process approach becomes one of continuous operation. The substitution of processes can be applied on a fundamental basis, for example, substitution of airless spray for conventional spray equipment can reduce the exposure of a painter to solvent vapors. Substitution of a paint dipping operation for the paint spray operation can reduce the potential hazard even further. In any of these cases, the automation of the process can further reduce the potential hazard (Table 74.5).

74.7.2 Isolation

Application of the principle of isolation is frequently envisioned as consisting of the installation of a physical barrier (such as a machine guard or device-refer to Tables 74.3 and 74.4) between a hazardous operation and the workers. Fundamentally, however, this isolation can be provided *without* a physical barrier through the appropriate use of distance and, in some situations, time.

Perhaps the most common example of isolation as a control strategy is associated with storage and use of flammable solvents. The large tank farms with dikes around the tanks, underground storage of some solvents, the detached solvent sheds, and fireproof solvent storage rooms within buildings are all commonplace in American industry. Frequently, the application of the principle of isolation maximizes the benefits of additional engineering concepts such as excessive noise control, remote control materials handling (as with radioactive substances), and local exhaust ventilation.

74.7.3 Ventilation

Workplace air quality is affected directly by the design and performance of the exhaust system. An improperly designed hood or a hood evacuated with an insufficient volumetric rate of air will contaminate the occupational environment and affect workers in the vicinity of the hazard source. This is a simple, but powerful, symbolic representation of one form of the close relationship between atmospheric emissions (as regulated by the Environmental Protection Agency) and occupational exposure (as regulated by the Occupational Safety and Health Administration). What is done with gases generated as a result of industrial operations/processes? These emissions can be exhausted directly to the atmosphere, indirectly to the atmosphere (from the workplace through the general ventilation system), or recirculated to the workplace. The effectiveness of the ventilation system design and operation impacts directly on the necessity and type of respiratory gear needed to protect the work force.

74.8 DESIGN AND REDESIGN*

74.8.1 Hardware

Designers of machines must consider the performance characteristics of machine operators as a major constraint in the creation or modification of both mechanical and electrical equipment. To do less would be tantamount to ignoring the limitations of human capabilities. Equipment designers especially concerned with engineering controls to be incorporated into machines, whether at the time of initial conceptualization or later when alterations are to be made, must also be cognizant of the principles of human factors (ergonomics). Equipment designers are aware that there are selected tasks that people can perform with greater skill and dependability than machines, and vice versa. Some of these positive performance characteristics are noted in Table 74.6. In addition, designers of equipment and engineering controls are knowledgeable of human performance limitations, both physically and psychologically. They know that the interaction of forces between people and their operating environment presents a never-ending challenge in assessing the complex interrelationships that provide the basis for that often fine line between safety versus hazard or health versus contaminant. Table 74.7 identifies the six pertinent sciences most closely involved in the design of machines and engineering controls.

It is both rational and reasonable to expect that, when engineering controls are being considered to eliminate or reduce hazards or contaminants, designers make full use of the principles established by specialists in these human performance sciences.

74.8.2 Process

A stress (or stressor) is some physical or psychological feature of the environment that requires an operator to be unduly exerted to continue performing. Such exertion is termed strain as in "stress and strain." Common physical stressors in industrial workplaces are poor illumination, excessive noise, vibration, heat, and the presence of excessive, harmful atmospheric contaminants.

Unfortunately, much less is known about their effects when they occur at the same time, in rapid sequence, or over extended periods of time. Research suggests that such effects are not simply

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Table 74.6 Positive Performance Characteristics—Some Things Done Better by

People	Machines
Detect signals in high noise fields	Respond quickly to signals
Recognize objects under widely different conditions	Sense energies outside human range
Perceive patterns	Consistently perform precise, routine, repetitive operations
Sensitive to a wide variety of stimuli	Recall and process enormous amounts of data
Long-term memory	Monitor people or other machines
Handle unexpected or low-probability events	Reason deductively
Reason inductively	Exert enormous power
Profit from experience	Relatively uniform performance
Exercise judgment	Rapid transmission of signals
Flexibility, improvision, and creativity	Perform several tasks simultaneously
Select and perform under overload conditions	Expendable
Adapt to changing environment	Resistance to many environmental stresses
Appreciate and create beauty	
Perform fine manipulations	
Perform when partially impaired	
Relatively maintenance-free	

additive, but synergistic, thus compounding their detrimental effects. In addition, when physical work environments are unfavorable to equipment operators, two or more stressors are generally present: high temperature and excessive noise, for example. The solution to process design and redesign is relatively easy to specify, but costly to implement—design the physical environment so that all physical characteristics are within an acceptable range.

Marketed in the United States since the early 1960s, industrial robots offer both hardware and process designers a technology that can be used when hazardous or uncomfortable working conditions are expected or already exist. Where a job situation poses potential dangers or the workplace is hot or in some other way unpleasant, a robot should be considered as a substitute for human operators. Hot forging, die casting, and spray painting fall into this category. If workparts or tools are awkward or heavy, an industrial robot may fill the job. Some robots are capable of lifting items weighing several hundred pounds.

An industrial robot is a general purpose, programmable machine that possesses certain humanlike capabilities. The most obvious characteristic is the robot's arm, which, when combined with the robot's capacity to be programmed, makes it ideally suited to a variety of uncomfortable/undesirable production tasks. Hardware and process designers now possess an additional capability for potential inclusion in their future designs and redesigns.

74.9 PERSONAL PROTECTIVE EQUIPMENT*

74.9.1 Background

Engineering controls, which eliminate the hazard at the source and do not rely on the worker's behavior for their effectiveness, offer the best and most reliable means of safeguarding. Therefore, engineering controls must be first choice for eliminating machinery hazards. But whenever an extra measure of protection is necessary, operators must wear protective clothing or personal protective equipment.

If it is to provide adequate protection, the protective clothing and equipment selected must always be:

- Appropriate for the particular hazards
- Maintained in good condition
- Properly stored when not in use, to prevent damage or loss
- kept clean and sanitary

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Table 74.7 People Performance Sciences

Anthropometry	Pertains to the measurement of physical features and characteristics of the static human body.
Biomechanics	A study of the range, strength, endurance, and accuracy of movements of the human body.
Ergonomics	Human factors engineering-especially biomechanics aspects.
Human factors engineering	Designing for human use.
Kinesiology	A study of the principles of mechanics and anatomy of human movement.
Systems safety engineering	Designing that considers the operator's qualities, the equipment, and the environment relative to successful task performance.

Protective clothing is available for every part of the human body. Hard hats can protect the head from falling objects when the worker is handling stock; caps and hair nets can help keep the worker's hair from being caught in machinery. If machine coolants could splash, or particles could fly into the operator's eyes or face, then face shields, safety goggles, glasses, or similar kinds of protection must be used. Hearing protection may be needed when workers operate noisy machinery. To guard the trunk of the body from cuts or impacts from heavy or rough-edged stock, there are certain protective coveralls, jackets, vests, aprons, and full-body suits. Workers can protect their hands and arms from the same kinds of injury with special sleeves and gloves. And safety shoes and boots, or other acceptable foot guards, can shield the feet against injury in case the worker needs to handle heavy stock which might drop.

It is important to note that protective clothing and equipment themselves can create hazards. A protective glove which can become caught between rotating parts, or a respirator facepiece which hinders the wearer's vision require alertness and careful supervision whenever they are used.

Other aspects of the worker's dress may present additional safety hazards. Loose-fitting clothing might possibly become entangled in rotating spindles or other kinds of moving machinery. Jewelry, such as bracelets and rings, can catch on machine parts or stock and lead to serious injury by pulling a hand into the danger area.

Naturally, each situation will vary. In some simple cases, respirators, chemical goggles, aprons, and gloves may be sufficient personal protective equipment to afford the necessary coverage. In more complicated situations, even the most sophisticated equipment may not be enough and engineering controls would become mandatory. Safety, industrial, and plant engineers should be expected to provide the necessary analyses to ascertain the extent of the hazard to employees whose work causes them to be exposed to the corrosive fumes.

74.9.2 Planning and Implementing the Use of Protective Equipment*

This section reviews ways to help plan, implement, and maintain personal protective equipment. This can be considered in terms of the following nine phases: (1) need analysis, (2) equipment selection, (3) program communication, (4) training, (5) fitting and adjustment, (6) target date setting, (7) break-in period, (8) enforcement, and (9) follow-through.

The first phase of promoting the use of personal protective equipment is called *need analysis.* Before selecting protective equipment, the hazards or conditions the equipment must protect the employee from must be determined. To accomplish this, questions such as the following must be asked:

- What standards does the law require for this type of work in this type of environment?
- What needs do our accident statistics point to?
- What hazards have we found in our safety and/or health inspections?
- What needs show up in our job analysis and job observation activities?
- Where is the potential for accidents, injuries, illnesses, and damage?
- Which hazards cannot be eliminated or segregated?

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The second phase of promoting the use of protective equipment is *equipment selection.* Once a need has been established, proper equipment must be selected. Basic consideration should include the following:

- Conformity to the standards
- Degree of protection provided
- Relative cost
- Ease of use and maintenance
- Relative comfort

The third phase is *program communication.* It is not appropriate to simply announce a protective equipment program, put it into effect, and expect to get immediate cooperation. Employees tend to resist change unless they see it as necessary, comfortable, or reasonable. It is helpful to use various approaches to publicity and promotion to teach employees why the equipment is necessary. Various points can be covered in supervisor's meetings, in safety meetings, by posters, on bulletin boards, in special meetings, and in casual conversation. Gradually, employees will come to expect or to request protective equipment to be used on the job. The main points in program communication are to educate employees in why protective equipment is necessary and to encourage them to want it and to use it.

Training is an essential step in making sure protective equipment will be used properly. The employees should learn why the equipment is necessary, when it must be used, who must use it, where it is required, what the benefits are, and how to use it and take care of it. Do not forget that employee turnover will bring new employees into the work area. Therefore, you will continually need to train new employees in the use of the protective equipment they will handle.

After the training phase comes the *fitting and adjustment* phase. Unless the protective equipment fits the individual properly, it may not give the necessary protection. There are many ways to fit or to adjust protective equipment. For example, face masks have straps that hold them snug against the contours of the head and face and prevent leaks; rubberized garments have snaps or ties that can be drawn up snugly, to keep loose and floppy garments from getting caught in machinery.

The next phase is *target date setting.* After the other phases have been completed, set specific dates for completion of the various phases. For example, all employees shall be fitted with protective equipment before a certain date; all training shall be completed by a certain date; after a certain date, all employees must wear their protective equipment while in the production area.

After setting the target dates, expect a *break-in period.* There will usually be a period of psychological adjustment whenever a new personal protective program is established. Remember two things:

- Expect some gripes, grumbles, and problems.
- Appropriate consideration must be given to each individual problem; then strive toward a workable solution.

It might also be wise to post signs that indicate the type of equipment needed. For example, a sign might read, "Eye protection must be worn in this area.

After the break-in phase comes *enforcement.* If all the previous phases were successful, problems in terms of enforcement should be few. In case disciplinary action is required, sound judgment must be used and each case must be evaluated on an individual basis.

If employees fail to use protective equipment, they may be exposed to hazards. Do not forget, the employer can be penalized if employees do not use their protection.

The final phase is *follow-through.* Although disciplinary action may sometimes be necessary, positive motivation plays a more effective part in a successful protective equipment program. One type of positive motivation is a proper example set by management. Managers must wear their protective equipment, just as employees are expected to wear theirs.

74.9.3 Adequacy, Maintenance, and Sanitation

Before selling safety shoes and supplying safety goggles at a company store, the attendants must be guided by a well-structured program of equipment maintenance, preferably preventive maintenance.

Daily maintenance of different types of equipment might include: adjustment of the suspension system on a safety hat; cleaning of goggle lenses, glasses, or spectacles; scraping residue from the sole of a safety shoe; or proper adjustment of a face mask when donning an air-purifying respirator.

Performing these functions should be coupled with periodic inspections for weaknesses or defects in the equipment. How often this type of check is made, of course, depends on the particular type of equipment used. For example, sealed-canister gas masks should be weighed on receipt from the manufacturer, and the weight should be marked indelibly on each canister. Stored units should then be reweighed periodically, and those exceeding a recommended weight should be discarded even though the seal remains unbroken.

Sanitation, as spelled out in the OSHAct, is a key part of any operation, and it requires the use of personal protective equipment, not only to eliminate cross-infection among users of the same unit of equipment, but because unsanitary equipment is objectionable to the wearer.

Procedures and facilities that are necessary to sanitize or disinfect equipment can be an integral part of an equipment maintenance program. For example, the OSHAct says, "Respirators used routinely shall be inspected during cleaning." Without grime and dirt to hinder an inspection, gauges can be read better, rubber or elastomer parts can be checked for pliability and signs of deterioration, and valves can be checked.

74.10 MANAGING THE SAFETY FUNCTION

74.10.1 Supervisor's Role

The responsibilities of the first-line supervisor are many. Direction of the work force includes the following supervisory functions:

- Setting goals
- Improving present work methods
- Delegating work
- Allocating manpower
- Meeting deadlines
- Controlling expenditures
- Following progress of work
- Evaluating employee performance
- Forecasting manpower requirements
- Supervising on-the-job training
- Reviewing employee performance
- Handling employee complaints
- Enforcing rules
- Conducting meetings
- Increasing safety awareness*

Supervisory understanding of the interrelationships of these responsibilities is a learned attribute. Organizations that expect their supervisors to offer a high quality of leadership to their employees must provide appropriate training and experiential opportunities to current supervisors and supervisory trainees alike.

74.10.2 Elements of Accident Prevention†

- Safety policy must be clearly defined and communicated to all employees.
- The safety record of a company is a barometer of its efficiency. An American Engineering Council study revealed "maximum productivity is ordinarily secured only when the accident rate tends toward the unreducible minimum.
- Unless line supervisors are accountable for the safety of all employees, no safety program will be effective. Top management must let all supervisors and managers know what is expected of them in safety.
- Periodic progress reports are required to let managers and employees know what they have accomplished in safety.
- Meetings with supervisors and managers to review accident reports, compensation costs, accident-cause analysis, and accident-prevention procedures are important elements of the overall safety program.
- The idea of putting on a big safety campaign with posters, slogans, and safety contests is wrong. The Madison Avenue approach does not work over the long run.

*B. D. Lewis, Jr., *The Supervisor in 1975,*

†R. De Reamer, *Modern Safety and Health Technology.*

- Good housekeeping and the enforcement of safety rules show that management has a real concern for employee welfare. They are important elements in the development of good morale. (A U.S. Department of Labor study has revealed that workers are vitally concerned with safety and health conditions of the workplace. A surprisingly high percentage of workers ranked protection against work-related injuries and illness and pleasant working conditions as having a priority among their basic on-the-job needs. In fact, they rated safety higher than fringe benefits and steady employment.)
- The use of personal protective equipment (safety glasses, safety shoes, hard hats, etc.) must be a condition of employment in all sections of the plant where such protection is required.
- Safety files must be complete and up to date to satisfy internal information requirements as well as external inspections by OSHA Compliance Officers and similar officials (Table 74.8).

74.10.3 Management Principles*

- Regardless of the industry or the process, the role of supervisors and managers in any safety program takes precedence over any of the other elements. This is not to say that the managerial role is necessarily more important than the development of safe environments, but without

Table 74.8 Requirements for Safety Files[a]

The following items are presented for your convenience as you review your administrative storage index to determine the adequacy of your safety-related files.

		Action Completed	
Number	Action Required	Yes	No
1.	Is there a separate section for safety-related files?		
2.	Are the following subjects provided for in the safety section of the files:		
	a. Blank OSHA forms?		
	b. Completed OSHA forms?		
	c. Blank company safety forms?		
	d. Completed company safety forms?		
	e. Blank safety checklists?		
	f. Completed safety checklists?		
	g. Agendas of company safety meetings?		
	h. Minutes of company safety meetings?		
	i. Records of safety equipment purchases?		
	j. Records of safety equipment checkouts?		
	k. Incoming correspondence related to safety?		
	l. Outgoing correspondence related to safety?		
	m. Record of safety projects assigned?		
	n. Record of safety projects completed?		
	o. Record of fire drills (if applicable)?		
	p. Record of external assistance used to provide specialized safety expertise?		
	q. Record of inspections by fire department, insurance companies, state and city inspectors, and OSHA compliance officers?		
	r. National Safety Council catalogs and brochures for films, posters, and other safety-related materials?		
3.	Are the files listed in item 2 reviewed periodically:		
	a. To ensure that they are current?		
	b. To retire material over five years old?		
4.	Are safety-related files reviewed periodically to determine the need to eliminate selected files and to add new subjects?		
5.	Is the index to the file current, so that an outsider could easily understand the system?		

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*R. De Reamer, *Modern Safety and Health Technology.* Copyright © 1980. Reprinted by permission of Wiley, New York.

manager and supervisor participation, the other elements have a lukewarm existence. There is a dynamic relationship between management and the development of safe working conditions, and management and the development of safety awareness, and the relationship must not be denied.

- Where responsibility for preventing accidents and providing a healthful work environment is sloughed off to the safety department or a safety committee, any reduction in the accident rate is minimal. To reduce the accident rate, and in particular, to make a good rate better, line managers must be held responsible and accountable for safety. Every member of the management team must have a role in the safety program. Admittedly, this idea is not new, but application of the concept still requires crystal-clear definition and vigorous promotion.
- Notwithstanding the many excellent examples of outstanding safety records that have been achieved because every member of management had assumed full responsibility for safety, there are still large numbers of companies, particularly the small establishments, using safety contests, posters, or safety committees as the focal point of their safety programs—but with disappointing results. Under such circumstances safety is perceived as an isolated aspect of the business operation with rather low ceiling possibilities at best. But there are some who feel that gimmicks must be used because foremen and the managers do not have time for safety.
- As an example of the case in point, a handbook on personnel contains the statement that "A major disadvantage of some company-sponsored safety programs is that the supervisor can't spare sufficient time from his regular duties for running the safety program." Significantly, this was not a casual comment in a chapter on safety. It was indented and in bold print for emphasis. Yet it is a firmly accepted fact that to achieve good results in safety, managers and supervisors *must* take the time to fulfill their safety responsibilities. Safety is one of their *regular* duties.
- The interrelationships of the many components of an effective industrial safety program are portrayed in Fig. 74.2.

74.10.4 Eliminating Unsafe Conditions*

The following steps should be taken to effectively and efficiently eliminate an unsafe condition:

- *Remove.* If at all possible, have the hazard eliminated.
- *Guard.* If danger point (i.e., high tension wires) cannot be removed, see to it that hazard is shielded by screens, enclosures, or other guarding devices.
- *Warn.* If guarding is impossible or impractical, warn of the unsafe condition. If a truck must back up across a sidewalk to a loading platform, the sidewalk cannot be removed or a fence built around the truck. All that can be done is to warn that an unsafe condition exists. This is done by posting a danger sign or making use of a bell, horn, whistle, signal light, painted striped lines, red flag, or other device.
- *Recommend.* If you cannot remove or guard an unsafe condition on your own, notify the proper authorities about it. Make specific recommendations as to how the unsafe condition can be eliminated.
- *Follow Up.* After a reasonable length of time, check to see whether the recommendation has been acted on, or whether the unsafe condition still exists. If it remains, the person or persons to whom the recommendations were made should be notified.

The following factors should be considered in organizing a plant that provides for maximum productivity and employee well-being:

- The general arrangement of the facility should be efficient, orderly, and neat.
- Workstations should be clearly identified so that employees can be assigned according to the most effective working arrangement.
- Material flow should be designed to prevent unnecessary employee movement for given work.
- Materials storage, distribution, and handling should be routinized for efficiency and safety.
- Decentralized tool storage should be used wherever possible. Where centralized storage is essential (e.g., general supply areas, locker areas, and project storage areas), care should be

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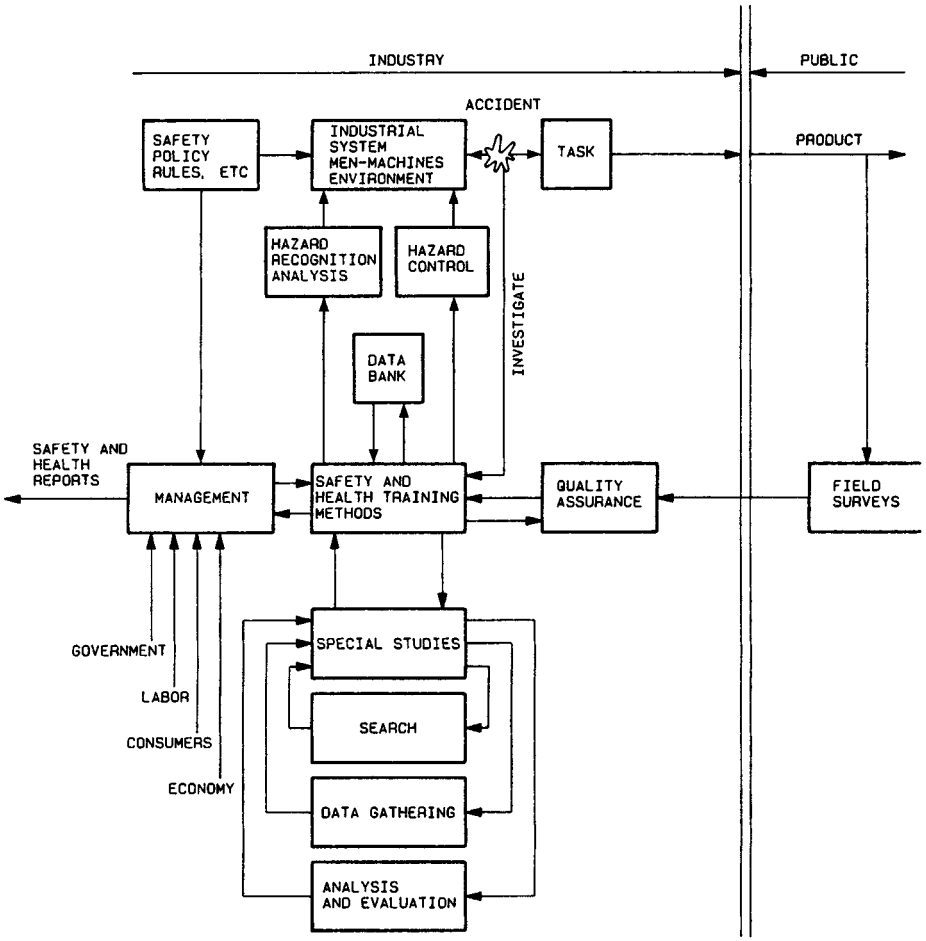

Fig. 74.2 Basic functions of an effective safety program. Reprinted with permission from *Industrial Engineering Magazine.* Copyright © 1979 American Institute of Industrial Engineers, Inc., 25 Technology Park/Atlanta, Norcross, GA 30092.

given to establish a management system that will avoid unnecessary crowding or congested traffic flow. (Certain procedures, such as time staggering, may reduce congestion.)

- Time-use plans should be established for frequently used facilities to avoid having workers wait for a particular apparatus.
- A warning system and communications network should be established for emergencies such as fire, explosion, storm, injuries, and other events that would affect the well-being of employees.

The following unsafe conditions checklist presents a variety of undesirable characteristics to which both employers and employees should be alert:

- *Unsafe Conditions—Mechanical Failure.* These are types of unsafe conditions that can lead to occupational accidents and injuries. *Note:* Keep in mind that unsafe conditions often come about as a result of unsafe acts.
- *Lack of Guards.* This applies to hazardous places like platforms, catwalks, or scaffolds where no guardrails are provided; power lines or explosive materials that are not fenced off or enclosed in some way; and machines or other equipment where moving parts or other danger points are not safeguarded.

- *Inadequate Guards.* Often a hazard that is partially guarded is more dangerous than it would be if there were no guards. The employee, seeing some sort of guard, may feel secure and fail to take precautions that would ordinarily be taken if there were no guards at all.
- *Defects.* Equipment or materials that are worn, torn, cracked, broken, rusty, bent, sharp, or splintered; buildings, machines, or tools that have been condemned or are in disrepair.
- *Hazardous Arrangement (Housekeeping).* Cluttered floors and work areas; improper layout of machines and other production facilities; blocked aisle space or fire exits; unsafely stored or piled tools and material; overloaded platforms and vehicles; inadequate drainage and disposal facilities for waste products.
- *Improper Illumination.* Insufficient light; too much light; lights of the wrong color; glare; arrangement of lighting systems that result in shadows and too much contrast.
- *Unsafe Ventilation.* Concentration of vapors, dusts, gases, fumes; unsuitable capacity, location, or arrangement of ventilation system; insufficient air changes, impure air source used for air changes; abnormal temperatures and humidity.

In describing conditions for each item to be inspected, terms such as the following should be used:

Broken	Leaking
Corroded	Loose (or slipping)
Decomposed	Missing
Frayed	Rusted
Fuming	Spillage
Gaseous	Vibrating
Jagged	

An alphabetized listing of possible problems to be inspected is presented in Table 74.9.

Hazard Classification

It is important to differentiate the *degrees of severity* of different hazards. The commonly used standards are given below.

- *Class A Hazard.* Any condition or practice with *potential* for causing *loss* of life or body part and/or extensive loss of structure, equipment, or material.
- *Class B Hazard.* Any condition or practice with *potential* for causing serious injury, illness, or property damage, but less severe than Class A.
- *Class C Hazard.* Any condition or practice with *probable potential* for causing *nondisabling* injury or illness, or *nondisruptive* property damage.

74.10.5 Unsafe Conditions Involving Mechanical or Physical Facilities*

The total working environment must be under constant scrutiny because of changing conditions, new employees, equipment additions and modifications, and so on. The following checklist is presented as a guide to identify potential problems:

1. Building
   - Correct ceiling height
   - Correct floor type; in acceptable condition
   - Adequate illumination
   - Adequate plumbing and heating pipes and equipment
   - Windows with acceptable opening, closing, and holding devices; protection from breakage
   - Acceptable size doors with correct swing and operational quality
   - Adequate railing and nonslip treads on stairways and balconies
   - Adequate ventilation
   - Adequate storage facilities
   - Adequate electrical distribution system in good condition
   - Effective space allocation
   - Adequate personal facilities (restrooms, drinking fountains, washup facilities, etc.)
   - Efficient traffic flow

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Table 74.9 List of Possible Problems to Be Inspected[a]

Acids	Dusts	Railroad cars
Aisles	Electric motors	Ramps
Alarms	Elevators	Raw materials
Atmosphere	Explosives	Respirators
Automobiles	Extinguishers	Roads
Barrels	Flammables	Roofs
Bins	Floors	Safety devices
Blinker lights	Forklifts	Safety glasses
Boilers	Fumes	Safety shoes
Borers	Gas cylinders	Scaffolds
Buggies	Gas engines	Shafts
Buildings	Gases	Shapers
Cabinets	Hand tools	Shelves
Cables	Hard hats	Sirens
Carboys	Hoists	Slings
Catwalks	Hoses	Solvents
Caustics	Hydrants	Sprays
Chemicals	Ladders	Sprinkler systems
Claxons	Lathes	Stairs
Closets	Lights	Steam engines
Connectors	Mills	Sumps
Containers	Mists	Switches
Controls	Motorized carts	Tanks
Conveyors	Piping	Trucks
Cranes	Pits	Vats
Crossing lights	Platforms	Walkways
Cutters	Power tools	Walls
Docks	Presses	Warning devices
Doors	Racks	

[a]*Principles and Practices of Occupational Safety and Health: A Programmed Instruction Course,* OSHA 2213, Student Manual Booklet 1, U.S. Department of Labor, Washington, DC, p. 40.

Adequate functional emergency exits
Effective alarms and communications systems
Adequate fire prevention and extinguishing devices
Acceptable interior color scheme
Acceptable noise absorption factor
Adequate maintenance and cleanliness

2. Machinery and Equipment
   Acceptable placement, securing, and clearance
   Clearly marked safety zones
   Adequate nonskid flooring around machines
   Adequate guard devices on all pulleys
   Sharp, secure knives and cutting edges
   Properly maintained and lubricated machines, in good working condition
   Functional, guarded, magnetic-type switches on all major machines
   Properly wired and grounded machines
   Functional hand and portable power tools, in good condition and grounded
   Quality machines adequate to handle the expected work load
   Conspicuously posted safety precautions and rules near each machine
   Guards for all pinch points within 7 ft of the floor

74.11 SAFETY TRAINING

74.11.1 Specialized Courses*

First-Aid Training

First-aid courses pay big dividends in industry. This statement is based on clear evidence that people trained in first aid are more safety conscious and less likely to have an accident.

The importance of first-aid training from the safety standpoint is that it teaches much more than applying a bandage or a splint. According to the Red Cross, "The primary purpose of first aid training is the prevention of accidents." Each lesson teaches the student to analyze (1) how the accident happened, (2) how the accident could have been prevented, and (3) how to treat the injury. But the biggest dividend of first-aid training is the lives that have been saved because trainees were prepared to apply mouth-to-mouth resuscitation, to stop choking using the Heimlich maneuver (ejection of foreign object by forceful compression of diaphragm), or to stem the flow of blood.

Since the OSHAct, first-aid training has become a matter of federal law—the act stipulates that in absence of an infirmary, clinic, or hospital in proximity to the workplace, a person or persons shall be adequately trained to render first aid. The completion of the basic American National Red Cross first-aid course will be considered as having met this requirement. Just what constitutes *proximity* to a clinic or hospital? The OSH Review Commission recognizing that first aid must be given within 3 minutes of serious accidents concluded that an employer whose plant had no one trained in first aid present and was located 9 minutes from the nearest hospital violated the standard (1910.151, Medical and First Aid).

Driver Training

The number 1 accident killer of *employees* is the traffic accident. Each year more than 27,000 workers die in non-work-related motor-vehicle accidents, and an additional 3900 employees are killed in work-related accidents. The employer pays a heavy toll for these accidents. Those that are work related are compensable, but the others are, nonetheless, costly. The loss of a highly skilled worker, a key scientist, or a company executive could have a serious impact on the success of the business.

There is, fortunately, something constructive that employers can do to help protect their employees and their executives from the tragedy and waste of traffic accidents. Driver training for workers and executives can be provided either in-house or through community training agencies.

Companies that have conducted driver-training programs report that the benefits of such training were not limited to the area of improved traffic-accident performance. These companies also experienced lower on-the-job injury frequency rates (the training produced an increase in safety awareness) and improved employee–community relations.

Companies have taken several approaches to driver training:

- A course has been made available to employees on a volunteer basis, either on- or off-hours.
- Driver training has been made mandatory for employees who operate a motor vehicle on company business.
- The company has promoted employee attendance at community-agency-operated programs.
- Full-scale driver-training programs have been conducted for all employees and members of their families. This is done off-hours, and attendance is voluntary.

Fire Protection Training

All employees must know what to do when a fire alarm sounds. All employees must know something about the equipment provided for fire protection and what they can do toward preventing a fire. They must know:

- The plan established for evacuation of the building in case of emergency.
- How to use the first-aid fire appliances provided (extinguishers, hose, etc.).
- How to use other protective equipment. (Every employee should know that water to extinguish fires comes out of the pipes of the sprinkler systems and that stock must not be piled so close to sprinkler lines that it prevents good distribution of water from sprinkler heads on a fire in the piled material. They should know that fire doors must be kept operative and not obstructed by stock piles, tools, or other objects.)

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- How to give a fire alarm and how to operate plant fire alarm boxes and street boxes in the public alarm system.
- Where smoking in the plant is permitted and where, for fire-safety reasons, it is prohibited.
- The housekeeping routine (disposal of wiping rags and waste, handling of packing materials, and other measures for orderliness and cleanliness throughout the plant).
- Hazards of any special process in which the employee is engaged.

All these "what-to-do" items can appropriately be covered in training sessions and evacuation drills.

Other Specialized Courses

Some of the other specialized courses that can be given for safety training are:

- Accident investigation
- Accident report preparation
- Hazard inspection
- Personal protective equipment
- Powered equipment and vehicles
- Safety recordkeeping
- Specific disasters

74.11.2 Job Hazard Analysis Training*

Admittedly, the conventional mass approach to safety training takes little of the supervisor's time. Group training sessions, safety posters, films, and booklets are handled by the plant safety engineer or other staff people. On the other hand, where safety training is carried out on a personalized basis, the first-line supervisor must necessarily do the training. This will take more of his or her time and require more attention to detail, but this additional effort pays off because of the increased effectiveness of the training method.

In launching a personalized safety-training program, the first step is the preparation of a job-hazard analysis for each job in the plant. To make the job-hazard analysis in an organized manner, use of a form similar to the one shown in Table 74.10 is suggested. The key elements of the form are: (1) job description; (2) job location; (3) key job steps; (4) tool used; (5) potential health and injury hazards; and (6) safe practices, apparel, and equipment.

A review of the form will indicate the steps in making a job-hazard analysis. To start an analysis, the key steps of the job are listed in order in the first column of the form. Where pertinent, the tool used to perform the job step is listed in the second column. Then, in the third column opposite each job step, the hazards of the particular step are indicated. Finally, in the fourth column of the form are listed the safe practices the employee must be shown and have discussed. Here the supervisor lists the safe work habits that must be stressed and the safety equipment and clothing required for the job.

In making the analysis, an organized approach is required so the less obvious accident hazards will not be missed. This means going out on the floor and actually watching the job being performed and jotting down key steps and hazards as they are observed. Supervisors who make such a job-hazard analysis are often surprised to find hazards in the job cycle that they had missed seeing in the past. Their original negative reaction to the thought of additional paperwork soon disappears. In the long run, supervisors realize that proper hazard analysis will help them do a better training job.

As previously stated, a job-hazard analysis is made for each job. In most cases, each supervisor will have to make from 5 to 10 different analyses. Of course, in maintenance and construction work, the variety of jobs covers a much wider range. Fortunately, these jobs can be grouped by the type of work performed and a job-hazard analysis can be made for each category of work, rather than for each job. For example, repair, installation, and relocation of equipment; cleaning motors; and unloading cars might be a few of the various categories of maintenance work to be analyzed.

74.11.3 Management's Overview of Training†

An effective accident prevention program requires proper job performance from everyone in the workplace. All employees must know about the materials and equipment they are working with, what

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Table 74.10 Job Hazard Analysis

Job Description: Three Spindle Drill Press—Impeller 34C6

Job Location: Bldg. 19-2, Pump Section

Key Job Steps	Tool Used	Potential Health and Injury Hazard	Safe Practices, Apparel, and Equipment
Get material from operation	Tote box	Dropping tote box on foot.	Wear safety shoes. Have firm grip on box.
		Back strain from lifting.	Stress proper lifting methods.
		Picking up overloaded boxes.	Tell employee to get help or lighten load.
Inspect and set up drill press	Drill press	Check for defective machines.	Do not operate if defective. Attach red or yellow "do not operate" tag.
		Chuck wrench not removed.	Always remove chuck wrench immediately after use.
		Making adjustments when machine is running.	Always stop spindle before making adjustments.
Drilling		Hair, clothing, or jewelry catching on spindle.	Wear head covering, snug-fitting clothing. No loose sleeves. Avoid wearing rings, bracelets, or wristwatches.
		Spinning work or fixture.	Use proper blocks or clamps to hold work and fixture securely.
		Injury to hands—cuts, etc.	Never wear gloves. Use hook, brush, or other tool to remove chips. Use compressed air only when instructed.
		Drill sticks in work.	Stop spindle, free drill by hand.
		Flying chips.	Wear proper eye protection.
		Pinch points at belts.	Always stop press before adjusting belts.
		Broken drills.	Do not attempt to force drill, apply pressure.
			James Black
			Signature
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			Date Page

hazards are known in the operation, and how these hazards have been controlled or eliminated. Each individual employee needs to know and understand the following points (especially if they have been included in the company policy and in a "code of safe practices"):

No employee is expected to undertake a job until he or she has received instruction on how to do it properly and has been authorized to perform that job.

No employee should undertake a job that appears to be unsafe.

Mechanical safeguards are in place and must be kept in place.

Each employee is expected to report all unsafe conditions encountered during work.

Even slight injury or illness suffered by an employee must be reported at once.

In addition to the points above, any safety rules that are a condition of employment, such as the use of safety shoes or eye protection, should be explained clearly and enforced at once.

The first-line supervisors must know how to train employees in the proper way of doing their jobs. Encourage and consider providing for supervisory training for these supervisors. (Many colleges offer appropriate introductory management training courses.)

Some specific training requirements in the OSHA standards must be met, such as those that pertain to first aid and powered industrial trucks (including forklifts). In general, they deal with situations where the use of untrained or improperly trained operators on skill machinery could cause hazardous situations to develop, not only for the operator, but possibly for nearby workers, too.

Particular attention must be given to new employees. Immediately on arriving at work, new employees begin to learn things and to form attitudes about the company, the job, their boss, and their fellow employees. Learning and attitude formation occur regardless of whether the employer makes a training effort. If the new employees are trained during those first few hours and days to do things the right way, considerable losses may be avoided later.

At the same time, attention must be paid to regular employees, including the old-timers. Old habits can be wrong habits. An employee who continues to repeat an unsafe procedure is not working safely, even if an "accident" has not resulted from this behavior.

Although every employee's attitude should be one of determination that "accidents" can be prevented, one thing more may be needed. It should be stressed that the responsibility assigned to the person in charge of the job—as well as to all other supervisors—is to be sure that there is a concerted effort under way at all times to follow every safe work procedure and health practice applicable to that job. It should be clearly explained to these supervisors that they should never silently condone unsafe or unhealthful activity in or around any workplace.

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