer Communications, National Cancer Institute, 7910 Woodmont Avenue, Suite 1320, Bethesda, MD 20205.*

The Office of Cancer Communications will also furnish physicians and dentists with "Smoker's Quit Kits," to assist patients who want to stop smoking.

The NCI also supports a Cancer Information Service (CIS) with a network of toll-free numbers, many of which are staffed through the NCI's 18 regional Comprehensive Cancer Centers. For a list of these numbers, call 800-638-6694.

**The National Institute for Occupational Safety and Health (NIOSH)** NIOSH, an Institute of the Centers for Disease Control within the U.S. Public Health Service, educates professionals and conducts research on the effects and control strategies for occupational hazards. NIOSH provides technical and non-technical publications on occupational health and safety problems, and technical or consultative services related to specific occupational health problems. Contact NIOSH for information regarding research and testing related to toxic substances, protective equipment, and effective testing procedures for evaluation of the workplace.

There are 11 regional NIOSH-supported Educational Resource Centers (ERCs) that provide multidisciplinary and multilevel training and continuing education for physicians, industrial hygienists, and others wishing to specialize in occupational health.

The NIOSH Clearinghouse for Occupational Safety and Health Information provides health professionals with information and assistance, and also performs bibliographic searches.

*For further information on ERCs or occupational health, or for lists of publications, call 513-684-8326 or write to: NIOSH Clearinghouse for Occupational Safety and Health Information, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, OH 45226.*

**Occupational Safety and Health Administration (OSHA)** While OSHA's 10 regional and numerous area offices are engaged in day-to-day enforcement of regulations and standards, OSHA also publishes a variety of materials on occupational hazards, such as *Coke Oven Work and Cancer,* and *Health Hazards of Arsenic.*

*To obtain these and other publications in OSHA's Cancer Alert Series call 202-523-7119 or write to: OSHA Publications Office, U.S. Department of Labor, Room N 3423, Washington, DC 20210.*

## UNIVERSITY-BASED PROGRAMS

Many universities have federally sponsored programs that try to bring together occupational health specialists, managerial staff, and workers for training and problem solving. Many of these programs are listed in the booklet, *Environmental and Occupational Cancer Information/Education* (NIH Publication No. 80–2155, June, 1980).

One of these, the Women's Occupational Health Resource Center (WOHRC), in affiliation with Columbia University's School of Public Health, addresses the occupational health problems of women, such as those described in this article. The WOHRC offers a research service, library, bi-monthly newsletter, fact sheets, workshops, conferences, and speakers bureau.

*Telephone 212-694-3464, or write to: Women's Occupational Health Resource Center, School of Public Health, Columbia University, 60 Haven Avenue, B-1, New York, NY 10032.*

## AMERICAN CANCER SOCIETY (ACS)

The American Cancer Society, through its Cancer Education and Early Detection Program, provides business and industry with specialized services and information for the workplace: assistance in planning education, prevention, and early detection programs for lung cancer, colorectal cancer, breast cancer, and cervical cancer; training of occupational health professionals to conduct smoking cessation counseling, breast self-examination instruction, colorectal cancer and cervical cancer programs; backup support in the form of information, films and leaflets.

These services are offered through local ACS Divisions, a complete list of which appears on the inside back cover of this issue of *Ca.* You may also wish to call your local ACS Division for a copy of the booklet, *On the Job Cancer Education Pays Three Ways.*

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# WOHRC FACT SHEET

WOMEN'S OCCUPATIONAL HEALTH RESOURCE CENTER

# Danger: Lungs At Work

**Many women, as well as men, are exposed at work to substances that irritate the lungs. Textiles, chemicals, detergents, pottery, porcelain and many other workplace materials give off dusts, fumes or gases that may cause lung damage. Constant irritation over a long period of time can result in a variety of infections and breakdowns in the respiratory system, leading to such diseases as chronic bronchitis, byssinosis (brown lung) and emphysema. If a worker exposed to lung irritants smokes, her chances of developing respiratory disease multiplies.**

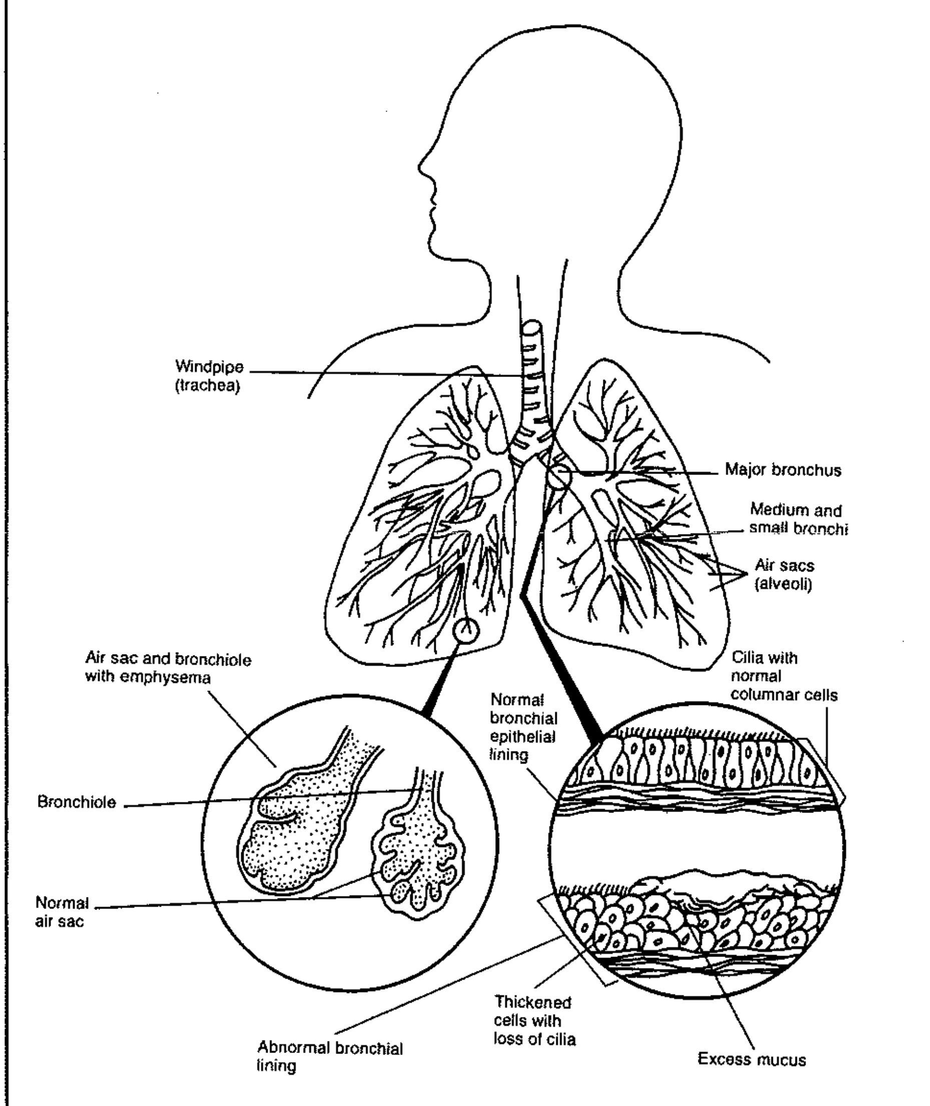
## How the lungs work

The lungs perform the vital function of transferring oxygen, which is necessary for life, to the blood which circulates it throughout the body. They are a part of the respiratory system which also includes the trachea or windpipe, the major breathing tube which connects to the nose and throat. This tube branches into two other main airways, the bronchi, one in each lung, which branch out further into medium-sized, then smaller airways, the bronchioles. These smallest airways end in delicate air sacs called alveoli, which resemble clusters of grapes. There are millions of such sacs throughout the lungs, all surrounded by tiny blood vessels. The oxygen from the air diffuses through the very thin walls of the alveoli into the red blood cells which transport it around the body.

The walls of the airways of the respiratory system are lined with mucus-producing glands like those of the nose. When the airways are irritated by dust, fumes or foreign particles in the air, these glands produce more mucus in order to dissolve and carry away the irritants. Constant irritation by smoking or industrial pollution can cause the mucus-producing glands to become swollen, blocking the airways.

The excess mucus from the glands may lead to chronic bronchitis, or it may cause pressure on the alveoli, or air sacs, causing their walls to tear or break down. This is emphysema.

When either of these conditions develop, the oxygen that passes through the alveoli walls is limited, and the air and fluid in the lungs become stale and more prone to infection which, in turn, leads




THE LUNGS AND LUNG DISEASE

Jeanne Stellman, *Women's Work, Women's Health* to further lung damage. A vicious cycle has set in.

### Textile work and byssinosis

Byssinosis, or brown lung, is caused by raw cotton dust. In some individuals it causes an allergic response: the small airways contract, making it difficult to exhale air. However, byssinosis has also been found to affect people who do not show an allergy. Either the cotton dust itself or a microorganism associated with it causes the lung tissue to harden. Byssinosis has been shown to lead to airway obstruction and serious lung impairment in periods of exposure shorter than 10 years.

Cotton mill workers have also been found to suffer from a disproportionate amount of chronic bronchitis, including wheezing, shortness of breath and cough. Cigarette smoking by cotton mill workers was shown in one study to quadruple the bronchitis rate.

Work with other kinds of textile fibers, both natural and synthetic, can also be damaging to the lungs, although not as much so as cotton dust.

**At risk: textile workers in mills producing cotton, synthetic fiber, wool, soft hemp, flax, sisal and processing of jute and kapok.**

### Chemical irritants

Chemical dusts and fumes, another cause of lung impairment, affect women in a number of industries. Meat wrappers in supermarkets often develop an asthma-like response when sealing the wrap, made of **polyvinyl chloride**, with a hot wire melting device. The heat releases gases and fumes, among them **phosgene** and **hydrochloric acid**, which are known to induce respiratory illnesses. The kind of refrigerated air in which meat wrappers work is also known to aggravate respiratory problems, although there is not yet enough research to document this in the industry itself.

Workers in plastics factories are exposed to similar fumes as well as to **plastics additives** such as **plasticizers** and **stabilizers.** Rubber workers, in addition to chemical fumes, may be exposed to such dusts as **talc** and **carbon black.** In one study, rubber workers who both smoked and were exposed to dusts and fumes were found to be 10 to 12 times more likely to have to retire because of lung disabilities than workers in unexposed areas of rubber factories who did not smoke.

**Cleansing agents**, which are used by large numbers of women both on and off the job, have also been shown to sometimes cause acute respiratory responses.

**At risk: meat wrappers; plastics and rubber workers; household workers; laundering, cleaning and other garment service workers.**

### Industrial dusts

A variety of dusts are known to cause the formation of fibrous tissue in the lungs. The most dangerous of these is **asbestos** which can also cause cancer. One study at a factory producing asbestos textiles and insulation materials found that women with a high degree of asbestos exposure lasting for as little as two years suffered excess rates of cancer of the lung. Another group of women employed longer but with lesser exposure suffered a mortality rate three times the average from other respiratory diseases.

A variety of **industrial dusts in contaminated clothing** can be hazardous to laundry workers. Lung disease has been found in women who laundered clothes for English pottery workers, and cases have been reported of cancer among wives and families of asbestos workers who brought home clothes to be laundered.

Cosmetologists and hairdressers, who are daily exposed to **sprays and lacquers**, may also be in danger of lung disease, although further research on this question is still needed. **Aerosol sprays** are known to be particularly hazardous because the droplets they exude are extremely small and can make their way deep into the respiratory tract where they can do the most harm. Household and janitorial workers who use aerosol sprays are also at risk.

Scarring and hardening of lung tissue has been reported among women employed in the manufacture of porcelain electrical parts where there was known exposure to **silica.** This is the dust that causes silicosis, an occupational disease known since the building of the pyramids.

**At risk: hospital and medical workers; household and janitorial workers; beauticians; and workers in asbestos and porcelain factories.**

### Plant and animal dusts

In addition to fiber dusts, such as that from cotton, other plant and animal dusts may cause lung disease. Some infect the alveoli and cause flu-like symptoms including fever, chills, a dry cough and a bluish tinge to the skin caused by lack of oxygen. If exposure is longlasting, a serious chronic lung ailment may develop.

A number of illnesses connected with agriculture and the raising of animals come under this heading. They include **farmer's lung** (from moldy hay); **mushroom worker's lung** (from mushroom compost); **bird fancier's lung** (from pigeon, parrot and other droppings); **turkey raiser's disease** and **chicken raiser's disease.**

According to some research, severe allergic reactions to **housedust** may be caused by a mite in the dust. **Enzymes** used in detergents were found to cause such allergic responses that products including them have been banned from further production in the United States.

The most widespread reactions of this kind, however, probably come from **contamination of humidifiers, air conditioners and heating systems by a variety of micro-organisms.** In one office where workers came down with chills, fever and shortness of breath, examination of the air conditioning system revealed that it was contaminated with an organism that has been associated with farmer's lung. Another outbreak, in a stationery factory, was traced to contaminated water in the air conditioning system.

**At risk: office workers; household and janitorial workers; agricultural workers.**

*Much of the above material was adapted from the article, **Occupational Lung Disease and Cancer Risk in Women,** by Jeanne M. Stellman, PhD, and Steven D. Stellman, PhD, in the November 1983 issue of **Occupational Health Nursing.***



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**Women's Occupational Health Resource Center**
117 St. John's Place
Brooklyn, N Y 11217

# WOHRC FACT SHEET

**WOMEN"S OCCUPATIONAL HEALTH RESOURCE CENTER**

# Formaldehyde Risks in the Workplace

**Although formaldehyde has been commercially used for some 90 years, it has only been in recent years that hazards associated with exposure have been enumerated; important new data added, and battles about exposure limits and control have hit the courts and the media.**

**Formaldehyde is used in large amounts in many settings—hospitals, factories, homes—which means that people can be exposed to a potentially hazardous chemical in ways they might not expect.**

**Here we present an overview of the problem.**

In 1983, the U.S. used more than 7.5 billion pounds of formaldehyde in some sixty different industrial applications.

Formaldehyde is a flammable gas. The commercial form is made by reacting methanol vapor and air in the presence of a catalyst. This produces a fairly pure form which is sold either as formalin, formaldehyde in a water-base solution or in a solid form.

The popularity of the chemical is not surprising: in its commercial form, formaldehyde is relatively pure, cheap, colorless and most important of all, highly reactive which makes it useful in linking separate molecules to make more complex chemicals.

Formaldehyde helps to make final products better. For example: formaldehyde and its derivatives are used to give paper "wet strength"; formaldehyde is a magic ingredient in transforming raw animal skin and fur into tanned leather; formaldehyde is used to harden and protect the gelatin surface of film and photographic papers.

In addition to its ubiquitous industrial use, formaldehyde works its way into the open air as a component of engine exhaust, incinerator smoke, and photochemical smog.

### Health Effects

Formaldehyde produces both obvious and more insidious health effects.

At exposure levels of 0.1-5 ppm, eyes burn and tear; upper respiratory passages are irritated. At higher concentrations, 10-20 ppm, coughing, tightening in the chest, heart palpitation and a sense of pressure in the head are produced.

When exposure reaches the 50-100 ppm level and above, serious conditions such as pulmonary edema or pneumonitis sometimes leading to death can occur.

Workers whose skin comes in contact with formaldehyde solutions or formaldehyde-containing resins, can develop an eczema-like reaction on various body parts including the eyelids, neck, fingers, scrotum, and flexor surfaces of the arm. Dermatitis can even be the result of contact with contaminated work clothes.

Jane Wechsler

Exposure to formaldehyde can also set off allergic reactions. A worker who has an allergy to formaldehyde may react to even the smallest amount and might even have to leave the job. Sensitization can occur suddenly, even after many years of exposure.

While these various health effects have long been recognized, it was only in 1979 that laboratory studies using rats and mice were done first by the Chemical Industry Institute of Toxicology and subsequently by the New York University Institute of Environmental Medicine which showed a link with the development of nasal cancer. Mutagenic effects in experimental animals also have been demonstrated.

### The Regulation Battle

Even before the cancer evidence, formaldehyde was recognized as an industrial hazard requiring imposed limits.

The OSHA standard requires an 8-hour time-weighted average (TWA) concentration limit of 3 ppm, a ceiling concentration of 5 ppm, and an acceptable maximum peak above the ceiling concentration of 10 ppm for no more than a total of 30 minutes during an 8-hour shift.

In 1976 with information about the irritant effects only, NIOSH recommended that worker exposure be controlled to concentrations no greater than 1ppm for any 30 minute sampling period.

By 1980-81, an expert panel convened by the Consumer Product Safety Commission and the Interagency Regulatory Liaison Group concluded that "it is prudent to regard formaldehyde as posing a carcinogenic risk to humans" and NIOSH recommended that formaldehyde be handled in the workplace as a potential occupational carcinogen.

An estimate of the extent of the cancer risk to workers exposed to various levels of formaldehyde at or below the 3 ppm standard has not been formulated but NIOSH has called for engineering controls and stringent work practices to reduce exposure to the lowest fesible limit.

Restriction on formaldehyde exposure is a matter of contention however, and there is disagreement about the meaning of formaldehyde laboratory test results.

Currently, while labor unions such as the United Automobile Workers, are pressuring OSHA for new tougher standards and immediate steps to limit exposure, and NIOSH is doing mortality studies on apparel workers, several courts have struck down bans on urea-formaldehyde (UF) foam insulation, a decision supported by the industry-sponsored Formaldehyde Institue.

Given an issue yet to be fully resolved, what can be done to provide protection in the interim?

### Who Is at Risk?

OSHA estimates that some 2.6 million workers—many of them women—are exposed to formaldehyde in a wide variety of industries.

Approximately half of the formaldehyde produced is used to make synthetic resins such as urea- and phenol-formaldehyde resins which in turn are used to make particleboard, fiberboard, and plywood.

Formaldehyde is extremely important to the textile and clothing trades because it is used in making creaseproof, crush roof, flame-resistant, and shrink-proof fabrics.

Formaldehyde is used in the hospital and health care sector for certain medications, sterilizing jobs,—including in kidney dialysis—and anatomical dissection. The use of formaldehyde in embalming fluids is required in all states.

The following list gives an idea of other products made with or containing formaldehyde:

| | |
|---|---|
| Adhesives | Insulation Foam |
| Cosmetics | Laminates |
| Detergents | Synthetic Lubricants |
| Dyes | Garden Hardware |
| Explosives | Surface Coatings |
| Food | Watersoftening Chemicals |
| Fuels | |
| Fungicides | Plastics/moldings (autos; appliances, sports goods) |
| Filters | |
| Paints | |
| Rubber | Friction Material |
| Paper | Fertilizers |

Although it is not the subject of this Fact Sheet, the general public also may be at risk. For example, when insulation foam is pumped into a home, formaldehyde gas is released and can remain for long periods causing eye and respiratory irritation.

### What to Do

The above descriptions of the use of formaldehyde and the product list point to jobs where exposure is probable.

In the workplace, a tip-off to the presence of formaldehyde can be its characteristic pungent odor. Noticeable signals such as eye tearing make its presence a reasonable suspicion. Tearing usually occurs at the 2-3 ppm level.

In general, the fewer the number of employees working with formaldehyde, the better.

There are several approaches to control, each with points to keep in mind. Before a control program is established, an exposure survey should be done.

#### ASSESSMENT

An initial exposure survey should be done by competent industrial hygienists or engineers and repeat surveys done thereafter. There are monitoring devices including a portable, direct-reading survey instrument available for measuring trace quantities of atmospheric formaldehyde.

Recently, NIOSH has found that passive monitoring done by badges that can be worn are not as accurate as traditional methods. According to "Workers' Compensation Monthly," Feb. 1984, NIOSH has informed the manufacturer that the device, as marketed, cannot be relied on for consistently-accurate readings.

#### PRODUCT SUBSTITUTION

The fact that controlling formaldehyde exposure is not a simple matter is quickly illustrated by the idea of product substitution. While this is a seemingly easy approach, it's difficult in practice because substitutes can in themselves be hazardous.

#### CONTAMINANT CONTROLS

Airborne concentrations of formaldehyde can be effectively contained by enclosing the source of fumes within the work area/and or using local exhaust ventilation. Ventilation should be regularly checked. Whenever there is a change in production or the work process, a reassessment should be done.

#### ISOLATION

Sometimes, employees can be isolated in a control booth or room where they can direct automatic equipment to do the job in a hazardous area. Air in the control center should be at greater pressure so that air will flow out—not in—to the protected area. While such a set-up is effective, it does not protect employees who must do on-site checks or maintenance.

#### PERSONAL EQUIPMENT

Protective gear—respirators, special clothes, goggles, gloves—is useful but it should not be the primary means of controlling exposure to formaldehyde. In emergencies, during installation or maintenance activities or when engineering and work practice controls have failed to do the job, PPE is a must.

#### EDUCATION

Informed employees, who know about the nature of the problem they face and how it is being controlled, can contribute to a safer workplace. In addition to the facts, employees need to know about appropriate personal hygiene measures. Worker should also be aware of the need to inform their physicians of their work with formaldehyde.

Information about formaldehyde exposure and effects constantly increases and it is important to keep up with scientific publications as well as regulatory agency announcements. Journals are a critical source of information.

For example, in February 1984, the "American Industrial Hygiene Association Journal" published a study of how formaldehyde is used to sterilize autopsy rooms and their ventilation system. To effectively disinfect a room, concentrations of 8600-14,000 ppm must be used. The article describes how such rooms can be sealed off, exposure reduced and emergencies like fires dealt with. Another article in the AIHA Journal, published a month later in March, discussed the exposure of embalmers to formaldehyde and other chemicals. □

Much of the above material reflects information in publications of NIOSH—particularly Current Intelligence Bulletin 34: "Formaldehyde: Evidence of Carcinogenicity"—and of the Chemical Industry Institute of Toxicology. The Amalgamated Textile Workers union also was helpful.

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**Women's Occupational Health Resource Center**
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# New OSHA Formaldehyde Standard; 7 Yr Battle Ends; Unions Still Unhappy

A new formaldehyde exposure standard which reduces permissible workplace levels to 1 part per million (ppm) from the current 3 ppm is scheduled to go into effect at the end of January 1988. A short term exposure limit (STEL) of 2 ppm was also set. Workplaces that exceed an 'action level' of 0.5 ppm over an 8 hour day will be required to comply with the monitoring, employee training and medical surveillance parts of the standard.

OSHA had been under threat of a contempt of court citation from the U.S. Court of Appeals for the District of Columbia, following a seven year battle waged by 14 unions and the American Public Health Association to obtain a more stringent standard. Since the late 1970's evidence has been mounting that formaldehyde is a human and animal carcinogen.

According to the *AFL-CIO News* 'organized labor can only declare a partial victory' and litigation is expected to continue. Clothing & Textile Workers Union President Jack Sheinkman has stated that the new standard "will not even require employers to notify workers of the cancer risk, nor provide minimal medical screening for the skin problems or allergies which commonly afflict workers handling permanent-press fabrics treated with formaldehyde."

## Where Workers Are Exposed to Formaldehyde

More than 2 milion workers are believed to be exposed to formaldehyde. The jobs marked with an * have many women workers:

**highest exposures**: (about 400,000 workers in industries currently above 1 ppm) furniture makers, foundries, laboratories* (pathology, anatomy, histology), funeral services*, hardwood plywood, particle board and fiberboard manufacturers

**middle range exposures**: (about 1 million workers in industries from 0.1 to 1 ppm) apparel manufacturers*, plastic molding makers, textile finishing*; formaldehyde production

**lowest range exposures**: (about 675,000 workers in industries from 0.1 to 0.5 ppm) paper and paperboard mills; photofinishing labs*, corrugated and solid fiber boxes, some electrical equipment makers*, hemodialysis*, softwood plywood, biology instructors*

## The Toxic Effects of Formaldehyde

Formaldehyde is an extremely reactive compound. Even at very low levels of 0.1 ppm it can cause irritation of the eyes, nose and throat. As the concentration increases, so does the irritation. Levels as low as 100 ppm it is immediately dangerous to life. Formaldehyde is a potent allergen, causing severe skin and lung allergies. Workers may not develop the allergies for some years and then find that they must abandon their jobs because they cannot tolerate even minimal contact with the chemical. Several recent studies have found that formaldehyde can cause human and animal cancer, including cancer of the nasal passages (nasopharyngeal).

## General Provisions of Revised Standard

In addition to lowing the exposure limit, any workplace with average levels over 0.5 ppm must have a workplace monitoring and worker training program and establish emergency procedures. Required are a medical surveillance and recordkeeping program, and establishment of regulated areas in which formaldehyde is to be used. Primary reliance is on engineering and work practice control, but if personal protection is needed the employer is to provide maintenance and selection.

 

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WOMEN'S OCCUPATIONAL HEALTH RESOURCE CENTER

# Cosmetology Risks

## FDA BAN ON METHYLENE CHLORIDE

The FDA proposed a ban on the use of methylene chloride as an ingredient in aerosol cosmetic products in December 1985, citing several toxicological studies which established that inhalation of the chemical causes chemicals in laboratory test animals. In its proposed ruling, the FDA notes that "hair care specialists represents the groups with the highest exposure level from aerosol hair sprays."

The Agency cites published data showing that consumer use of a spray for 5 seconds will cause 50 parts per million of methylene chloride to remain in the breathing zone for 5 to 10 minutes after spraying. This study was carried out by researchers at Dow Chemical and Alberto Culver companies. Cosmetologists would be exposed for far greater lengths of time.

**"For the hair specialist, the lifetime (cancer) risk is 1 in 100 to 1 in 1000" according to FDA estimates.**

When the FDA calculated the risk based on the cancer induction rate observed in mice exposed to 2,000 parts per million of methylene chloride, it estimated that the lifetime cancer risk for cosmetologists is between 1 in 100 to 1 in 1000. (Using the same calculation for consumers, the risk was calculated to be between 1 in 1,000 to 1 in 10,000.)

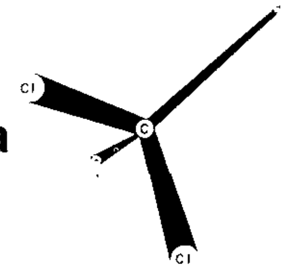
**Aerosols: a particular hazard**

The FDA notes in its analysis that the "risks are relatively high" for hair stylists not because methylene chloride is a particularly potent carcinogen but because the exposures from aerosol uses are high.

Other aerosols will also pose special hazards. For example, the Cosmetics Ingredient Review Expert Panel, a cosmetics industry sponsored group, has concluded that while formaldehyde is safe for use as an additive in low concentrations to lotions and other cosmetic products, it "cannot be concluded that formaldehyde is safe in cosmetic products intended to be aerosolized."

Cancer risks from aerosolized hairsprays are not new. Vinyl chloride was a very popular "inert" propellant previously used for this purpose until it was found to be a human carcinogen when a cluster of liver cancers was discovered among vinyl chloride manufacturing workers. It is no longer used as a propellant.

# Methylene Chloride: OSHA Guide and Toxicology Data



A set of guidelines on health hazards and methods for controlling methylene chloride were issued in March by OSHA as its response to a request for a health hazard alert and emergency temporary standard from the United Auto Workers and six other unions. The UAW cited recent National Toxicology Program (NTP) data showing the chemical's carcinogenicity. (These data are the basis of proposed FDA banning of methylene chloride in aerosols. OSHA critics this as a more appropriate and stringent agency response.)

The following is among the information contained in the guidelines:

**Metabolism:** The body handles methylene chloride by at least two pathways. The first produces highly reactive intermediates, such as formaldehyde, known to interact with genetic material and proteins. The second pathway produces carbon monoxide and carbon dioxide. The carbon monoxide will bind to hemoglobin, forming carboxyhemoglobin, which can have serious effects on the heart and circulatory system. Levels 2 to 3 times those of a one pack per day smoker have been found after methylene chloride exposure.

**Human Effects:** No conclusive epidemiological data on human cancer is available, although some studies have been published. An excess risk for hypertensive heart disease was found among exposed Eastman Kodak workers. At high concentrations it is also irritating and has a narcotic effect.

**Animal Studies:** Several studies have established methylene chloride to be an animal carcinogen.

**Likely Exposure Situations:** Approximately 235,000 tons/yr produced. 25% is used in paint stripping operations. Women workers are likely to be exposed in the electronics industry where it is used in printed circuit board manufacture. These aerosol products contain methylene chloride: hair sprays, cleaners, room deodorants, herbicides and insecticides. Many female dominated occupations and women who work in the home will be exposed.

**Control:** Ventilation, both local and exhaust, and product substitution are the two best methods for eliminating exposure. Lower temperatures will reduce air concentrations.

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WOMEN'S OCCUPATIONAL HEALTH RESOURCE CENTER

# Ethylene Oxide: How To Use It Safely

**Ethylene oxide (EtO) is a chemical widely used in a gaseous form to sterilize medical supplies and equipment — usually that which cannot be subjected to intense heat. According to a recent survey by the National Institute for Occupational Safety and Health (NIOSH), there were approximately 10,000 EtO sterilization units in use in 8,100 hospitals in the United States. Not counted are others found in dental clinics and clinical laboratories. An estimated 75,000 health care workers are directly exposed to the gas, while another 25,000 — most of them working in hospital Central Supply areas where the sterilizers are usually located — are indirectly exposed because of leaking equipment or improper ventilation or operating procedures.**

**Until recently, the accepted exposure for EtO was 50 ppm (parts per million parts of air), but recent research on its effects on animals and humans has led to warnings that it is a potent health hazard. In humans, it has been shown to be associated with leukemia, diseases of the circulatory system, upper respiratory complaints, and abnormal behavior of gene cells. In laboratory animals it is linked with leukemia, tumors, sterility and malformed fetuses.**

Such evidence led California health authorities in the summer of 1982 to issue a warning on the use of EtO and to recommend a new legal exposure limit of only one part per million. The Women's Occupational Health Resource Center, several of whose staff members have been involved in an intensive study of EtO hazards, urges a limit of .05 ppm, with 1 ppm for short-term exposure.

For protection against EtO, WOHRC recommends the following safeguards:

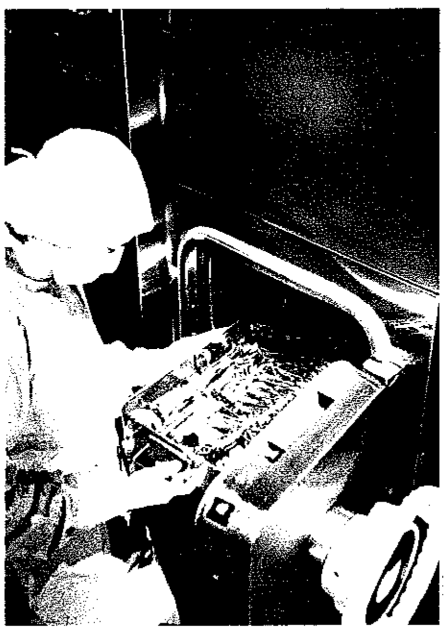
## ■ FOR WORKERS

### Operating procedures

The single greatest source of employee exposure to EtO occurs when the sterilizer door is opened at the completion of a cycle. Eighty percent of this contamination can be eliminated by an additional air-purging phase at the end of the cycle.

**DO** run an additional cycle, filtering the air twice rather than the conventional once.

**DO** also leave the sterilizer door open for a full 15 minutes after the end of the final cycle, before removal of the sterilized items.



American Sterilizer Company

**Ethylene oxide sterilizers like this one are common in hospitals.**

**DON'T** do the above, however, unless there is adequate local ventilation. (See below.)

**DO** wipe moisture from items prior to sterilization. If moisture is left on instruments the ethylene oxide will form ethylene chlorohydrin and ethylene glycol which are not removed, as is EtO, during the aeration process. Ethylene chlorohydrin, in particular, is highly mutagenic and possibly carcinogenic.

**DO** sterilize items together that require common aeration time. The items can be pre-packaged so that contact with them is minimized.

**DON'T** retrieve some items while others are still being aerated. This leads to unnecessary exposure.

**DO** put sterilized items into the aerator *immediately* after the 15-minute open door period.

**DON'T** leave them unattended for any length of time because some can begin to release much of the EtO into the workplace air.

**DO**, if there must be a distance between sterilizer and aerator, pull the cart behind you to the aerator.

**DON'T** push it in front of you, thereby making it easier to inhale the EtO fumes.

### Personal protective equipment

Personal protective equipment such as goggles, gloves and respirators are the least effective method of controlling EtO exposure. This is especially true while the worker is operating the sterilizer and aerator, since they restrict mobility and comfort. In fact, it is advised that protective gloves are not needed during transport of sterilized items to the aerator because baskets and carts used for sterilization are normally made of metal which does not absorb EtO. However,

**DO** use such equipment as goggles, heavy duty gloves and self-contained breathing equipment when changing gas cylinders in order to avoid contact with liquid sterilant remaining in the connecting lines.

### Medical screening

**DO** have an annual medical examination if you are exposed to EtO at work. The exam should include a complete physical, blood cell count and urinalysis.

**DON'T** remain at the same job if adverse effects of working with the chemical are found. Ask your doctor to back you in seeking a change in working conditions.

## ■ FOR EMPLOYERS

### Equipment

Ten percent of the institutions using EtO sterilizers recently surveyed did not use aerators, and almost half used EtO flash bags, an inherently dangerous process in which worker exposure to EtO is inevitable.

**DO** always provide aerators because EtO can condense and form a moist film on plastic. When this film is allowed to remain on hospital instruments after sterilization it is not only harmful to workers, but has been known to cause rashes in hospital patients. The aerator evaporates whatever traces of EtO remain on the instruments.

**DON'T** place the aerator across the room or at considerable distance from the sterilizer, as is common in many hospital Central Supply areas. This exposes workers to contamination from EtO when the items are being transferred from sterilizer to aerator.

**DO** make sure that each sterilizer has a properly installed vent line that leads outside the building.

**DON'T** allow sterilizers to vent into the workroom.

**DO** make sure that the building air duct emitting the EtO is located more than 25 feet away from any air ducts leading into the building.

**DON'T** allow EtO emitting ducts to have any contact with air conditioning ducts.

**DO** install exhaust devices in the workroom so that contaminated air is drawn out. Both exhaust fans and hoods over doors can be used. Canopy hoods over the tops of doors are usually sufficient, but sometimes side and bottom draft hoods may also be called for.

**DON'T** allow contaminated air to flow from the work site to other areas of the hospital or laboratory.

**DO** locate local exhaust pickups in areas where there is a strong possibility of leaks. The exhaust should be decontaminated by use of a catalytic converter or fire box or a decontamination furnace.

**DON'T** allow EtO to escape into the air when supply tanks in the sterilizer are changed.

**DO** enclose the tanks in ventilated cabinets, with chamber emergency valves connected to either an outside exhaust stack or the original ventilation system.

**DO** control EtO release from a sterilizer venting to a sanitary sewer. This can be done either by centrifugal liquid gas separators on the vacuum pump outlet, or by ventilating the drain area, which is probably less expensive.

**DO** provide closed carts which fit directly in front of the sterilizer so that items can be transferred to the aerator without the worker being exposed to EtO fumes.

**DON'T** use flash bags or any type of "flash" sterilization process unless it is carried out under a fume hood which chemically "scrubs" the air and draws it up and out of the room.

### Ventilation

All EtO equipment and sterilized items should be kept in well ventilated areas.

**DO** ventilate aerators as carefully as the sterilizers themselves. Aeration cabinets should be vented by means of exhaust ducts which lead through decontaminating apparatus to the outside.

**DON'T** locate these ducts any closer than 25 feet from any air intake system.

### Personnel policies

**DO** educate workers on how to operate EtO equipment with maximum safety and minimum exposure. Organize in-service and orientation programs to explain the dangers of the chemical and the best ways to handle all the equipment involved.

**DO** organize an "action team" with a high level of knowledge and expertise to handle emergency situations such as leaks and spills.

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FOUNDATION FOR WORKER, VETERAN AND ENVIRONMENTAL HEALTH INC.

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# ETHYLENE OXIDE

## Human Cancer Risks Grow

The District Court ruling follows the publication of a study Swedish factory workers which has found that even at low levels of exposure, workers at the ETO producing factories were suffering from leukemia and stomach cancer rate ten times above the national Swedish rates. Eight cases of leukemia were found where only 0.8 were expected and six cases of stomach cancer were reported compared to the 0.65 cases expected for the 733 exposed workers.

The implications of these findings for health care workers are not yet clear, however, it was estimated that some of the exposed men had worked at exposure levels close to the new OSHA standard. Cancer-causing substances are assumed to act in a dose-related fashion, that is, they have a greater effect at higher doses. The National Institute for Occupationally Safety and Health's (NIOSH) estimates of health care worker exposures place them at levels above these Swedish factory workers.

*Ref: Hogstedt, C., Aringer, L. and Gustavsson, A. 'Epidemiologic support for ethylene oxide as a cancer causing agent.' JAMA(255), 1575-1578, 1986.*

## Lab data shows more harm

Two more laboratory studies of the biological effects of ETO have demonstrated effects to the reproductive capacity of male mice and of enhanced mutation (alteration of genetic materials) in hamster cell cultures. Both experiments demonstrated a dose-related response for the effects.

Groups of male mice subjected to increasing levels of ETO gas exhibited increasing dominant-lethal test effects. This test mates treated males with untreated females, sacrifices the pregnant females and counts the number of dead embryos. Many substances toxic to male reproduction will increase the number of dead embryos, as in the current report on EtO. In mice the later stages of sperm development appear to be the most susceptible to ETO.

*Ref: Generoso, WM et al, ETO Dose and Dose-Rate Effects in the Mouse Dominant-Lethal Test.' Env. Mutagenesis 8, 1-7, 1986.*
*Hatch, G. et al, 'Mutation and Enhanced Virus Transformation of Cultured Hamster Cells by Exposure to ETO.' Env. Mutagenesis 8, 67-76, 1986.*

## Court orders ceiling

The Occupational Safety and Health Administration has been ordered by the U.S. Court of Appeals in Washington D.C.to stiffen the ethylene oxide, ETO, standard by adding a short-term exposure limit [STEL] The current standard, successfully challenged by three unions and the Public Citizen Research Group, requires that exposure only be controlled to an average level of 1 part per million (1 ppm).

The STEL had been a hotly contested issue during the 1984 OSHA standards-making procedure, with many experts and groups attesting to the potentially toxic effects of short-term excursions to relatively high levels, a condition which occurs often in health care situations, such as during the transfer of sterilized materials from the ETO sterilizer unit to the aerator unit. OSHA, under pressure from the Office of Management and Budget, did not include the STEL in its final rulemaking.

The major implications of the STEL will be for workers in health care, where the predominant human exposure is thought to occur, despite the fact that health care uses of ETO represent only about 0.5% of the total production in the U.S.

The District Court refused a petition by the Association of Ethylene Oxide Users.

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# Pointing the Finger at Nail Salons

In 1984 about 48 million manicures and 20 million pedicures were purchased by Americans. Their nails were sculpted by the *80,000 nail sculptors* who apply dental acrylic, *methyl methacrylate*, to the nails to strengthen and lengthen them. This new technology has created nail artists who literally shape and decorate finger and toe nails.

The job can involve exposure to *toluene, isopropyl alcohol, butyl acetate, ethyl methacrylate, methacrylic acid* and assorted *nuisance dusts* exposures. Recently an industrial hygiene assessment of fingernail sculpting showed that while none of the fume and dust levels reached the OSHA exposure limits, many nail sculptors exhibited symptoms of nose and throat and skin irritation, drowsiness, dizzy spells and trembling and other effects much more frequently than a comparison population.

One of the culprits in the irritation may be the dust generated from filing treated nails, *polymethyl methacrylate*. Serious allergic responses (sensitization) from the acrylates both in sensitized users and sculptors are possible. In one case the effects on the nails were so severe that the user's nail plates had not yet regrown after a period of seven years.

The National Institute for Occupational Safety and Health carried out a Health Hazard Evaluation survey and found that 2 out of 3 nail sculptors developed itching and rash between five and six times a month. NIOSH has recommended the following precautions: 1) wear blouses that protect the arms and torso; 2) wash hands and face gently with soap to remove offending dusts; 3)apply barrier creams to the exposed skin.

The long-term effects of exposure to methacrylate dusts are not known. These substances are known mutagens (cause genetic abnormalities) in experimental systems. Animals injected with methacrylates have developed adverse reproductive effects, including fetal death and birth defects. No human evidence is available.

# Unsuccessful Attempts at Fume and Dust Control

Some of the salons studied had installed tables with local ventilation units installed. These were found to be completely ineffective in reducing dust and fume levels. The researchers attribute the ineffectiveness either to the low power of the units or to the fact that the filter units had not been changed in at least five months (or to both). Manufacturer recommendations are for 1-3 month replacement periods.

Improving ventilation in the salons is important, according to the researchers. Local exhaust ventilation, such as suction ducts directly over the workbench, would greatly reduce the fume and dusts levels.

(References: Hipakka, D and Samimi, B, "Exposure of Acrylic Fingernail Sculptors to Organic Vapors and Methacrylate Dusts," *AIHA J (48)*, 230-237, 1987.
National Institute for Occupational Safety and Health, *Health Hazard Evaluation, Determination of Monomeric Methyl Methacrylate Vapors at the Hair Zoo Beauty Salon*, (DHEW:NIOSH Pub. No 77-119). Cincinnati Ohio: GPO, 1976.)

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# WOHRC FACT SHEET

WOMEN'S OCCUPATIONAL HEALTH RESOURCE CENTER

# Handling Chemotherapeutic Drugs

**Drugs for treatment of cancer have been used so widely in recent years that concern is growing over the health hazards they may pose to the health care workers who handle them. The very chemical properties that make antineoplastic drugs effective weapons against cancer — their ability to interfere with the cellular replication of rapidly dividing cancer cells — may also make these drugs hazardous to workers who are exposed to them. These workers include not only nurses, who mix and administer most of the drugs, but doctors, pharmacists and the maintenance workers who clean up after all are finished.**

**Research on these hazards is still incomplete, but one study showed increased mutagenic activity in the urine of nurses who handled cancer chemotherapeutic agents. This is of concern because mutagens change the cellular DNA that controls cell division and heredity. Many mutagens also cause cancer. There are other, anecdotal reports of lightheadedness, dizziness, facial flushing and nausea by nurses and pharmacists who were unprotected while preparing the drugs.**

A recent survey by the Women's Occupational Health Resource Center and the Comprehensive Cancer Center at Columbia University of two large teaching hospitals and three affiliated community hospitals found marked inconsistency in policies and procedures for safely handling cancer chemotherapeutic drugs. Practices varied not only from hospital to hospital, but even within the same institution and among individual practitioners. In some hospitals there were no safety policies at all. In others, even when safeguards were available, they often were not employed.

### Who is at risk

In most hospitals, chemotherapeutic drugs are mixed and administered by nurses. Pharmacists and physicians — mainly residents and fellows rather than attending physicians — handle them to a lesser degree. Whereas pharmacists in this study tended to dispense all the cancer drugs at a single time of day, nurses are likely to use them at their stations throughout the day, depending on their arrival from the pharmacy and on the times prescribed for the patients. Individual nurses usually mix and administer between two and twenty doses per day.

Thus, although the risk to individual workers from handling the drugs a few times may be small, the fact that so few people handle them so frequently intensifies the potential hazards and makes safety practices all the more necessary and important.

Barbara Aufiero

**A preferred safeguard in mixing chemotherapeutic drugs is a vertical laminar flow hood like this one.**

### Physical facilities

In the hospitals surveyed, 80 percent of the drugs were prepared under a laminar flow hood, which is the preferred method for shielding workers from contaminants. Three percent of the drugs were prepared under a horizontal flow hood, which is less effective, and 17 percent were mixed without any hood at all.

Even if hoods are used, however, they may not be sufficient protection. Those observed by the survey team all used HEPA (high efficiency particulate air) filters whose efficacy has not been tested specifically for chemotherapeutic drugs. In no instance did the surveyers find a charcoal or other filter designed to chemically scrub the air.

The placement of the hoods also tended to reduce their efficiency. Most were installed in small rooms with high traffic where the movement of workers would interfere with the flow of ventilating air. Industrial hygiene data show that this kind of installation, in addition to the movement of the worker's arms within the hood, can decrease protection. In fact, unless the hoods are carefully installed, maintained and used, they may exacerbate rather than prevent exposure. This is especially so if hood blowers are not adjusted to make sure that no contaminated air blows back into the worker's face or into the workroom.

Several of the procedures used also increased risk of exposure to the drugs through the skin as well as the respiratory tract. In the survey, 49 percent of the drugs were purchased in ampules that had to be broken before use. This procedure has been experimentally shown to leave particles in the air even when it is performed under a hood. Other leaks can come from syringes, tubing and stopcock connections and the expelling of air from an infusion line.

### Personal protective equipment

Seventy-five percent of those surveyed used gloves while mixing drugs, but none of the nurses continued to wear the gloves when administering the drugs to patients. No one used a chemical fume mask during either mixing or administering the drugs.

Similarly, routine wearing of laboratory coats varied. Only about a third of the physicians wore them. Most of the nurses considered their uniforms to be their lab coats, with fewer than 25 percent wearing additional protection. All of the nurses wore their uniforms home. There were no laundry facilities available for nurses' uniforms.

None of the housekeeping staff members who disposed of contaminated trash were seen wearing protective clothing.

### Training

Although several of the institutions surveyed had extensive training programs centered on patients' reactions to the drugs, none provided basic training in safety for the hospital personnel. None demonstrated safe practices for either mixing or administering chemotherapeutic agents. Nurses, because they received information about toxic effects of drugs on patients, may have been somewhat aware of the hazards to themselves. However, in no case were nonprofessional staff provided with information, training or guidance to indicate that there might be danger, or that certain work practices might reduce their exposure.

### Disposal techniques

The survey found many unsafe practices in the disposal of contaminated equipment and trash. In some of the preparation areas, the leavings from chemotherapeutic procedures were not separated from other trash. In 60 percent of these areas survey personnel found needle destructor clippers, a disposal device that clips needles from syringes containing drugs. No special precautions were taken when the needles broke. In all cases, I.V. bottles were dumped with the regular refuse.

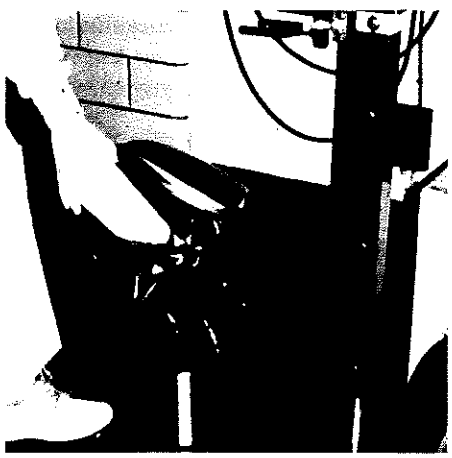
The hospital with the best practices had all drug-contaminated equipment except I.V. bottles packaged into ziplock bags and delivered to the pharmacy for incineration. But even here, as in all others surveyed, no special arrangements were made for the collection and disposal of patient excreta or regurgitation. Personnel who handled it took no special precautions and wore no special protective equipment.

This is particularly dangerous since drugs are often not entirely absorbed by the body, and trace amounts can be expected in the excreta and regurgitation of cancer patients who have been treated with chemotherapeutic drugs.

### An additional warning

This survey, it should be noted, concentrated only on university medical centers and community hospitals. Private doctors' offices and private practice pavilions within institutions were not examined. However, it is likely that potential exposure in these areas is even greater, since few are equipped with hoods and personal protective equipment, or practice protective disposal techniques.

It is also important to note that some of the substances used in chemotherapeutic drugs, such as alkylating agents, interact directly with DNA, the material that controls cell replication and heredity. It is generally accepted by the toxicological community that exposure to these drugs should be avoided as far as possible.



Barbara Aufiero

**Drug-contaminated trash should be kept separate from other trash and disposed of in covered receptacles with removable linings.**

### What can be done

More data is still needed for a decision on the best kind of hoods. But there are immediate steps that can be taken for the protection of personnel handling these drugs. Scandinavian research has already indicated lower mutagenic activity in the urine of hospital staff members who observe proper industrial hygiene.

The following checklist indicates some of the protective procedures already available:

- ☐ Are all personnel who handle chemotherapeutic drugs and the trash resulting from their use wearing long sleeved protective clothing, such as a lab coat, while performing these duties?
- ☐ Are they also wearing disposable gloves?
- ☐ When intravenous pushes or infusions are being injected, or when a syringe is being cleared of air bubbles, is cotton gauze wrapped around the needle and I.V. tubing to prevent particles escaping into the room?
- ☐ In disposing of patient wastes, are disposable urinals with tight-fitting caps used? (See American Hospital Supply catalog #13592, 13593, 13595.)
- ☐ Are wastes from regurgitation collected in boxes lined with disposable trash lining?
- ☐ Are syringes, unclipped needles, vials, gloves and the like discarded in a specially designated waste container that is covered and remains separate from the general trash?
- ☐ Are uniforms and reusable isolation gowns kept separate from the regular laundry?
- ☐ Are mixing procedures carried out in a hood demonstrated to give operator protection? (Horizontal hoods do not suffice.)
- ☐ Before and after mixing drugs, is the hood and whole mixing area wiped down thoroughly with a detergent-based solution?
- ☐ In vertical hoods, are surfaces under the air grills wiped thoroughly at least once every two weeks?
- ☐ Is the hood inspected routinely by the hood contractor?

*This fact sheet is based on research by Jeanne Stellman, Ph.D.; Barbara Aufiero, MPH; and Robert Taub, M.D., Ph.D., presented at the American Society for Preventive Oncology, March 26, 1982.*

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# ANTI-CANCER DRUGS...

## OSHA issues guidelines

In 1979 the first scientific report indicating the potential hazard of exposure for nurses and pharmacists who mix and/or administer anti-cancer drugs was published by a group of Finnish geneticists. Other researchers have since confirmed that finding and have demonstrated that some of these agents were absorbed by workers handling them.

Since most cancer chemotherapeutic agents are highly toxic and many can cause cancer or birth defects, several professional groups and the National Institutes of Health have issued guidelines for their safe handling. In early 1986 OSHA joined this growing group of agencies by issuing an 'OSHA Instruction PUB 8-1.1: Guidelines for Cytotoxic (Antineoplastic) Drugs.'

The OSHA instruction deal with various aspects of drug handling, including drug preparation, administration and waste disposal. They are not legal requirements but do establish work practices that should be regarded as safe. Copies of the document are available at no charge from the OSHA Area Office to members of health care facilities.

## Public interest survey

The extent to which health care institutions are in compliance with the OSHA guidelines on handling antineoplastic drugs will be the subject of an study by the Health Research Group, a Ralph Nader affiliate.

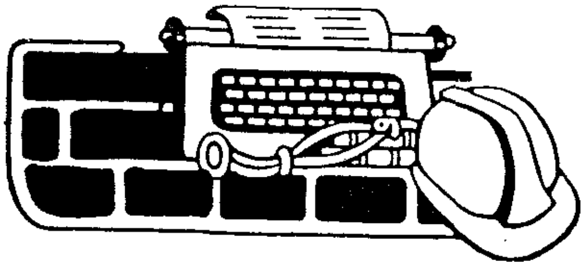
OSHA has not announced any plans to monitor health care facilities to determine the effectiveness of the voluntary guidelines nor is it known at this time whether the guidelines themselves have been adequately distributed to health care facilities.

The survey is now in its final stages of preparation. Participation in the survey will be voluntary.

## More worker exposure data

Scientists in France have completed an investigation in nurses of the genetic effects of handling anti-cancer drugs and have observed no significantly increased rate of abnormalities. The nurses in this study worked with a smaller number of doses than did nurses in other studies in which genetic changes had been observed. The exact nature, extent and meaning of genetic changes is not yet well-understood and such changes have not been related to specific diseases or risks as yet.

*Ref: Stucker, I. et al, Int'l Arch Occup Environ Hlth 57, 195-205, 1986.*



# NITROSAMINES

## WHAT ARE NITROSAMINES?

Nitrosamines are a family of chemicals. Approximately 80% of the nitrosamines are potent carcinogens (cancer causing agents). Though industries sometimes use nitrosamines directly in processing or manufacturing, most workplace exposure to nitrosamines comes from the chemical conversion of chemical preservatives, such as nitrites, nitrates, amines, and other nitrogen containing compounds, which have been added to products to enhance their properties. Unfortunately, these additives can be readily converted to nitrosamines. This conversion happens especially quickly when processing temperatures are high, or when the process or product also contains acid.

## WHERE ARE NITROSAMINES FOUND?

Nitrosamines have been found in cutting and lubricating oils, cosmetics, scotch and beer, home and industrial pesticides, animal feeds, rubber and tire factories, cooked meats which contain nitrites as preservatives. Several years ago there was a great deal of publicity about the formation of nitrosamines in cooked bacon and luncheon meats. Chemical nitrite preservatives were added to the meats and were converted to nitrosamines by the temperature of cooking. It is interesting that the levels of nitrosamines that can be formed in cutting oils, the lubricants used in most machining and industrial cutting operations, to which thousands of workers are exposed, are hundreds, even thousands of times greater than that found in bacon!

Among workers who can be exposed are machinists using synthetic cutting fluids, herbicide formulators and applicators, workers in leather tanneries and rubber tire manufacturing plants are exposed to nitrosamines when they are chemically converted from preservatives, agricultural workers who handle nitrosamine-containing herbicides, and actresses and models whose skin is in contact cosmetics, locations, and creams containing nitrosamines.

## HOW DANGEROUS ARE NITROSAMINES?

In 1943, it was discovered that nitrosamines cause cancer. Since then numerous studies have shown these compounds to be extremely hazardous. However, no nitrosamine is currently regulated by OSHA.

## NITROSAMINES IN CUTTING OILS

In 1976, it was estimated that 780,000 workers were exposed to cutting oils. Cutting oils are used in drilling, gear cutting, grinding, bathing, milling and other machining operations. They are used for cooling, lubricating and removing metal or plastic chips, filings and cuttings from the contact area. Other names used for these oils are cooling, grinding, industrial, lubrication, and synthetic oils or fluids.

These oils or fluids are usually divided into four groups:

1. Straight Oils contain mineral oil, fat and additives. They do not mix in water.
2. Soluble Cutting Oils are similar to the straight oils but contain emulsifiers which enable water to be mixed in.
3. Semi-Synthetic Cutting Oils contain both a natural oil such as mineral oil and a synthetic base. Additives, emulsifiers, and water are also used.
4. Synthetic Cutting Fluid is a completely artificial product. The soluble base provides the lubrication and additives are used to enhance its performance.

## PREVENTING HEALTH HAZARDS FROM CUTTING OILS

Whenever possible the best control solution is the prevention of the hazard. Here are some engineering solutions which will either reduce or eliminate nitrosamine formation cuttiing oils. Many of these steps will also effectively reduce nitrosamine exposures in other industries and industrial products.

1. Temperature control: by either cooling the oil with an oil cooler or by not allowing the oil to reach a certain temperature, nitrosamine formation can be prevented. A simple thermometer can be used to monitor this. If constant high temperatures are encountered then an oil cooler should be installed.

2. Acid Control: the pH, or amount of acidity, in an oil will greatly affect the rate of nitrosamine production. Nitrosamine formation is enhanced at a pH of less than 7. Testing for pH is very simple and inexpensive. If the acidity is high the addition of a base such as lye can lower it. Also the addition of a buffer such as sodium bicarbonate (baking soda) can stabilize the acidity.

3. Substitution: A number of cutting fluids are available which do not contain nitrosamine producing chemicals. Ironically, these substitutes are not only safer but often they are cheaper. A key question in working with or ordering cutting fluids is: do they contain nitrite preservatives? If they do then it is likely that nitrosamines will be produced.

4. Maintenance: Changing the oil at regular intervals will prevent nitrosamine buildup.

## WHAT SHOULD YOU DO IF YOU THINK YOU MAY BE EXPOSED TO NITROSAMINES?

If you work with cutting or lubricating oils, or other products which may contain nitrogen-based preservatives, your exposure will depend on the type of oil or other product you are using. Remember, some nitrosamines such as nitrosoethanolamine may be added directly to cutting oils and other products, OR they may be formed while you are working.

The best way to determine whether there are nitrosamines present requires air sampling and testing of the products, usually with highly specialized equipment. Chemical analysis may be difficult and expensive to do. You can get a good deal of information, however, without air sampling.

1. Read the labels: Look for such chemical names as nitrites, nitrates, amines, amides, aniline, and nitroso.
2. Request Material Safety Data Sheets (MSDS): Under many state Right-to-Know Laws and the federal Hazard Communications Standard, you can request these sheets, which should tell you if nitrosamine-producing additives are used.

You can also:

1. Request a Health Hazard Evaluation (HHE) from NIOSH by calling your local NISOH office and requesting a survey.
2. Request an OSHA inspection: Even though there is no Threshold Limit Value for nitrosamines, OSHA can cite this hazard under the General Duty Clause.

## REDUCING OCCUPATIONAL EXPOSURE:

1. Ventilation can be used to remove any airborne nitrosamines. Usually this means using local ventilation, such as a capture hood.
2. Respirators which are designed to remove airborne nitrosamines can be used but they must be designed to "filter out" nitrosamines. Not all respirators can do this. Check with the manufacturer or NIOSH to be sure.
3. Protective clothing will produce a physical barrier between you and the hazard. Gloves, aprons and barrier creams will reduce skin contact and absorption, but not eliminate it. Though nitrosamines can pass through gloves made of certain materials, thick gloves kept in good condition still offer the greatest protection.
4. Treatment processes may be used to rid the oil of nitrosamines by removing, converting or destroying the nitrosamines produced. These are usually specialized processes which may be expensive to purchase.
5. Isolation of the process which uses cutting or lubricating oils from crowded work areas will minimize exposure to non-users.

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# WOHRC FACT SHEET

**WOMEN"S OCCUPATIONAL HEALTH RESOURCE CENTER**

# ASBESTOS: What to Do; When to Act

**Asbestos is an example of a good commercial material with bad health implications. Although some 5 million tons of asbestos are produced annually, and there are an estimated 3,000 ways to use it—asbestos is used in roofing and flooring products; reinforcing material in cement; pipes, sheets and coating materials; friction products, fireproofing textiles and thermal and acoustical insulations—a great body of research has shown that asbestos fibers can cause cancer and debilitating lung diseases. Historically, the danger to workers with high levels of exposure was the first to be defined. Today we know that long-term, low-level exposure presents a real hazard to other workers, particularly cigarette smokers. And, risk to the public is a growing concern.**

**Although the asbestos problem calls for attention, knowing when to act and just what to do is essential. Dealing with asbestos can be both dangerous and expensive. Fortunately, there are step-by-step ways to proceed.**

Asbestos is a generic term covering a wide variety of naturally-occurring mineral silicates which are separable into fibers. The fibers of commercially valuable asbestos are nonflammable, strong, fairly resistent to chemicals, and have thermal and electrical insulating properties. Given these attributes, it's no surprise that the U.S. uses some 900,000 tons of asbestos annually, mostly in the construction industry.

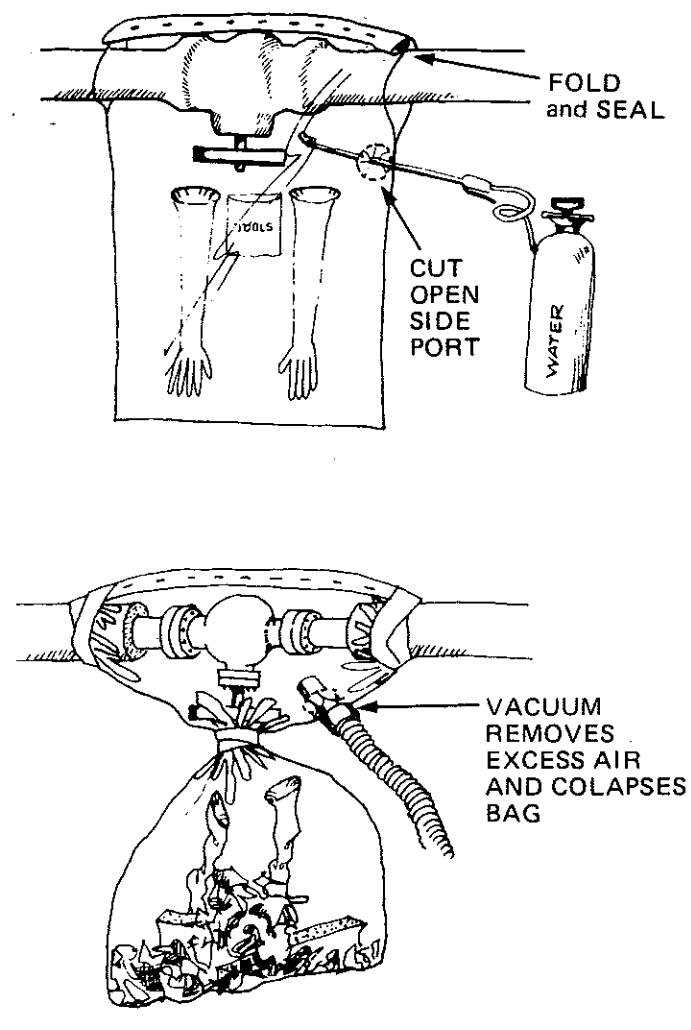
But asbestos fibers have other properties as well—because of their fibrous form, small size and resistence to degradation, they can remain suspended invisibly in the air we breathe for long periods of time, posing a serious health hazard.

Asbestos fibers can be released into the air during mining, milling and processing. For commercial use, asbestos fibers are generally mixed with other materials. These mixtures are often friable, which means that they can be easily crumbled or damaged, releasing fibers into the air as the material ages or is disturbed. Friable asbestos material presents a hazard during installation and in the surrounding area thereafter. Even if asbestos fibers have settled, they can re-circulate if they are disturbed for example, by a janitor dusting or sweeping.

Last November, OSHA issued an Emergency Temporary Standard lowering the existing permissible exposure level by 75% to 0.5 fibers/cc. Also, EPA has ordered all schools to inspect their buildings for asbestos and report their findings to employees and parents.

The possibility of asbestos contamination is literally everywhere in our surroundings. To best address the problem, it is necessary to (1) assess whether or not

*continued*




*Asbestos Control Technology*

**The "Profo Bag," designed for encapsulated removal of asbestos pipe covering, is an example of the many commercial products available to make asbestos control easier and safer.**

*continued*

it exists and the extent of exposure and (2) to decide the most effective, safest and economically feasible way to correct the situation.

Assessment should be done in this order: inspection; sampling; analysis, exposure analysis.

## Assessing the Problem

• **Inspection**—Asbestos was used in cement products, plaster, fireproof textiles, thermal and accoustical insulation, wall or ceiling decoration.

Friable materials are usually found on overhead surfaces, steel beams, ceilings and occasionally on walls and pipes. As soft or loosely bound asbestos material ages or is damaged, asbestos fibers are likely to be released. It is therefore most productive to inspect areas where water damage might occur, such as ceilings; areas where there is a lot of maintenance activity or other activity such as ball throwing in a gymnasium where direct contact can occur; areas where vandalism —scraping or gouging walls—has occurred; areas where vibration from sources within or without the building might loosen softly-bound asbestos.

• **Sampling**—Friable material should always be sampled and this can be done fairly simply. Sampling should be done when the area in question is not in use with as few people around as possible. Sampling can be done by using a dry clean container such as a film canister or a small wide-mouth jar to gently bore into the material with a twisting motion. The jar should be tightly sealed and labelled. It should always be held away from the face. The area being sampled can be misted with water to prevent fiber release. If any material breaks off and falls on the floor, wet mop. These "bulk samples" should be taken for about every 5,000 feet of material of the same color and texture. If many samples are to be taken, a NIOSH approved respirator should be worn. The air in a suspect area can also be sampled by means of a special pump. However this does not reveal the source of the fibers.

• **Analysis**—The State Asbestos Program Agency or the EPA Regional Asbestos Coordinator should be contacted for their assistance and advice in finding a laboratory competent in bulk sample analysis. The laboratory should be able to do polarized light microscopy and x-ray diffraction, if necessary, and to provide a complete report.

• **Exposure Assessment**—If the lab does confirm the presence of asbestos, the degree of exposure can be assessed by checking the following factors: condition of the friable material; how big an area is of concern; the possibility of water damage; how much the area is used and the likelihood of damage; how friable the bound material is and if it is exposed. Friable asbestos in a direct air stream or air plenum may or may not represent a danger depending on the potential for human contact.

## Controlling Exposure

If there is no evidence of asbestos in the air, no action save for follow-up inspection is necessary. If action must be taken, temporary safeguards such as: substituting wet cleaning methods for dry ones (e.g. mopping instead of dusting); re-scheduling to reduce bystander or building user exposure, and filtered respirators for maintenance workers should be employed.

Depending on many factors—the characteristics of the material; structure use and configuration; user activity; cost—asbestos control can be achieved in two ways: (1) Containment or (2) Removal.

## Containment

It is possible to isolate friable asbestos material to reduce or prevent fiber release by either enclosing or encapsulating it.

Enclosure places a barrier such as a suspended ceiling or attached lath system between the friable asbestos and the surrounding area. Fiber fallout continues but it occurs behind the barrier. While it can reduce exposure, this method has some drawbacks: long-term effectiveness is uncertain and continued air monitoring is necessary.

Friable asbestos can also be contained by the application of a sealant to envelope or coat the fiber matrix to eliminate fallout and protect against contact damage. For example, latex paint can be sprayed over the area. While sealants can be highly effective, they are not a total solution. They must be carefully chosen and a sealed-off surface is not forever immune to damage. Also, the fiber release problem will reappear when renovation or demolition must be done.

## Removal

Sometimes building characteristics, the inability to eliminate exposure or questions about the health impact of any continued exposure may point to only one solution: removal. The EPA has many regulations about asbestos stripping and removal. Dry removal of untreated friable asbestos material is not recommended. Specific EPA approval is required if it must be used because workers, the rest of the structure and the surrounding community can be affected. The construction of barriers and rapid vacuum techniques are employed in dry removal.

Friable materials can more safely be dealt with using a "wet" technique. Water makes the material less friable. The release of fibers is lessened and the fibers that are released into the air will fall rapidly making their removal easier. Plain water is not an ideal substance to use in removal because it tends to penetrate slowly and incompletely and to cause a runoff which can carry fibers to other areas, fibers that can re-enter the air following evaporation. For this reason a "wetting" agent or surfacant is used which greatly reduces the amount of water needed for saturation and results in a better job. While wet removal reduces the asbestos exposure level by 75%, "wet" water reduces the exposure level by 90% as compared to dry removal.

Asbestos control is a complicated job but one made easier by the kind of step-by-step approach that we have outlined, the use of EPA guidelines, and the variety of commercial services and protective devices and tools available. □

*This fact sheet reflects information in EPA Guidance Document #450, "Asbestos-Containing Materials in School Buildings" and Document #560, "Guidance for Controlling Friable Asbestos-Containing Material in Buildings."*

For permission to reprint this fact sheet, information about bulk orders , or any other information on this topic, write to:



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# A Guide to Chemicals Used in Jobs With Large Numbers of Women Workers

(Adopted, with permission from the 2nd Edition of Work is Dangerous to Your Health, by Jeanne Mager Stellman and Susan M. Daum, New York: Pantheon (in press)

ARTIST AND CRAFTS PEOPLE

Acetone
Alcohols: benzyl, ethyl, isopropyl, methyl
Benzene
Bromides
Carbon disulfide
Carbon monoxide
Carbon tetrachloride
Chloroform
Chromates
Dimethyl formamide
Ethylene dichloride
Fluorine and compounds
Formaldehyde
Glycidyl ethers
Glycol ethers
Heptane
Hydrogen sulfide
Metal compounds:
Antimony; Arsenic; Cadmium; Chromium; Cobalt; Copper; Gold salts; Lead; Lithium; Manganese; Mercury; Nickel; Selenium; Zinc
Methyl chloroform
Methyl ethyl ketone
Methylene chloride
Morpholine
Nitrogen dioxide
Pentachlorophenol
Perchloroethylene
Petroleum distillates
Phthalate esters
Solder fluxes
Styrene
Textile dyes
Toluene
Triethanolamine
Turpentine
Xylene

BARBERS AND COSMETOLOGISTS

Ammonium thioglycolate
Asbestos (some hair dryers)
Benzene
Depilatories: thioglycolic acid
Detergents (synthetic): hexachlorophene
Dyes:
aminophenols, anisidine, cobalt, p-phenylene diamine, resorcin, styrene
Hair tonics: lanolin, mercuric chloride, beta-naphthol
Infections: bacteria, fungi
Perfumes
Propellents: dichlorodifluoromethane; methylene chloride
Soaps
Talc
Ultraviolet light
Vibrations (hand held machines)
Wave solutions

CERAMIC MAKERS AND WORKERS

Acetylene
Acids:
chromic, nitric, oxalic, phoshoric
Calcium oxide
Ceramic molding
Chromates
Coal tar pitch volatiles
Cupric acetate (pigment)
Ethylamine
Fluorides
Freon
Hydrogen selenide
Hydroquinone
Mercurous chloride (paint)
Metals and their compounds:
aluminum; antimony ; arsenic; barium; beryllium; bismuth; cadmium; cobalt; lead; lithium; manganese; mercury; molybdenum; nickel; platinum; selenium; silver; tellurium; thorium; tin; uranium; vanadium; zinc; zirconium
Silica (crystalline) and silicates
Talc
Titanium Dioxide
X-rays
Yttrium

DENTAL PRODUCTS MAKERS, DENTAL TECHNICIANS, AND DENTISTS

Aluminum phosphate (cement)
Anesthetics:
ethyl chloride, nitrous oxide
Antibiotics
Benzoyl peroxide
Cadmium (in amalgam)
Disinfectants (aromatics)
Ethyl acrylate (dentures)
Germanium (in alloys)
Indium
Infections: hepatitis B, herpes
Lead (in alloys)
Mercury (in amalgam)
Methyl methacrylate (plastic dentures)
Methylene chloride
Natural oils:
eugenol, menthol, peppermint, wintergreen
Noise
Phosphoric acid
Plastics: acrylic resins
Platinum (in alloys)
Rhodium
Silica (cystalline)
Soaps
X-ray
Zinc compounds (in cement)

DRY CLEANERS

Acetates: amyl, tert-butyl
Acetic acid
Benzene
Carbon disulfide
Carbon tetrachloride
Cellosolves
Chlorofluoroethane
Chlorinated benzenes
Chlorinated diphenyl oxide
Chloroform
Cyclohexylamine
Dichloroethylenes
1,2,-dichloropropane
Ethyl ether
Isopropylamine
Methyl alcohol
Methyl chloroform
Methylcyclohexanol
Naphtha (coal tar fractions and petroleum distillates)
Perchloroethylene
Propylene dichloride
Stoddard solvent
Tetrachloroethane
Trichloroethylene

ELECTRICAL AND ELECTRONICS WORKERS, INCLUDING APPLIANCE AND SCIENTIFIC EQUIPMENT MAKERS

Aluminum compounds
Ammonia
Asbestos
Barium nitrate
Beryllium and compounds
Bismuth compounds (for fuses)
Boron trifluoride (for nuclear instruments)
Cadmium (in solder flux)
Chlorinated diphenyls and naphthalenes
Chlorofluoromethanes and ethanes
Coal tar and fractions
Copper
Diborane
Dimethyl formamide
Germanium
Graphite
Indium
Iron pentacarbonyl
Ketones
Lead
Lithium hydride
Mercury and compounds
Methyl trichlorosilane (insulation)
Molybdenum and compounds
Naphthalene
Neon
Nickel and compounds
Osmium and compounds
Ozone
p-phenylene diamine

Phenol
Phosphine
Plastics: allyl resins, diisocyanate resins (for refrigerators and freezers), epoxy resins, fluorocarbons,phenolic resins, polyurethane (for refrigerators and freezers)
Platinum and compounds
Propylene imine
Pyridine
Radiation: infrared, ionizing (in radar tube manufacture), microwaves, ultraviolet
Selenium (in rectifiers)
Selenium hexafluoride
Silicas: crystalline, mica
Silicon tetrahydride
Silver
Talc
Tantalum metal and dust
Tellurium
Thallium (in infrared instruments)
Thorium
Titanium and compounds
Trichloroethylene
Tungsten
Welding and soldering fumes
Xylene (for quartz crystal oscillators)
Zinc and compounds

ELECTRICAL AND ELECTRONIC WORKERS: SEMI-CONDUCTOR MAKERS

Acetone
Acids: Acetic, hydrochloric, hydrofluoric
Alumina
Ammonia
Antimony and compounds
Arsenic and compounds
Arsine
Bismuth and compounds
Boron compounds: nitride, oxide, tribromide, trichloride
n-butyl acetate
Cadmium and compounds
Carbon monoxide
Carbon tetrachlorid
Cellosolve
Chlorine
Chlorobenzene
Diborone
Dichlorosilane
Diethyltelluride
Epoxy resins
Ethanol
Ethylene glycol
Freons
Gallium
Germanium and compounds
Helium
Hexamethyldisilazane (HMDS)
Hydrogen
Hydrogen peroxide
Hydrogen selenide
Hydrogen sulfide
Indium
Isopropyl alcohol
Lead sulfide
Magnesium silicide
Methanol
Methyl ethyl ketone (2-butanone)
Methylene chloride
Nitrogen
Nitrogen trifluoride
Nitrous oxide
Oxygen
Perfluoropropane
Petroleum distillate
Phosphine
Phosphorous and compounds
Radiation: infrared, ionizing, ultaviolet, x-ray
Silane
Silica
Silicon and compounds
Solvents
Stibine
Sulfuric
Tellurium and compounds
Tetrachloroethylene
Toluene
Trichloroethane
Trichloroethylene
Vanadium pentoxide fumes
Vapor degreasers
Xylene
Zinc compounds

FARMERS AND AGRICULTURAL WORKERS
Ammonia (corn growing)
Arsenic
Asbestos
Bacteria infections
Butylamine (fumigant)
Calcium cyanamide (in fertilizer)
Calcium oxide
Coal tar and fractions (polycyclic hydrocarbons)
Cold
Crag herbicide
Cupric sulfate
Cychlohexyl isocyanate
Detergents (synthetic)
2,4-D (2,4-dichlorophenoxyacetic acid)
Ethylene dibromide (cabbage growers)
Fluorides (vegetable growers)
Fruits (allergies)
Heat
Hexane
Hydrazine
Hydrogen cyanide (crop fumigant)
Infections: virus, bacterial, parasitic, rickettsial
Kerosene
Lead
Lubricants
Mercury compounds
Methoxychlor (insecticide for crops and animals)
Methyl bromide (fumigant)
Morpholine
Nitrogen oxides (in silage)
Oils
Pesticides
Poisonous plants
Ragweed
Solvents
Sunlight
Trimellitic anhydride
Vegetables (allergies)

FOOD PROCESSORS AND HANDLERS, INCLUDING CANNERS
Acetaldehyde (preservative)
Acids: adipic (additive), acetic (as preservative), butyric, nitric (pickling), propionic (additive)
Acrolein (coffee roasters, cooks)
Allergies (vegetable material, molds and spores)
Allyl propyl disulfide
Ammonia (ice cream makers)
Ammonium carbonates (in baking soda)
Amorphous silica
Bacteria: anthrax
Bleaches:
benzyl peroxide, hydrogen peroxide, nitrogen dioxide, sulfur dioxide,
Calcium oxide
Camphor (synthetic)
Carbon dioxide
Chlorodiphenyl
Citrus oil
Cupric sulfate (additive)
Detergents
1,2-dichloroethylene
Dinitolmide (additive)
2,6-di-tert-butyl-p-cresol
Ethyl acetate (confectioners)
Ethylenediamine (casein and albumin processing)
Ferrous sulfate (additive)
Formic acid
Freons
Fumigants: acrylonitrile, ethyl bromide, ethylene bromide, ethylene oxide, formaldehyde
Fungi
Fungicides: mercurials
Gum arabic
Heat and cold
Hydrogen chloride
Infections
Insecticides
Iodine
Lead
Methylene chloride
Nitrogen (quick freezing of food)
Nitrogen oxides
Ozone

Phosphoric acid (gelatin makers)
Phosphorous (yellow)
Potassium bromate (additive)
Potassium nitrate (additive)
Propylene oxide
Quinone (gelatin makers)
Radiation: ionizing radiation, microwaves, ultraviolet radiation
Resins
Salt
Soaps
Sodium hydroxide
Sodium metabisulfate (preservative)
Stannous chloride (additive)
Styrene
Tetrasodium pyrophosphate (additive)
Tin compounds (inorganic)
Titanium dioxide (colorant)
Trichloroethylene (in caffine processing)
Vegetable juices
Zinc compounds (gelatin makers)

HORTICULTURE WORKERS
Calcium oxide
Carbon dioxide
Copper
Cyanide
Diquat (plant growth regulator)
Nicotine (pesticide)
Phosdrin
TEDP (tetraethyl dithionopyrophosphate)
TEPP
1,1,2,2-tetrachloroethane (fumigant)
Thiram
2,4,5-T (plant hormone and herbicide [now banned])

HOSPITAL WORKER, NCLUDING NURSES AND DOCTORS
Anesthetics:
cycloporpane, diethyl ether, enflurane,ethyl bromide, ethyl chloride, ethyl ether, ethylene oxide, halothane, methoxyfluorane, nitrous oxide
Antineoplastic drugs:
adriamycin, cisplatin, methotrexate, mitomycin C
Antibiotics
Antiseptics
Beryllium
Cobalt
Detergents (synthetic)
Disinfectants and germicides
Drugs
Fumigants
Glutaraldehyde (used in sterilizing)
Infections: bacteria, viruses expecially hepatitis
Iodine
Iodoform (disinfectant)
Isopropyl alcohol
Moisture
Morpholine (corrosion inhibitor in autoclaves)
Oxygen
Radiation: ionizing, ultrviolet, X-rays
Soaps
Talc
Tricresyl phosphate (in sterilizing surgical instruments)

HOSPITAL WORKERS: BACTERIOLOGISTS AND TECHNICIANS
Benzene
Chromium compounds
Dioxane (diethylene ether)
Ethyl alcohol
Formaldehyde
Infections: bacteria, virus
Mercuric chloride
Picric acid
Selenium and compounds
Toluene
Xylene

HOSPITAL WORKERS: MICROSCOPISTS
Acetylene tetrabromide (refractive index oil in microscopy)
Benzidine
Isoamyl alcohol
Platinum and compounds
Selenium and compounds
Xylene
Zinc compounds

HOSPITAL WORKERS: PATHOLOGIST, AUTOPSY ATTENDENTS
Epoxy resins
Formaldehyde
Infections: virus(hepatitis and others)
Xylene

JEWELRY MAKERS AND WORKERS, JEWELERS
Acetates:
amyl, sec amyl acetate (artifical pearls), isoamyl (artifical pearls)
Arsine
Cadmium fumes
Chromium compounds
Hydrogen chloride
Hydrogen cyanide
Lead
Mercury and compounds
Nitric acid
Nitrogen oxide
Platinum
Rhodium salts
Silver
Sulfuric acid
Titanium dioxide (synthetic diamonds)

LABORATORY WORKERS
Acetic anhydride
Acetonitrile
2-acetylaminofluorene (AAF)
Acetylene tetrabromide (refractive index oil in microscopy)
4-aminodiphenyl
Ammonia
Antimony tribromide
Barium compounds
Bromine
Bromoform
Butyl alcohols
Carbon tetrachloride
Chromates
Cyclopentane
Diazomethane
3,3'-dimethylbenzidine
Dioxane
Ethyl butyl ketone
Ethyl ether
Ferrous ammonium sulfate
Fluorine
Glucose oxidase (stabilizer)
Heptane
Hexamethyl phosphoramide (HEMPA)
Hexane
Hydriodic acid (reagent)
Hydrogen bromide
Hydrogen chloride
Hydrogen sulfide
Iodine and iodine compounds
Isoamyl alcohol (microscopy)
Isoamyl and isobutyl acetate
Ketene
Manganese dioxide (reagent)
4,4'-methylenebis (n,n-dimethyl) benzenamine (reagent)
Mercurous nitrate (reagent)
Methyl bromide
Methylene chloride
Molybdenum compounds
Nitric oxide
3-nitrophenol (indicator solution)
Osmium tetroxide
Oxalic acid
Ozone
Phenyl trichlorosilane (reagent)
Phosphorous acid, ortho (lab analysis)
Potassium compounds
Potassium sulfide (reagent)
Rhodium salts
Silver and compounds
Sodium (reagent)
Sodium hydroxide
Sodium peroxide
Sulfuric acid

tert-butyl chromate (chromatography)
Tetramethyl silane
Thallium
Tin compounds (inorganic)
o-toluidine
Zinc sulfate (reagent)

LAUNDRY WORKERS
Acetic acid
Bacteriocides
Bleaches: chloride of lime, chlorine
Detergents (synthetic)
1,3-dichloro-5,5-dimethylhydantoin
Fluorides
Formic acid
Heat
Hydrogen difluorides
Oxalic acid
Soaps
Sodium and potassium hydroxides
Tetrachloroethylene (in presoak)

PHOTOGRAPHIC CHEMICAL MAKERS AND USERS
Acetaldehyde
Acetic acid
Acrylamide
Alcohols: amyl, butyl, isoamyl
Amitrol
Ammonia (automatic film processing)
Ammonium metavanadate
Ammonium persulfate
Ammonium sulfide (in developers)
Ammonium tetrachloroplatin
Ammonium thiocyanate
Aniline and derivatives
Barium and compounds
Benzene
Benzyl chloride (in developers)
Bromine
Butylamine (in developers)
Cadmium bromide
Calcium chlorate
Chlorine (in developers)
Chromium and compounds
Cresol (in developers)
Cresylic acid (in developers)
Crotonaldehyde
Cyanide
Dimethyl hydrazine (in developers)
Dimethylamine
Dinitrobenzene (in developers)
Dinitrophenol (in developers)
Ferric ammonium citrate
Ferric ammonium oxalate
Ferrous ammonium sulfate
Hydrogen bromide
Hydrogen peroxide (in developers)
Hydroquinone (in developers)
Iodine
Iron Chloride
Lead iodide
Light: high intensity, photographing
Mercury compounds
Methylamine
Nitrobenzene
p-nitrochlorobenzene
Nitrophenol
Oxalic acid
Ozone (photographers)
Petroleum naphtha
Phenol
p-phenylene diamine (in developers)
Platinum and salts
Potassium hexachloroplatin
Potassium persulfate (reducing agent)
Potassium tetrachloroplatinate
Quinone (in developers)
Selenium
Silver compounds
Soluble molybdenum compounds
Styrene
Sulfuric acid
Tellurium and compounds
Thiourea
Trichloroethylene (plate cleaners)
Triethylamine
Trinitrotoluene (TNT)
Uranium and compounds
Vanadium and compounds (in developers)
Zinc bromide

POTTERY MAKERS AND WORKERS
Aluminium and compounds
Antimony trifluoride
Carbon dixoide
Fluoride dust
Hydrogen chloride
Lead
Silica (amorphous)
Talc
Zirconium compounds

SOLDER AND SOLDER FLUX MAKERS AND USERS
Acids
Ammonium chloride
Antimony and compounds
Arsenic
Arsine
Bismuth and compounds
Boron trifluoride
Cadmium and compounds
Copper and compounds
Epoxy resins
Ethylenediamine
Hydrazine (in fluxes)
Infrared radiation
Lead
LPG (liquefied petroleum gas)
Silver and compounds
Tin and compounds
Zinc compounds (in fluxes)