clean air to provide a safe atmosphere

7 Personal protective devices, such as special clothing or eye and respiratory protection

8 Good housekeeping, including cleanliness of the workplace, waste disposal, adequate washing, toilet, and eating facilities, healthful drinking water, and control of insects and rodents

9 Special control methods for specific hazards, such as reduction of exposure time, film badges and similar monitoring devices, continuous sampling with preset alarms, and medical programs to detect intake of toxic materials

10 Training and education to supplement engineering conrols

Substitution

Replacement of a toxic material with a harmless one is a very practical method of eliminating an industrial health hazard

In many cases a solvent with a lower order of toxicity or flammability may be substituted for a more hazardous one In a solvent substitution, it is always advisable to experiment on a small scale before making the new solvent part of the operation or process For example, carbon tetrachloride can be replaced by solvents such as methyl chloroform, dichloromethane, aliphatic petroleum hydrocarbons, or one of the fluorochlorohydrocarbons (The precautions listed earlier in this chapter should be reviewed) Detergent-and-water cleaning solutions can be considered for use in place of organic solvents Benzene can be replaced by toluene in most lacquers, synthetic-rubber solutions, and paint removers Natural rubber cements with aliphatic hydrocarbon solvents can perform virtually the same function as benzene cements The felt-hat industry has controlled the hazard of mercurialism by substituting mercury-free carroting materials Foundries using parting compounds that contain free silica can minimize the silicosis hazard by substituting relatively harmless powders Sandstone grinding wheels have been largely replaced by artificial abrasive wheels usually made of aluminum oxide

Changing the process

A change in process often offers an ideal chance to improve working conditions Most such changes, of course, are made to improve quality or reduce cost of production, only occasionally to improve the in-plant environment Yet, we must always keep this possible benefit in mind This applies to the safety engineer more than anyone else

In some cases, a process can be modified to reduce the exposure to a dust or fume and thus markedly reduce the hazard In the automobile industry, the amount of lead dust created by grinding solder seams with small high-speed sanding disks was greatly reduced by changing to hand filing Brush-painting or dipping instead of spray painting will minimize the concentration of airborne contaminants from toxic pigments Other examples of change of process are arc welding in place of riveting, vapor degreasing to replace hand-washing of parts, airless spraying techniques and electrostatic devices to minimize overspray as replacements for hand-spraying, and machine application of lead oxide to battery grids which reduced lead exposure in making storage batteries

In buying individual machines, the need for accessory ventilation, noise suppression, vibration and heat control should be considered *before* purchase Often the best approach is to thrash out these requirements with the supplier in advance

Isolation or enclosure

Some potentially dangerous operations can be *isolated* from the people nearby, which solves the exposure problem The isolation can be by a physical barrier (such as an acoustic box to contain noise from a whining blower or a screaming rip saw), or by time (such as providing semi-automatic equipment so a person doesn't have to stay near the noisy machine constantly), or by distance (remote controls)

Isolation is particularly useful for limited operations requiring relatively few workers or where control by any other method is too difficult or too expensive The job is isolated from the rest of the operation and thus the majority of the workers are not exposed to the hazard The workers actually concerned with the operation can then be pro-