CWA Occupational Safety and Health Fact Sheet #23

High Tech Toxics & the Workplace

The electronics or semiconductor industry has often been described as clean and safe. It is typically compared to the "smokestack industries" that are characterized as polluting the workplace and the environment. High tech semiconductor plants are depicted as sanitary hospital or laboratory-like facilities where workers in clean white coats perform creative production jobs. In reality, many high tech employees work under very stressful working conditions and risk exposure to a wide variety of toxic chemicals. Although conditions vary significantly with the various manufacturing processes, exposure to untested combinations of chemicals, job stress, and detailed hand-work translate into serious health hazards.

Health Hazards

The manufacture and assembly of high tech electronic equipment requires the storage, use, and disposal of a wide range of hazardous substances. Solvents, acids, alkalies, metals, gases, plastics, resins, and fiberglass are used in significant quantities. Accidents, faulty equipment, and inadequate procedures and processes can result in hazardous exposures to workers. Scientific studies conducted in the U.S. and Europe have identified hazardous conditions and resultant high rates of occupational illnesses within the semiconductor industry.

Production workers are the most likely to be exposed to hazardous conditions. Nearly every production job involves the use of chemicals for cleaning, stripping, or degreasing. Particularly hazardous conditions may involve maintenance personnel who enter enclosed or confined spaces and are exposed to toxic substances.

Commonly used solvents, i.e., chemicals used to dissolve other materials include trichloroethylene, toluene, acetone, methylene chloride, perchloroethylene, glycol ethers, isopropyl alcohol, chloroform, xylene, and trichloroethane. Trichloroethylene, methylene chloride, perchloroethylene, and trichloroethane have been identified as cancer-causing substances. Also, glycol ethers are toxics that have been identified as causing reproductive problems.

Exposure occurs primarily as a result of skin contact with and/or absorption and inhalation (breathing) of hazardous chemicals. Skin exposure may result in dermatitis or skin rash, edema or swelling, and blistering. Skin contact occurs as a result of direct immersion, splashing, spilling, solvent-soaked clothing, contact with solvent-wet objects, and improper personal protective equipment. Solvents may dissolve the body's natural protective barrier of fats and oils leaving the skin unprotected from further irritation.

Solvents vaporize at room temperature. When vaporization occurs, it should be contained by appropriate engineering controls like enclosed systems and local exhaust ventilation. If proper engineering controls are not used, workers may inhale toxic chemical vapors causing upper respiratory irritation. In addition, solvents may affect the central nervous system acting as

depressants and anesthetics causing headaches, nausea, drowsiness, dizziness, complaints of irritation, abnormal behavior, general ill feeling, and unconsciousness. These symptoms should be viewed as visible signs of potential disease. Excessive and continued exposure to certain solvents may result in liver, lung, kidney, and reproductive damage, as well as cancer.

Acids and alkalies are used for electroplating, soldering, fluxes, crystal polishing, and metal picking. These substances may cause serious burns if they are splashed into the eyes or on the skin. If vapors or mists are inhaled, they may result in a burning of the linings of the nose, mouth, throat, and lungs.

Semiconductor workers are exposed to metals primarily through skin contact and inhalation of metal dusts and fumes. Metals are used for electroplating, etching, soldering, bonding, sealing, crystallization, deposition, and metallization. Exposure may cause headaches, general ill feeling, anemia, central nervous system and kidney damage, and reproductive problems.

Gases are utilized in doping and crystal growing, and may form deposition products like phosgene, ozone, and carbon monoxide. Exposure may occur in doping and crystal growing if there are leaks in the machines or enclosures. Potential exposure to gases occurs through breathing or inhalation. Such exposure may produce eye damage, headaches, shivering, tiredness, nausea, and possible kidney and liver damage.

Plastics and resins are also used in several high tech processes. Inhalation or skin contact may occur when curing resins; cutting, heating, or stripping wires; or cutting, grinding or sawing a hardened product. Exposure to these substances may result in skin rashes and upper respiratory irritation.

Semiconductor workers may come into contact with polychlorinated biphenyls (PCBs) used as insulators in some electrical equipment. These exposures may cause skin disorders, digestive problems, headaches, upper respiratory irritations, reproductive problems, and cancer.

Workers may also be exposed to fiberglass. This material is utilized as filler in epoxy resins and other plastics, in wire coatings, electrical insulation, and in printed circuit boards. Exposures may produce skin and upper respiratory irritations.

The seriousness of the described health effects is dependent upon the particular substance to which the worker is exposed, the amount of the substance exposure, the length of time or duration of the exposure, how often or frequently the exposure occurs, and how the substance enters the body (skin contact or absorption, breathing or inhalation, eating or ingestion).

Additional hazards to which high tech workers are exposed include radiation, noise, and occupational stress. Musculoskeletal and job stress problems are related to repetitive and monotonous detail work, overtime and work speed-ups, lifting, improper sitting, and prolonged standing.

Controlling Hazards
The best method of controlling potential occupational safety and health hazards is through the implementation of the hierarchy of controls, i.e., elimination, substitution, engineering controls, administrative controls, and personal protective equipment. The elimination of hazards is ideal. However, where this cannot be achieved, substitution of less hazardous substances for more toxic substances provides important protection to workers. Engineering controls are widely utilized in semiconductor operations.

Engineering controls are design methods such as the enclosure of hazardous substances and the implementation of local exhaust ventilation systems that prevent harmful worker exposures. Ideally, the proper time to establish engineering controls is when the workplace is being designed. However, quite often this is either not done or not possible. In these circumstances, the following measures should be considered:

Closed Systems
Where possible, work operations that involve potentially hazardous exposures should be conducted in closed systems. Closed systems allow for materials to be brought into the workplace in sealed containers and emptied into storage tanks, thus preventing employee contact or exposure to the substance. Unfortunately, not all operations lend themselves to such an approach.

Changing a Process
Another control method would be alteration or changing a work operation to minimize worker exposure. For example, vapor degreasing could be accomplished with the use of dip tanks with adequate ventilation controls rather than having the worker hand-wash parts in open containers.

Isolation or Enclosure
Where possible, potentially hazardous work operations might be isolated or enclosed to reduce employee exposures. An example of this process would be utilizing acoustic panels to reduce noise and enclosing chemical processes to eliminate airborne contamination. Isolated equipment may be operated by remote control from some protected location. The degree of isolation should be determined by the toxicity of the substance, the amount of the contaminant exposure, and the involved work patterns.

Local Exhaust Ventilation
Local exhaust ventilation is a system located at the source of contaminant generation that captures the hazardous substance(s) before it/they escape into the workplace environment. Local exhaust ventilation systems are the preferred ventilation control method because they remove air contaminants rather than just dilute them. Local exhaust ventilation systems should be used when substitution, changing the process, or isolation and enclosure are not compatible with the work operation.

General Ventilation
General or dilution ventilation systems add or remove air from the workplace to keep the

concentration of air contaminants below hazardous levels. General ventilation consists of air flow through open windows or doors, fans, and roof ventilators. It should be remembered that general ventilation control only dilutes air contaminants, unlike local exhaust ventilation that removes air contaminants. Therefore, general ventilation should not be used to remove great amounts of air contaminants from the workplace environment or to control major localized sources of air contamination. When using general ventilation systems, care should be taken not to re-circulate the toxic substances throughout the workplace.

Administrative Controls

An employer might decide to use administrative controls to minimize occupational exposure to toxic substances. Administrative controls include changes in work procedures and policies, reduced hours of work in in hazardous work operations, staffing, and training. Administrative controls do not remove the hazard and, thus, should not be viewed as long-term substitutes for elimination, substitution, or engineering controls.

Training is an extremely important administrative control. Electronics and semiconductor manufacturers should develop and implement comprehensive, effective safety and health training programs. Such programs should include information on the identification of workplace hazards, coverage of identified occupational hazards/working conditions, and control of/prevention from exposure to identified hazards. Remember it is the employer's responsibility to provide workers with safe and healthful working conditions including relevant training.

Personal Protective Equipment

When it is not possible or feasible to eliminate hazardous levels of air contaminants or other hazards from the workplace, it may become necessary for the employer to provide personal protective equipment so that toxic exposures may be minimized. However, personal protective equipment should only be used when it is not possible to implement elimination, substitution, engineering, or administrative controls. Personal protective equipment does nothing to minimize or eliminate the source of the problems, i.e., the hazard. Thus, if the personal protective equipment fails to work properly, the worker suffers immediate exposure to the toxic substance.

Personal protective devices include eye and face protection such as safety glasses, goggles, and face shields; hearing protection like ear muffs and ear plugs; protective clothing such as gloves, coveralls, aprons, and boots; protective creams and lotions; and respirators. It is extremely important that the employer furnishes the proper type of personal protective equipment for specific work operations and exposures. For example, when an employee is working with a particular solvent, she/he should be provided the proper gloves to prevent the substance from seeping through the gloves and causing harmful skin contact.

More and more, employers have begun emphasizing the use of respirators rather than implementing adequate engineering controls. Respirators should not be viewed as substitutes for engineering controls. Rather, when used, they should be seen as offering only short-term or emergency protection. An approved respirator should be appropriate for the particular hazard or work environment in which the respirator is to be utilized (e.g., dust masks should not be used to

protect against chemical exposures). In addition, the type of air contaminant, its expected maximum concentration, the possibility of oxygen deficiency, the life of the respirator, and available escape routes should be determined before the work is initiated. Before supplying employees with respirators, employers should provide workers complete physical examinations to determine their physical adaptability to respirators and provide them thorough respiratory protection training programs.

Other controls procedures include:

Medical Surveillance

The development and implementation of a comprehensive medical surveillance program is an essential element of an employer's workplace safety and health program. Such a program should include baseline and follow-up medical examinations for all workers. Exams should include a thorough medical and work history- including information on work with/exposures to hazardous substances. Results from these examinations provide baseline data that will allow for the detection and evaluation of the harmful effects of particular work operations/exposures upon individual workers. In turn, with the permission from individual workers, the union can use an individual's medical information to pressure employers to provide safe and healthful working conditions.

In addition to periodic medical examinations, employers should conduct initial and periodic exposure monitoring tests where hazardous substances are use or contained. Where this monitoring is conducted in active work areas, instrumentation/industrial hygiene equipment should be equipped with an alarm mechanism that triggers a warning if contaminant concentrations reach or exceed safe levels- providing for the implementation of emergency response procedures. Monitoring data can be effectively used to help identify and control hazardous workplace exposures.

Maintenance

All employers should make sure that adequate maintenance procedures and schedules are established and adhered to. Poor maintenance of workplace equipment usually results in the inadequate operation of machinery and, in turn, causes increased worker accidents and illnesses. A regular maintenance schedule should include periodic shutdowns of all equipment. In addition, employees performing maintenance should be provided with the necessary personal protective equipment.

Good Housekeeping

Employers should establish and maintain good housekeeping practices. Proper good housekeeping procedures include a thorough cleaning of the workplace, adequate washing, toilet, eating, and waste disposal facilities. Employers should ensure that toxic substance spills are cleaned immediately. Work practices should also be in effect for the safe disposal of toxic chemicals and other hazardous substances.

Personal Hygiene

Employers should make hand-washing facilities readily available to employees working with or near toxic substances. It is important that workers be able to wash promptly in case of accidental

splashes of toxic substances. Where called for, convenient access to emergency showers should be provided. Also, eating and storage or drinking of foods and liquids should be forbidden where toxic substances are used.

What Can You Do?

All CWA members should make sure that their employer is providing a safe and healthful workplace. The key to making the workplace safe for all CWA members is strong, active local safety and health committees. The committee can identify dangerous conditions at the workplace and discuss them with management. If the employer refuses to cooperate, the committee can request an OSHA inspection. The committee should always coordinate its activities through the local officers, the CWA Representatives, and negotiated safety and health committees. For additional information or assistance, contact your local officers, the CWA Representatives, and negotiated safety and health committees.

In addition, CWA members may obtain information and assistance by contacting the:
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