SELF-EVALUATION OF OCCUPATIONAL SAFETY AND HEALTH PROGRAMS

PREPUBLICATION COPY

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Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
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FOREWORD

The National Institute for Occupational Safety and Health has a continuing responsibility to develop new approaches to the problem of ensuring a safe and healthful work environment through involvement with basic and applied research.

Toward this end, NIOSH has developed and expanded the concept of occupational self-evaluation as an additional approach to promoting safety and health among employers and employees in industry.

This concept as contained here is offered as an adjunct to existing regulatory procedures for compliance with the Occupational Safety and Health Act of 1970 and is intended to provide greater awareness of potential hazards in the development of comprehensive occupational safety and health programs.

J Michael Lane

J. Michael Lane, M.D.
Acting Director, National
Institute for Occupational
Safety and Health

PREFACE

Most employers and employees recognize the need to create a safe and healthful workplace, but they may find it difficult to interpret appropriate regulations. Organized labor groups recognize the need for employees to practice good work habits, and many workers appreciate the benefits to be gained by so doing. Recent evidence suggests the desirability on the part of management to provide comprehensive occupational safety and health programs as an effective way to reduce the cost of absenteeism, production time losses, and cost of workers' compensation and disability insurance. An approach to assure a safe and healthful work environment for working men and women is that of self-evaluation.

Self-evaluation is a systematic approach to be used by both employer and employees to readily identify and correct potential workplace hazards. The concept of self-evaluation, although not new to some businesses, has not been generally used in any well-designed or industrywide manner. Through its use, employers and employees will become aware of existing and potential occupational safety and health problems, and, in a spirit of cooperation, are stimulated to take corrective action. Thus, in-place resource persons, with outside assistance if necessary, can work to improve the quality of their own work environment.

This document, the basic core, "Self-Evaluation of Occupational Safety and Health Programs," is applicable to all industries. It provides comprehensive information to help implement occupational safety and health self-evaluation programs. It must be used with a complementary document, "Self-Evaluation Instrument" (SEI), which is written for specific types of industries. Within the SEI are comments and questions applicable to specific within-plant situations where both hazards and potential hazards may exist. These sections in the SEI are designed to be reproduced; each section should be given to the persons responsible for supervising the area to which it applies, and they, along with the employees working there, are to complete them. The various responses to the questions may then be used to:

- analyze the work situation,
- develop a plan whereby corrective action may be taken around work and production schedules,
- form the basis for educational and training programs, and
- emphasize for employers and employees the areas of potential concern.

Although work sites may vary depending on the product or service provided, the approach to recognition and correction of potential occupational safety and health problems, through the use of this instrument, are common to all. Thus, the SEI and the basic core document will assist employers and employees to better understand the desirability of meeting requirements of federal or state OSHA regulations and of going even beyond this minimum to develop and implement a comprehensive occupational safety and health program.

As each establishment completes the SEI and periodically repeats the process, employers and employees will gain insight into the wide range of potential occupational safety and health problems and acquire a certain measure of assurance that the workplace is in compliance with state and federal OSHA standards.

When the SEI has been completed and the results analyzed, priorities should be set for any necessary corrective measures based on:

- the seriousness of the potential problem,
- the planning necessary to minimize expense,
- production and working schedules,
- the availability of expertise, and
- other priorities.

Use of this document, then, provides a method to develop preventive strategies to reduce the need for disability determinations and reduce existing costs of worker compensation — a method whereby immediate measures can be taken to improve the safety and health of the work environment.

Loren L. Hatch, D. O., Ph.D.
Medical Officer (Occupational Medicine)

P. G. Rentos, Ph.D.
Scientist Director (Industrial Hygienist)

Frank W. Godbey
Industrial Hygiene and Safety Specialist

Edward L. Schrems, Ph.D.
Operations Research Analyst (Decision (Scientist)

ABSTRACT

"Self-Evaluation of Occupational Safety and Health Programs" presents a concept of self-evaluation whereby management and labor can join together in self-assessment to recognize and prevent or control the potential hazards of their own plant and working area and, thereby, ensure a safer and more healthful work environment.

This document presents a basic information core applicable to most industries. The program for self-evaluation is outlined and the steps needed for its implementation are given. Within plants, problem areas offering the potential for improved safety and health are specifically described.

A "Self-Evaluation Instrument" applicable to a specific industry is to be used with this basic document. It offers questions and comments designed to pinpoint plant situations that need upgrading.

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ACKNOWLEDGMENTS

The self-evaluation concept developed in this document is not unique; the particular use to which we have applied this concept is, however, the result of the interest and guidance given the project by Dr. John F. Finklea, M.D., former Director of the National Institute for Occupational Safety and Health (NIOSH).

NIOSH personnel have devoted much time, talent, and expertise in preparing this volume. Specifically, we acknowledge and appreciate the efforts of the:

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INTRODUCTION

Your Occupational Safety and Health (OSH) program is an essential activity. Its goal is to provide a work and a physical environment for each employee that is as free as possible from potential hazards to safety and health. Good management and work practices, as well as legal requirements, make safety and health priority concerns for all employers and employees.

Self-evaluation offers a system by which you and your employees can identify and systematically attempt to solve safety and health problems. The approach is private and voluntary. It assists workplaces in improving the quality of their environment by using in-house resources along with outside assistance and consultation where needed.

The most successful safety and health programs translate internal commitment and individual awareness into action. The self-evaluation approach sensitizes employers and employees to their work environment and encourages them to share responsibilities in this area.

LEGAL REQUIREMENTS AND SELF-EVALUATION

Self-evaluation, with subsequent corrective action, should provide satisfactory assurance that the establishment has identified and addressed the problems that would be cited by a federal or state inspector. Most establishments recognize the need to comply with the law, but many find it difficult to interpret the law and define their responsibilities. This process will help you to understand not only your legal responsibilities, but will assist you to appreciate the benefits of going beyond the minimum requirements of the law, i.e., into the development and implementation of a comprehensive OSH program.

The Occupational Safety and Health Act of 1970 (Act) essentially requires employers to provide employment free from recognized safety and health hazards that could result in injury, illness, or death. All establishments employing one or more persons are subject to the Act. The administration of the Act falls under several agencies:

—OSHA (The Occupational Safety and Health Administration), in the U.S. Department of Labor (DOL), establishes and enforces occupational safety and health standards through inspections, citations, and fines.

—NIOSH (National Institute for Occupational Safety and Health), in the U.S. Department of Health, Education, and Welfare (DHEW), recommends safety and health standards and conducts research, investigations, demonstrations, and programs of education and training relating to occupational safety and health.

—OSHRC (The Occupational Safety and Health Review Commission), an independent government body, holds hearings on appeals from DOL or the employer and renders decisions, which may be appealed.

—State OSHA Programs (State Occupational Safety and Health Administration Programs). Some states (20 in October 1978) have chosen to assume responsibility for administration of the Act. Under special plans negotiated with DOL, states agree to establish programs of inspection, citation, and training that meet or exceed the minimum standards promulgated under the Act. (Many of these standards, in addition to other accepted guidlines for professional practice, have been used in the Self-Evaluation Instrument (SEI).

The Act also authorizes DOL inspectors (or state inspectors in states with OSH programs) to enter any working establishment at any reasonable time. Inspectors or compliance officers may look at whatever they wish and may question any employer, owner, operator, agent, or employee. OSHA compliance procedures provide for citations and fines for noncompliance.*

As your establishment completes an SEI, you will have an idea of the wide range of potentially hazardous areas an OSHA compliance officer will consider in inspecting or reviewing. A compliance officer would probably concentrate on some key areas of your establishment and issue citations if you are in violation of any OSHA standards. This would not necessarily imply, however, that you are in compliance in areas in which you were not cited. The SEI helps you and the employees appraise potentially hazardous areas and operations throughout the workplace and set priorities for improvement. This self-evaluation manual describes recommended approaches for problem solving.

OSHA'S VOLUNTARY COMPLIANCE PROGRAM

The main emphasis of OSHA has been on mandatory, government-enforced compliance. Now, however, OSHA is also promoting the concept of voluntary compliance. Their voluntary compliance program encourages employers and employees to seek information about the Act and to make improvements within their establishment with onsite technical assistance and consultation from federal or state personnel, or both. This consultation, however, focuses only on OSHA standards as they apply to a particular workplace; it does not provide help in establishing a total program, which would include preventive occupational medical practices.

Self-evaluation provides employers with a means of establishing good safety and health programs in a voluntary manner. The education and professional consultation provided by this system should enable you to pinpoint problem areas and to correct them with measurable results. Self-evaluation complements OSHA's inspection and consultation efforts by assisting employers to go beyond the minimum requirements.

*In *Marshall, Secretary of Labor, et al. v. Barlow's, Inc.*, May 23, 1978. Docket No. 76-1143), the U.S. Supreme Court indicated that the employer could require a search warrant be obtained by the OSHA inspector prior to entry on the premises for inspection in holding that the employer "was entitled to a declaratory judgment that the Act is unconstitutional insofar as it purports to authorize inspections without warrant or its equivalent and to an injunction enjoining the Act's enforcement to that extent."

TOWARD IMPLEMENTATION OF COMPREHENSIVE OSH PROGRAMS

Compliance with OSHA standards emphasizes the correction of conditions that are, or can become, hazardous. Many such conditions, however, result from individuals' unsafe acts, which may reflect managerial apathy or oversight. To have an acceptable safety and health program, your program must include:

—*Employee involvement.* Even the best conceived program will have little effect where employees do not function as the key safety and health resource.

—*Management direction.* Effectiveness requires management commitment both financially and philosophically.

—*Accountability and responsibility.* Who does what within the OSH program must be clearly fixed within your organization and understood by all.

—*Supervisory participation.* Essential to the success of any program is participation at the supervisory level.

—*Self-evaluation.* Regularly conducted walk-through surveys by management, supervisors, and employees are needed to identify and correct potential hazards.

—*Training.* Health and safety training should be conducted on a regular basis, and safety meetings should be held monthly.

—*Medical controls.* As a minimum, a first-aider, trained according to OSHA standards should be present on all shifts at even the smallest establishment.

—*Accident and absenteeism records.* Records should be analyzed to uncover physical or psychological problems affecting safety and health that might not be apparent during regular walk-throughs.

This program manual for self-evaluation has been tailored to your particular needs, with action steps that you can take now.

THE PROGRAM

CONTENTS

EMPLOYEE-CENTERED SAFETY AND HEALTH PROGRAM

OVERVIEW

The size and scope of your OSH program will depend upon the size of your workplace, the number of employees, your geographic location in relation to emergency care facilities and medical clinics, and the number and extent of potential hazards inherent in your operations. For optimum effectiveness, regardless of size and employee complement, your program must have certain major elements:

—A comprehensive safety and health policy, published and distributed to all employees.
—A written set of basic objectives outlining the results expected and the timetable for their completion. These should be reasonable and attainable with feedback to monitor results.
—A functional organization chart specifying reporting relationships and responsibilities for all staff and consultants involved in the program.
—A commitment from management, as part of permanent policy, acknowledging its responsibility to initiate and maintain a continuous program of safety and health.
—A plan for "shared responsibility," and representation such that all functional groups and organizational levels participate in setting priorities and implementing action steps.
—A system, with identifiable benchmarks, for reporting progress and evaluating performance and effectiveness.

SETTING OSH GOALS AND OBJECTIVES

The goals of your OSH program should reflect the priorities of your workplace and should serve as the underlying principles for more specific policies and procedures.

This list of goals might address such priorities as:

—Assuring employees of safe and healthful working conditions.
—Facilitating the proper placement of employees according to their physical capabilities, mental abilities, and emotional stability so that they can work efficiently without endangering their own health and safety or that of others.
—Providing medical care and rehabilitation for the occupationally ill and injured.
—Encouraging all employees to maintain personal health.
—Avoiding adverse effects on the surrounding community through undue exposure to toxic effluents in air, water, or soil.

These principles must be clearly stated and naturally addressed to key issues; they need not, however, be lengthy or complex. These goals, which may be objectives, should provide the philosophical framework for more specific objective setting. It is these measurable objectives by which your program's performance can be measured. Examples of such objectives are to:

—Create and maintain a worker placement program that evaluates employees as to their physical capabilities, mental abilities, and emotional make-up to maximize their effectiveness without endangering their own health, or safety, or both.
—Create a medical care and rehabilitation program for the occupationally ill and injured.
—Provide the information and education to employees and their families on specific occupational hazards and the basic principles of preventive health maintenance and practices.

In setting program objectives you should seek the widest range of input. A questionnaire might be developed and circulated to all employees to obtain their ideas. This will ensure employee involvement in establishing the program itself and will provide you with first hand knowledge of problems and situations that should receive attention. Refer to the section on Techniques for Employee Involvement for more specific information.

The feedback you receive from this survey should be analyzed to identify common concerns and interrelated problem areas. Only after this is done can you rank these objectives and develop time frames for attainment.

SPECIFIC PROGRAM ELEMENTS

Depending on the size of your establishment and the nature of your operations, your OSH program will need to include elements of first aid, safety, industrial hygiene, and occupational health nursing and medicine.[1] Although large workplaces may have professionals in these disciplines on staff, it is unlikely that smaller work places would have the need or resources to hire full-time professionals in these areas. In these instances, a hot-line, the services of insurance companies, local health departments, industrial clinics, governmental agencies, or independent consultants could be used for specialized assistance. With training and experience, the staff you now have can perform some environmental evaluation techniques such as noise monitoring or air sampling thereby lessening your dependence on outside resources. Reliance on existing staff to carry out your OSH programs demands a clear organization structure identifying individuals with specific responsibilities.

Following is a brief overview of the key factors in safety, health, and hygiene.

Safety

A safety program is not imposed on company organization, but must be built in to every process or product design. The critical elements in any successful program are:

—employee involvement,
—management leadership and support,
—assignment of responsibility,
—maintenance of safe working conditions,
—establishment of safety training,
—an accident record and investigation system,
—medical and first aid systems, and
—acceptance of personal responsibility by all employees.

Managerial interest in safety must be sincere and constantly visible; without this even the best policies will be meaningless. No matter how small your organization, any attempts you make to stop accidents without a definite guiding policy will fail and you will find yourself continuously "fighting fires."

Your safety policy should contain a few essential assumptions:

—Employee awareness and involvement are keys to program success.
—Safety is paramount and will take precedence over any short cuts.
—Every attempt will be made to reduce the possibility of an accident or any other undesirable outcome that might occur.
—Your company intends to comply with all safety laws and is willing to go beyond their minimum requirements.

Behind these statements must lie a total safety program including:

—Development and application of safety standards for equipment, work methods, and products.
—Safety inspection to identify potential hazards, both in production and in products. Packaging and instruction sheets designed to alert users to hazards inherent in the product.
—Accident investigation to determine future preventive action.
—Accident records and accident-cause analysis to determine accident trends and provide targets for corrective action. This record keeping system is also required by OSHA.
—Education and training in safety principles.
—Personal protective equipment to provide injury protection.
—Safety publicity to step up program interest and participation using motivational techniques and behavior modification.
—Off-the-job accident prevention.

Health

Regardless of the size of your establishment, a good occupational health program should

[1] Occupational Health Services and HMO's. L. L. Hatch. In: Proceedings, 1978 Group Health Institute. Group Health Association of America, 1717 Massachusetts Avenue, NW, Washington, DC 20036. September 1978.

maintain the health of your work force, prevent or control occupational and nonoccupational diseases and accidents, and prevent and reduce disabilities and the resulting lost time.

Specifically, your program should provide for the following:

- —Health maintenance activities such as:
  - •disease prevention; maintenance of a healthful environment in cooperation with environmental engineering, industrial hygiene, and safety personnel;
  - •early detection and treatment of illness through medical survelliance and biological monitoring, as well as special tests for employees potentially exposed to toxic agents and stressful environments;
  - •emergency medical care;
  - •rehabilitation of disabled workers;
  - •placement of workers in accordance with their physical and mental abilities;
  - •maintenance of workers' physical fitness.
- —Medical records containing complete information on employees' physical conditions, with reference to environmental sampling records.
- —Immunization programs.
- —Health education and counseling.
- —Communication by employees with their personal physicians regarding any medical services they receive at their place of work and reporting of off-site medical care to medical department, for purpose of determining possible work-related illness patterns.

Industrial Hygiene

The science of industrial hygiene deals with the identification, evaluation, and control of those physical, chemical, and biological agents and psychological stresses in the workplace that may affect workers' health. These agents include such common workplace hazards as:

- —toxic materials that may be breathed, swallowed, or absorbed into the body as fumes, vapors, dusts, or mists;
- —noise and vibration;
- —ionizing and nonionizing radiation;
- —extremes of temperature, and humidity, and barometric pressures;
- —light;
- —bacteria and fungus;
- —viruses;
- —plant and insect pests; and
- —shift work stress, elevated or deep work area stress.

An industrial hygiene program involves the use of sampling equipment, measurement instrumentation, and laboratory analysis to assess your occupational environment. Any equipment and facilities you use must meet acccepted professional standards and be used properly. Industrial hygiene surveys are necessary to identify potential health hazards and to develop necessary control measures.

Most smaller establishments cannot afford to maintain all the equipment and facilities they need; they must depend upon outside services and rentals for much of their program. It is extremely important to study your equipment needs thoroughly before you make any purchases so you will not acquire equipment that is too complicated or is not well suited to your particular measurement needs. The determination of your equipment needs should be carried out as a cooperative effort with the use of employees, consultants, and equipment distributors. If you use consultants or available technical assistance for most of the measurement work, you should have less need to purchase equipment.

If your measurements require laboratory assistance, you should use an industrial hygiene laboratory where the staff can often provide valuable advice on measurements and has experience in industrial hygiene monitoring and analytical techniques.

An industrial hygiene program should provide:

- —Plant inspection and identification of potential health problems.
- —Measurement or evaluation of these potential problems (e.g., noise measurement, air sampling to determine employees' exposure to airborne contaminants, measurement of air velocities at ventilation hoods, etc.).
- —Information to both management and employees of the existence and magnitude of industrial hygiene problems and the need for engineering and administrative controls, personal protection, and suggestions for biological monitoring (e.g., high lead exposures, need for local ventilation, periodic blood tests).
- —Advice to management of the most effective engineering and administrative controls.

—Coordination of corrective action and subsequent evaluation of its effectiveness.
—Application of ergonomics (human factors).

Health, hygiene, and safety must operate together as a single program. The activities of each element interrelate and support each other, so that your staff's responsibilities in these areas can and should be closely integrated.

PROGRAM STAFFING AND ORGANIZATION

The makeup of your occupational safety and health staff will depend largely on the size of your establishment, the number and degree of potential hazards, and the resources available for salaries and consulting fees. A very small establishment, employing only a few people, will not find it practical to hire a full-time physician or nurse even if their operations have potentially high hazard potential. On the other hand, a large establishment, with relatively few potential hazards, might well employ a full-time physician with an emphasis on preventive health maintenance.

This section begins with a discussion of the minimum staffing requirements for any workplace and then recommends health and safety professionals normally found in larger or more hazardous establishments.

First Aider

Every establishment, no matter how small, should have one person on each shift who is trained in first aid. In a small establishment, this person will undoubtedly have regular duties not related to first aid, whereas in a large establishment, full-time first aiders might be employed.

In selecting first aiders, you should look for employees who are people oriented and who have demonstrated some leadership qualities. You might consider a person who has been permanently injured and must be given lighter duties. Former military corpsmen, firemen, or para-medics often have training and experience especially qualifying them for the job with additional training.

First aiders must have formal training, such as the senior life saving courses offered by the American Red Cross. You can obtain more information through your local chapter of the Red Cross. Military corpsman training may be acceptable for first aiders, and in individual cases, previous training and job experience can be substituted for the formal Red Cross course.

Consulting Physician

Every establishment not directly employing a full- or part-time physician must have available the services of a consulting physician. This might be a doctor from a nearby hospital with which you have emergency care arrangements or a private practitioner in the community oriented to occupational medicine.

The consulting physician must approve all first aid supplies and be available to give medical directions to nurses employed by or serving your establishment.

Part-Time Nursing Services

Many small establishments employ a part-time nurse directly or by arrangement with a local nursing service that can send a nurse to the plant to hold sick call on a regular basis or visit the plant on request. For example, public health agencies run by the city or county sometimes supply nursing services to industry for a fee. Also, the Visiting Nursing Association or Community Health Association, both voluntary groups, often are willing to serve industry for a fee. If you receive nursing services from an outside source, it is important that the same nurse always be assigned to your plant so he/she can maintain familiarity with your working conditions and environment. Any nurse, whether employed directly by your establishment or serving the employees must receive medical direction from a physician and should be occupationally oriented.

Full-Time Occupational Nurse

Larger establishments or those with high levels of potential hazards should employ a full-time nurse. For the maintenance of complete health services, it is recommended that there be one nurse for up to 300 employees, two or more nurses for up to 600 employees, and three or more nurses up to 1,000 employees. There should be one nurse for each additional 1,000 employees up to 5,000 and one nurse per each additional 2,000 employees. Additional nurses may be required because of hazards present in a particular plant and to supply service for second and third shifts. This number will be reduced in inverse ratio to the number of technical and nonprofessional workers employed in the medical department.[1] The

[1]The New Nurse in Industry. J. A. Lee. DHEW(NIOSH) 78-143. National Institute for Occupational Safety and Health, Cincinnati, Ohio. 1978.

structure of reporting responsibilities is a significant factor in the effectiveness of an occupational nursing program. The nurse should report to two people. Ideally, the first should be a top administrator, such as a personnel manager, who knows and understands plant policies, budgets, purchasing, etc., and has decision making power; and the second, the responsible physician. Just as a part-time nurse cannot function in a medical vacuum, a full-time nurse must receive medical direction. Although some establishments have traditionally had the nurse report to the safety director, this is not recommended. In addition to nurses' accountability to management and to a physician, they are legally bound to the Nursing Practice Act in the particular state.

The nurse should be a graduate of an accredited school of nursing and licensed to practice in the state where he or she is employed. Because the registered nurse represents the physician and is more accessible, this person must be qualified to serve as your employees' professional advisor, educator, and counselor in health matters. The nurse should be a member of professional or speciality nursing organizations and make good use of the speciality journals, books, and guides available in the occupational health field. The American Board for Occupational Health Nurses, Inc., is the certification board for the speciality of occupational health nurses. Upon satisfactory completion of a comprehensive examination, qualified occupational health nurses become certified and must show evidence of nursing competency every 5 years. The nurse becomes indispensable almost in inverse proportion to the lack of medical service provided by a licensed physician.

The nurse should be in the plant when the physician is there. In balancing nursing and physician services, a ratio of 1 hour of physician's time to 3 hours of nurse's time has worked out satisfactorily in many plants. A ratio of 3 hours of physician's time to 9 hours of nurse's time per 100 workers is desirable, and when comprehensive preplacement and periodic physical examinations are done, this ratio is necessary.

Full- or Part-Time Occupational Physician

Generally only large establishments (over 3,000 employees) will find it possible to have a full-time occupational physician on site. Medical programs for small establishments commonly provide for periodic visits by a physician under contract or on call, with emergency cases referred to the physician for treatment.

Several formulas have been suggested for the apportionment of the physician's in-patient time. One approach is to allow 2 physician-hours per week for the first 100 employees and 1 additional physician-hour per week for each additional 100 employees.

Any such formula should be modified to fit the needs of your particular plant. You should also consider the extra time the physician devotes to completing medical records, insurance, worker's compensation, and other forms, as well as to planning, telephone consultations, correspondence, and conferences with your management, aside from the actual hours he/she spends at your plant seeing employees or assessing the work environment.

It is likely that most of the occupational health programs at small plants will continue to be operated by physicians who are primarily family physicians rather than by specialists in occupational medicine. Nevertheless, the physician who serves your plant should know something of occupational medicine and how it differs from general medicine. The physician should have an understanding of the occupational safety and health and worker's compensation regulations in your state. He/she should be knowledgeable concerning the potential toxic hazards in your plant and methods for eliminating or controlling them as well as be able to treat occupationally related illnesses. The physician should be a member of the local medical society and be acquainted with your state medical association's committee on occupational health as well as with other specialists in occupational medicine qualified to provide additional information and guidance. If possible, your physician should become a member of one or more occupational medical specialty societies and, if he/she is working full time in occupational medicine, should apply for diplomate status in occupational medicine from the American Board of Preventive Medicine.

Industrial Hygiene Services

You can obtain industrial hygiene services from many sources. Although many large establishments, particularly those dealing with toxic products or potentially hazardous conditions, employ full-time industrial hygienists, small workplaces may find this is impractical or overly expensive. Outside part-time services may be much more feasible. Many workers' compensation insurance carriers have industrial hygiene services available to you as a policy-holder. You might also contact federal, state, and local labor and health departments, nearby universities, or a large corporation in your area that employs industrial hygienists. Also, there are a few independent consultants with general comprehensive and specialized industrial hygiene capabilities (see the section in this manual for sources of information and consultation).

No matter what the source is, it is important that the industrial hygienist you select has the proper education and training. Your consultant should have at least a B.S. degree in one of the hard sciences (e.g., physics, chemistry, biology, etc.) or engineering and possibly an advanced degree such as a M.S., Sc.D., or Ph.D. The American Academy of Environmental Engineers and the American Board of Industrial Hygiene administer specialty board certification examinations for exceptionally well-qualified industrial hygienists. When you make a decision to use the services of an industrial hygienist, his or her educational credentials should be considered along with their particular experience.

Safety Director

Regardless of your company's size, one staff person should be assigned responsibility for overall safety activities on either a full- or part-time basis. Just as other managers are selected for their specific knowledge and initiative, so should the Safety Director be. Although he or she may hold collateral duties in your safety and health program, this person should have some experience and training in safety management. If possible, your director should be a safety professional. The Board of Certified Safety Professionals sets standards in this area and certifies competent individuals. The American Society of Safety Engineers is a professional organization to which many directors and safety staff members belong. At a minimum, your director should take the short-term safety courses such as those provided by OSHA and the National Safety Council. Continuing education and a budget providing funds for obtaining resource materials and current literature should be available.

OSH Program Director

The director of your safety and health program, who should understand the objectives and be able to develop and carry out programs to meet them, may be the same person who is your in-house source of safety and health information. Your director may spend either full or part time on these responsibilities depending upon the size and scope of your program. In smaller plants, with no in-house safety and health expertise, the director may have responsibilities other than the OSH program (such as a personnel director would have) and will depend on state and federal government agencies, insurance companies, or consultants for advice on program development. It is especially important that the director have the authority to implement programs and procedure, to acquire funding and make expenditures, and to delegate responsibilities to other personnel through their supervisor. Your director should be familiar with processes and materials within your workplace and should have knowledge of the principles of occupational safety and health. Regardless of the size of your operations, for clarity of program structure, you should assign one person with the responsbility of implementing the overall program.

Figures have been provided to help you in analyzing your staffing needs (Figures 1 and 2) and in outlining a reporting structure (Figure 3).

TECHNIQUES FOR EMPLOYEE INVOLVEMENT

Just as top management commitment to your OSH program is essential to its success, no program can operate effectively without the support and active participation of all employees. Each employee should recognize that an effective program is in their self-interest and should act as a continuing source of information and suggestions. There are two essential elements for ensuring employee involvement in improving the work environment: an overall climate that motivates them toward involvement and specific programs that offer them opportunities for participation with both tangible and intangible rewards.

What specifically can your establishment do to create a favorable climate for employee activity? Here are some of the essentials:

- —*Conditions of work.* The work environment must be as safe, healthy, and comfortable as possible for employees. Potential hazards resulting from inadequate or faulty equipment or from air contaminants must be minimized. Employees cannot be motivated to adopt safe work practices or to use protective equipment if

OCCUPATIONAL SAFETY AND HEALTH STAFF REQUIREMENTS

OSH program activities/ procedures	Frequency (per week or month)	Time required (per week or month)	Qualifications of individual	Number of staff needed	In-house or consultant

Figure 1. Sample form to be used in analyzing staff requirements, by program activity or procedure.

OCCUPATIONAL SAFETY AND HEALTH STAFF REQUIREMENTS

Position	Needed, yes/no	Time, week	No. of individuals needed	Duties performed
First aiders				
Registered nurse(s)				
Part time				
Full time				
Consultant				
Practical nurse(s) (licensed)				
Part time				
Full time				
Hygienist				
Part time				
Full time				
Consultant				
Technicians (Laboratory, Medical, etc.)				
Part time				
Full time				
Consultant				
Physician				
Part time				
Full time				
Consultant				
OSH program director				
Safety engineer				
Safety committee				
Clerical				

Figure 2. Sample form to be used in analyzing staff requirements, by organization or position.

OCCUPATIONAL SAFETY AND HEALTH STAFF REQUIREMENTS

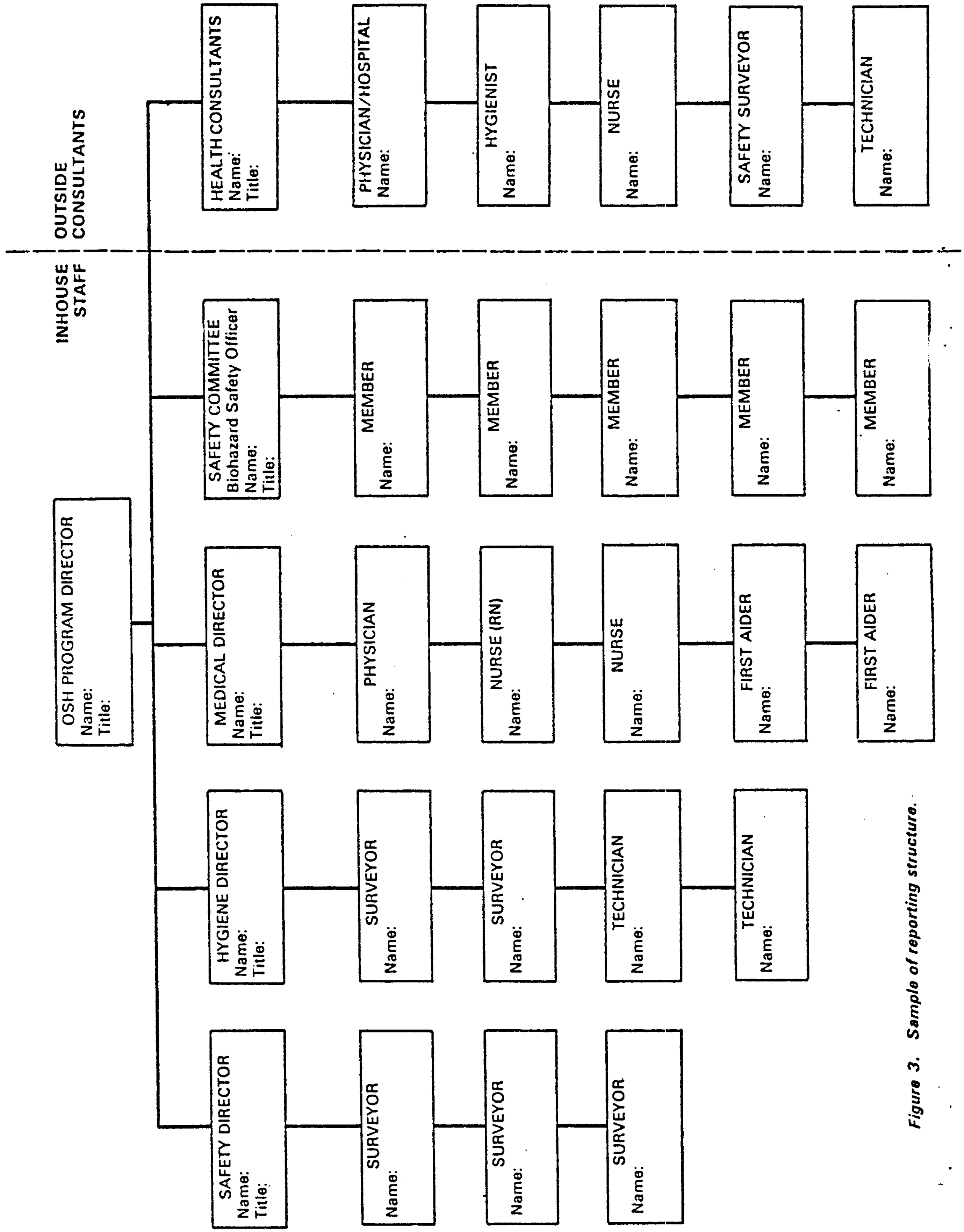

Figure 3. Sample of reporting structure.

management fails to provide an adequate work environment or fails to institute any controls to protect employees from hazardous substances and operations.

—*Commitment.* Management must convince employees through their actions that they are committed to safety and health and that they believe productivity goes hand-in-hand with a safe and healthful work place.

—*Communications.* There should be open, nonthreatening communications that allow employees to express problems and recommendations and that allow management to publicize decisions and policies.

—*Job satisfaction.* If employees find no satisfaction in the work they do, they are less likely to be motivated to follow safe work practices. A dull and repetitive job can lower employees' sense of involvement and make them less alert to hazard prevention. Some repetitive jobs are necessary, and where they are, special emphasis should be made on specific programs to stimulate employee concern for safety and health as keys to their own well being. When possible, "job enrichment" programs, job rotation, etc., should be considered. Just as unsafe conditions can cause low morale, low morale can also cause the unsafe conditions.

Any number of negative factors in employee-management relationships can work against cooperation in health and safety matters, as in any other joint effort. If work relationships are good and employee attitudes towards management positive, the more likely the success of any program.

If you would like to discover employees' beliefs in management's commitment to health and safety and just how free the communication is on these issues at your workplace, you might consider conducting a brief, anonymous survey to get employees' opinions and attitudes towards the safety and health program. This would also provide you with a method of opening channels of communication and allow you the benefits from a broader source of recommendations for improvement.

Employees could receive a simple, one-page questionnaire (such as that suggested in Figure 4); after completing it, they could drop it in a centrally located ballot box without revealing their identity.

If your establishment is large enough to prevent identifying individuals, employees can be asked to indicate their department on the questionnaire so that results can be compared on a departmental basis. The survey will identify areas for improvement in your health and safety program, but it will not necessarily tell you what ought to be done to bring about improvement. Results should be fed back to employees in group meetings or through in-house publications. Employees can then be asked to clarify specific problem areas and offer suggestions. Management's prompt response and sincere effort to institute needed improvements will reinforce their credibility as well as involve employees in the overall program.

A survey of this type is only one way of assessing and improving the climate in which your safety and health program functions. The basic act of undertaking a program to encourage participation in health and safety issues will itself help bring about a better work atmosphere. Many types of programs can be effective and can be tailored to the particular needs of your work place. The following are some ideas you might consider:

—*Survey of safety and health hazards.* Have each department make a survey of the potentially hazardous aspects of their operation. A checklist for each department could be developed by using the results of the first survey. Then a rotating employee committee could make periodic inspections of those potentially hazardous areas. This would give all employees a chance to participate at some point in inspecting and improving conditions within their own work areas.

—*Committees.* Safety, health, and hygiene committees should include employee representatives. If the representatives have some special training to assist them in carrying out their committee responsibilities and if they are well respected by their coworkers, their participation will have greater significance to their fellow employees.

—*Suggestions award program.* You can encourage employee suggestions for health and safety improvements by

SURVEY OF THE OCCUPATIONAL SAFETY AND HEALTH PROGRAM

		AGREE	DISAGREE
1.	This organization actively promotes employee safety.	☐	☐
2.	This organization actively promotes employee health.	☐	☐
3.	The health and safety of employees is put ahead of productivity here.	☐	☐
4.	New employees are given adequate training in safe work practices.	☐	☐
5.	Employees here are encouraged to make specific suggestions relating to on-the-job health and safety.	☐	☐
6.	The health and safety rules and regulations make sense to me.	☐	☐
7.	If I observed a safety hazard in my work area, I would not hesitate to report it.	☐	☐
8.	Accidents or near misses are sometimes covered up.	☐	☐
9.	This organization is fair in the way it disciplines employees for safety violations.	☐	☐
10.	Accidents are investigated promptly.	☐	☐
11.	Too many accidents here are caused by employee carelessness.	☐	☐
12.	Too many accidents here are caused by poorly maintained equipment.	☐	☐
13.	Most employees do use personal protective equipment and clothing where it is required.	☐	☐
14.	If the equipment we use were better designed, accidents could be reduced.	☐	☐
15.	The medical and/or first aid services and facilities here are adequate.	☐	☐
16.	Safety and health problems are discussed.	☐	☐

17. Comments ______________________________

____

____

Figure 4. Sample questionnaire designed to obtain employee reaction to the safety and health program.

offering awards for the best suggestions or offering bonuses for all suggestions implemented.

—*Contests*. Contests are widely used to promote safety and health. They can be directed at the individual employee or at the department. Competition can focus on the least accident record in a given period, on the best suggestions for posters, or on improved housekeeping, outstanding adherence to safety regulations, etc.

—*Recognition*. Awards can be given to employees for suggestions, as mentioned earlier, or for excellent health and safety records. A continuous bonus system can be instituted for accident-free individuals or departments. Awards can be monthly and can take various forms. Employee involvement can be recognized through articles in any in-house publications or a periodic safety and health newsletter. Award dinners can be effective in recognizing individual achievement. Department outings are a good way of honoring the "safest" work area.

—*Special training programs*. Employees can be offered special training in first aid, fire protection, air and noise sampling techniques, and other safety and health related areas. This will enhance their work skills and open new opportunities for their advancement as well as lessen your establishment's dependence on outside services.

—*Special areas for participation*. Aside from general occupational safety and health committee participation, employees can be grouped into committees to deal with specific issues such as fire protection, emergency evacuation, first aid, and the distribution and maintenance of personal protective equipment.

In determining what specific types of programs would be most effective at your establishment, you should consider the goals and interests of your employees and what kinds of awards or recognitions are likely to have the most meaning to them, but with variety.

The primary goal in increasing employee involvement is to strengthen the overall program and improve working conditions at your establishment. However, it is likely that by giving some employees added responsibilities and encouraging communication on safety and health issues from all employees, their overall morale might increase considerably.

BUDGETING FOR THE OSH PROGRAM

The person responsible for your safety and health program is also responsible for the preparation of the budget for this activity with accounting assistance. Your budget has to be realistic so as to be within your financial resources, but must be adequate to meet your needs. In general, two criteria should determine the size of your budget: number of employees and type of potential hazards in your plant.

Budget Development

To develop your budget you will have to identify which costs are related to what services and activities. In general, the following items will be included:[2]

—Labor
- salaries—professional, consultant;
- social security payments (or special pension or retirement fund payments);
- unemployment and disability insurance taxes; and
- fringe benefits such as group, life, hospital, and medical insurance; uniforms and laundry.

—Special training programs. Employees can be offered special training in first aid.

—Materials
- capital expenditures—equipment, supplies, drugs, solutions;
- depreciation of equipment, repairs;
- replacement of expendable supplies (medications, dressings, etc.); and
- office supplies (photocopy or reproduction) necessary for recordkeeping.

—Overhead
- rent, lights, heat, gas, water, ventilation;
- telephone, telegraph, postage, freight;
- fire and theft insurance;
- repairs, decoration, alteration, maintenance, and calibration;
- cleaning and custodial service; and
- product liability.

—Employee care
- special examinations;
- special immunization programs or case finding surveys; and
- emergency service (ambulance, oxygen service).

—Contingent fund
- petty cash.

—Miscellaneous
- travel, including transportation, lodging, meals;
- professional journals, textbooks;
- special education, training; and
- malpractice insurance (medical/nursing).

Other factors you should consider in preparing your budget include:

—The addition of new, potentially hazardous manufacturing or operating processes that may require special instructions, handling techniques, or equipment.

—The need for new safety and health equipment in monitoring the use of this equipment; you should be sensitive to a frequent need for calibration or excessive maintenance, thus suggesting replacement.

—The addition of new health maintenance programs.

—The growth of your plant such that satellite dispensaries or services may be required.

—Change in the number and time of work shifts.

Program Finances

Because of differences in methods of cost-accounting among various workplaces, it is rarely possible to compare the cost of one in-plant program with another. One company will back charge certain items of overhead to the safety and health department, whereas others will exclude these same items from operating

[2]Organization and Operation of an Occupational Health Program. H. Howe. Journal of Occupational Medicine, 17(6):360-400, June 1975.

costs. Therefore, how your company handles bookkeeping items will influence your program costs.

Although numerous studies have been made to determine an average annual cost per employee for safety and health programs, there are too many variables to come up with uniformly accurate figures. As a rule of thumb, a large program could provide good service at a per-employee annual cost of approximately $25; however, special hazards or smaller workplace size may increase this cost to $50 or more per employee.

Medical costs per employee will often diminish as a company enlarges; some surveys indicate an inverse relationship between the per-employee cost and the company size.

In short, there is no way to prescribe the exact size of your budget for safety and health. As your program becomes more efficient, however, your costs should decrease.

Use the following three budget sheets (Figures 5-7) to identify the major cost elements in your program.

Benefits

Since your safety and health program will not be a revenue producing operation, it will be easy to slight it when budget allocation occurs. However, the benefits of a preventive safety and health program can lead to:

—increased productivity;
—reduced absenteeism and illness;
—reduced worker's compensation rates;
—reduced injury, severity, and frequency rates; and
—improved employee morale.

The funds earmarked for your safety and health program should be treated as the scarce resource they are and be allocated to provide the most benefit for the dollar.

BUDGET WORKSHEET #1
OCCUPATIONAL HEALTH AND SAFETY RESPONSIBILITY, IN-HOUSE COSTS

Item	Cost per year	Cost per employee hour worked*
LABOR		
Health salaries		
(Physician, nurse, counsellors)		
Safety salaries		
(Safety engineer, industrial hygienist)		
Fringe and other costs		
(FICA, insurance, pension, etc.)		
Sub-total, labor costs	______	______
MATERIALS		
Equipment purchase		
(Amortized over life of equipment)		
Equipment maintenance		
(Include depreciation, repairs calibration, guarding)		
Supplies		
Medical and safety		
Office		
Promotional (in-house)		
Sub-total, supplies	______	______
OVERHEAD		
Rent and associated costs		
(Include heat, light, etc.)		
Communication		
(Telephone, postage, brochures)		
Ongoing maintenance		
(Cleaning, repair, security)		
Sub-total, overhead	______	______
MISCELLANEOUS (Itemize)		
OUTSIDE SERVICES (See Worksheet 2 for details)		
FUTURE CONSIDERATIONS (See Worksheet 3 for details)		
Sub-total, future considerations	______	______
TOTAL YEARLY COSTS, HEALTH AND SAFETY	______	______

* Use 2000 hours/year for each full-time employee.

Figure 5. Sample budget worksheet for in-house costs.

BUDGET WORKSHEET #2
OCCUPATIONAL HEALTH AND SAFETY PROGRAM, OUTSIDE SERVICES

Item	Cost per service*/unit	Number of unit occurrences per year	Cost per year
LABOR			
Health consultant fees (Physician, nurses, industrial hygienists)			
Safety consultant fees (Safety engineer)			
Employee treatment program (Emotionally stressed employees, alcoholism, drug abuse)			
Specialized instruction programs (Seminars, on-and off-site)			
Sub-total, labor	______	______	______
MATERIALS			
Promotional materials (Visuals, paycheck stuffers, literature rack, etc.)			
Equipment rental (Monitoring equipment)			
Personal protective equipment (Company subsidized)			
Association costs (Accreditation programs, safety/health associations)			
Sub-total, materials	______	______	______
OTHER SERVICES (Itemize)			
Sub-total, other services	______	______	______
TOTAL, OUTSIDE SERVICES HEALTH AND SAFETY	______	______	______

* Employee examination, tests, air samples, etc.

Figure 6. Sample budget worksheet for outside services.

BUDGET WORKSHEET #3
OCCUPATIONAL HEALTH AND SAFETY PROGRAM, FUTURE CONSIDERATIONS

Item	Month installed current year	Cost, one time safety health analysis	Continuing costs, safety health surveillance	Cost per year
NEW PROCESSES				
NEW MANUFACTURING TECHNIQUES				
NEW EQUIPMENT				
EXPANSION HEALTH/ SAFETY PROGRAM				
New program				
Current plant				
Satellite operations				
Overseas operations				
OTHER FORESEEABLE CONSIDERATIONS (Itemize)				
TOTAL, FUTURE CONSIDERATIONS	________	________	________	________

Figure 7. Sample budget worksheet for future considerations.

RECOGNIZING AND CONTROLLING SAFETY AND HEALTH HAZARDS

OVERVIEW

Identifying potential hazards may be one of the most difficult tasks in your safety and health program. Everyday familiarity with operations may dull your awareness of factors in the work environment. Far too often, however, we fail to follow what our senses tell us, and we accept conditions that can result in injury and illness. The first step in hazard recognition is to be sensitive to the work environment and take heed of the danger warnings your senses provide. By trusting the evidence of your own senses and taking action when they are offended, you have taken a significant step in your health and safety program.

In many companies, all employees are encouraged to inspect their workplaces each day and to report any potentially hazardous conditions. Employees who are constantly on the alert are of great value in preventing injury or other undesirable events to themselves or others. Training your employees to do this constitutes a critical first step in a system for hazard recognition.

RECORDKEEPING

Accurate injury and illness records are invaluable in providing information for your safety and health program. Since injury and illness recording is already a requirement under law (i.e., OSHA Forms 101 and 200), you should use this information to your advantage to:

—reveal which operations are most hazardous;
—determine weaknesses in your safety and health program;
—judge the effectiveness of your program by comparing it with past records or records of other similar plans;
—aid in accident analysis and investigation;
—identify the causes of occupational diseases by relating them to particular exposures, or processes, or both; and
—satisfy legal and insurance requirements.

Accurate records can be used to analyze illnesses and injuries so problem areas can be identified and corrected. One way to compile data would be to list the following for each accident or illness:

—name of person;
—job title of person;
—apparent cause of injury or illness;
—type of work being performed;
—extent of injury or illness;
—part(s) of the body affected; and
—equipment, or material, or both being used.

For example, such an analysis may show employees have had 50 eye injuries in 1 year, which would indicate the need to enforce eye protection measures. These forms can be cross indexed to reveal employees highly susceptible to accidents as well as supervisors who do not enforce safety and health practices. They can also be used for calculating the costs involved in an accident or illness.

In addition to illness and injury records, you should maintain an accurate and uniform system of industrial hygiene records on all environmental agents in your workplace. Industrial hygiene records are essential for evaluating and controlling employee exposures and may protect you in legal cases where your employees become ill from sources other than those in the workplace. For example, correlation of industrial hygiene records with medical records (preemployment physicals and regular physicals) can help identify the origin of an illness and whether it is occupational or nonoccupational. Also, these records as well as illness records can be correlated with medical records to detect hazardous conditions or susceptible individuals (i.e., those who contract diseases more readily than others). The main point is that these records and data be obtained and maintained in a systematic manner. If your establishment is not prepared to collect these data, you should seek assistance from a qualified industrial hygienist.

Your industrial hygiene records should be:

—*Complete.* Records should at a minimum include date, type of equipment, name of surveyor, department or work area surveyed, operations in progress, type of agents, levels, exposure time, tolerance limit values, number of employees exposed, etc.

—*Up-to-date.* For serious hazards, surveys should be done regularly to minimize exposure and to see if control equipment is operating properly. After any new process is begun or altered, another survey should be conducted.

—*Retained.* Records should be retained to furnish a detailed exposure record on all employees. They should be retained long enough so that the latent period between exposure and onset of an illness or disease manifestation is covered. For example, asbestosis is manifest after approximately 20 years. NIOSH often recommends retention for length of employment plus 30 years.

Uniform records should follow the OSHA Standard for Environmental Record Keeping and Retention.

INSPECTIONS

Since recordkeeping alone is not sufficient to maintain safe conditions, employee work practices as well as every portion of your physical plant, equipment, and machinery should be subject to regular inspections. These inspections should be both formal and informal and include both employees and supervisors. Together they should develop checklists, schedules, and guidelines. If you use employees most familiar with the processes, machines, conditions, and practices, this will promote their involvement and help them recognize their responsibilities in this area. If your plant or facility is kept as clean as possible, this will improve employee morale and help in the inspection process by not covering up potential hazards.

Although you will need to develop your own checklist along with the SEI covering your particular hazards and processes, the following list of basic work hazards can be used as a guide:

—pinch points
—catch points
—shear points
—squeeze points
—flying objects
—falling objects
—"run-in" points
—electricity
—gases
—heavy objects
—chemicals and flammables
—hot and cold objects and radiation
—sharp and pointed objects
—slippery surfaces

You should also refer to the accident statistics published by your state and the federal government and to "Accident Facts" published annually by the National Safety Council. These statistics frequently disclose potential accident causes that may exist in your plant but that have not, as yet, resulted in injuries.

The following is a list of some unsafe work practices:

—Do employees operate equipment without authority?

—Do employees operate equipment at unsafe speeds?

—Have guards been removed or been rendered ineffective?

—Do people use defective tools or equipment; or use equipment in unsafe ways; or use hands or body instead of tools?

—Do people overload or handle materials unsafely?

—Do people stand or work under suspended loads, open hatches, or scaffolds; or ride loads; or get on or off equipment or vehicles in motion; or walk on railroad tracks; or cross car tracks or vehicular thoroughfares except at crossings?

—Do people repair or adjust equipment in motion; under presure; while electrically charged; or containing dangerous substances?

—Does anyone or anything distract workers?

—Are personal protective equipment or safety devices not used or poorly suited to your needs?

—Is there poor housekeeping or a failure to remedy unsanitary or unhealthful conditions?

—Do employees engage in horseplay or pranks within the work area?

In addition to regular inspections, the mechanical engineer and the maintenance superintendent (or the person who corresponds to this function) should make frequent trips through your plant so that necessary work orders for guards or for correcting faulty equipment can be written up on the spot. These staff members should also watch for unsafe conditions and practices and report them. Correction and followup procedures should receive immediate action.

BUILDING SAFETY INTO YOUR OPERATIONS

In most industrial accidents, both an unsafe condition and an unsafe act are contributing factors. Unsafe conditions can be a direct cause of accidents themselves and can often lead people to perform unsafe acts. Unsafe acts can result from poor machine design, inadequately planned methods, or other engineering deficiencies. Thus, by eliminating hazards caused by unsafe conditions, you may also reduce the likelihood of injury from an unsafe act.

Design for Safety

The ultimate goal is to design environments, equipment, and job procedures that minimize hazards to your employees and ensure that your products can be used safely by purchasers. When a high degree of safety is incorporated into equipment design or the planning of a process, your need for training and supervision to control unsafe acts will be less frequent.

Your company policy should specify that employee protection must be designed and built into the job before the job is executed. To add this element after an operation has begun is usually more costly, less efficient, and less effective. In evaluating the safety aspects of your machine design, some of the following general points may be useful:

—Design the machine so that it is impossible for the operator to get at the point of operation or any other hazard point while the machine is operating.
—Design the machine so that corners and edges are rounded.
—Locate machine controls so that the operator will not be in the vicinity of the point of operation while actuating the controls.
—Place the controls so that the operator will not have to reach excessively or move his body off balance to operate the machine.
—Build power transmission and drive mechanisms as integral parts of the machine.
—Build overload devices into the machine.
—Design the machine for single-point lubrication.
—Design mechanical instead of manual holding devices.
—Design a mechanical device for feeding and ejecting parts so as to eliminate the use of hands for such operations.
—Minimize motor "drift" time by using braking devices.
—Provide fail-safe interlocks so that the machine cannot be started while it is being loaded, unloaded, or worked on.
—Provide a grounding system for all electrical equipment.
—Provide standard access platforms and ladders for inspection and maintenance of equipment.
—Design component parts of equipment for easy and safe removal and replacement and to facilitate maintenance.
—Minimize possible sources of objectionable noise.

Purchasing

Your safety operations should be closely tied not only with your engineering department but also with the purchasing department. You should require suppliers to provide information on contents of all raw materials and toxicity information where it is available. If the supervisor does not have safety data sheets, you may wish to contact the American Industrial Hygiene Association for relevant copies. Purchasing from a vendor who will not help to identify and correct potential hazards misses a critical opportunity for preventing undesired, costly events.

Your staff with safety and health responsibilities should devise and put in writing safety standards that will guide in purchasing. These standards should be set up so that the hazards involved in a particular kind of equipment or material are identified before use and are controlled or eliminated where possible (as by substituting a safe material for a dangerous one or by using guards).

PRIORITY SETTING

Once you have identified and evaluated your health and safety hazards, you should set priorities for correction. Of course those hazards creating an imminent danger to your employees should be corrected first. Those corrections requiring a large financial investment, or technological expertise, or both may take more time and planning, but an optimal balance must be made between the economic impact and employee health.

Your program for improvement should be broken into short- and long-term goals. It must have, from the outset, involvement and support from employees, supervisors, and management. Each of these groups must actively participate to keep the program in the right spirit and sequence. The three worksheets at the end of this chapter (Figures 8-10) can be used to outline your needs for improvement and to assign responsibility to staff members.

CONTROLLING AND CORRECTING HAZARDS

There are three basic means of controlling or correcting hazards:

- —Engineering controls—physical changes in processes or machinery designed to eliminate or control hazards,
- —Administrative controls—changes in work practices and organization to eliminate or control hazards, and
- —Personal protective equipment—clothing or devices worn by employees to protect them against hazards and contaminants.

In the controlling and correcting process you may use all three. In general, however, the most preferred control is through engineering, and the least preferred is personal protective equipment. For more specific information on the use of these controls, refer to the chapter in this manual on personal protective equipment and chapters on specific hazards.

Although financial constraints may limit you from making full use of engineering controls immediately, your long-term goal should be to include them as new processes, materials, techniques, and machinery are introduced. It is very possible you will have some processes for which personal protective equipment is the only feasible hazard control. In those instances, you should consider instituting administrative controls to lessen the need for personal protection. For example, if you have employees needing to wear respirators 8 hours a day, you should consider the possibilities for rotating shifts or work assignments to limit the number of hours per day that each person must wear this device.

INCENTIVES

Developing and maintaining an interest in safety and health at your workplace is a difficult task. In general, people have a tendency to overlook practices or programs to which they do not feel a strong personal commitment. In addition to educating your staff to the importance of sound safety and health practices and to demonstrating your continued interest in this area, you must develop incentives to maintain employee interest in the program.

Listed here are a few examples of possible elements in an incentive program. However, your incentive program will have to reflect the values and interests of your employees so it can be meaningful to them.

Part of the Job

Safety and health should continually be stressed as part of each person's job. Employees should see safety and health as part of their responsibility to themselves and their fellow workers.

Cost of Accidents

The far reaching costs of accidents should be stressed to both management and employees. This can include such factors as increased insurance and repair costs, increased work loads, loss of employee time, etc.

Recognition of Good Safety Practices

Employees with strong safety records should be recognized through any in-house publications or community newspapers or should be singled out for attention by awards or banquets. Employees who suggest improvements in the safety and health program should also be recognized.

One company offered $100 each month to employees selected at random (by employee badge number) if their work group experienced no accidents or absenteeism during the 1-month period. At the end of each month, $50 was deducted for any injury in the group and $25 for each absence.

Consideration of Safety and Health Activities in Overall Performance Evaluation

Employees should be aware that their safety and health activities are an element in determining any promotions or pay increases as well as any disciplinary actions or terminations they might receive. This is especially true for supervisors.

For more specific information on employee motivation, see the section in this manual on the techniques for employee involvement.

SUGGESTED PRIORITIES FOR CHANGE

Department ______________ Prepared by ______________ Date ______________

Hazardous conditions	Priorities (Rank Order)
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Figure 8. Sample worksheet to be used for determining improvement priorities.

RESPONSIBILITY FOR CHANGE

Department ______________ Prepared by ______________ Date ______________

Foreman or Supervisor	OSH Staff	Management	Consultants

Figure 9. Sample worksheet to be used for classifying hazardous conditions in terms of responsibility and priority for improvement.

ACTION FOR CHANGE

Priority # ____________

Department ____________ Prepared by ____________ Date ____________

Description of hazardous condition	Recommended action	Person accountable	Dates: Start	Dates: Complete	Cost

Figure 10. ***Sample worksheet to be used for determining action to be taken for improvements.***

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MATCHING THE EMPLOYEE TO THE JOB: SELECTION AND TRAINING

To be effective, your safety and health program should provide for the proper selection, placement, and training of employees. These elements complement one another, since proper selection for a particular job results in higher productivity as well as lower turnover, absenteeism, and overall training costs.

PREPLACEMENT EXAMINATIONS

Just as past employment, education, and personal references are important in your hiring procedures, so should the past and present health of the employee be important. Preplacement examinations should be the first step in your safety and health program.

The preplacement examination is made to determine and record the health condition of prospective workers so they can be assigned to jobs suitable to their mental ability and physical capacity. This should also help ensure that their disabilities, if any, will not affect their performance, safety, and health or that of others.

It is especially important in this examination to identify workers with heart disease and back problems or those who may be pregnant so that they can be placed in positions that will not adversely affect their health. By collecting preplacement data on workers, you are providing yourself with added protection from potential liability. For example, examinations for hearing can identify any hearing impairments suffered by prospective or transfer employees before any noise exposure at the workplace.

The scope of these examinations should be determined by your physician using information supplied by nurses, industrial hygienists, and engineering personnel. The nature of your industry, its inherent hazards, and the variations among jobs in physical demands and in health exposures will indicate what tests should be included in the examination. Job transfer within your workplace also requires medical evaluation.

It must be remembered when establishing medical examinations that specifications of the Medical Requirements Standards of the Act must be followed. For example, tests for asbestos, benzene, vinyl chloride, or suspect carcinogens must be performed as specified in the standard. This is also true of monitoring studies and medical surveillance.

MEDICAL FOLLOWUP AND SURVEILLANCE

In addition to preplacement examinations, you should consider providing employees periodic examinations. If your operations are nonhazardous, 2- or 3-year intervals can occur between examinations. It is recommended, however, that employees past 40 years of age be examined annually because certain degenerative disorders occur more frequently after this age.

You should require regular examinations for workers who are exposed to health hazardous processes or materials, or whose work involves responsibility for the safety of others, such as vehicle and crane operators. For example, hazardous substances like lead or carbon tetrachloride are usually subjected to process controls that will protect workers from poisoning. However, you would be wise to require periodic examinations of such workers to be certain that your engineering and hygiene controls are continuing to be effective. This procedure also enables early detection of the hypersusceptible individual and the worker who engages in unsafe practices that defeat the control measures. Any employees having on-the-job difficulties that may be health related should receive special examinations.

The existence of special problems leading to or compounding work difficulties can sometimes be determined through techniques other than medical examinations. Supervisor/employee interviews, interim medical history, observation of personal habits and workplace relationships, and analysis of attendance records can provide additional insight into problem areas (e.g, Figures 11a, 11b).

Upon termination of a worker's employment, many companies perform examinations and record the findings. This is particularly important where operations involve exposure to health hazards such as lead, benzene, silica and asbestos dust, or harmful noise. The effects of these exposures are complex and a long time period may elapse before they appear.

ERGONOMICS

The information obtained from your medical and hygiene program will help you assess the overall fit between individual workers and their jobs. This study of the relationship between the employee and the work environment is known as *ergonomics*. It involves evaluating the kinds of stresses, both physical and mental, that employees encounter in their jobs. Ergonomics tries to reduce or eliminate work-related stress by evaluating the worker's emotional and physical makeup in relation to the demands of a particular job. When you consider the enormous variations in height, weight, age, skills, and strength among men and women and the equally enormous variation in jobs, machines, and tools, the need for such an evaluation is obvious.

By systematically evaluating the physical and mental stress employees face on the job, methods and techniques for reducing or eliminating them can often be devised. Evaluating the ergonomic factors in your establishment means looking closely at the jobs employees perform, what motions are required, how often they are performed, how difficult they are physically and mentally, how monotonous they are, etc., and then considering your employees' capabilities to function in these positions.

To assist in the evaluation, it is helpful to keep in mind some overall signs of ergonomic stress (e.g., frequent errors, boredom, finger-hand-arm or foot-leg injuries or soreness, muscle cramps and strains, back injuries) and try to identify their causes.

Back injuries are among the most common work-related disabilities. They often result from employees lifting or carrying weights that are too heavy or from lifting them too frequently. It is important to evaluate just how physically demanding the jobs in your establishment are. Here are some guidelines for defining heavy, medium, and light work:

- —Heavy: Lifting 100 lb or more with frequent lifting, or carrying of objects weighing up to 50 lb, or both.
- —Medium: Lifting 50 lb maximum with frequent lifting, or carrying of objects up to 20 lb, or both.
- —Light: Lifting 20 lb maximum with frequent lifting, or carrying of objects weighing up to 10 lb, or both.

The ability of an employee to perform a job falling into one of these categories depends on a number of factors such as age, size, sex, and physical condition. Environmental factors such as heat or cold, humidity, noise, fumes, etc., may also have an effect and should not be overlooked. Employees performing work beyond their capabilities or in an uncomfortable environment will become more easily fatigued, suffer more accidents, and become ill more frequently. Examining such statistics by department, or job category, or both can help to pinpoint problems either on the job itself or as a result of the assignment of particular employees to it.

Applying the results of your survey can take many forms, such as better training for employees; new, more properly designed equipment; job rotation; or reassignment.

The following section discusses some possible solutions to a few ergonomic problems.

Physical Demands

Limits or guidelines on maximum weights to be carried by workers of different age, sex, and physical condition categories should be established. The following table[1] (page 29) shows one set of suggested guidlines.

[1]Fundamentals of Industrial Hygiene. J. B. Olishifski and F. E. McElroy. National Safety Council, Chicago, IL 60611. 1971. p. 318.

OCCUPATIONAL TOXIC EXPOSURE HISTORY

Employee Name ____________ Social Security Number ____________ Job Classification ____________ Today's Date ____________

Please answer the following questions. Begin with present job, list all jobs in chronological sequence you have held whether full time or part time.

COMPANY NAME OR SELF-EMPLOYED. City, state. (Include any military service.)	DATES From Mo./Yr.	To Mo./Yr.	AVG. Hours/ week	JOB TITLE or major activities*	LIST POTENTIAL HAZARDS EXPOSED TO: *Physical* (Noise, radiation, vibration, electrical, shock, temperature extremes, etc.)	*Chemical* (Mercury, lead gases, fumes, acids, solvents, caustics, fly ash, dust, etc.)	*Biological* (Viruses, bacteria, parasites, fungus, animal bites, etc.)	*Psychological* (Boredom, work shift, fatigue, risk of falling or being buried, repetetive tasks, etc.	PERSONAL PROTECTIVE EQUIPMENT WORN ON JOB (Hard hats, respirators, ear plugs, gloves, aprons, goggles, safety shoes, etc.) List for each job

*Be as specific as possible. If you held more than one job with the same employer, list each job title or major activity. Indicate by checkmark if any of your jobs had a physician available for workers.

Figure 11a. An example of the type of questions to be asked to determine past occupational exposures.

OCCUPATIONAL TOXIC EXPOSURE HISTORY (continued)

I. If you have had any secondary work such as firefighting, civil defense, farming, gardening, please list:

Type of work	Dates From	To

II. List hobbies and active sports you do (past and present) such as painting, woodworking, welding, hairdressing, scuba-diving, etc.

III. Please comment on any work-related experiences you have had that you believe may have been harmful to your health.

IV. Have you or your present of former spouse had any adverse reproductive outcome? If so please indicate circumstances (e.g. stillborn, deformed, miscarriage, irregular menses, etc.)

Figure 11 b. (Reverse of Figure 11 a.) An example of the type of questions to be asked to determine nonoccupational exposure.

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REASONABLE WEIGHT LIMITS FOR OCCASIONAL LIFTING

Age (years)	Male	Female
14-16	33 lb	22 lb
16-18	42 lb	26 lb
18-20	51 lb	31 lb
20-35	55 lb	33 lb
35-50	46 lb	29 lb
Over 50	35 lb	22 lb

From the Swiss Accident Insurance Institute.

You should be careful not to use different physical capabilities as a basis or excuse to discriminate. With the proper equipment and training, most jobs can be performed by people with widely varying statures and strengths. Installation of equipment and machinery for lifting and carrying heavy objects is often the best way of eliminating excessive physical stress.

If manual lifting and carrying are going to be done, instruction of employees in proper methods is essential. Several such methods can reduce stress and the risk of injury. The illustrations (p. 32) suggest some techniques.

Adjustable chairs, stools, and benches for sedentary employees are essential to work comfort. Sometimes a new, overall work layout with better access to materials, equipment, and controls will ease the work.

If the work pace is such that employees become physically exhausted, you might try more frequent or differently scheduled rest periods. The same can hold for mentally fatiguing or boring work. Rotation of work assignments, or redesigning jobs, or both might also prove helpful. Don't overlook other environmental conditions, such as noise, that can add to the mental or physical stress of a job.

A wide variety of special tools has been created for static, repetitive work. For example, a rachet screwdriver is preferable to an ordinary one. The pushing motion required to operate a rachet tool is often less stressful than the twisting motion. Specially designed pliers with curved, padded, spring-open handles and thumb stops are much easier to use repeatedly than standard pliers. Easy access to parts in table assembling operations is also important to avoid constant reaching and stretching motions.

ALCOHOLISM AND DRUG ABUSE

Alcoholism, or problem drinking, is only one of many factors that can affect employee morale and performance. Of the 100 million people in the United States who use alcoholic beverages, it is estimated that 8 million, or about 1 in 13 (7.7%), have a drinking problem. Over four million of these people work in industry. The cost to the national economy in hospitalization, days lost from the job, inefficiency at work, accidents, and loss of skilled workers because of alcoholism is in excess of $10 billion a year. On the basis of numerous studies, it has been determined that 5% of the employees in any industry will have a drinking problem. Problem drinking ranks third along with heart disease, cancer, and mental illness as one of the nation's four most serious disorders.

Studies indicate that employees with drinking problems lose an average of 22 to 30 working days each year from the effects of alcohol alone and have twice as many accidents as other employees. In addition, they have three to four times as many off-the-job accidents and a 2½ times greater absence rate. An employee with a drinking problem is in desperate need of help. Much can be done to rehabilitate the employee if the disorder is recognized.

For years, the only method of handling the alcoholic in industry was dismissal. This led to ignoring or covering up for the problem drinker until the situation became so bad that punitive action was taken. Not only the drinker's family was affected; the employer lost the services of a skilled employee with years of investment in training. The present method of dealing with the problem drinker is treatment rather than punishment. By adopting definite policies, which are carried out consistently, you can solve many of these problems.

There are three main elements in a problem drinking situation:

- —the individual problem drinker himself (rehabilitation),
- —the people who surround the problem individual, and
- —economics of the situation relating to the problem drinker.

Your workplace's policy on alcoholism and drug abuse must be clearly stated and understood by employees and management. The direction of this policy can have a significant effect on whether your employees seek help on their own

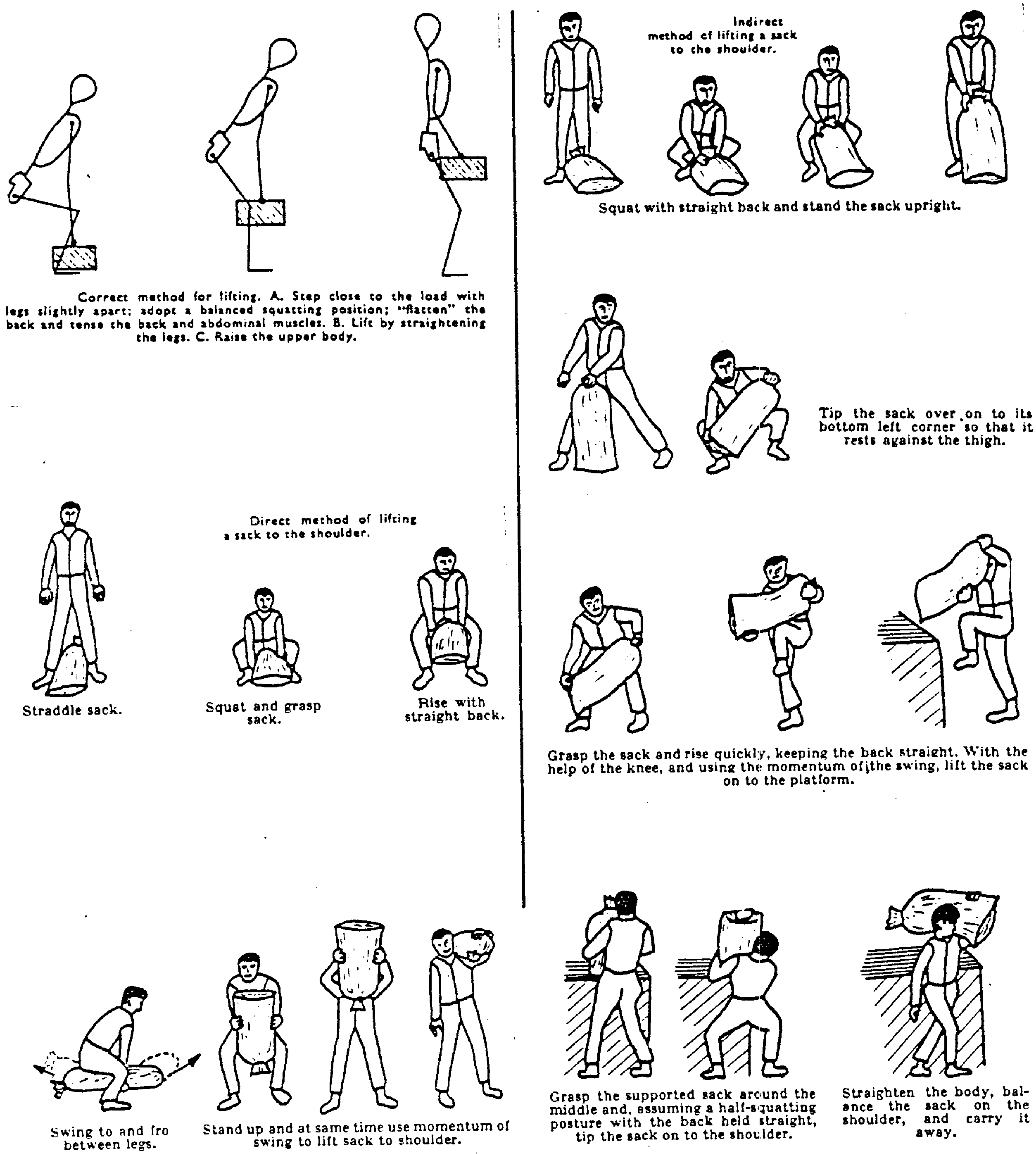

Figure 12. Manual handling of various loads in industry. (Reprinted with permission from: Encyclopaedia of Occupational Health and Safety. Vol. II. International Labor Office. McGraw-Hill. 1974. pp. 778-779.)

or wait for managerial action. A typical policy statement might include the information below:

> The use of alcohol by an employee becomes a matter of concern to this company when it interferes with his or her job performance, conduct, attendance, and safety. This company is committed to the rehabilitation, wherever possible, of the employee whose drinking becomes a problem.

Certain principles should underlie the operation of your establishment's program. These could include such points as:

- —Alcoholism, or problem drinking, is an illness and should be so treated.
- —Your company's concern is only with problem drinking. There is no interest in social drinking and no desire to intrude upon the employee's private life.
- —The majority of employees who develop alcoholism can be helped to recover, and your company will offer appropriate assistance.
- —The decision to seek diagnosis and accept treatment for any suspected illness is the responsibility of the employee. However, continued refusal of an employee to seek treatment when it appears that substandard performance may be caused by any illness is not tolerated. Alcoholism will not be an exception to this commonly accepted principle.
- —It is in the best interest of employees and your company that when alcoholism is present it should be diagnosed and treated at the earliest possible stage.
- —Confidential handling of the diagnosis and treatment of alcoholism is essential.

Although there is no typical alcoholic person, industry has historically developed a pattern of reaction to "alcoholics," whether real or imaginary. Alcoholism has been covered up until work performance and behavior have become so intolerable that the person was fired. This means that alcoholism has become a recognized problem mostly for people who have many years of service and are at their peak of experience, skill, and productivity.

Despite the efforts of your program, not all problem drinkers will cooperate in their treatment and you may have to consider termination or dismissal in cases where no improvement can be expected.

The person in a key position to help the employee with a drinking problem is the supervisor. However, problematic behavior and changing work patterns can indicate any number of disorders, not necessarily alcoholism. *No one expects the supervisor to determine whether someone is an alcoholic or whether he or she has a personal problem.* The vital role of the supervisor in solving the problem of alcoholism should be very clearly defined.

To provide your supervisors with guidelines for handling possible alcoholism-related problems, the following procedure is suggested:

What NOT to do:

- —*Do not diagnose.* Supervisors should not attempt to identify employees having alcoholism and other behavioral problems. This is a case-finding and diagnostic function that calls for special training and expertise.
- —*Do not discuss "drinking."* Except in situations where drinking or evidence of intoxication occurs on the job or while performing job-related duties, supervisors should not discuss drinking or "drinking problems" with employees under their direction.
- —*Do not write "alcoholism" into the record.* No supervisor should enter any document or memorandum into an employee's personnel record bearing the diagnosis or supposition that an employee has alcoholism.
- —*Do not dismiss without offering alternatives.* No supervisor should terminate a previously satisfactory employee for unsatisfactory performance before giving the employee an opportunity for diagnosis of any disorder, including alcoholism, that could be remedied through treatment.
- —*Do not forget company policy.* No other actions should be taken by supervisors that are in any way inconsistent with your company's policy of recognizing alcoholism as a treatable disorder.

What TO do:

- —*Document performance.* Performance of employees should be thoroughly *documented* (by time and date) through the use of confidential standard appraisal forms and observational data kept by supervisors. The supervisor should periodically compare these notations with previous observations of an employee's work to determine what changes, if any, have occurred.

—*Schedule performance interview.* If performance deteriorates significantly, the supervisor could then schedule a *special performance appraisal interview* with the employee to:
- •Establish a plan for improvement.
- •Advise him/her that: work behavior must be corrected; private or company counselors are available on a confidential basis to assist him/her if personal problems are contributing to the performance decline; and medical assistance is available to help with any physical ailments that may cause performance problems (it is recommended that the supervisor send the employee for a medical exam).

—*Arrange for appointment with counselor.* If the employee indicates an interest in a confidential interview with a counselor, the supervisor should arrange for an appointment.

—*Review improvement plan.* The supervisor should meet periodically with employee to review the established plan for improvement.

—*Schedule second performance interview.* If the problems continue, the supervisor should schedule another performance review within a few weeks, depending upon the seriousness of the problems.

—*Take appropriate action.* If these interviews and counselling do not result in more adequate performance, the supervisor will take the appropriate disciplinary action.

—*Handle alcoholism as a chronic illness.* An employee with alcoholism who accepts treatment may or may not have an occasional relapse. If such *relapses* are long enough to affect attendance or performance, the suggested criteria for administrative decisions is, "What action would be consistent with the way this company would handle any other chronic illness affecting performance to a similar degree?"

The role and responsibility of counselors within your program include:

—Confidentially discussing potential alcoholism and/or related problems with employees.

—Referring employees to treatment agencies.

—Advising supervisors, upon request, on the handling of an employee with a drinking problem within the job situation.

—Maintaining followup of all cases.

—Developing and maintaining training programs for supervisors in dealing with troubled employees.

—Developing a thorough acquaintance with all community resources for helping those with drinking problems and other behavioral disorders.

Although statistics are available that estimate the number of problem drinkers in the work force, no reliable statistics exist on employees suffering from drug abuse. As in the case of alcoholism, potential drug abuse problems can be initially identified by monitoring work performance.

Many of the techniques suggested for alcoholism can be equally useful in dealing with drug addiction problems.

DEVELOPING A TRAINING PROGRAM

An effective accident prevention and occupational health hazard control program demands proper job performance. When people are trained to do their jobs properly, they will do them safely. This means that your supervisors must know how to train an employee in the safe, proper way of doing a job, as well as know how to supervise. It also means that supervisors should be familiar with good training techniques. Safety professionals (whether on staff or consultants) can help your supervisors design such training programs.

Training Needs

You should employ training programs:

—for new employees,

—when new equipment or processes are introduced,

—when procedures have been revised or updated,

—when new information must be made available, and

—when employee performance needs to be improved.

Here are some indications that you might need a good training program:

—proportionate increase in accidents and injuries,

—insurance rates higher than other companies in the same type of work, or a rate that is on the upswing,

—excessive equipment damage or product spoilage,
—high labor turnover, and
—expansion of plant and equipment.

Program Objectives

Training programs should have clear objectives that determine the scope of the training and guide in the selection and preparation of training materials. To make sure the objectives really cover the needs of those to be trained, you should review the trainees' job descriptions and job analyses. Hazards or potential accidents associated with each step of a job should be identified, and a solution for each hazard should be developed to minimize or eliminate the exposure. These, along with personal observations and performance tests, will reveal where training is needed. As a minimum, all safety training programs should cover the work station, personal protective equipment, general housekeeping, and emergency action plans.

Training New Employees

When new employees come to work, they immediately begin to learn things and to form attitudes about your company, their jobs, bosses, and fellow employees. This happens whether or not you make the effort to provide training. So new employees can learn the things they need to know and develop good work practices, you should develop systematic training programs.

When beginning employment, each of your employees should know your company's safety policy. Unfortunately, the amount that can be learned during the induction procedure is limited, and unfamiliarity with their surroundings and interest in matters of more immediate concern make it difficult for your employees to absorb and retain much safety and health instruction. You should consider, therefore, what information must be given first, and the best way to present it. The following things should be communicated to each employee:

—The management of your company is sincerely interested in preventing accidents and illnesses.
—Most accidents are preventable.
—Although a program of safeguarding and controls operates throughout the workplace, management is willing to go further as needs and methods are discovered.
—Employees are expected to report any unsafe conditions encountered while working to their supervisors.
—No employee is expected to undertake a job until he or she has learned how to do it and is authorized to do it by his or her supervisor.
—No employee should undertake a job that appears to be unsafe.
—Any employee suffering an injury, even a slight one, is required to report it at once.

In addition to these points, any rules that are a condition of employment, such as wearing of eye protection or safety hats, should be understood and enforced at once.

Preliminary Instruction

A safety film can do a good job of stimulating and instructing new employees. It changes the pace, relieves the monotony of much talking, and can present a carefully planned message in exactly the same way to every new employee.

When new employees have a preplacement examination, the doctor or nurse should tell about the work of the medical department as it relates to the employees and encourage them to make use of its services. Medical personnel, as well as staff providing general safety information, should emphasize the importance of reporting all injuries, day or night, on any shift.

The final step in the safety and health training provided by your employment office should be to emphasize the importance of the supervisor. Your employees must understand that the supervisor is responsible for job training and that such training will include safe work procedures. So there will be no gap and no contradiction between the information given in the employment office and that given later, supervisors should be familiar with the full scope of your company's safety training program.

THE ROLE OF THE SUPERVISOR IN TRAINING

In each department, supervisors should give new employees additional safety instruction. Although this may cover some of the points made in the employment office interview, it should focus specifically on the kind of work the employee will perform.

On-the-job training is widely used because the trainee can be producing while being trained. Whether the supervisor or another staff member does the instructing, the training should be carefully planned and organized.

In too many cases, on-the-job training is a hit-or-miss procedure where the trainee is told to learn a job by following another worker around. In these situations, the lead worker may be too busy to do any training, may not know good training procedures, or may even be reluctant to train another employee to do his job. Therefore, the person to whom the trainee has been assigned should be one who knows the job thoroughly, is a safe operator, and has the patience, time, and desire to help others.

Some advantages of on-the-job training are:

—The worker is more likely to be highly motivated because the guidance is personal.

—The instructor can identify specific performance deficiencies and correct them promptly.

—The training results can quickly be judged since real equipment is being used and the finished work can be evaluated.

—The training is practical and realistic and can be geared to individual needs.

Timing is important; not only do the trainees like to get help when needed, but the supervisor can judge the trainee's progress continually so the next unit or phase of instruction can be presented when the trainee is ready.

The immediate job of preventing accidents and controlling work health hazards logically falls upon the supervisor because safety and production control are closely associated to supervisory functions.

Whether or not your company has a formalized safety program, the supervisor has certain key responsibilities in preventing accidents and illnesses:

—Establishing work methods that are well understood and consistently followed. This is essential, since many injuries and health problems are initially reported as resulting from "unsafe methods or procedures," when later investigation discloses that no standard method or procedures had ever been set up for these operations.

—Giving job instructions with an emphasis on the safety aspects of the job. This will help eliminate the lack of knowledge or skill, which is the most frequent cause of accidents.

—Analyzing job demands and worker capabilities before making job assignments. Safety, as well as good job performance, requires that a supervisor be sure the worker is qualified to do the job and thoroughly understands the work method. Since even experienced workers need some direction, continued supervision is necessary even after a safe work method has been established and workers have been instructed according to that method. When people deviate from established safe practices, injuries result. To prevent this, supervisors must continually watch for unsafe work methods and correct them as soon as they are observed.

—Maintaining equipment and workplace in safe condition. Accidents often result from tools and equipment in poor condition, from a disorderly workplace, or from using make-shift tools because the right tools are not available. By correcting these situations you will also be maintaining your workplace in the most efficient condition.

These five functions are a normal and necessary part of the supervisor's job, which no one else can perform. To be sure that supervisors perform this role, it should be included in your company's policy statement. You should issue clear orders defining the safety duties of all persons and the lines of authority between them. In addition, a careful program of education should be instituted to help supervisors understand their role and to give them help in their work of preventing accidents.

Specifically, the objectives of this program should be to:

—establish supervisors as the key in preventing accidents and involve them fully in your company's accident prevention program,

—provide supervisors with information on causes of accidents and health hazards as well as methods of prevention,

—give supervisors an opportunity to consider accident prevention problems for their operations and to develop solutions based on their own experience.

The following outline is based on the National Safety Council's "Key Man Development" course and suggests some subjects that you could include in a safety course for your supervisors. The knowledge and philosophy of accident prevention is not "just common sense," as some slogans proclaim. Rather, most successful programs follow a fairly well-established pattern and include a specialized body of information accumulated over a period of many years. Visual aids are available through the National Safety Council on these subjects and should be used at every meeting.

- —*Safety and the supervisor.* Safety and efficient production go together. Accidents affect production, profits, morale, and public relations.
- —*Know your accident problems.* Elements of an accident. Unsafe acts, unsafe conditions, accident investigations, measurements of safety performance. Accident costs.
- —*Human relations.* Basic needs of workers. The supervisor as a leader.
- —*Maintaining interest in safety.* Committee functions, maintaining good employee relations. The supervisor's role in off-the-job safety.
- —*Instructing for safety.* Importance of job instruction. Making a job safety analysis. Job instruction training.
- —*Industrial hygiene.* Environmental health hazards. Skin diseases. Lighting, noise, ventilation, temperature effects.
- —*Personal protective equipment.* Eye protection, face protection, foot and leg protection, hand protection. Respiratory protective equipment. Protection against ionizing radiation. OSHA requirements.
- —*Industrial housekeeping.* Results of good housekeeping. The responsibility of the supervisor. OSHA requirements.
- —*Materials handling and storage.* Lifting and carrying, handling specific shapes. Hand tools for materials handling. Motorized equipment. Hazardous liquids and compressed gases.
- —*Guarding machines and mechanisms.* Principles of guarding. Benefits of good guarding. Types of guards. Standards and codes. OSHA requirements.
- —*Hand and portable power tools.* Selection and storage. Training in the safe use of tools.
- —*Fire protection.* Determining fire hazards. Understanding fire chemistry. Fire brigades. Review the supervisor's job.

All supervisors should be given a basic course of this type which has been tailored to the particular needs of your workplace. It should be repeated on a regular basis as a refreshed course for your experienced supervisors and as training for new and prospective supervisors.

Prepared courses (such as the "Key Man" course) are usually available complete with textbook, supervisors' safety manual, instructors' guide, student kit, certificate of completion, and visual aids. The use of a prepared course saves a great deal of time and effort and can be adapted to your particular needs.

In order to be effective, the instruction must be well organized and interesting. No matter what combination of teaching methods are used (lecture, case study, demonstration, etc.), there should be a well-organized lesson plan to ensure that the following elements are covered: introduction, objectives, presentation, training aids, application, summary, test, and assignment.

Safety and health training for supervisors needs to be a continuing program to be effective. A limited effort, such as holding a few meetings, may cause supervisors to do a better job for a short time, but interest will lag if the initial effort is not followed up. Supervisors usually reflect the attitudes of the management level above them as to what is important and what can be ignored. If a superintendent clearly communicates his commitment to safety and health, supervisors are likely to give greater attention to safety and health.

To hold its own in an atmosphere of change and shifting priorities, your safety and health program must not be allowed to become static.

Companies having formal induction training programs are convinced that they pay off in lower labor turnover, good employee relations, and prevention of accidents. In these programs, it is important that safety and health receive as much emphasis as any other element. Health and safety issues must not be submerged in a mass of information so that they will be remembered only vaguely, if at all. Employees must carry away a deep, personal conviction that health and safety are important to them and to their company.

Training is only one way to influence human behavior. Safe performance is encouraged by your example as an employer who spares no effort to create healthy and safe working conditions and procedures and who insists that these procedures be taught and followed.[2]

[2]Material condensed from Accident Prevention Manual for Industrial Operations. Seventh Edition, Chapter 9, National Safety Council, Chicago, IL. 1974.

MEASURING PROGRAM EFFECTIVENESS

Any program or activity in which you invest time and resources on a continual basis should prove its worth. A well-structured OSH program should lend itself to objective performance measurement as well as to more subjective evaluation.

OBJECTIVE PROGRAM MEASURES

Statistical data are your principal evaluation tool in this area. Essentially, you should concentrate on inspection results and accident data in making analyses. Your findings in these areas can be compared over time within your own company (e.g., interdepartmental comparison) or reviewed against the performance of other work places engaged in similar operations.

Your inspection reports should show a decreasing number of hazards as your OSH program continues in operation. These reports should also indicate the period of time for which a hazard has existed. Naturally, you should distinguish between those hazards that are relatively simple and inexpensive to correct and those that will require substantial expenditures, or broad-scale administrative action, or both.

In conducting these inspections and in preparing reports, you must consistently use the same "yard stick" (i.e., the same activity/situation must be measured by the same criteria). This consistency requirement can be much more easily met when a well-structured OSH program operates consistently throughout your company. Your program should have already defined the standards, practices, and responsibilities against which assessments can be made. Supervisors should understand that health and safety activities are part of their performance appraisal.

In addition to inspections, an ongoing cause and cost analysis of your illness and injury experiences indicates the overall effectiveness of your program and identifies areas of weakness. Good recordkeeping is essential to making this kind of evaluation. You should consider both lost time and nonlost time illnesses and injuries for a comprehensive picture of your program's performance. (See Chapter II for more information on recordkeeping.) This can be done by charting the first aid services used by your employees (i.e., in what department do most minor injuries occur, to what part of the body, during what shift, etc.) A reporting system (through your nurse or physician) of common employee complaints (e.g., headache, respiratory irritations, etc.) can provide early warning of potential health hazards.

The calculation most frequently used to summarize OSH performance is the "incidence" rate:

Frequency or Incidence Rate (F.R.)[1]

$$\text{F.R.} = \frac{\text{No. disabling illnesses or injuries} \times 200{,}000^{2}}{\text{No. man-hours worked}}$$

The following measures provide additional weighting to help you gain further insight as to the scope of your problem and its relationship to similar work places:

Severity Rate (S.R.)

$$\text{S.R.} = \frac{\text{No. man-days lost} \times 200{,}000^{2}}{\text{No. man-hours worked}}$$

Disabling Injury/Illness Index (DII)

$$\text{DII} = \frac{\text{S.R.} \times \text{F.R.}}{40}$$

[1]Accident Facts. National Safety Council, Chicago, IL. 1974. p. 32.

[2]The 200,000 is equivalent to 100 full-time workers at 40 hours per week for 50 weeks and automatically adjusts for differences in hours of exposure.

An effective program should reduce these measures or maintain them at acceptable levels. The data used for these measures should be collected on a monthly, quarterly, and annual basis for comparison purposes. (They can be obtained from OSHA forms 101 and 200, which you are required to complete.) These forms should fit into your action plans for correction. To determine acceptable severity and frequency rates for your particular industry, you should obtain information on the performance levels of other work places engaged in comparable activities. These figures can be obtained from your trade association or from the National Safety Council.

The last objective criterion by which program effectiveness may be judged is cost. Your OSH program should reduce costs associated with:

—illness,
—injury,
—absenteeism, and
—employee turnover.

In calculating the savings you receive from lessened costs in these areas, you should look for:

—fewer and smaller insurance claims,
—fewer lost hours, and
—fewer training costs, or start-up costs, or both associated with hiring new employees.

It is difficult to set guidelines for any dollar savings your program should create in these areas. They will vary based on your particular industry and past safety and health performance. You should be wary, however, of relying too heavily on financial return as an effectiveness measure or as a selling point for an OSH program itself. Much of the economic impact of well-run OSH programs will be in costs you never incur (e.g., fatalities, costly legal suits resulting from occupational illnesses or injuries). The purely economic savings you receive may be offset in part by the increased costs associated with an effective program (e.g., physical improvements in your work place and additional consultant service).

SUBJECTIVE PROGRAM MEASURES

As a result of an effective program, you should be able to perceive a number of changes in your employees' behavior. Employees should exhibit more awareness of safety and health and should give feedback in these areas by inspecting their worksites, reporting unsafe conditions, and volunteering suggestions for program improvement. An effective program should contribute to improved health and morale within your workforce. The program should address problems such as alcoholism and drug abuse; it should make employees sensitive to these issues and offer them counselling and treatment. An effective program should generate interest and participation in health and safety committees. Membership on such a committee should offer prestige and the opportunity to influence company operations in a critical area.

A recent study by the federal government indicates that several key factors are associated with low illness/injury rate companies.[3]

—Low-rate plants had greater management commitment and involvement in safety matters.
—Low-rate plants used a more humanistic approach in dealing with employees. They provided greater levels of employee supervision and managed production procedures to a greater extent.
—Low-rate plants had a higher level of housekeeping. In addition, the quality of the environment at the low-rate plants was better than that at high-rate plants.
—Low-rate plants had less turnover and absences and a more stable work group than did the high-rate plants.

PROGRAM ACTIVITY MEASURES

An adequate assessment of your OSH program should include an evaluation not only of results but of activity. This analysis focuses on *what* activities your program stimulates (e.g., management involvement, environmental assessment, etc.) and assesses the quality of performance in each of these areas. The "activity list" that follows identifies a range of activities and performance criteria that can be tailored to your particular workplace.[4] To quantify the results of your assessment, the "rating form" appended to the "activity list"

[3] Safety Program Practices in High Versus Low Accident Rate Companies; An Interim Report. A. Cohen, M. Smith, and H. H. Cohen. DHEW(NIOSH) 75-185. National Institute for Occupational Safety and Health, Cincinnati, Ohio. June 1975.

[4] A Quantitative and Qualitative Measure of Industrial Safety Activities. R. F. Diekemper and D. A. Spartz. ASSE Journal, 15:12-19, December 1970. The Activity Standards and Rating Form are reprinted with permission of the American Society of Safety Engineers.

ACTIVITY STANDARDS

A. ORGANIZATION & ADMINISTRATION

Activity	Poor	Fair	Good	Excellent
1. Statement of policy, responsibilities assigned.	No statement of Loss Control policy. Responsibility and accountability not assigned.	A general understanding of Loss Control, responsibilities and accountability, but not written.	Loss Control Policy and responsibilities written and distributed to supervisors.	In addition to "Good" Loss Control policy is reviewed annually and is posted. Responsibility and accountability is emphasized in supervisory performance evaluations.
2. Safe operating procedures (SOP's).	No written SOP's.	Written SOP's for some, but not all, hazardous operations.	Written SOP's for all hazardous operations.	All hazardous operations covered by a procedure, posted at the job location, with an annual documented review to determine adequacy.
3. Employee selection and placement.	Only pre-employment physical examination given.	In addition, an aptitude test is administered to new employees.	In addition to "Fair" new employees' past safety record is considered in their employment.	In addition to "Good" when employees are considered for promotion, their safety attitude and record is considered.
4. Emergency and disaster control plans.	No plan or procedures.	Verbal understanding on emergency procedures.	Written plan outlining the minimum requirements.	All types of emergencies covered with written procedures. Responsibilities are defined with backup personnel provisions.
5. Direct management involvement.	No measurable activity.	Follow-up on accident problems.	In addition to "Fair," management reviews all injury and property damage reports and holds supervision accountable for verifying firm corrective measures.	In addition to "Good" reviews all investigation reports. Loss Control problems are treated as other operational problems in staff meeting.
6. Plant safety rules.	No written rules.	Plant safety rules have been developed and posted.	Plant safety rules are incorporated in the plant work rules.	In addition, plant work rules are firmly enforced and updated at least annually.

B. INDUSTRIAL HAZARD CONTROL

1. Housekeeping—storage of materials, etc.	Housekeeping is generally poor. Raw materials, items being processed and finished materials are poorly stored.	Housekeeping is fair. Some attempts to adequately store materials are being made.	Housekeeping and storage of materials are orderly. Heavy and bulky objects well stored out of aisles, etc.	Housekeeping and storage of materials are ideally controlled.
2. Machine guarding.	Little attempt is made to control hazardous points on machinery.	Partial, but inadequate or ineffective, attempts at control are in evidence.	There is evidence of control which meets applicable Federal and State requirements, but improvement may still be made.	Machine hazards are effectively controlled to the extent that injury is unlikely. Safety of operator is given prime consideration at time of process design.
3. General area guarding.	Little attempt is made to control such hazards as: unprotected floor openings; slippery or defective floors; stairway surfaces; inadequate illumination, etc.	Partial but inadequate attempts to control these hazards are evidenced.	There is evidence of control which meets applicable Federal and State requirements—but further improvement may still be made.	These hazards are effectively controlled to the extent that injury is unlikely.
4. Maintenance of equipment, guards, handtools, etc.	No systematic program of maintaining guards, handtools, controls and other safety features of equipment, etc.	Partial, but inadequate or ineffective maintenance.	Maintenance program for equipment and safety features is adequate. Electrical handtools are tested and inspected before issuance, and on a routine basis.	In addition to "Good" a preventative maintenance system is programmed for hazardous equipment and devices. Safety reports filed and safety department consulted when abnormal conditions are found.

Activity	Poor	Fair	Good	Excellent
5. Material handling—hand and mechanized.	Little attempt is made to minimize possibility of injury from the handling of materials.	Partial but inadequate or ineffective attempts at control are in evidence.	Loads are limited as to size and shape for handling by hand, and mechanization is provided for heavy or bulky loads.	In addition to controls for both hand and mechanized handling, adequate measures prevail to prevent conflict between other workers and material being moved.
6. Personal protective equipment—adequacy and use.	Proper equipment not provided or is not adequate for specific hazards.	Partial but inadequate or ineffective provision, distribution and use of personal protective equipment.	Proper equipment is provided. Equipment identified for special hazards, distribution of equipment is controlled by supervisor. Employee is required to use protective equipment.	Equipment provided complies with standards. Close control maintained by supervision. Use of safety equipment recognized as an employment requirement. Injury record bears this out.

C. FIRE CONTROL AND INDUSTRIAL HYGIENE

1. Chemical hazard control references.	No knowledge or use of reference data.	Data available and used by foremen when needed.	In addition to "Fair" additional standards have been requested when necessary.	Data posted and followed where needed. Additional standards have been promulgated, reviewed with employees involved and posted.
2. Flammable and explosive materials control.	Storage facilities do not meet fire regulations. Containers do not carry name of contents. Approved dispensing equipment not used. Excessive quantities permitted in manufacturing areas.	Some storage facilities meet minimum fire regulations. Most containers carry name of contents. Some approved dispensing equipment in use.	Storage facilities meet minimum fire regulations. Most containers carry name of contents. Approved equipment generally is used. Supply at work area is limited to one day requirement. Containers are kept in approved storage cabinets.	In addition to "Good" storage facilities exceed the minimum fire regulations and containers are always labeled. A strong policy is in evidence relative to the control of the handling, storage and use of flammable materials.
3. Ventilation—fumes, smoke and dust control.	Ventilation rates are below industrial hygiene standards in areas where there is an industrial hygiene exposure.	Ventilation rates in exposure areas meet minimum standards.	In addition to "Fair" ventilation rates are periodically measured, recorded and maintained at approved levels.	In addition to "Good" equipment is properly selected and maintained close to maximum efficiency.
4. Skin contamination control.	Little attempt at control or elimination of skin irritation exposures.	Partial, but incomplete program for protecting workers. First-aid reports on skin problems are followed up on an individual basis for determination of cause.	The majority of workmen instructed concerning skin-irritating materials. Workmen provided with approved personal protective equipment or devices. Use of this equipment is enforced.	All workmen informed about skin-irritating materials. Workmen in all cases provided with approved personal protective equipment or devices. Use of proper equipment enforced and facilities available for maintenance. Workers are encouraged to wash skin frequently. Injury record indicates good control.
5. Fire control measures.	Do not meet minimum insurance or municipal requirements.	Meets minimum requirements.	In addition to "Fair" additional fire hoses and/or extinguishers are provided. Welding permits issued. Extinguishers on all welding carts.	In addition to "Good" a fire crew is organized and trained in emergency procedures and in the use of fire fighting equipment.
6. Waste—trash collection and disposal, air/water pollution.	Control measures are inadequate.	Some controls exist for disposal of harmful wastes or trash. Controls exist but are ineffective in methods or procedures of collection and disposal. Further study is necessary.	Most waste disposal problems have been identified and control programs instituted. There is room for further improvement.	Waste disposal hazards are effectively controlled. Air/water pollution potential is minimal.

D. SUPERVISORY PARTICIPATION, MOTIVATION AND TRAINING

Activity	Poor	Fair	Good	Excellent
1. Line supervisor safety training.	All supervisors have not received basic safety training.	All shop supervisors have received some safety training.	All supervisors participate in division safety training session a minimum of twice a year.	In addition, specialized sessions conducted on specific problems.
2. Indoctrination of new employees.	No program covering the health and safety job requirements.	Verbal only.	A written handout to assist in indoctrination.	A formal indoctrination program to orientate new employees is in effect.
3. Job hazard analysis.	No written program.	Job hazard analysis program being implemented on some jobs.	JHA conducted on majority of operations.	In addition, job hazard analyses performed on a regular basis and safety procedures written and posted for all operations.
4. Training for specialized operations (Fork trucks, grinding, press brakes, punch presses, solvent handling, etc.)	Inadequate training given for specialized operations.	An occasional training program given for specialized operations.	Safety training is given for all specialized operations on a regular basis and retraining given periodically to review correct procedures.	In addition to "Good" an evaluation is performed annually to determine training needs.
5. Internal self-inspection.	No written program to identify and evaluate hazardous practices and/or conditions.	Plant relies on outside sources, i.e., Insurance Safety Engineer and assumes each supervisor inspects his area.	A written program outlining inspection guidelines, responsibilities, frequency and follow up is in effect.	Inspection program is measured by results, i.e., reduction in accidents and costs. Inspection results are followed up by top management.
6. Safety promotion and publicity.	Bulletin boards and posters are considered the primary means for safety promotion.	Additional safety displays, demonstrations, films, are used infrequently.	Safety displays and demonstrations are used on a regular basis.	Special display cabinets, windows, etc. are provided. Displays are used regularly and are keyed to special themes.
7. Employee/supervisor safety contact and communication.	Little or no attempt made by supervisor to discuss safety with employees.	Infrequent safety discussions between supervisor and employees.	Supervisors regularly cover safety when reviewing work practices with individual employees.	In addition to items covered under "Good" supervisors make good use of the shop safety plan and regularly review job safety requirements with each worker. They contact at least one employee daily to discuss safe job performance.

E. ACCIDENT INVESTIGATION, STATISTICS AND REPORTING PROCEDURES

1. Accident investigation by line personnel.	No accident investigation made by line supervision.	Line supervision makes investigations of only medical injuries.	Line supervision trained and makes complete and effective investigations of all accidents; the cause is determined; corrective measures initiated immediately with a completion date firmly established.	In addition to items covered under "Good" investigation is made of every accident within 24 hours of occurrence. Reports are reviewed by the department manager and plant manager.
2. Accident cause and injury location analysis and statistics.	No analysis of disabling and medical cases to identify prevalent causes of accidents and location where they occur.	Effective analysis by both cause and location maintained on medical and first-aid cases.	In addition to effective accident analysis, results are used to pinpoint accident causes so accident prevention objectives can be established.	Accident causes and injuries are graphically illustrated to develop the trends and evaluate performance. Management is kept informed on status.
3. Investigation of property damage.	No program.	Verbal requirement or general practice to inquire about property damage accidents.	Written requirement that all property damage accidents of $50 and more will be investigated.	In addition, management requires a vigorous investigation effort on all property damage accidents.
4. Proper reporting of accidents and contact with carrier.	Accident reporting procedures are inadequate.	Accidents are correctly reported on a timely basis.	In addition to "Fair" accident records are maintained for analysis purposes.	In addition to "Good" there is a close liaison with the insurance carrier.

RATING FORM

	Poor	Fair	Good	Excellent	Comments
A. ORGANIZATION & ADMINISTRATION					
1. Statement of policy, responsibilities assigned.	0	5	15	20	
2. Safe operating procedures (SOP's.).	0	2	15	17	
3. Employee selection and placement.	0	2	10	12	
4. Emergency and disaster control planning.	0	5	15	18	
5. Direct management involvement.	0	10	20	25	
6. Plant safety rules.	0	2	5	8	
Total value of circled numbers	____	+____	+____	+____ × .20	Rating ________
B. INDUSTRIAL HAZARD CONTROL					
1. Housekeeping—storage of materials, etc.	0	4	8	10	
2. Machine guarding.	0	5	16	20	
3. General area guarding.	0	5	16	20	
4. Maintenance of equipment guards, hand tools, etc.	0	5	16	20	
5. Material handling—hand and mechanized.	0	3	8	10	
6. Personal protective equipment—adequacy and use.	0	4	16	20	
Total value of circled numbers	____	+____	+____	+____ × .20	Rating ________
C. FIRE CONTROL & INDUSTRIAL HYGIENE					
1. Chemical hazard control references.	0	6	17	20	
2. Flammable and explosive materials control.	0	6	17	20	
3. Ventilation—fumes, smoke and dust control.	0	2	8	10	
4. Skin contamination control.	0	3	10	15	
5. Fire control measures.	0	2	8	10	
6. Waste—trash collection and disposal, air/water pollution.	0	7	20	25	
Total value of circled numbers	____	+____	+____	+____ × .20	Rating ________
D. SUPERVISORY PARTICIPATION, MOTIVATION & TRAINING					
1. Line supervisor safety training.	0	10	22	25	
2. Indoctrination of new employees.	0	1	5	10	
3. Job hazard analysis.	0	2	8	10	
4. Training for specialized operations.	0	2	7	10	
5. Internal self-inspection.	0	5	14	15	
6. Safety promotion and publicity.	0	1	4	5	
7. Employee/supervisor contact and communication.	0	5	20	25	
Total value of circled numbers	____	+____	+____	+____ × .20	Rating ________

	Poor	Fair	Good	Excellent	Comments
E. ACCIDENT INVESTIGATION, STATISTICS & REPORTING PROCEDURES					
1. Accident investigation by line supervisor.	0	10	32	40	
2. Accident cause and injury location analysis and statistics.	0	3	8	10	
3. Investigation of property damage.	0	10	32	40	
4. Proper reporting of accidents and contact with carrier.	0	3	8	10	
Total value of circled numbers	____	+ ____	+ ____	+ ____ × .20	Rating ________

SUMMARY

The numerical values below are the weighted ratings calculated on rating sheets. The total becomes the overall score for the location.

A. Organization & Administration	________
B. Industrial Hazard Control	________
C. Fire Control & Industrial Hygiene	________
D. Supervisory Participation, Motivation & Training	________
E. Accident Investigation, Statistics & Reporting Procedures	________
TOTAL RATING	________

weights each factor and performance level. You can use this form to score your program activity by specific area and develop a simple summary of overall performance.

RELATIVE RISK ASSESSMENT[1]

Industry and businesses need to know how to assign priorities to potential hazards in order to plan the most effective use of materials, personnel, and finances and to design facilities control. Many experienced administrators and managers can quickly make risk assessments because of the nature of the problems. Not all situations lend themselves to easy analysis, however. A simple statistical procedure can be used where:

—detail needs to be provided,
—answers are not readily apparent,
—statistical support is required, or
—weighting factors need to be applied.

As an example, let us take the problem of deciding whether a plant should become involved with research or pilot production plants and the potential risk of workers using viral vectors to produce recombinant DNA molecules.

Relative risk (RR) is an estimate of the chance that individuals performing research or production involving the use of viral vectors in the production of DNA molecules will develop work-related illnesses as compared with the chance that individuals performing similar duties, not invloving viral vectors to produce recombinant DNA molecules, will develop work-related illness.

An estimate of RR can be calculated from data displayed in a 2 × 2 contingency table of the general form:

	DNA Workers	*Non-DNA Workers*	*Total*
Work-related illness	A	B	A + B
Nonwork-related illness (controls)	C	D	C + D

If sex-specific frequencies are needed for some study, the following notations could be substituted.

A_f, B_f, C_f, D_f, = females
A_m, B_m, C_m, D_m = males

The RR is estimated by the quantity:

$RR = (A/B) + (C/D) = AD/BC$ ("odd's ratio," or "cross-product ratio")

If an estimate of age-adjusted RR is desired (for example below age 50 and over age 50) this may by computed by a procedure that weights the age-specific RR according to the amount of information on which each is based. Thus, C become C′, D becomes D′; this represents the expected numbers that would result if the total number of nonwork-related illness was the same as the total number of work-related illness in the DNA and non-DNA workers. Hence,

$$C' = (A + B)[C + (C + D)]$$
$$D' = (A + B)[D + (C + D)]$$

The resultant 2 × 2 contingency tables (by age) can be summed to a single combined contingency table:

	DNA Workers	*Non-DNA Workers*	*Total*
Work-related illness	$A_1 + A_2$	$B_1 + B_2$	$(A_1 + A_2) + (B_1 + B_2)$
Nonwork-related illness	$C'_1 + C'_2$	$D'_1 + D'_2$	$(C'_1 + C'_2) + (D'_1 + D'_2)$

Then the estimated age-adjusted RR summary is computed as:

$RR = (A_1 + A_2) \cdot (D'_1 + D'_2/(B_1 + B_2) \cdot (C'_1 + C'_2)$

This pooling is only possible if the true probabilities corresponding to ratios $A_1/(CA_1 + B_1)$ and $A_2/(A_2 + B_2)$ are equal and if the true probabilities corresponding to ratios $C_1/(C_1 + D_1)$ and $C_2/(C_2 + D_2)$ are equal. It does not take into account the number of controls in determining weights.

A more accurate weighting system would be to use the population age distribution to determine weights. Then the age-adjusted RR would be:

$$(\pi_1 A_1 + \pi_2 A_2)(\pi_1 C_1 + \pi_2 C_2 + \pi_1 D_1 + \pi_2 D_2) /$$
$$(\pi_1 C_1 + \pi_2 C_2)(\pi_1 A_1 + \pi_2 A_2 + \pi_1 B_1 + \pi_2 B_2)$$

where π_1 = proportion of the population in the first age group (below 50)
$\pi_2 = 1 - \pi_1$ = proportion in the second age group (50 or over)

Probability values associated with a chi-square test of the basic (not adjusted or pooled) 2 × 2 contingency table greater than .05 can be assumed to be nonsignificant. A significance test of the age-adjusted RR would be needed.

Bibliography

Some Methods for Strengthening the Common Chi-Square Tests. W. G. Cochran. Biometrics 10:417-451. 1954.
Epidemiology, Principles and Methods. P. MacMahon. Little, Brown & Co. 1970.

[1]Presented at meeting of the Committee on Genetic Experimentation (COGENE) of the International Council of Scientific Unions (ICSU), Key Biscayne, Florida, June 1-2, 1978, L. L. Hatch.

INFORMATION AND CONSULTATION SOURCES

You are involved in the self-evaluation process primarily because employees and management have made the commitment to strive for optimal safety and health conditions. A fundamental goal of this program is to encourage employees and employers to work at self-improvement of the worksite using existing staff and in-house resources.

In doing so, you should begin program development with the resources provided by the self-evaluation procedure (i.e., Self-Evaluation Instrument, which is used with this Program Manual) and then look to public and private agencies providing free or minimal cost information and services (e.g., federal, state, and local health and labor departments, insurance carriers, nearby universities, etc.). After exploring these sources, you should consider using private consultants for assistance in solving particularly difficult problems.

This program manual should be used first for initial direction. If the information provided here is insufficient for your particular needs, you should next try referral to literature or agencies that might be helpful. Following is a list of information resources:

—If you have a carrier for workers' compensation insurance, the company probably has safety and health specialists on staff who are familiar with minimum standards and technical information currently available and who can be quite helpful in advising you in accident and illness prevention and control.

—Trade associations often have technical materials, programs, and industry data available for your specific needs.

—The Department of Labor through the Occupational Safety and Health Administration (OSHA) has invaluable data interpreting the law and providing additional information for meeting the standards that apply to you. This information is available free of charge or obligation.

—The Department of Health, Education, and Welfare through the National Institute for Occupational Safety and Health (NIOSH) provides invaluable printed material. Staff from this agency will do industrial hygiene surveys of particularly hazardous plants as time permits upon request of employers and three or more employees.

—Machine or product manufacturers can be helpful in providing additional information on precautions you might take in using their products. Any special problems should be referred to them first.

—Professional societies in the safety, industrial hygiene, and medical fields issue publications in the form of journals, pamphlets, and books that may be quite useful (e.g., American Society of Safety Engineers, Occupational Health Institute). They can also recommend individuals from their societies to serve as consultants.

—Local colleges and universities sometimes have industrial hygiene, public health, medical or other relevant departments with faculty and libraries to assist you.

After you have exhausted all your resources, hiring a private consultant may be an alternative. The consultant should be selected by matching his/her specialty and your specific problem. Try to select consultants in your geographic location (most professional societies have lists of their representatives by region) to save on travel expenses. When considering the expense of hiring a consultant, you should also be aware that paying consulting fees might still be considerably less expensive than adding a permanent specialist to your payroll. Also, consultants, because they are independent from your establishment, can often contribute fresh, original, and unbiased viewpoints.

Specific references and resources that may be helpful are listed below.[1-2] By using these resources, you may be able to solve many of your problems inexpensively and effectively.

INDUSTRIAL HYGIENE AND CHEMICAL ENGINEERING

Air Sampling Instruments for Evaluation of Atmospheric Contaminants. Fourth Edition. American Conference of Governmental Industrial Hygienists, Cincinnati, OH. 1972. Gives instrument description and source of supply for U.S. distributors.

The Determination of Toxic Substances in Air; A Manual of ICI Practice. N.W. Hanson, D.A. Reilly, and H. E. Staff, editors. W. Heffer & Sons, Cambridge, England. 1965. Includes some procedures not given elsewhere.

Industrial Dust: Hygienic Significance, Measurement and Control. Second Edition. McGraw-Hill, New York, NY. 1954.

The Industrial Environment—Its Evaluation and Control. Third Edition. DHEW (NIOSH) 74117. National Institute for Occupational Safety and Health, Cincinnnati, OH 45226. 1973. An industrial hygiene textbook, rather than a syllabus, covering a broad range of subjects from mathematics to medicine.

Industrial Ventilation—A Manual of Recommended Practice. Thirteenth Edition. Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, Lansing, MI. 1974. Provides new developments and standards for industrial ventilating systems.

Noise and Vibration Control. L.L. Beranek, editor. Academic Press, New York, N.Y. 1970. The practical treatment of noise control design and construction.

Respiratory Protective Devices Manual. Committee on Respirators, American Industrial Hygiene Association—American Conference of Governmental Industrial Hygienists. Lansing, MI. 1963.

OCCUPATIONAL HEALTH AND RELATED JOURNALS

Occupational Safety and Health: Standards, Interpretations, Regulations, and Procedures. Occupational Safety and Health Administration, Washington, DC 20210. (Distributed by the Superintendent of Documents.) Vol. I — General Industrial Standards; Vol. II — Maritime Standards; Vol. III — Construction Standards; Vol. IV — Other Regulations and Procedures; Vol. V —Compliance Manual. The information subscription service provided by OSHA for current awareness. 1973—

SAFETY DATA SHEETS, GUIDES, MANUALS

AIHA Hygienic Guide Series. American Industrial Hygiene Association, 66 South Miller Road, Akron, OH 44313. Separate data sheets on specific substances giving hygienic standards, properties, industrial hygiene practice, specific procedures, and references.

ANSI Standards, Z37 Series, Acceptable Concentrations of Toxic Dusts and Gases. American National Standards Institute, 1430 Broadway, New York, NY 10018. These guides represent a consensus of interested parties concerning minimum safety requirements for the storage, transportation, and handling of toxic substances; they are intended to aid the manufacturer, the consumer, and the general public.

ASTM Standards with Related Material. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

Data Sheets. Manufacturing Chemists' Association, 1825 Connecticut Avenue, NW, Washington, DC 20009. Includes information on properties, hazards, handling, storage, hazard control, employee safety, medical management, etc., of specific chemicals.

Industrial Safety Data Sheets. National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611. Information and recommendations regarding the safe handling of chemicals and safe practices in the work environment.

Safety Guides. Manufacturing Chemists' Association, 1825 Connecticut Avenue, NW,

[1] Sources of Consultation and Reference Aids. W. R. Lee. Section XI, Occupational Diseases: A Guide to Their Recognition. M.M. Key, A.F. Henschel, J. Butler, R.N. Ligo, I.R. Tabershaw, and L. Ede, Editors. DHEW (NIOSH) 77-181. National Institute for Occupational Safety and Health, Cincinnati, OH 45226. 1977. pp. 523-556. Also available as: Consultation and Reference Sources for Occupational Health. W.R. Lee. Journal of Occupational Medicine, 17(7):446-456, July 1975.

[2] Accident Prevention Manual for Industrial Operations. Seventh Edition. National Safety Council, Chicago, IL. 1974. pp. 591-630.

Washington, DC 20009. Information and recommendations pertaining to safe practices in the work environment.

TLVs. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment....American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, OH 45201. Annual; threshold limits based on information from industrial experience and experimental human and animal studies; intended for use in the practice of industrial hygiene.

AIHA Ergonomic Guide Series. American Industrial Hygiene Association, 64 Wolf Ledges Drive, Akron, OH 41313. A valuable source of information on ergonomics.

SAFETY SOURCES OF HELP

American National Red Cross Safety Service, 17th and "D" Streets, NW, Washington, DC 20006. Offers free courses in first aid.

National Society for the Prevention of Blindness, Inc., 79 Madison Avenue, New York, NY 10016. Addresses industry, safety, and educational meetings to project NSPB recommendations and program aims.

STANDARDS AND SPECIFICATION GROUPS

American National Standards Institute, 1430 Broadway, New York, NY 10018. Coordinates and administers the federated voluntary standardization system in the United States.

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103. World's largest source of voluntary consensus standards for materials, products, systems, and services.

FIRE PROTECTION ORGANIZATIONS

Factory Insurance Association, 85 Woodland Street, Hartford, CT 06015. Composed of a group of captial stock insurance companies to provide engineering, inspections, and loss adjustment service to industry.

Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062. An industrial fire protection, engineering, and inspection bureau established and maintained by mutual fire insurance companies.

National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210. The clearing house for information on fire protection and fire prevention. Nonprofit technical and educational organization.

Underwriter Laboratories Inc., 207 East Ohio Street, Chicago, IL 60611. Not-for-profit organization whose laboratories publish annual lists of manufacturers whose products proved acceptable under appropriate standards.

INSURANCE ASSOCIATIONS

The American Association of State Compensation Insurance Funds, P.O. 5922, San Francisco, CA 94101. Produces technical information available to safety engineers.

American Mutual Insurance Alliance, 20 North Wacker Drive, Chicago, IL 60606. Disseminates information on safety subjects; conducts specialized courses for member company personnel. Prints several publications.

American Insurance Association Engineering and Safety Service, 85 John Street, New York, NY 10038. Issues many publications on accident prevention.

TRADE ASSOCIATIONS

American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, IL 60016. Serves as a clearinghouse for information in this industry.

American Gas Association, 1515 N. Wilson Boulevard, Arlington, VA 22209. Serves as a clearinghouse and advisor to its member companies.

American Iron and Steel Insitute, 1000 16th Street, NW, Washington, DC 20036.

American Meat Institute, 1600 N. Wilson Boulevard, Arlington, VA 22209.

American Mining Congress, 1200 18th Street, NW, Washington, DC 20036.

American Paper Institute, 260 Madison Avenue, New York, NY 10016.

American Petroleum Institute Safety and Fire Protection Service, 1801 D Street, NW, Washington, DC 20006.

American Public Power Association, 2600 Virginia Avenue, Washington, DC 20037.

American Pulpwood Association, 605 Bird Avenue, New York, NY 10016.

American Road Builders Association, 525 School Street, SW, Washington, DC 20024.

American Trucking Association, Inc., 1616 P Street, NW, Washington, DC 20036. Membership available to any person concerned with truck safety.

The American Waterways Operators, Inc., 1250 Connecticut Avenue, NW, Suite 502, Washington, DC 20036.

American Water Works Association, 2 Park Avenue, New York, NY 10016.

American Welding Society, 2501 NW 7th Street, Miami, FL 33125. Devoted to the proper and safe use of welding by industry. Booklets and other publications available.

Associated General Contractors of America, Inc., 1957 E Street, NW, Washington, DC 20006.

Association of American Railroads, 1920 L Street, NW, Washington, DC 20006.

Can Manufacturers Institute, Inc., 1625 Massachusetts Avenue, NW, Washington, DC 20036. Acts as a clearinghouse of information on the metal can industry in the United States.

The Chlorine Institute, 342 Madison Avenue, New York, NY 10017. Provides a means for chlorine producers and firms with related interests to deal with problems.

Compressed Gas Association, Inc., 500 Fifth Avenue, New York, NY 10036. Provides information on safe handling and storage of gases.

Edison Electric Institute, 90 Park Avenue, New York, NY 10016.

Graphic Arts Technical Foundation, 4615 Forbes Avenue, Pittsburgh, PA 15213.

Gray and Ductile Iron Founder's Society, Inc., Cast Metals Federation Building, Rocky River, OH 44126.

Industrial Safety Equipment Association, Inc., 2425 Wilson Boulevard, Arlington, VA 22201. Devoted to the promotion of public interest in safety.

Institute of Makers of Explosives, 420 Lexington Avenue, New York, NY 10017. Booklets on the safe transportation, handling, and use of explosives.

International Association of Drilling Contractors, 211 N. Ervay, Suite 505, Dallas, TX 75201.

International Association of Refrigerated Warehouses, 7315 Wisconsin Avenue, NW, Washington, DC 20014.

Linen Supply Association of America, 975 Arthur Godfrey Road, Miami Beach, FL 33140.

Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, NW, Washington, DC 20009. Information available on safe handling, transportation, and use of chemicals.

National Association of Manufacturers, 1776 F Street, NW, Washington, DC 20006.

National LP-Gas Association, 79 W. Monroe Street, Chicago, IL 60603. Programs and information to train the public in safe handling and uses of LP-gas.

Printing Industries of America, Inc., 1730 N. Lynn Street, Arlington, VA 22209.

Scaffolding and Shoring Institute, 2130 Keith Bldg., Cleveland, OH 44115. Booklets on shoring available.

The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, NY 10017. Information available on plastics and safety.

U. S. ORGANIZATIONS

Air Pollution Control Association, 4450 Fifth Avenue, Pittsburgh, PA 15213.

The American Occupational Medical Association. School of Public Health, University of Pittsburgh, Pittsburgh, PA 15261.

American Chemical Society, 1155 Sixteenth Street, NW, Washington, DC 20036.

American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, OH 45201.

American Industrial Hygiene Association, 66 S. Miller Road, Akron, OH 44313.

American Medical Association, Committee on Occupational Toxicology and Council on Occupational Health, 535 North Dearborn Street, Chicago, IL 60610.

American National Standards Institute, 1430 Broadway, New York, NY 10018.

American Public Health Association, 1015 Eighteenth Street, NW, Washington, DC 20036.

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

American Society of Tropical Medicine and Hygiene, Emory University Branch, P.O. Box 15208, Atlanta, GA 30333.

The Fertilizer Institute, 1015 18th Street, NW, Washington, DC 20036.

Industrial Health Foundation, Inc., 5231 Centre Avenue, Pittsburgh, PA 15232.

Industrial Medical Association, 150 North Wacker Drive, Chicago, IL 60606.

Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, NW, Washington, DC 20009.

National Safety Council, 425 N. Michigan Avenue, Chicago, IL 60611.

Society of Toxicology. Robert A. Scala, Secretary, Medical Research Division, Esso Research and Engineering Company, P.O. Box 45, Linden, NJ 07036.

UNITED STATES GOVERNMENT AGENCIES

Atomic Energy Commission, Division of Biomedical Environmental Research, Washington, DC 20545.

Department of Commerce

National Bureau of Standards, Washington, DC 20234.

National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22151.

Department of Labor

Bureau of Labor Statistics, Fourteenth Street and Constitution Avenue, NW, Washington, DC 20210

Occupational Safety and Health Administration, Fourteenth Street and Constitution Avenue, NW, Washington, DC 20210

Department of Interior

Bureau of Mines, C Street between Eighteenth and Nineteenth Streets, NW, Washington, DC 20240.

Mining Enforcement and Safety Administration, C Street between Eighteenth and Nineteenth Streets, NW, Washington, DC 20240.

Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460.

PUBLIC HEALTH SERVICE

Center for Disease Control, Atlanta, GA 30333

National Institute for Occupational Safety and Health (NIOSH) Parklawn Building, 5600 Fishers Lane, Rockville, MD 20852; 4676 Columbia Parkway, Cincinnati, OH 45226; 944 Chestnut Ridge Road, Morgantown, WV 26505.

<u>NIOSH Regional Offices</u>

DHEW, Region I
(CT, ME, MA, NH, RI, VT)
Government Center
(JFK Federal Building)
Boston, MA 02203
Tel.: 617/223-6668/9

DHEW, Region II
(NJ, NY, PR, VI)
26 Federal Plaza
New York, NY 10007
Tel.: 212/264-2485/8

DHEW, Region III
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Tel.: 415/556-3781

DHEW, Region X
(AK, ID, OR, WA)
1321 Second Avenue
Mail Stop 502
Seattle, WA 98101
Tel.: 206/442-0530

Health Resources Administration

National Center for Health Statistics, 330 Independence Avenue, SW, Washington, DC 20201.

National Institutes of Health

National Cancer Institute, Bethesda, MD 20014.

National Clearinghouse for Mental Health Information (NCMHI), National Institute of Mental Health, 5600 Fishers Lane, Rockville, MD 20852.

National Heart and Lung Institute, Bethesda, MD 20014.

National Institute of Environmental Health Sciences (NIEHS), P.O. 12333, Research Triangle Park, NC 22079.

SCHOOLS OF PUBLIC HEALTH IN THE UNITED STATES AND CANADA

University of California School of Public Health. Earl Warren Hall, Berkeley, CA 94720.

University of California at Los Angeles School of Public Health, Los Angeles, CA 90024.

Columbia University School of Public Health and Administrative Medicine, 600 West 168th Street, New York, NY 10032.

Harvard University School of Public Health, 55 Shattuck Street, Boston, MA 02115.

University of Hawaii School of Public Health, 1860 East West Road, Honolulu, HI 96822.

University of Illinois at the Medical Center, School of Public Health, P.O. Box 6998, Chicago, IL 60680.

Johns Hopkins University School of Hygiene Health, 1325 Mayor Memorial Building, and Public Health, School of Medicine, 60 College Street, New Haven, CN 06510.

Loma Linda University School of Public Health, Loma Linda, CA 92345.

University of Michigan, School of Public Health, Ann Arbor, MI 48104.

University of Minnesota School of Public Health, 1325 Mayor Memorial Building, Minneapolis, MN 55455.

University of North Carolina School of Public Health, Chapel Hill, NC 27514.

University of Oklahoma School of Health, 800 North East 13th Street, Oklahoma City, OK 73104.

University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA 15261.

University of Puerto Rico School of Public Health, Medical Sciences Campus, GPO Box 5067, San Juan, PR 00905 (teaching in Spanish).

University of Texas at Houston, School of Public Health, P.O. Box 20186, Astrodome Station, Houston, TX 77025.

University of Toronto School of Hygiene, Toronto 5, Ontario, Canada.

Tulane University School of Public Health and Tropical Medicine, 1430 Tulane Avenue, New Orleans, LA 70112.

University of Washington School of Public Health and Community Medicine, F 356d Health Sciences Building, Mail Drop SC-30, Seattle, WA 98195.

Yale University Department of Epidemiology and Public Health, School of Medicine, 60 College Street, New Haven, CN 06510.

EDUCATIONAL RESOURCE CENTER PROGRAM DIRECTORS (July 1978)

NIOSH has funded the following schools, colleges, and universities for the purpose of developing educational programs for occupational health specialists.

Marcus M. Key, M.D., The University of Texas Health Science Center, P.O. Box 20186, Houston, TX 77025. (713) 792-4300.

Gareth M. Green, M.D., The Johns Hopkins University, School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, MD 21205, (301) 935-3720 or 3537.

David A. Fraser, Sc. D., Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, Chapel Hill, NC 27514, (919) 966-1023.

John T. Wilson, M.D., Sc. D., Department of Environmental Health, University of Washington, Seattle, WA 98195, (206) 543-6991.

Raymond R. Suskind, M.D., Department of Environmental Health, University of Cincinnati College of Medicine, 3223 Eden Avenue, Cincinnati, OH 45267, (513) 872-5701.

John M. Peters, M.D., Sc.D., Harvard University, School of Public Health, 665 Huntington Avenue, Boston, MA 02115, (617) 732-1260.

Conrad P. Straub, Ph.D., University of Minnesota, School of Public Health, 420 Delaware Street, S.E., Minneapolis, MN 55455, (612) 373-8080.

Herbert K. Abrams, M.D., Department of Family & Community Medicine, University of Arizona Health Sciences Center, Tuscon, AZ 85724, (602) 882-6244.

Bertram W. Carnow, M.D., School of Public Health, University of Illinois at the Medical Center, P.O. Box 6998, Chicago, IL 60680, (312) 996-7811.

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CONTENTS

WORKSITE SAFETY and HEALTH

PLANT SAFETY AND HEALTH

VENTILATION

Ventilation is one of the most important engineering controls available for improving or maintaining the quality of the air in your establishment. It may be used for one or for a combination of the following reasons:

- —heating, cooling or humidity control;
- —removing a contaminant (dusts, fumes, mists, gases, vapors);
- —diluting the concentration of a contaminant;
- —providing pressurization to prevent cross-contamination between different work areas; or
- —supplying make-up air (air supplied to replace exhausted air).

These basic uses of industrial ventilation can be divided into three major applications:

- —the prevention of fire and explosion,
- —the control of atmospheric contamination within acceptable levels, and
- —the control of temperature and humidity for worker comfort.

General ventilation, sometimes known as dilution ventilation, controls the air quality by diluting the concentration of contaminants before they reach the workers' breathing zone. It is most effective in controlling the concentration of low toxicity contaminants from minor or decentralized sources. General ventilation does not, however, reduce the amount of hazardous material released into the air. Therefore, employees working close to a source of air contaminants may not be adequately protected by general ventilation alone.

Local exhaust ventilation is the preferred method of controlling contaminants in the work environment. A local exhaust system is one in which the contaminant being controlled is captured at or near its source or point of dispersion. For example, grinding wheels and dip tanks are often provided with a local exhaust system. In contrast to dilution or general ventilation, local exhaust ventilation places much more reliance on mechanical methods of controlling air flow. A local exhaust system usually includes the use of hoods or enclosures, ductwork leading to an exhaust fan, and an air cleaning device (e.g., filters and cyclone separators)for air pollution abatement.[1]

All local and general exhaust ventilation systems must have air to exhaust, and that air must be replaced pound for pound by a make-up air system. The supply and distribution of make-up air is often overlooked or neglected in the design of ventilation although it is fundamental to its successful operation.

A local exhaust system is usually superior to general ventilation for the purpose of contaminant control. Its advantages include the following:

- —If the system is properly designed, the capture and control of a contaminant can be complete, preventing any worker exposure.
- —The required volume rate of air exhausted is less than local ventilation and as a result, the volume of make-up air required is less. Local ventilation saves in both capital investment and heating costs.
- —The contaminant is contained in a smaller exhausted volume of air. Therefore, if air pollution control is needed, it is less costly.
- —Many local exhaust systems can be designed to capture large settleable particles or at least to confine them within a hood and thus greatly reduce the labor required for good housekeeping.
- —Other equipment in the workroom is better protected from the harmful effects of the contaminant, including corrosion, abrasion, or clogging between joints of moving parts.
- —The performance of the local exhaust system is not likely to be adversely

[1]The Industrial Environment—Its Evaluation and Control. DHEW (NIOSH) 74-117. National Institute for Occupational Safety and Health, Cincinnati, OH 45226. 1973. p. 574.

affected by wind direction or velocity, inadequate make-up air, etc. This is in contrast to general ventilation, which can be greatly affected by seasonal factors.[1]

Usually the best indicator that your ventilation system is inadequate is the detection of environmental problems that should be controlled by ventilation. These include:

—high air contaminant concentration as indicated from air sampling; and

—complaints about odors, heat, cold, humidity, or specific health problems related to contaminant exposure.

If any of these conditions exist, local exhaust and general ventilation air flow measurements should be made. These measurements should be made by a person well qualified and experienced in ventilation measurements (e.g., safety engineer, industrial hygienist, or heating, ventilating, and air conditioning engineer). If your ventilation systems appear to be inadequate, there are a few simple checks you can make in locating the problem. These are:

—Be sure dampers in ductwork are set properly.

—Be sure there are no holes, cracks, etc., in ductwork resulting from corrosion or structural failure.

—If dust is being exhausted, open some sections of ductwork to check for excessive dust deposits.

—If an air cleaning device is used, check to see that it is clean.

—Have an engineer check to see that the exhaust fan is operating properly.

—Check inlets and outlets for obstructions, and for free movement of motorized or free-swing louvers.

If these problems do not exist, you should analyze the basic design of your system. In checking this and in considering design changes in a system, professionals with experience in this area should be consulted.

The U.S. Environmental Protection Agency (EPA) requires that air pollution control equipment be used to prevent the discharge of excessive amounts of air contaminants to the atmosphere. A qualified professional should determine the need for and the type of control equipment. In some cases, air pollution control will not be necessary because of the nature of the contaminant or the amount being exhausted. Professional help can prevent needless installation of equipment.

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LIGHTING

Adequate, well-balanced lighting is essential for safe working conditions as well as for maintaining the quality and the quantity of your production. Poor illumination can create a number of hazardous conditions such as:

—direct glare (bright lights),
—reflected glare (reflective surfaces),
—dark shadows,
—excessive visual fatigue, and
—delayed adaption from bright to dark.

Recognizing and correcting these conditions is an important part of your OSH program.

Lighting systems usually consist of general illumination and local or supplementary illumination. Use of supplementary illumination is important to prevent eye fatigue that occurs on certain jobs and that may contribute to poor eyesight. If employees complain of eye fatique and headaches, it is usually an indication that lighting is inadequate.

If there is any question as to the adequacy of lighting in any work area at your establishment, illumination measurements should be taken with a light meter. Although a visual check may identify many lighting problems, a survey with an illumination measurement device such as a light meter is the only certain way of identifying all such problems.

Illumination measurements are made in units known as footcandles. When conducting a lighting survey:

—Measurements should be taken at points where tasks are being performed as well in aisles and general routes of travel.
—Measurements should be taken away from the body and any other objects that might cast shadows and give distorted measurements.

The results of your measurements should be compared with some recommended illumination levels such as those listed on the following table.

If illumination levels in some areas are inadequate, engineering modifications or maintenance controls should be considered. Some examples include:

—different general lighting fixtures for varying illumination levels.
—supplementary lighting such as localized incandescent lamps for small tasks.
—painting room surfaces light colors to reflect the present lighting; improving surface lighting.
—paint machinery and equipment to help make the machinery more visible than the surrounding area.
—a regular maintenance program for cleaning and replacing light bulbs.

If you have illumination problems at your establishment, you probably will want to consult with an expert in lighting before deciding on the purchase and installation of equipment.

If you have employees working in areas with no natural lighting or in nondaylight hours, emergency lighting is necessary for their sáfety. The amount of emergency lighting does not have to match the intensity of normal lighting, but it does need to be adequate for employees to safely exit from the building. The lighting should be continuous along the entire exit route with no areas of total darkness, however small. Additional emergency lighting is necessary for establishments such as hospitals, hotels, etc., where a complete evacuation of people would be impractical.

LEVELS OF ILLUMINATION CURRENTLY RECOMMENDED[1]

Area	Footcandles on Tasks[2]
Assembly	
Rough easy seeing	30
Rough difficult seeing	50
Medium	100
Fine	500[3]
Extra fine	1000[3]
Building (Construction)	
General construction	10
Excavation work	2
Building exteriors	
Entrances	
Active (pedestrian and/or conveyance)	5
Inactive (normally locked, infrequently used)	1
Vital locations or structures	5
Building surrounds	1
Garages—automobile and truck	
Service garages	
Repairs	100
Active traffic areas	20
Parking garages	
Entrance	50
Traffic lanes	10
Storage	5
Inspection	
Ordinary	50
Difficult	100
Highly difficult	200
Very difficult	500[3]
Most difficult	1000[3]
Loading and unloading platforms	20
Freight car interiors	10
Locker rooms	20
Machine shops	
Rough bench and machine work	50
Medium bench and machine work; ordinary automatic machines, rough grinding, medium buffing and polishing	100
Fine bench and machine work, fine automatic machines, medium grinding, fine buffing and polishing	500[3]

Area	Footcandles on Tasks[2]
Extra-fine bench and machine work, grinding, fine work	1000[3]
Materials handling	
Wrapping, packing, labeling	50
Picking stock, classifying	30
Loading, trucking	20
Inside truck bodies and freight cars	10
Offices	
Cartography, designing, detailed drafting	200
Accounting, auditing, tabulating, bookkeeping, business machine operation, reading poor reproductions, rough layout drafting	150
Regular office work, reading good reproductions, reading or transcribing handwriting in hard pencil or on poor paper, active filing, index references, mail sorting	100
Reading or trascribing handwriting in ink or medium pencil on good quality paper, intermittent filing	70
Reading high-contrast or well-printed material, tasks and areas not involving critical or prolonged seeing such as conferring, interviewing, inactive files, washrooms	30
Corridors, elevators, escalators, stairways	20
Storage rooms or warehouses	
Inactive	5
Active	
Rough bulky	10
Medium	20
Fine	50

[1]Fundamentals of Industrial Hygiene. J.B. Olishifski and F.E. McElroy. National Safety Council, Chicago, IL 60611. 1971. pp. 232-233.

[2]Minimum on the task at any time.

[3]Can be obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the recommended brightness ratios. These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion, color and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

THE PHYSICAL PLANT

The physical environment of all employees should be as free as possible from hazards. A strict regular maintenance program for your physical plant is an essential part of your safety and health program.

All buildings should be designed, constructed, equipped, and maintained so as to be in compliance with applicable building codes, fire prevention codes, state and federal occupational safety and health standards, and the Life Safety Code of the National Fire Protection Association. These codes and standards cover a wide variety of aspects of your physical plant and standard equipment. These include the following basic elements present at most establishments:

—walking surfaces,
—stairways,
—exits,
—ladders,
—elevators,
—heating system, and
—electrical system.

You should examine each of these aspects present at your establishment and, after reviewing the relevant codes and standards, make your own inspection checklist. Much of what is required is simply a matter of common sense, and many hazards can be corrected by your employees with minimal expenditure or training. This chapter will review each of these areas briefly and then refer you to the applicable codes and standards.

Walking Surfaces

Walking surfaces must be properly protected and maintained to prevent slipping and tripping. Hard, high-polished surfaces should be treated with slip-resistant floor wax. Stairs, elevator entrances, and areas around building entrances may require additional protection through the use of mats, carpeting, runners, or tapes. Quick cleanup of any spillage is also essential.

Tripping often results from objects or projections such as open file cabinets, stock, and wastepaper baskets left in the aisles. Defective tiles, boards, and carpeting can also cause tripping accidents.

For specific requirements, check:

—Safety Requirements for Floor and Wall Openings, Railings, and Toeboards (A12.1). American National Standards Institute, 1430 Broadway, New York, NY 10018.

—Occupational Safety and Health Standards, Subpart D — Walking and Working Surfaces. Federal Register, 29 CFR 1910, June 1974.

Stairways

Stairways, like walking surfaces, can be a constant source of slipping or falling accidents if they are not properly designed and maintained. The following protection and maintenance procedures should be adopted:

—Slippery stairs should be protected with special tapes or mats.
—If carpeting is used to prevent slipping, it should be kept in good repair.
—Handrails should be provided for all stairways consisting of more than three steps.
—Since exterior, unenclosed stairways and catwalks are extremely hazardous when wet, securely fastened metal gratings should be placed on treads.

Since the design and construction of stairs is so important, you should consult the relevant standards before installation.

For specific codes and standards relating to stairways, refer to:

—Safety Standards for General Industrial Stairs (A64). American National Standards Institute, 1430 Broadway, New York, NY 10018.

—Occupational Safety and Health Standards, Subpart D — Walking and Working Surfaces. Federal Register, 29 CFR 1910, June 1974.

Exits

All too often, the adequacy and condition of exits are overlooked until an emergency arises. Exits should be inspected and properly maintained not only for normal use by employees but to ensure rapid emergency evacuation. Here is a checklist of points that should be considered:

—Exits should be easily accessible and visible at all times.
—Illuminated signs should clearly indicate the location of exits.
—Exit doors should swing open in the direction of the exit movement.
—Exits doors should never be blocked or locked by chain or cable when the building is occupied.

—Exits should be located to minimize employee passage through areas with hazardous operations.
—Guidelines for walking surfaces, illumination, etc., are particularly important near exit doors.

For specific information regarding the size, number, and location of exits, refer to:
—Occupational Safety and Health Standards, Subpart E — Means of Egress. Federal Register, 29 CFR 1910, June 1974.

Ladders

Ladders must be of sound construction, properly set-up, and regularly inspected. Each new ladder should be thoroughly inspected before it is put into use and once every three months thereafter. Here are some specific checkpoints recommended by the National Safety Council:[1]

—Never place a ladder in front of a door that opens toward the ladder unless the door is locked, blocked, or guarded.
—Face the ladder when going up or down and never slide down a ladder. Check the shoes for grease, mud, or anything slippery before climbing.
—Hold with both hands when going up or down. If material must be handled, raise or lower it with a rope.
—Do not climb higher than the third rung from the top on straight or extension ladders or the second tread from the top on stepladders.
—Use ladders during a strong wind only in emergencies, and only if securely tied.
—Do not leave placed ladders unattended, especially outdoors, unless they are anchored at top and bottom.
—Avoid placing tools or other items where they may cause slipping and falling hazards.

For specific codes and requirements relating to ladders, refer to:

Occupational Safety and Health Standards, Subpart D — Walking and Working Surfaces. Federal Register, 29 CFR 1910, June 1974.

The National Safety Council Ladder Inspection Checklist[1] (that follows) can be used in making routine inspections.

[1]The Ladder Inspection Checklist, which is reprinted with permission of the National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611, is from: Accident Prevention Manual for Industrial Operations. Seventh Edition. National Safety Council, Chicago, IL. 1974. p. 415.

Elevators

Careful maintenance of elevators and escalators can reduce the incidence of accidents and the need for repairs. Inspections and tests of all installations should be performed only by qualified persons on the following recommended schedule:

—every 3 months for power passenger elevators.
—every 6 months for escalators and power freight elevators.
—once a year for hand elevators and power and hand dumbwaiters [1]

The elevator code[2] and the inspector's manual[3] should be used by those making the inspections.

Most elevator related accidents occur at landings and are due to tripping or slipping at the entrance; being caught by the car door; falling down the hoistway; or being caught by the car itself. To assist in preventing this:

—The automatic car leveling device should be adjusted by a competent mechanic.
—The condition of landing sills should be constantly checked for slipping and tripping hazards.
—Illumination should be adequate.

An alarm connected to a central station should be provided for elevator occupants to use when an elevator is stuck. As an additional precaution, elevator equipment rooms should be locked to prevent entry by unauthorized persons.

Heating System

Heating systems should be properly operated, inspected, and maintained according to the following safe work practices:

—Follow established operating instructions.
—Keep controls operative; never block out or bypass any safety control.
—Purge gas-fired equipment to remove combustible mixtures before igniting burners. Follow proper igniting procedure and stand clear of burners, doors, and other furnace openings to avoid burns if a flareup occurs.
—Follow good housekeeping practices to prevent accumulation of flammable materials around heating equipment.

[2]Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks (A17.1). American National Standards Institute (ANSI). New York, NY. 1971.
[3]Practice for the Inspection of Elevators, Escalators, and Moving Walks (A17.2). American National Standards Institute (ANSI). New York, NY. 1973.

LADDER INSPECTION CHECKLIST

General — Item To Be Checked	Needs Repair	Condition O.K.
Loose steps or rungs (considered loose if they can be moved at all with the hand)	☐	☐
Loose nails, screws, bolts, or other metal parts	☐	☐
Cracked, split, or broken uprights, braces, steps, or rungs	☐	☐
Slivers on uprights, rungs, or steps	☐	☐
Damaged or worn nonslip bases	☐	☐
Stepladders		
Wobbly (from side strain)	☐	☐
Loose or bent hinge spreaders	☐	☐
Stop on hinge spreaders broken	☐	☐
Broken, split, or worn steps	☐	☐
Loose hinges	☐	☐
Extension Ladders		
Loose, broken, or missing extension locks	☐	☐
Defective locks that do not seat properly when the ladder is extended	☐	☐
Deterioration of rope, from exposure to acid or other destructive agents	☐	☐
Trolley Ladders		
Worn or missing tires	☐	☐
Wheels that bind	☐	☐
Floor wheel brackets broken or loose	☐	☐
Floor wheels and brackets missing	☐	☐
Ladders binding in guides	☐	☐
Ladder and rail stops broken, loose, or missing	☐	☐
Rail supports broken or section of rail missing	☐	☐
Trolley wheels out of adjustment	☐	☐
Trestle Ladders		
Loose hinges	☐	☐
Wobbly	☐	☐
Loose or bent hinge spreaders	☐	☐
Stop on hinge spreader broken	☐	☐
Center section guide for extension out of alignment	☐	☐
Defective locks for extension	☐	☐
Sectional Ladders		
Worn or loose metal parts	☐	☐
Wobbly	☐	☐
Fixed Ladders		
Loose, worn, or damaged rungs or side rails	☐	☐
Damaged or corroded parts of cage	☐	☐
Corroded bolts and rivet heads on inside of metal stacks	☐	☐
Damaged or corroded handrails or brackets on platforms	☐	☐
Weakened or damaged rungs on brick or concrete slabs	☐	☐
Base of ladder obstructed	☐	☐
Fire Ladders		
Markings illegible	☐	☐
Improperly stored	☐	☐
Storage obstructed	☐	☐

—Wear personal protective equipment as needed.
—Prepare and use a maintenance inspection checklist for each heating device as a guide to ensure that all components are inspected.
—Adjust, repair, or replace faulty items promptly.

Inspections should be conducted regularly by individuals who have specialized technical training and experience as heating engineers or the equivalent. Records of these inspections should be maintained and used to help identify hazardous or faulty equipment. Inspections should include:

—adjusting air-fuel supply to provide proper buring mix;
—testing safety shut-off valves, flame safeguard, temperature control switches, interlocks, and other safeguards; and
—checking for leaks in gas piping and equipment.

Electrical System

The safety of your electrical system, like that of your heating system, is dependent on safe work practices and the regular inspection and maintenance of all equipment. Electrical equipment should be selected carefully, since most equipment is designed and built for specific types of service. It will operate with maximum efficiency and safety only when used for the purposes and under the conditions for which it was designed.

Your electrical system should be regularly inspected by qualified, experienced electricians, and written records of the inspections should be retained. The person who is responsible for the inspection and maintenance of your system should be aware of the particular hazards it poses, and should be thoroughly familiar with the National Electrical Code. You should formulate your own checklist based on all the codes that are applicable to equipment present at your establishment.

References you can use to determine codes and requirements applying to your system include:

—National Electrical Code. 1975 edition. No. 70-1975. National Fire Protection Association, Boston, MA.
—Occupational Safety and Health Standards, Subpart S — Electrical, Federal Register, 29 CFR 1910, June 1974.

SANITATION

Sanitation is concerned with controlling the spread of infection and other health hazards not inherent in your particular manufacturing process. This includes monitoring and controlling the following:

—a safe, potable, and adequate water supply,
—collection and disposal of liquid and solid wastes,
—a safe food supply,
—control and elimination of insects and rodents,
—adequate sanitary facilities and personal services,
—maintenance of general cleanliness within the workplace, and
—personal hygiene.

Monitoring and controlling sanitation can be accomplished through a regular inspection program. Initial inspections should be aimed toward identifying inadequate facilities, poor cleanliness, and general unsanitary conditions. Once the necessary procedural and physical corrections have been made, inspections should only be concerned with the general cleanliness and maintenance of these facilities. The following is a general checklist for conducting a sanitation survey:

—Make general inspections of facility for cleanliness, rodents, insects, etc.

—Make inspections of toilet facilities and any other personal service areas for cleanliness.

—Inspect food preparation facilities for general cleanliness. Frequent inspections by a local health department would help to ensure cleanliness and safe practices.

—If a private water supply is being used, be sure that the water is tested for physical, chemical, and bacteriological impurities.

—Inspect the facility for any piping and equipment cross connections between potable and nonpotable water systems.

—Inspect to be sure that nonpotable water is not being used as potable water.

—Inspect to see that waste disposal containers are emptied and cleaned out regularly.

—Respond to any complaints about insects or rodents by using an in-house or professional exterminator.

—Be sure that there are a sufficient number of drinking fountains available such that employees need travel only a short distance for their use (i.e., no more than 200 feet).

—There should be approximately one fountain for every 50 employees. Discourage use of any portable drinking water dispensers. If they are used, be sure that they are closed tightly and have a tap.

—Dipping cups of common drinking cups should not be used. If ice is used in direct contact with drinking water, be sure the ice is made from potable water to avoid contamination.

—Be sure that nonpotable water sources are clearly marked.

—Be sure that all waste products are disposed of properly so that they don't contaminate water supplies or the surrounding environment.
- •Liquid wastes should be handled by some acceptable water treatment process.
- •Solid wastes should be handled by incineration or sanitary landfill.

—Vending machines should be kept clean and sanitary. Perishables should be refrigerated.

—Separate toilet facilities should be provided for each sex. They should be private with a door and partitions, and they should be equipped at all times with toilet tissue and with covered receptacles for women. The number of facilities can be calculated as shown on the following table.

Number employees, each sex	Minimum number toilets
1 -15	1
16 -35	2
36 -55	3
56 -80	4
81 -110	5
111-150	6
151-	7 + 1 added for each 40 employees

Lavatories should be provided according to the following table. They should be properly equipped with hot and cold running water, hand soap, and individual paper towels or hot air dryers so that employees do not dry their hands with a common towel.

Number employees	Minimum number lavatories
1 -100	1 fixture/10 employees
101-	1 fixture/each additional 15 employees

—If showers are needed or provided, there should be one shower for each ten employees of each sex who may use them. They should have body soap, hot and cold water, and individual clean towels or hair drying system. Showers are especially important where contaminants and irritants get on skin and hair.

—If employees need to wear protective clothing, changing rooms with separate storage facilities for street clothes and protective clothing should be provided. Washing and drying facilities should be provided if workers' clothing becomes wet, or excessively soiled, or both, or become contaminated by toxic or irritating materials. Many companies keep spare outer clothing available for workers whose own clothes become contaminated.

Records should be kept of employee illness, whether work related or not, so that any sickness resulting from unsanitary conditions can be detected. This is especially important for problems such as food poisoning where an epidemiological study may be necessary.

You should have an ongoing program to advise employees on good personal hygiene, especially when they might be handling toxic and irritating materials. This should include advising them that family members could be exposed to toxic and irritating materials through exposure to their clothing. Consequently, work clothing should be changed or specially cleaned before going home.

PERSONAL PROTECTIVE EQUIPMENT

An effective program of personal protection is essential for any employee who uses potentially hazardous equipment or is exposed to potentially hazardous agents. Although equipment is available that can literally protect a person from head to toe, too much protective equipment can be extremely uncomfortable for employees and can greatly reduce their productivity. Therefore, determining priorities for using personal protective equipment is very important. The three broad applications are:

—emergency situations such as fires or chemical leaks,
—protection from accidental injury by falling objects or chemical splashes, and
—temporary protection while engineering or administrative controls are being designed or implemented but are not yet complete.

The success of your overall OSH program depends strongly on staff management involvement and clearly defined organizational and responsibility; this also applies to your personal protective equipment program. A single person should be responsible for the program. At larger or more hazardous establishments, this could be the Safety Director, the Director of Occupational Safety and Health Program, the Industrial Hygiene Director, the Personnel Director, or another staff person. At a smaller establishment where these positions may not exist, the plant manager or foreman might assume this responsibility.

Regardless of the size of your establishment, you should follow some basic steps in setting up your program:

—Identify operations, situations, and work areas where protective equipment is needed.
—Determine potential hazard level.
—Decide on general "sense" (e.g., hearing, sight) or function (e.g., respiratory, motion) to be protected.
—Determine need and type of professional consultation, if any.
—Initiate engineering/administrative control programs identifying goals and time frames.
—Investigate the available protective equipment, including a "hands-on" examination, and individual pieces using consultants where necessary and employees where possible.
—Establish education/awareness program to stimulate employee involvement.
—Set up an ongoing fitness/maintenance program for protective equipment.

Although the person in charge of the program might delegate some responsibilities to their employees, he or she must maintain overall control and followup. In some instances, it will also be necessary to use the services of consultants, especially if health hazards are present (or suspected of being present) at your establishment and you do not have either an industrial hygienist on your staff or proper monitoring equipment.

The first step in your program is to determine which operations and jobs require personal protective equipment. This evaluation can be done by properly trained employees, or by qualified health and safety professionals, or both. Under all circumstances, the people involved in the management of your program should be familiar with the basic concepts and categories of protection available. These include:

—eye protection from flying particles, dust, sparks, splashing chemicals, and mists, and harmful radiation from welding, bright lights, or extremely hot objects;
—hearing protection from high noise levels;
—head protection from falling objects and chemical splashes, and from bumping head on equipment;
—face and eyes protection from flying particles, chemical splashes, dusts, mists, and welding rays or other radiation;
—lung protection from dusts, mists, gases, vapors, fumes, and smoke, and
—limb, foot, and torso protection from falling or flying objects, splashing chemicals, mists, heat, cuts, electricity, machinery welding, etc.

Selection of proper equipment is not always a simple matter so equipment should be investigated thoroughly before purchase. Again, depending on the size of your establishment, the qualifications of your regular staff, and types of hazards present, you may wish to consult with health and safety professionals or equipment distributors.

Manufacturers and distributors of health and safety products will be able to answer questions and help in selection of proper equipment if they are given enough information about the hazards involved. It is also quite likely that you can receive assistance from them at no cost to you. They will be able to provide information by which you can evaluate various types of equipment, especially in regard to popularity, effectiveness, and limitations. Whenever possible, compare at least two similiar products. Your employees should also be consulted about the comfort and appearance of equipment before its purchase since it will directly affect their willingness to use it. In some cases, you might wish to have several employees "test" a piece of protective equipment before you purchase it for a larger group.

The equipment you select should be certified by the National Institute for Occupational Safety and Health (NIOSH), or be approved by the U.S. Bureau of Mines (USBM), the American National Standards Institute (ANSI), or the U.S. Food and Drug Administration (USFDA). Try to select equipment that will give full protection but that will not be so uncomfortable as to discourage employees from using it. In purchasing equipment, the cost can be borne by the employer, employee, or both. However, if your employees do the purchasing independently, this should be controlled to ensure that the proper equipment is selected. (See "A Guide to Industrial Respiratory Protection."[1]) Some types of equipment often used are:

—safety glasses, goggles, or special filter lens for eye protection;
—earplugs, muffs, or helmets for hearing protection;
—hard hats, hoods, or other special coverings for head protection;
—face shields, hoods, or helmets for face and eye protection;
—respirators for respiratory or breathing protection;
—whole-body coverings, gloves, boots, or partial coverings to protect the limbs and torso.

You will be most likely to need professional consultation if your operations require respirators to protect employees from hazardous air contaminants. Basically there are three types of respirators:

—air purifying (filters, gas masks, and chemical cartridge);
—atmosphere (air) supplied respirators (hose masks, air line respirators, abrasive blasting respirators, air supplied hoods and suits); and
—self-contained breathing apparatus.

[1]A Guide to Industrial Respiratory Protection. J. A. Pritchard. DHEW (NIOSH) 76-189. National Institute for Occupational Safety and Health, Cincinnati, OH. June 1976.

Choosing the proper respirator can be a complicated matter (see Figure 13). By following the steps on this chart, you can use the information you have regarding particular hazards to estimate what types of respirators might best meet your needs.

In addition, a medical evaluation should be made to determine which of your employees are physically able to use positive and negative pressure respirators. For example, employees with cardio-pulmonary problems could compound those problems if they regularly used respirators or if they used certain types of respirators.

A similar set of guidlines for selecting eye protection for a number of hazardous operations can be seen in the diagram that follows.

Once needs have been determined and the personal protective equipment has been selected and purchased, you should plan for the distribution of the equipment. In larger establishments, there might be several distribution centers. Certain types of protective equipment might require individual fitting; this will determine their pattern of distribution. For example, earplugs might be distributed through the clinic at large establishments or through a part-time or consulting nurse at smaller workplaces so that they can be properly fitted. Definite locations should be designated and all equipment should be picked up and returned to preestablished locations. Only in this way can you be sure that proper maintenance is carried out and that all employees requiring equipment have received it. Also, if equipment is available for emergency use only, it is important for distribution areas to be easily accessible to the employees.

Through regular use, most personal protective equipment deteriorates or becomes fouled with contaminants. A regular maintenance program should include cleaning, inspection, and testing of equipment. Some equipment must be cleaned at the end of each working day. Respirator filters and cartridges must be replaced periodically. Disposable type respirators, which can be discarded after one day, are also available for certain operations.

Finally, although employees may have the proper equipment available to them, they often will not use it. Motivating employees to use personal protection is not a simple matter especially when the equipment may be uncomfortable. Knowing what stimulates the employees in your establishment and

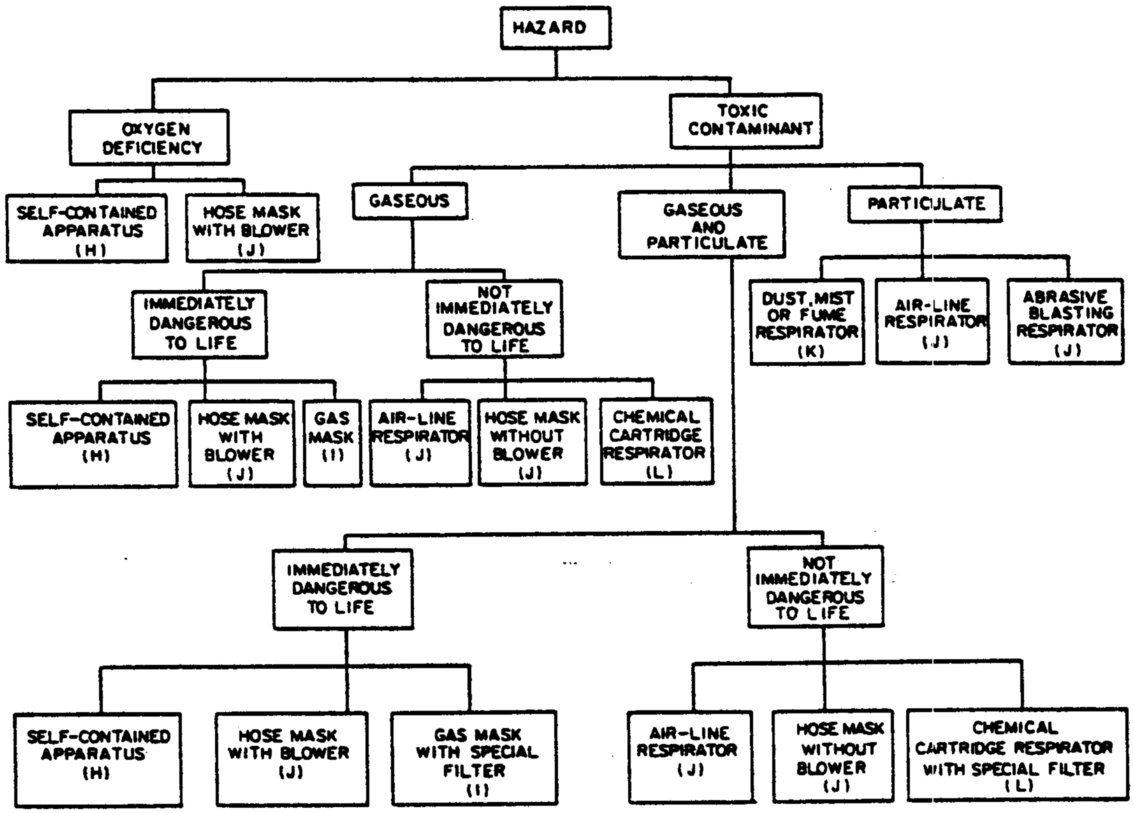

Figure 13. Suggested outline for selecting respiratory protective devices. Letters in parenthesis refer to Subparts of Title 30, CFR, Part 11, which discuss the items. (Reprinted with permission of the National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611, from: Accident Prevention Manual for Industrial Operations. Seventh Edition. National Safety Council, Chicago, IL. 1974. p. 490.)

understanding their attitudes will usually help you to select proper techniques to assure their cooperation in continuing usage of the equipment. Some methods you might use include:

—educating employees on the seriousness of potential hazards,
—educating supervisors in motivating equipment usage,
—disciplining employees for failure to use required equipment,
—enforcing the use of equipment by visitors and other nonoperating personnel in the area,
—selecting equipment that is as comfortable and attractive as possible.

Employees should be given complete instructions on the proper use and care of the equipment. Without this knowledge, employees' efforts to protect themselves may be ineffective. Therefore, training sessions should be conducted at the time of initial issuance of equipment and periodically thereafter.

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CRITERIA FOR SELECTING EYE PROTECTION

OPERATION — hazard	Goggles—flexible fitting, regular ventilation	Goggles—flexible fitting, hooded ventilation	Goggles—cushioned fitting, rigid body	Spectacles—metal frame with sideshields	Spectacles—plastic frame with sideshields	Spectacles—metal-plastic frame with sideshields	Welding goggles—eyecup type, tinted lenses	Chipping goggles—eyecup type, clear safety lenses	Welding goggles—coverspec type, tinted lenses	Chipping goggles—coverspec type, clear safety lenses	Welding goggles—coverspec type, tinted plate lens	Face shield (available with plastic or mesh window)	Welding helmets
ACETYLENE—burning, cutting, welding sparks, rays, molten metal, flying particles							X		X		X		
BABBITTING molten metal splash, heat		X		X				X		X		X	
CHEMICAL HANDLING* splash, burns, fumes		X										X	
CHIPPING flying particles, dust	X		X					X		X			
COMPRESSED AIR EXPOSURE flying particles, air blast	X	X						X		X			
DUSTS nuisance, corrosive particles	X	X	X										
ELECTRIC ARC WELDING* sparks, molten metal, harmful rays													X
FURNACE OPERATIONS* glare, heat, molten metal splash							X		X		X		
LIGHT GRINDING flying particles	X		X	X	X	X							
HEAVY GRINDING* flying particles	X		X					X		X			
HAND TOOL OPERATIONS—drill, chisel, wire and bolt cutters, etc. flying particles, wire whiplash, etc.	X		X	X	X	X							
LABORATORY* chemical splash, glass breakage, explosion		X											
LASER USAGE* intense infrared radiation	Refer to ANS Z136—1973 (Safe Use of Lasers).												
MACHINING flying particles, dust	X		X	X	X	X						X	
MOLTEN METALS* heat, glare, sparks, splash							X		X				
SPOT WELDING sparks, flying particles	X		X	X	X	X						X	
WORK IN VICINITY OF WELDING OR ARC WELDING* sparks, molten metal, harmful rays				X ••	X ••	X ••							

Bold type indicates operation—light type indicates hazard.

* For additional comment, see proposed revisions for American National Standard Z87

•• With absorptive lenses.

X = Recommended Optimum Protection

*Reprinted from February 1975 NATIONAL SAFETY NEWS, a National Safety Council publication, 444 N. Michigan Avenue, Chicago, IL 60611; Programming Personal Protection: Eye and Face. National Safety News, 3(2):55, February 1975.

MACHINE GUARDING

Guarding is the most fundamental engineering control you can use to protect your employees from injury. A comprehensive program for guarding is an essential element of any safety program in a workplace where machinery is necessary for productive purposes.

All "energy input" (Mechanical, thermal, electrical, or chemical) used in production is hazardous in varying degrees. Mechanical eneregy used to put machinery into motion is the most common potential work hazard. Guards are as varied as the facilities, machines, and operations for which they are designed. To be effective, these guards should encompass both the power transmission parts of the machine and the areas at the point of operation. Properly employed, they will provide protection from any of the following:

—direct contact with an injury-producing part,
—kickbacks of materials being processed,
—mechanical failure of the machine,
—electrical failures, and
—human/machine interactive (fit) failures.

Using the same terms to describe different circumstances can lead to confusion. Normally, "guarding" refers to point-of-operation guards, whereas "safeguarding" refers to any barrier or cover that protects other danger points. As used here, however, we will refer to both types as "guarding."

The key problem is to design a guard that adequately protects the worker without interfering with the worker's ability to operate the machine efficiently and comfortably. If a guard makes operations excessively cumbersome, it won't be long before your workers remove or circumvent it. The best guards are the ones that fit well into the work environment and become a natural part of the machinery. A well-designed guard should smoothly guide the worker away from the point of danger. Rather than the guard being a distraction, the absence of the guard should be highly visable and uncomfortable to the worker.

Nationally accepted standards for machine guarding are contained in the "American National Safety Standard for Mechanical Power Transmission Apparatus" available from the American National Standards Institute (ANSI). This safety code has been widely adopted by most states and establishments that have maintained low accident rates.

Although codes and standards can give you overall guidance in the proper guard design, the effectiveness of each guard still largely depends on the skill of those who actually design and construct the guard. Each guard is made-to-order since each individual machine presents its own problems. The most effective guards are usually provided by the manufacturer of the machine, although with sufficient knowledge and skill, homemade guards can meet your needs.

If there are machines in your establishment that do not have sufficient guarding, you should seek the help of one of the following:

—manufacturer of the machine itself,
—manufacturer or distributor of safety equipment,
—insurance company safety consultant,
—safety consultants available through government agencies,
—local safety council consulting engineer,
—private consulting engineers, or
—qualified engineers employed by your establishment.

Although it is not recommended that you attempt to design homemade guards without consulting with a qualified person, you should seek the ideas and opinions of those employees who daily operate the machine. They will be able to point out the most hazardous aspects of the machinery, and they will also know which guards would seriously inhibit their efficiency and comfort.

Listed below are some very basic principles and techniques of mechanical guarding excerpted for OSHA pamphlet 2057. The information provided in this booklet should be helpful to you in understanding mechanical guarding and establishing a program. It is suggested that you obtain your own complete copy of OSHA 2057, since only a portion is reprinted here.

An acceptable guard, in conclusion, should:

—conform to federal and state OSHA requirements;
—afford maximum protection;
—be considered a permanent part of the machine or equipment, yet not be too difficult to remove or replace when necessary;
—prevent access to the danger zone during operation;
—be convenient—it must not interfere with efficient operation or maintenance of the machine, or give discomfort to the operator;

—not weaken the machine structure;
—be designed for a specific job and a specific machine;
—be durable, resistant to fire and corrosion, and easily repaired;
—be constructed well enough to resist normal wear and shock and to require minimum maintenance;
—not present hazards in itself, such as rough edges, splinters, pinch points, shear points, or sharp corners.[2]

Design and installation of guarding for all machinery is only one part of your program. Regular maintenance and inspection of guarding devices is essential to the effectiveness of any program. Inspections should be made periodically to determine not only the smooth functioning of guards but also whether employees are actually using guards properly.

In addition, a guarding program should include education and training of your employees in this area.

[2]Handbook of Accident Prevention for Business and Industry. Fourth Edition. National Safety Council, Chicago, IL. 1970. pp. 42-43.

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ACTIONS AND MOTIONS THAT CREATE HAZARDS[1]

Since safety standards cannot be drawn which will cover every conceivable hazardous mechanical exposure, it is often necessary to use imagination and ingenuity to protect unusual situations. If the basic hazardous actions and motions are understood, it is easier to evaluate the hazard and to develop effective control measures, whatever the machine. Actions or motions involving the most hazardous exposures may be classified as:

Rotating, Reciprocating, and Transverse Motions.
In-Running Nip Points.
Cutting Actions.
Punching, Shearing, and Bending Actions.

Rotating, Reciprocating, and Transverse Motions

Rotating, reciprocating, and transverse motions create hazards in two general areas—at the point-of-operation where work is being done, and at the points where power or motion is being transmitted from one part of a mechanical linkage to another. Since guarding at the point-of-operation will be discussed under the other classifications of action or motion, this section will be devoted primarily to situations where power is being transmitted or the point-of-operation is not clearly defined (extractors, mixers, etc.)

Any rotating object is dangerous. Even smooth, slowly rotating shafts can grip clothing or hair, and through mere skin contact, force an arm or hand into a dangerous position. Accidents due to contact with rotating objects are not frequent, but the severity of injury is always high.

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, rotating bar stock, lead screws, and horizontal or vertical shafting are typical examples of common rotating mechanisms which are hazardous. The danger increases when bolts, oil cups, nicks, abrasions, and projecting keys or screw threads are exposed when rotating.

In many cases, the rotating mechanism is located within a stationary case or shell and consists of a revolving cylinder, a screw, agitator blades, or paddles. Washing machines, extractors, raw material mixers, and screw conveyors are typical examples of this type of hazardous rotating mechanism.

Reciprocating and transverse motions are hazardous because, in the back and forth or straight line action, a worker may be struck or caught in a pinch or shear point between a fixed or other moving object.

In-Running Nip Points

In-running nip points are a special danger existing only through action of rotating objects. Whenever machine parts rotate toward each other, or where one rotates toward a stationary object, an in-running nip point is formed. Objects or parts of the body may be drawn into this nip point and be bruised or crushed.

The in-running side of rolling mills and calenders, or rolls used for bending, printing, corrugating, embossing or feeding and conveying stock, the in-running side of a chain and sprocket, belt and pulley, a geat rack, a gear and pinion, and a belt conveyor terminal are typical examples of nip point hazards.

[1]The Principles and Techniques of Mechanical Guarding. OSHA 2057. U.S. Department of Labor, Occupational Safety and Health Administration. Washington, DC. Revised August 1973.

Cutting Actions

Cutting action results when rotating, reciprocating, or transverse motion is imparted to a tool so that material being removed is in the form of chips. The danger of cutting action exists at the movable cutting edge of the machine as it approaches or comes in contact with the material being cut. Such action takes place at the point-of-operation in cutting wood, metal, or other materials as differentiated from punching, shearing, or bending by press action.

Typical examples of mechanisms involving cutting action include band circular saws, milling machines, planing or shaping machines, turning machines, boring and drilling machines, and grinding machines.

Punching, Shearing, and Bending Actions

Punching, shearing, or bending action results when power is applied to a ram (plunger) or knife for the purpose of blanking, trimming, drawing, punching, shearing, or stamping metal or other materials as differentiated from removing the material in the form of chips. The danger of this type of action lies at the point-of-operation where stock is actually inserted, maintained, and withdrawn.

Typical examples of equipment involving punching, shearing, or bending action include power presses, foot and hand presses, bending presses or brakes as well as squaring, guillotine, and alligator shears.

METHODS OF GUARDING ACTIONS AND MOTIONS

Whenever hazardous machine actions or motions are used, a means for providing protection for the operator and fellow workers is essential. And, there may be several ways to guard a situation, particularly at the point-of-operation.

This does not mean that certain guarding methods are not preferable to others, but the type of operation, the size or shape of stock, the method of handling, the physical layout, the type of material, and production requirements or limitations may present important considerations. A certain flexibility in operations may also determine the practicability of the method to be used.

As a general rule, power transmission apparatus can be protected by fixed enclosure guards. It is when guarding the point-of-operation, where work is being done on an object, that the most effective and practical of several means of guarding must be selcted.

CLASSIFICATION OF GUARDS

The methods of guarding may be grouped under four main classifications:

1. Enclosure Guards
   a. Fixed enclosures.
   b. Adjustable enclosures.
2. Interlocking Guards
   a. Enclosure or gate guard with electrical or mechanical interlock.
   b. Barrier with electrical or mechanical interlock activating a brake.
   c. Electronic or other type field or beam connected with operating and stopping mechanism.
3. Automatic Guards
   a. Moving barrier connected to operating mechanism of machine (push away).
   b. Removal device connected to operator, and operating mechanism of machine (pull-away).
   c. Limitation of stroke.
   d. Automatic pressure release devices.
4. Remote Control, Placement, Feeding, Ejecting
   a. Two-hand tripping devices (also multiple operation).
   b. Automatic or semiautomatic feed.
   c. Special jigs or holding devices.

Enclosure Guards

Fixed enclosure guards should be used in preference to all other types. They prevent access to dangerous parts at all times by enclosing the hazardous operation completely. They are also used to restrain bursting machine parts from flying about. They admit the stock but will not admit hands into the danger zone because of limited feed opening size. They may be constructed so as to be adjustable to different sets of tools or dies, but once adjusted they should be fixed.

Enclosure guards may be installed at the point where cutting, bending, punching, or shearing action takes place on material being processed, and at other places where there may be a hazard to men inserting or manipulating stock. They may also be used to prevent contact with rotating, reciprocating, and transverse motion of machine members away from the point-of-operation.

Interlocking Guards

When a fixed enclosure guard is not practicable, an interlocking enclosure or barrier should be considered as the first alternative.

An interlocking enclosure guard is not fixed and may be opened or removed as the operation requires. However, due to an electrical or mechanical interlocking connection with the operating mechanisms, the operation of the machine is prevented until the guard is returned to an operating position and the operator can no longer reach the point of danger.

An interlocking enclosure guard should do three things:

1. Shut off or disengage the power to prevent the starting of the machine when the guard is open.
2. Guard the danger point before the machine can be operated.
3. Keep the guard closed until the dangerous part is at rest, or stop the machine when the guard is opened.

When gate guards or hinged enclosure guards are used with interlocks, they should be so designed as to completely enclose the point-of-operation before the operating clutch can be engaged.

An interlocking barrier guard quickly stops the machine or prevents application of injurious pressure when any part of the operator's body contacts the barrier. The barrier may be a bar, a rod, a wire, or some similar device (not an enclosure), extended across the danger zone and interlocked electrically or mechanically with a braking mechanism. Electrical interlocking devices should be so designed that if they fail, they fail safe, making the guarded machine inoperative.

Another type of interlocking barrier may be in the form of an electric-eye beam, a magnetic, radioactive or similar type circuit so designed and installed that when the operator's hand or any part of the body is in the danger zone, the machine cannot be operated, or if the hand or any part of the body is inserted while the machine is in motion, it will immediately activate a braking mechanism.

Automatic Guards

When neither an enclosure guard nor an interlocking guard is practicable, an automatic guard may be used.

An automatic guard acts independently of the operator, repeating its cycle as long as the machine is in motion. This type of guard removes the operator's hands, arms, or body from the danger zone as the ram, plunger, or other tool closes on the piece upon which work is being done. It is operated by the machine itself through a system of linkages connected to the operating mechanism.

Common types of automatic guards are sweep and push-away devices which are moving barriers crossing the danger zone when the machine is activated, and pull-away devices consisting of hand and arm attachments which pull the operator away from the danger zone.

Sweep and push-away devices should be designed to prevent the operator from reaching behind or across the protective device into the danger zone before the machine has completed its closing cycle. The device itself should not offer a hazard by creating a shear point between the moving guard and a stationary or moving part of the machine.

Automatic pressure release or pivoting arm devices provide utility, yet protect in-running nip point situations.

Remote Control, Placement, Feeding, Ejecting

Although they are not guards in the technical sense, there are certain methods which can be used to accomplish the same effect, that is, of protecting the operator from the hazardous point-of-operation. They may be used to complement one of the other types of guards, or may be used in lieu of guards.

Two-handed operating devices may be used to activate the machine. These devices require simultaneous action of both hands of the operator on electrical switch buttons, air control valves, or mechanical levers. On presses with a noninterrupting stroke, two-handed operating devices should require manual operation until a point is reached in the cycle at which the hazard ceases. Hand controls may be interconnected with foot controls to permit operation of the machine. The actuating controls should be so located as to make it impossible for the operator to be able to move his hands from the controls to the danger zone before the machine has completed its closing cycle. The two-handed controls should be so designed as to prevent the blocking, tying down, or holding down of one control to allow one hand free access to the point-of-operation. When more than one man is working a machine, additonal controls should be installed and designed so that all men must simultaneously activate the starting mechanism from remote locations.

Automatic or semiautomatic feeding mechanisms such as roll, plunger, chutc, siide and dial feeds, and revolving dies may be used in conjunction with ram enclosures. Special soft metal handtools may be used to place or remove parts in conjunction with an enclosure, interlocking or automatic guard. Special jigs, holding device and dies may be used to manipulate stock at the point-of-operation, yet keep hands safe. Mechanical or air-operated ejecting mechanisms may be used to remove parts, thus eliminating the need for the hands to be placed in the danger zone.

The theory behind these methods is that if for good reason it is impossible to completely enclose or isolate the hazard, the next best device or combination of devices should be used to keep the exposure to a minimum.

POTENTIALLY HAZARDOUS OPERATIONS

The term "hazardous operation" is used to refer to processes or activities at your establishment that expose one or more individuals to psychological or physical harm.

Many hazardous operations are hazardous only because we let them be so. In some circumstances, present technology or the nature of the operation may make it impossible to remove all personal danger. At best, your establishment will have few if any hazardous operations. Sometimes this can be achieved easily, involving only a slight change in procedures. At other times, there may be no economical method of changing a particular piece of machinery or a process so that it is reasonably safe, and the only practical solution may be complete replacement or redesigned production process.

No one safeguard should be relied on to reduce the danger of personal injury to acceptable levels. Single protective measures have a way of becoming inoperative, being ignored, or otherwise failing to do their task, thereby indicating the need for backup measures. Neither the primary nor the backup safeguard must necessarily be mechanical; employee training, education, rules, and procedures can be relied on as a safeguard.

As an example, a punch press is equipped with a device to prevent double cycling. In addition, each operator has been thoroughly trained in the operation of the machine, has been instructed about the danger of inserting his hands into the danger zone, and received instructions, periodically reinforced, not to place his hands under the dies. If he forgets or becomes careless, the built-in safeguard is likely to prevent an accident, or if the press double cycles, as it may do, normal operator procedure will prevent an accident. Both safeguards—mechanical and procedural—must fail simultaneously for personal injury to occur. The probability of this happening is slight, provided there is a routine, continuing procedure to ensure that no safeguard is inoperative for any significant length of time. Even where dies are fully enclosed, operator training and awareness of the hazard are needed as a backup to ensure that the press is not operated with the guards damaged or removed.

Where the hazard is severe, one backup system may not be enough. In such a situation, two or more engineering controls may be provided against a particular hazard, in additon to administrative controls. For instance, a railroad crossing may simply have a warning sign, which alone will not force anyone to stop. The driver is expected to "stop, look, and listen," but experience has shown that the sign alone is ineffective. To assist in warning the driver, the train will give audible signals, and further, flashing lights may be installed. But all of these depend on the driver reacting to warning signals; if the road over the tracks is still clear, inattentive drivers do ignore the signals. Crossing gates, which place a physical barrier across the road as the train approaches, are considerably better in reducing the hazard to acceptable levels.

In many situations, the danger of personal injury may not be severe enough to warrant any special safeguard, so that you can reasonably rely on common sense and prudence to avoid an accident after suitable training. For example, no guard is necessary to keep typists' fingers from "pinch points" under the movable carriage, nor is it necessary to devise engineering controls to keep one's fingers from being burned while changing light bulbs. These are commonly encountered hazards with which all of us are likely to be familiar, and even if we become careless, the consequences are not usually severe.

The variety of equipment and procedures that can constitute hazardous operations is so great that it would be impossible to review the specific dangers and controls applicable to each. The hazards of a single piece of machinery can vary according to its specific design.

This entire manual, in a broad sense, deals with hazardous operations. Chapters on guarding and personal protective equipment are particularly relevant. You should review them with each hazardous operation in mind. If necessary, you should then seek outside assistance—from equipment manufacturers and distributors, engineering consultants, reference books, agencies, and associations. The chapter in this manual on sources of resources (information and consultation) will assist you in locating appropriate help. Finally, do not neglect your greatest resource—the employees—for analyzing and controlling each hazardous operation.

HANDLING AND STORAGE OF HAZARDOUS MATERIALS

Hazardous materials are generally considered as such because of some inherent characteristic not easily abated without destroying the qualities that make the product useful. Alcohol, which is flammable, can be diluted with water to the point where it no longer presents a flash fire hazard, but by doing so we may have destroyed its usefulness as a solvent or chemical reactant. Similarly, sodium in its pure form is dangerously reactive. It causes deep flesh burns on contact with the skin and explodes in contact with moisture; in chemical combination as sodium chloride (i.e., table salt), sodium is harmless, but also useless, if the special properties of the pure sodium were needed.

In some cases, and particularly if the hazard from a material is especially severe, another material may be substituted that is less hazardous. However, the basic approach to safeguarding employees from hazardous materials is not to eliminate the material, but to provide protective measures for storage and use.

A material may be hazardous from more than one standpoint, and the labeling provided by the manufacturer may not identify all of the hazards or their true severity. A useful reference work for any establishment that handles a variety of chemicals, solvents, or other potentially dangerous materials is "Dangerous Properties of Industrial Materials."[1] The characteristics which make a material hazardous include:

—toxicity,
—flammability,
—reactivity,
—corrosiveness,
—nuclear radiation, and
—irritation (skin, eyes, nose, lungs).

The degree of hazard is also influenced by factors such as particle size, volatility, concentration, temperature of storage and use, quantity used, and method of use. A highly reactive and explosive material like an organic peroxide may be shipped to you in a "safe" container (under alcohol, in the case of peroxides), but if during use, the protective cover or encasement is removed or lost, the material becomes much more hazardous than the container label might indicate.

[1]Dangerous Properties of Industrial Materials. Fourth Edition. N.I. Sax. Van Nostrand Reinhold Co., New York, NY. 1975.

The first step in the control of hazardous materials is to identify them: their location by room or work area, quantity, and in what operations they are used. All chemicals, solvents, cleaning fluids, compressed gases, or any other substance about which you have any doubts should be included. List the complete chemical name if available, the manufacturer or supplier (including telephone number), trade name, warnings given on the label ("eye irritant," or "extremely flammable," etc.), quantity stored or used, and the purpose for which the material is present. DO NOT ASSUME THAT A MATERIAL IS HARMLESS JUST BECAUSE THERE IS NO WARNING ON THE LABEL.

Unless the quantities are quite small and no potential danger can be envisioned from their storage and use, you should list the substance and be certain that you have complete data on the hazards it presents. Manufacturers' data sheets and catalogs are useful in compiling this information, as is the "Dangerous Materials" handbook mentioned previously. The Manufacturing Chemists' Association publishes chemical data sheets, available at nominal cost, on many commonly encountered materials. More specialized reference works may be needed in certain instances, and if any doubt remains as to the hazards of a material and the precautions that must be taken, you should contact a specialist in this area.

Information on hazardous materials is also available free or at a nominal charge from:

—National Institute for Occupational Safety and Health (NIOSH),
—Occupational Safety and Health Administration (OSHA),
—Energy Research and Development Administration (ERDA) (for nuclear safeguards),
—National Safety Council,
—American Chemical Society,
—Society of the Plastics Industry (SPI), and
—Trade associations.

For more specific information, refer to the chapter in this manual on Information and Consultation Sources.

Once hazardous materials have been identified, controls should be established for their purchase, storage, distribution, and use. It is not uncommon for a particular establishment to "outlaw" a substance as too hazardous for its operations, only to have the material repurchased because of lax controls. Another common problem arises in quantity purchases of a hazardous material for purposes of economy. A 5-gallon drum may be bought even though only small laboratory quantities are needed. Obviously employee exposure is much greater from bulk quantities than small, individual containers, unless specially constructed storage facilities are provided. The audit of hazardous substances in your establishment should indicate the normal consumption of a substance by each department; the staff responsible for purchasing should be instructed to limit stocks to those reasonably necessary.

Procedures should be established to screen potentially hazardous materials before purchase and to review manufacturer's safety data sheets. As the need for a new material arises, an analysis should be made of the problems that are likely to occur in its storage and use; only after the proper controls have been initiated, should purchase be permitted. Preferably, purchase of all hazardous substances should be centralized.

Safe storage facilities must be provided. Laxity in this area causes many injuries due to container leakage and incompatability of jointly stored materials. Strong oxidizers, flammable and explosive substances, highly corrosive materials, and radioactive substances should be assigned special storage areas. They should be segregated not only from general storage and use areas but also from each other. The amounts permitted to be stored at a location will depend on:

—the relative hazard of the material;
—the type of storage container (e.g., bulk 50-gallon drums versus 1-gallon sealed cans);
—the distance of the storage area from other parts of the establishment;
—the effectiveness of controls provided (ventilation, fire extinguishing system, explosion relief panels, drains, etc.);
—their accessibility in case of emergency and
—the availability of explosion-proof refrigerators.

TOXICOLOGY

Toxicology is the study of the nature and action of poisons and other substances otherwise harmless that prove toxic to living organisms under certain conditions. Any material can cause bodily harm if present in excessive concentrations. You are probably aware that some agents used at your establishment are potentially hazardous to employees, but you might be uncertain about others. To determine if a particular substance contains toxic materials and what those materials are, you can check with the following sources:

—manufacturer or distributor of the material,
—toxic substance list published annually by NIOSH,
—OSHA General Industry Standards -Subpart Z,[1]
—resource books on toxicology,
—consultants, and
—university bio-hazard committee.

All known chemicals can enter the body by various routes. The main routes of entry and absorption are:

—inhalation through the lungs,
—skin contact, and
—ingestion.

The concentration of a toxic material reaching a critical organ or tissues will vary according to the route of entry. Although inhalation is the most common mode of industrial exposure, skin contact with hazardous substances can cause percutaneous absorption. Some substances such as organic solvents, phosphorus, and mercury can pass through the skin and be absorbed directly into the body. Therefore, direct skin contact with toxic materials should be avoided. For this reason, hands must be washed before using toilet facilities.

Ingestion of substances in toxic quantities is not common in industry, although it may occur by eating food or smoking, etc., that have been contaminated with the toxic substance or by putting contaminated hands in the mouth.

Although toxic substances may be classified according to their physical and chemical properties, toxicology is concerned more with the body's response to various substances. The following are some of the common classifications of toxic substances:

—Irritants—corrosive materials, such as acids, alkalies, and ozone, that cause inflammation of mucous surfaces in lungs, eyes, and skin.

—Asphyxiants (simple and chemical)
- Simple—inert gases, such as methane, nitrogen, and carbon dioxide, that, as they increase in concentration, dilute the oxygen in the atmosphere to a point inadequate to sustain life.
- Chemical—gases, such as carbon monoxide and hydrogen cyanide, that prevent the body from utilizing oxygen.

—Anesthetics and narcotics—organic substances, such as acetylene, ethylenes, ethyl ether, propane, or acetone, that have depressant action on the central nervous system (resulting in lowered breathing and heart rates).

—Systemic poisons—substances that cause:
- liver damage (e.g., carbon tetrachloride and tetrachloroethane),
- kidney damage (e.g., halogenated hydrocarbons and uranium),
- nervous system disorders (e.g., mercury, manganese, carbon disulfide, and lead),
- blood or blood producing tissue damage (e.g., arsine, benzene, and nitrobenzene).

—Lung damaging substances—substances such as silica, asbestos, and toluene diisocyanate (TDI).

The health effect an air contaminant may have depends upon:

—the severity of the toxic effect,
—the concentration of the substance inhaled, and
—the period of exposure to the air contaminant.

Where other factors influence effects, the last two of the three listed above are the ones we have most control over. TLVs (Threshold Limit Values) are guidelines used for controlling the concentrations and lengths of exposures. The TLV is the concentration of an airborne substance that a worker may be exposed to, averaged over an 8-hour period, for 40 hours a week during a working lifetime without harmful effects. In considering this concept, it must be remembered that the TLV is a guideline and the best policy is to minimize air contaminant concentrations no matter what the TLV. Also, some substances do not have a

[1]Code of Federal Regulations, Title 29, Part 1910, Subpart Z, Occupational Health and Environmental Control.

TLV. For these, the best policy again is to minimize concentrations as far as possible. This is especially important since some individuals are more susceptible to certain substances than others and may experience ill effects from exposure to concentrations even at TLV.

In determining individual exposure, the concentration and duration of exposure must be considered so that a time-weighted average (TWA) may be calculated. The TWA can be calculated from the following formula:

$$\text{TWA (8 hours)} = \frac{C_1T_1 + C_2T_2 \ldots + CnTn}{8}$$

where Cn is the concentration of the air contaminant during any time period Tn (hours).

The TWA exposure can then be compared with the TLV to judge whether a person is overexposed to an air contaminant.

Air sampling to evaluate toxic substances in the work environment should be conducted by industrial hygienists or employees trained in sampling techniques.

Some persons may have physiological characteristics due to their age, sex, state of health, previous exposure to toxic substances, or genetic inheritance, such that they would be considered hypersusceptible. It is important to recognize that even though these individuals may have very low exposures, they may be adversely affected. For example, it is known that pregnant women are more susceptible to toxic substances. During pregnancy, women have altered blood flow volumes and composition and altered lung function that can affect the maternal and fetal response to toxic substances. It is also known that physical stress can affect the fetal heart rate, depending upon the intensity of the stress and the physical capabilities of the mother. Certain toxic substances such as carbon monoxide, lead, benzene, carbon disulfide, nitrobenzene, and many others can injure the unborn child and possibly the mother.

The best way to prevent overexposure to susceptible individuals is through maximum control of contaminants. Where this is not achieved or where the material is unusually toxic to the unborn child, medical screening and special placement programs may be required to keep the hypersusceptible persons away from the toxic substances.

Some toxic substances have an increased toxic action when in the presence of other potentially hazardous agents or conditions. This is known as the synergistic effect. For example, each of the two substances may be considered slightly hazardous at certain concentrations. However, exposure to both at once may produce an extremely hazardous condition. The question of mixed-substance exposure is extremely difficult, and specialized consultation should be obtained. It is important to realize these possibilities and consider possible occurrences in your establishment.

You should determine what specific toxic substances present are potential hazards to employees at your establishment and refer to the chapter covering that substance for more information.

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CHEMICAL AGENTS

ACIDS

Acids are corrosive substances (with a pH value less than 7) that are used for a variety of purposes in industry and that can have toxic effects. The degree of toxicity depends upon the particular acid and its concentration.

It is important to know all the types of acids used in your establishment, what processes they are used in, and how many employees are actually or potentially exposed to them. Most acids are liquids, but a few exist in solid form. Health hazards can also arise from acid mist or dust. The following are examples of acids commonly found in industry:

—acetic	—oxalic
—chromic	—perchloric
—formic	—picric
—hydrochloric	—phosphoric
—hydrocyanic	—sulfuric
—nitric	

Examples of industrial processes using acids include:

- —metal cleaning, pickling, and etching
- —electrolysis
- —electroplating
- —battery making
- —paper making
- —chemical synthesis

Your establishment might use acids or processes other than those listed above. If you are uncertain as to whether a particular substance contains acids, check with the manufacturer, refer to a suitable reference book, or contact a knowledgeable person.

After you have identified potential problems, they should be studied in detail to determine their seriousness. A large part of this evaluation should consist of air sampling conducted by an industrial hygienist or a person trained in air sampling techniques. Individual employee exposure to acids should be measured to determine the needs for controls and personal protective equipment.

Engineering and administrative controls can be used to reduce employee exposure to acid mist or dust in the air, as well as to lessen the hazard of direct contact of acid with the skin and eyes. Engineering controls include:

- —local exhaust ventilation (hoods or process enclosures),
- —general ventilation, or
- —a combination of the above.

Administrative controls include:

- —eliminating the use of a particular acid;
- —replacing one acid with a less toxic one;
- —instituting procedures to reduce accidents associated with the handling, transporting, and storing of acids;
- —limiting employees' exposure time to vapors, mists, or dusts.

For example, when mixing concentrated acids with water, the acids should always be poured into the water, never the reverse. This lessens the danger of acid being splashed.

When engineering and administrative controls have failed to limit employees' exposures, personal protective equipment should be used. Depending on the use of acids at your establishment, the following types of equipment might be needed by employees:

- —gloves and aprons for handling acids,
- —eye and face protection against splashes,
- —respirators for emergency or short-term use where high concentrations of acid are present in the air, and
- —protective shoe covering.

In addition, emergency eye wash, routine washing facilities, and overhead showers should be present in each department or work area where acids are regularly used. These should be in good working condition and simple to operate and provide a minimum of 15 minutes of copious water flow. The chapter on personal protective equipment provides more specific information on strategies for limiting exposure.

Acid mists produced by liquid acids can result in lung damage if inhaled. Routine or accidental contact of acids with the skin or eyes can result in serious burns and irritation. Some acid mists, such as sulfuric, can corrode teeth over an extended period of time. Chromic acid is particularly dangerous and has been linked to lung and skin cancer.

If you have a physician present at your establishment, he or she is undoubtly aware of employee exposure to acids and should be conducting appropriate examinations and tests on employees to identify any potential impact on their health. If you use an outside medical facility, you should be certain that the physicians there are aware of the acids and their forms of exposure (mist, fumes, etc.) present at your establishment. Recommended tests for employees exposed to acids include pulmonary function tests, particularly forced vital capacity (FVC) and forced expiratory volume for 1 second (FEV_1) and their ratio (FEV_1/FVC) on a scheduled basis.

Employees should be advised of the health hazards of the particular acids with which they work. They should be instructed in the proper procedures for handling, transporting, and storing acids. Training in the use of personal protective equipment and the operation of engineering controls should also be given.

ALKALIES

Alkalies are corrosive materials widely used in industry. They neutralize acids and have a pH value greater than 7. The danger to employees depends upon the specific alkali used and its concentration. Generally, the hydroxides are the most irritating.

It is important to know all the types and concentrations of alkalies used in your establishment, the processes involved, and the number of employees potentially exposed. Alkalies are common in chemical process industries and are used as cleaning agents in many industrial operations. Most alkalies are solids, but they are often used in a liquid solution.

The following are examples of common industrial alkalies:

—ammonium hydroxide
—barium hydroxide
—barium oxide
—calcium chloride
—calcium oxide (quicklime)
—calcium sulfide
—potassium hydroxide
—sodium carbonate (soda ash)
—sodium hydroxide (lye or caustic soda)
—sodium sulfide

Your establishment might use alkalies not listed above. If you are uncertain as to whether or not a particular substance contains alkalies, check with the manufacturer, refer to a suitable reference book, or contact a knowledgeable person. For more specific information, refer to the chapter in this manual on sources of information and consultation.

When potential problems have been indentified, they should be studied in detail to determine their possible adverse effects. A large part of this evaluation should consist of air sampling conducted by an industrial hygienist or an employee trained in air sampling techniques. The air sampling will indicate employee exposure and the need for measures to control exposures.

Engineering and administrative controls can be used to reduce exposure to alkali vapor, mist, or dust in the workroom air and can lessen the hazard of direct contact of alkalies with skin or eyes.

Engineering controls include:

—local exhaust ventilation (hoods or process enclosures),
—general ventilation, or
—a combination of the above.

Administrative controls include:

—eliminating the use of particular alkalies;
—replacing one alkalie with a less toxic one;
—instituting procedures to reduce the possibilities of accidents involved with the handling, transporting, and storing of alkalies ;
—limiting the duration of exposure to vapors, mists, or dusts.

When engineering and administrative controls have failed to limit employees' exposures, personal protective equipment should be used. Depending on the use of alkalies at your establishment, the following types of protective equipment might be needed by employees:

—gloves and aprons for handling alkalies,
—eye protection against splashes,
—respirators for emergency or short-term use where high concentration of alkalies are present, and
—protective shoe covering.

In addition, emergency eye baths, routine washing facilities, and overhead showers should be present in each department or work area where alkalies are regularly used. These should be in good working condition and simple to operate and provide a minimum of 15 minutes of copious water flow. The chapter on personal protective equipment can provide you with more specific information.

Alkalies can severely irritate the skin, eyes, and throat. If alkalie vapor, mist, or dust are concentrated enough, the lungs can also be irritated.

If you have a physician present at your establishement, he or she should be aware of employee exposure to alkalies and should be conducting appropriate examinations and tests to determine what effect, if any, the exposure is having on your employees' health. If you use an outside medical facility, you should be certain that the physicians there are aware of the alkalies present at your establishment. Recommended tests for employees exposed to alkalies include spirometry, particularly forced vital capacity (FVC) and forced expiratory volume for 1 second (FEV_1) and their ratio (FEV_1/FVC).

Employees should be advised of the health hazards that can result from overexposure to alkalies. They should be instructed in the proper procedures for handling, transporting, and storing alkalies; emergency procedures; and the use of personal protective equipment.

GASES

Many different gases used in industry can have a potentially toxic effect on employees. Some are directly manufactured products and others are byproducts of other processes. The presence of any contaminant gases in the workroom atmosphere should be investigated so that the potential health hazards can be identified.

It is important to know all the types of gases present at your establishment, what processes they are used in, and how many employees are actually or potentially exposed to them. Any process that produces or possibly produces any gases should be identified. To assist you in doing this, you will find a list of common industrial gases and their uses at the end of this chapter.

Your establishment might use or produce gases not on this list. If you are uncertain as to whether a particular substance contains a potentially harmful gas, check with the manufacturer, refer to a suitable reference book, or contact a knowledgeable person. For more specific guidance, refer to the section of this manual listing sources of information and consultation.

When potential problems have been identified, they should be studied in detail to determine their extent. A large part of this evaluation should consist of air sampling conducted by an industrial hygienist or personnel trained in air sampling techniques. The air sampling will indicate employee exposure and the need for control measures.

Exposure to gases can be minimized through the use of engineering and administrative controls. Since concentrations of gases can result from many different sources, controls must be designed to deal with each contaminant separately. Engineering controls that should be considered include:

- —local exhaust ventilation (hoods or process enclosures),
- —general ventilation, or
- —a combination of the above.

Administrative controls are often the easiest, most effective, and least costly. Some general controls include:

- —eliminating the gas by changing the process to stop its generation,
- —altering the process to decrease the amount of gas generation into the air,
- —limiting the duration of employee exposure.

Often different combinations of controls can be used to limit employee exposures more effectively.

When engineering and administrative controls fail to maintain exposure at acceptable levels, respirators should be used as as interim measure. Some gases such as ammonia and hydrocyanic acid can be absorbed through or irritate the skin. Protective clothing should be used by employees exposed to these gases. The chapter on personal protective equipment provides more specific information.

Gases can have negative health effects ranging from skin and lung irritation to asphyxiation and even death. If you have a physician present at your establishment, he or she should be aware of employee exposure to gases and should be conducting appropriate examinations and tests on employees to determine what effect, if any, the exposure is having. If you use an outside medical facility, you should be certain that the physicians there are aware of the gases present at your establishment. Tests for employees exposed to gases depend on the particular gas in question and are performed to determine overexposure to gases or changes in lung capacity. Some frequently used tests include complete blood count (CBC), chest X-ray, urinalysis, electrocardiogram (EKG), and pulmonary function studies (FEV_1, FVC, and their ratio FEV_1/FVC).

Employees should be advised of the potential hazards posed by each particular gas and should be instructed in the proper procedures for handling and storing. Most important, they must be informed as to the correct type and use of respirators to control their exposure.

GAS	SOURCES OR USES
Acetylene	Welding, torch cutting, starting material for synthesis of chemicals.
Ammonia	Distillation of coal, action of steam on cyanamide, catalytic combination of nitrogen at high temperature and pressure, refrigeration, petroleum refining, manufacture of fertilizer, nitrogenous materials.
Butane	Production of fuels, propellants.
Carbon dioxide	Mining, caves, tunnels, wells, fire extinguisher manufacture, dry ice manufacture, combustion, fermentation.
Carbon monoxide	Incomplete combustion of fossil fuels.
Chlorine	Laundry bleach, manufacture of chlorates and perchlorates, and other inorganic and organic compounds.
Cyanides (hydrogen cyanide)	Fumigation, electroplating, mining, production of resin monomers, heat treating, extraction of gold and silver from ores, pesticides, production of acrylonitride.

GAS	SOURCES OR USES
Fluorine	Production of fluorine itself.
Hydrogen	Battery charging, production of hydrogen itself.
Freon	Refrigerant, aerosol propellant.
Methane and propane	Fuels, refrigerants, propellants.
Nitrogen dioxide	Reaction of nitric acid with metals (dipping, pickling, or etching), production of explosives, dyes, lacquers and celluloid, electric arcs, welding, manufacture of nitric acid.
Ozone	Electrical equipment, electrostatic air cleaners.
Phosgene	Exposure of chlorinated hydrocarbon vapors to hot flames, hot metal, or ultraviolet radiation.
Sulfur dioxide	Burning of sulfur, combustion of fossil fuels, refrigeration, bleaching, fumigating, preserving.
Hydrogen sulfide	Decay of organic (sulfur containing) substances, processes using sulfur in any form.

INORGANIC DUSTS

Inorganic dusts are mineral dusts that, when inhaled, can cause harmful effects on the health of employees. Consequently, high air concentrations of inorganic dusts should be identified and controlled.

There are many different inorganic dusts and many industrial processes that generate them. Wherever a mineral is used as a raw material, excessive dust generation is possible. An important source of exposure is the grinding, machining, sanding, or mixing of dry products with mineral content. Each point of handling dust-generating materials should be studied closely. The following is a list of some of dusts which are commonly found in industry:

—amorphous silica	—feldspar
—asbestos	—fiber glass
—calcium compounds	—fuller's earth
•cement	—granite
•gypsum	—graphite
•lime	—iron oxides
•limestone	—mica
•marble	—silica
—carborundum	—slate
—clays	—talc
	—tin oxides

Your establishment might have concentrations of dusts not listed above. If you are uncertain as to whether a particular substance generates inorganic dusts, check with the manufacturer or distributor of the product, refer to a suitable reference book, contact a knowledgeable person, or call a hot-line. For more specific guidance refer to the section of this manual listing information and consultation sources.

When potential dust problems have been identified, they should be studied in detail to determine their seriousness. This should be done by taking air samples of the work environment and personal samples for exposed employees and comparing these with published concentrations with the Threshold Limit Value (TLV) for the particular dust. This evaluation should be made by an industrial hygienist or by an employee or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory.

Engineering or administrative controls or both can be instituted in most cases to maintain dust concentrations within an acceptable range. Engineering controls are those that lower dust concentrations through such modifications as:

—local exhaust ventilation (hoods or process enclosures),
—general ventilation, and
—changing dry processes to wet processes.

Administrative controls are those that limit employee exposure by:

—controlling handling procedures to reduce dust generation;
—performing all cleanup through the use of wet vacuums or wet cleaners—*no dry sweeping;*
—keeping waste and scraps in sealed bags for disposal.

When engineering and administrative controls have failed to limit employee exposure, respirators should be used. Refer to the chapter on personal protective equipment for more specific information. Employee exposure will also be reduced by vacuuming work clothes before they are removed.

Exposure to inorganic dusts can cause pneumoconiosis. Some specific types of pneumoconiosis and their causes are asbestosis (asbestos), silicosis (silica), baritosis (barium), siderosis (iron oxide), and stannosis (tin). Some dusts cause pathologic changes (i.e., they cause the formation of fibrous tissue in the lung) and may induce cancer. Serious lung disablement, however, can result from exposure to almost any dust if the concentrations are high enough and if the duration of exposure is sufficient.

By educating employees as to the serious hazards associated with inhaling inorganic dust, employees may gain incentive to control their own exposure through proper use of respirators or through careful handling of dust producing materials. Their training should include when, where, and how to wear respirators and which type. (See page 66.)

If you have a physician present at your establishment, be sure that he or she is aware of employee exposure to inorganic dusts. A schedule should be set for conducting appropriate examinations and tests on employees to determine any health effects. If you use an outside medical facility, you should be certain that the physicians there are aware of the inorganic dusts to which employees are exposed so that scheduled medical tests can be made. Recommended tests for employees exposed to inorganic dusts include chest X-rays and forced vital capacity (FVC), forced expiratory volume for 1 second (FEV_1), and their ratio (FEV_1/FVC).

ASBESTOS

Asbestos produces a particularly harmful inorganic dust. Consequently, recognition and control of high asbestos concentrations in your working environment are essential.

The concentrations can result from a number of processes or materials such as:

—heat insulation	—air filtration
—brake linings	—paint filler
—electrical wire insulation	—shingles, asbestos boards
—pipe and furnace fitting	—pump packing
—asbestos textiles, clothing, blankets	—fireproofing steel beams in the construction industry
—vinyl asbestos tile	—asbestos ventilation ducts

Any associated handling and manufacturing of asbestos laden products is likely to produce dust.

Asbestos fiber problems may be evaluated by taking environmental air samples as well as breathing space samples for exposed employees and comparing these concentrations with the Threshold Limit Value (TLV) for asbestos. This evaluation should be made by an industrial hygienist or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory.

Engineering or administrative controls or both can be instituted in most cases to maintain asbestos dust concentrations within an acceptable range. Engineering controls are those that lower concentrations through some kind of engineering modifications such as:

—local exhaust ventilation (hoods or process enclosures),
—general ventilation,
—changing dry processes to wet processes, or
—a combination of the above.

Administrative controls are those that limit employees' exposure by:

—eliminating the use of asbestos;
—limiting employees' lengths of exposure to high concentrations of asbestos;
—controlling the handling procedures to reduce dust generation;
—performing all cleanup through the use of wet vacuums or wet cleaners—*no dry sweeping;*
—keeping waste and scraps in sealed bags for disposal.

When engineering and administrative controls have failed to limit employees' exposures, respirators should be used. In addition, clothing should be vacuumed before it is removed. Refer to the chapter on personal protective equipment for more specific information.

When inhaled as a dust, asbestos can cause pneumoconiosis, or more specifically known as asbestosis. Lung cancer may also result from asbestos exposure, particularly among smokers.

If you have a physician present at your establishment, he or she is undoubtly aware of employee exposure to asbestos and should be conducting appropriate examinations and tests to determine any potential health impact. If you use an outside medical facility, you should be certain that the physicians there are aware of the asbestos present at your establishment. Recommended tests for employees exposed to asbestos include chest X-rays and forced vital capacity (FVC), forced expiratory volume for 1 second (FEV_1), and their ratio (FEV_1/FVC).

SILICA

Silica (SiO_2) is a very common compound found in nature. It is usually of very low toxicity, but when finely divided into particles small enough to be inhaled, it can become harmful to health.

Harmful silica dust concentrations in the air can result from a number of processes such as:

- —abrasive manufacturing
- —ceramics manufacturing
- —foundry work
- —furnace and kiln lining
- —granite cutting
- —mining
- —pottery making
- —refractory manufacturing
- —road construction
- —sandblasting
- —sandpaper manufacturing
- —sandstone grinding
- —silver polishing
- —street sweeping
- —tunnel work

Any associated handling and manufacturing of silica laden products is also likely to produce dust.

Quartz is 100% pure silica. Other materials containing high concentrations of silica are:

- —tridymite
- —tripoli
- —chalcedony
- —onyx
- —sandstone
- —cristobalite
- —flint
- —agate
- —silica flour
- —diatomaceous earth silica

The hazards associated with each of these substances depend upon their silica content (i.e., the greater percent of silica in the composition, the greater the hazard). Since particle size is another very important factor, processes like grinding, sanding, and chipping may present increased hazards.

Silica problems can be evaluated by taking air samples and comparing the dust concentration with the Threshold Limit Value (TLV) for silica. This evaluation should be made by an industrial hygienist or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory.

Engineering or administrative controls or both should be instituted to maintain dust concentrations within an acceptable range. Engineering controls are those that lower dust concentrations through some kind of engineering modifications such as:

- —local exhaust ventilation (hoods or process enclosures),
- —general ventilation,
- —changing dry processes to wet processes, or
- —a combination of the above.

Administrative controls are those that limit employees' exposures by:

- —eliminating the use of compounds containing silica,
- —limiting employees' lengths of exposure to silica.

When engineering and administrative controls have failed to limit silica exposures, repirators should be used. Also, care should be taken to vacuum the work clothes of employees exposed to silica dust before they are removed. Refer to the chapter on personal protective equipment for more specific information.

Exposure to silica can cause a severe lung disability known as silicosis. Silicosis can develop in employees over a period of years.

If you have a physician present at your establishment, he or she should be aware of employee exposure to silica dust and should be conducting the appropriate examinations and tests to determine what effect, if any, the exposure is having on employees' health. If you use an outside medical facility, you should be certain that physicians there are aware of the silica exposure at your establishment. Recommended tests for employees exposed to silica are chest X-rays and forced vital capacity (FVC), forced expiratory volume for 1 second (FEV_1), and their ratio (FEV_1/FVC).

METALS, METALLOIDS, AND AND THEIR COMPOUNDS

Industry uses many different types of metals and metalloids, some of which have been classified as harmless through experimentation or experience. Other metals or metalloids such as lead, mercury, or arsenic are known to be highly toxic. In an industrial environment, use of toxic metals and metalloids, regardless of the degree of toxicity, should be monitored for the protection of your employees.

Any toxic metals or metalloids can be considered as potential hazards. Therefore, you should identify all metals, metalloids, or compounds containing them as to type, nature, or processes in which they are used and as to quantity used per period of time. The following is a list of toxic metals and metalloids that should be considered hazardous:

—aluminum	—mercury
—antimony	—nickel
—arsenic	—osmium
—barium	—palladium
—beryllium	—phosphorus
—boron	—platinum
—cadmium	—selenium
—chromium	—silver
—cobalt	—tellurium
—copper	—thallium
—germanium	—tin
—indium	—titanium
—iron	—tungsten
—lead	—vandadium
—lithium	—zinc
—magnesium	—zirconium
—manganese	

Some of these substances are much more toxic than others and, therefore, of greater concern. As dusts, mists, fumes, and vapors, they are hazardous if inhaled, ingested, or contact the skin.

When potential problems have been identified, they should be studied in detail to determine their extent. A large part of this evaluation should involve air sampling conducted by an industrial hygienist or employee trained in air sampling techniques. The air sampling will indicate employee exposure and the need for control measures.

Air concentrations of toxic metals and metalloids in the workroom can result from many sources. Engineering and administrative controls should be designed to deal with each contaminant separately. Basic engineering controls include:

—local exhaust ventilation (hoods or process enclosures),
—general ventilation, or
—a combination of the above.

The following administrative controls are often the easiest, most effective, and least costly to use:

—eliminating the contaminant by substituting another nontoxic or less toxic material,
—altering the processing or handling procedures of contaminants to decrease the amount released into the air,
—controlling cleanup procedures to reduce the use of sweeping or compressed air,
—controlling waste collection and disposal to minimize the spread of contaminants,
—limiting duration of employee exposure.

Different combinations of controls can be used to control employee exposure most effectively.

When engineering and administrative controls fail to maintain acceptable exposure levels, personal protective equipment such as respirators, protective clothing, and gloves should be used as an interim measure. Protective clothing should be vacuumed before it is removed and should be cleaned regularly. Refer to the chapter on personal protective equipment for more specific information.

Metals can adversely affect employee health—from skin irritation to severe nervous disorders and even death. If you have a physician present at your establishment, he or she should be aware of employee exposure to metals and should be conducting appropriate examinations and tests to determine what effect, if any, the exposure is having on employees' health. If you use an outside medical facility, you should be certain that the physicians there are aware of the metals present at your establishment. Recommended tests for employees exposed to metals include pulmonary function tests, enzyme level and substance concentrations in blood or urine, electroencephalograph (EEG), electromyography, and chest X-rays. The tests relevant to each metal should be administered to exposed employees.

A program of employee education and training should stress proper handling procedures and correct use of respirators and protective clothing. The employees should be aware of the health hazards presented by metals to which they are exposed and the proper precautions to take against overexposure.

ORGANIC DUSTS

Organic dusts are produced by vegetable sources such as grain, wood, and cotton. Some can have a harmful effect on health, especially if present in high concentrations.

It is important to know all the types of organic dusts to which employees at your establishment might be exposed. There are many different organic dusts and many processes that can cause dust generation. The following are examples of organic dust sources that should be considered as possible health hazards:

—bagasse	—jute
—castor bean	—maple bark
—coal	—paprika
—cotton	—sisal
—flax	—tarmarind
—grain	—tobacco
—gum acacia	—wood
—hay	—wool
—hemp	

If you are uncertain as to whether a particular vegetable source produces potentially hazardous dusts, check a suitable reference book or contact a knowledgeable person. For more specific guidance, refer to the section of this manual listing sources of information and consultation.

Organic dust problems can be evaluated by taking air samples in the work environment and personal samples for exposed employees and comparing the dust concentration with the Threshold Limit Value (TLV) for that particular dust. This evaluation should be made by an industrial hygienist or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory.

Engineering or administrative controls or both can be instituted in most cases to reduce organic dust concentrations or exposures. Engineering controls are those that lower concentrations through mechanical modifications such as:

—local exhaust ventilation,
—general ventilation,
—changing dry processes to wet processes.

Administrative controls are those that limit employee exposure by:

—controlling handling procedures to reduce dust generation;
—performing all cleanup through the use of wet vacuums or wet cleaners—*no dry sweeping;*
—keeping waste and scraps in sealed bags for disposal;
—limiting employees' length of exposure to high concentrations of organic dust by rotation of workers, frequent rest periods, etc.

When engineering and administrative controls have failed to limit employee exposures, respirators should be used. The chapter on personal protective equipment will provide you with more specific information. Exposure can also be reduced by vacuuming work clothes before they are removed.

Organic dusts can cause a number of lung disorders known as extrinsic allergic alveolitis and hypersensitivity pneumoconiosis. Recurrences of these disorders may lead to brochitis, emphysema, or pathologic changes resulting in pulmonary fibrosis. In addition to dusts themselves, you should be aware of some additional hazardous substances often associated with organic dusts. Proteolytic enzymes, which can be carried by dusts, come from animal tissues and can cause severe skin and lung irritation. Mycotoxins, which can also be carried by dusts, are produced by molds and cause allergic reactions and lung damage if breathed.

If you have a physician present at your establishment, he or she is undoubtly aware of employee exposure to organic dusts and should be conducting appropriate tests and examinations on employees to determine what effect, if any, the exposure is having on their health. If you use an outside medical facility, you should be certain that the physicians there are aware of the organic dusts to which your employees are exposed. Recommended tests for employees exposed to organic dusts include chest X-rays, forced vital capacity (FVC), forced expiratory volume for 1 second (FEV_1), and their ratio (FEV_1/FVC).

By educating employees about the serious hazards associated with inhaling organic dusts, employees may gain incentive to control their own exposure through proper use of respirators or through careful handling of dust producing materials. Their training should include when, where, and how to wear respirators.

ORGANIC SOLVENTS

In the simplest terms, organic solvents are liquid or vaporous materials containing carbon that can dissolve other materials. Today, hundreds of organic solvents can be toxic in varying degrees and are potentially injurious to the health of employees if used without proper controls. Excessive exposure to solvent vapors can also affect the productivity and efficiency of your employees.

It is important to know all the types of organic solvents used at your establishment, how they are used, and how many employees are exposd to them. Some of the most common industrial uses for solvents are:

- —adhesives
- —artificial leathers
- —degreasers
- —dry cleaning
- —extraction of fats and oils
- —floor polishes
- —impregnation agents
- —lacquers
- —paints
- —paint removers
- —plastics
- —rubbers
- —shoe creams
- —synthetic textiles
- —textiles
- —varnishes
- —waxes

The hazard potential of a solvent depends on its inherent toxicity, the vapor pressure, and use. Solvents with low vapor pressures exist mainly in liquid form. However, if the solvent is sprayed or heated, vapor concentrations will increase. Solvents with higher vapor pressures will have higher vapor concentrations.

Health hazards from organic solvent vapors should be evaluated through air samplings by an industrial hygienist or by an employee or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory. Organic solvent vapor concentrations and employee exposure to those concentrations should be measured in assessing potential health hazards.

If it is determined that organic solvent vapor concentrations are too high, engineering or administrative controls or both should be instituted to protect workers. Engineering controls can lower vapor concentrations through engineering modifications such as:

- —local exhaust ventilation (hoods or process enclosures),
- —general ventilation, or
- —a combination of the above.

Administrative controls may also be used, especially is they seem to be easier, as effective as, and less expensive than engineering controls. They include:

- —substituting less volatile or less toxic solvents for those solvents in use (i.e., using the least hazardous solvent possible);
- —controlling handling procedures to minimize splashes, spills, or anything that would increase vapor concentrations;
- —limiting employee exposure to high concentrations.

When engineering and administrative controls have failed to limit complete exposure to organic solvent vapors, personal protective equipment should be used. Depending on the uses of organic solvents at your establishment, the following types of equipment might be used:

- —gloves and aprons for handling solvents,
- —eye protection against splashes,
- —respirators for emergency or short-term use.

When concentrations are high you should refer to the chapter on personal protective equipment for more specific information.

Some organic solvents in either liquid or vapor form may be highly toxic whereas others are not. As a liquid they can:

- —cause skin irritation (i.e., dematitis),
- —be absorbed into the bloodstream through the skin,
- —enter the bloodstream through ingestion,
- —injure the eyes by being splashed or sprayed into them.

As a vapor, organic solvents can:

- —enter the bloodstream by inhalation,
- —enter the bloodstream through skin absorption.

If you have a physician present at your establishment, be sure that he or she is aware of employee exposure to solvents. A schedule should be set for conducting appropriate examinations and tests on employees to determine any health impact. If you use an outside medical facility, you should be certain that the physicians there are aware of the solvents present at your establishment, so that scheduled medical tests can be made.

Employees should be trained in the safe handling of solvents and the proper personal protection. The effects of organic solvents on the central nervous system range from mild symptoms to death. It is therefore important for both you and your employees to know the hazard potential for each solvent present at your establishment.

PESTICIDES

Any chemical used to control pest organisms is referred to as a pesticide. Pesticides are generally classified into five types: insecticides, rodenticides, fungicides, herbicides, and fumigants. Many cases of human poisoning result annually from misuse of these substances. Poisoning can cause a variety of physical conditions, depending upon the type of pesticide and the severity of exposure. These include excessive sweating, tearing of the eyes, vomiting, headaches, dizziness, tremors, convulsions, cancer, and sometimes death. Any establishment producing or using any type of pesticide should have a hazard control program to prevent overexposures.

Although there are literally hundreds of pesticides, their purpose, chemical structure, and toxicological properties permit them to be classified as:

—*Organophosphorous compounds*. Examples: azodrin, bidrin, demetron (Systox), disulfoton (Disyston), parathion, dimethoate (Cygon), meta-systox-R, phorate (Thimet), mevinphos (Phosdrin), tepp, and azinphos methyl (Guthion).

—*Carbamates*. Examples: aldicarb (Temick), arprocoarb/propoxur (Baygon), carbofuran (Furadan), methomyl (Lannate), amino carb (Matacil), zectran, and carbaryl (sevin).

—*Chlorinated hydrocarbons*. Examples: DDT, BHC, lindane, methoxychlor, chlordane, aldrin, dieldrin, heptachlor, and endrin.

—*Miscellaneous pesticides*. Examples: botanicals (pyrethrins), organomercury compounds, organic nitrogen compounds, organic sulfur compounds, organic thiocyanate compounds, and others.

Pesticides exist in solid, liquid, and vapor forms. Some are highly toxic to humans and others are not. The pesticide group most commonly associated with toxic effects in humans is the organophosphorous compounds. Organophosphate exposure can cause tremors, convulsions, and possibly death. Vomiting, excessive sweating, tearing, headaches, and dizziness are other symptoms of overexposure.

It is important for you to know the hazard potential of each pesticide used at your workplace. The degree of hazard depends upon the particular pesticide used and the method of application and distribution.

Chlorinated hydrocarbons are generally not acutely toxic to humans unless ingestion, inhalation, or massive skin absorption causes excessive exposure. However, they present an additional hazard in that they tend to be persistent in nature (i.e., they do not easily break down chemically). Although these pesticides may cause dermatitis, nervous excitation, convulsion, coma, and death, as do organophosphates, the biological causes are different and treatment will be different.

Signs and symptoms of carbamate intoxication are similar to those of organophosphorus compounds. In general, exposure to pesticides is most likely to occur in their production, and among farm workers, tree sprayers, and professional exterminators.

Employees' exposure levels to pesticides should be made by an industrial hygienist or by an employee or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory.

The most common source of exposure results from accidental spillage on the skin. Exposure levels in these cases is not easily quantified. Establishing and enforcing correct handling procedures will greatly reduce this spillage, as well as reduce the resulting airborne concentrations of pesticides.

The second most frequent source of exposure is through inhalation. In these situations, it is especially important that you have a program of air sampling conducted by qualified personnel.

Some engineering controls you might use to lower concentrations of and exposure to pesticides are:

—local exhaust ventilation (hoods or process enclosures)
—general ventilation, or
—a combination of the above.

Some administrative controls you might use to limit employee exposures are:

—using the least toxic pesticide that will still fulfill your purpose;
—controlling handling procedures to prevent accidents by spills;
—limiting employee exposure to high air concentrations by rotating shifts, establishing rest periods, etc.

Some general safety rules regarding containerization and handling of pesticides are:

—Keep foodstuffs and eating utensils in an

area away from possible exposure.
—Do not eat or smoke in areas of potential pesticide exposure.
—Do not put fingers in mouth or rub eyes while working.
—Wash hands before eating, smoking, or using toilet.
—Provide showering and changing facilities for all employees exposed to pesticides.

Proper warning signs should be posted and each container clearly identified as to its contents and hazard. Areas treated with pesticides should have posted signs listing the pesticide used, boundaries covered, date of treatment, as well as special instructions to stay out of area during periods of high concentrations.

When engineering or adminstrative controls or both fail to minimize exposure to pesticides, personal protective equipment in the form of gloves, clothing, eye protectors, and respirators should be used as an interim measure. Refer to the chapter on personal protective equipment for details.

If you have a physician present at your establishment, he or she should be aware of employee exposure to pesiticides and should be conducting appropriate examinations and tests on employees to determine what effect, if any, the exposure is having on their health. If you use an outside medical facility, you should be certain that the physicians there are aware of the pesticides used by your establishment. Appropriate medical tests can then be given to exposed employees. Cholinesterase tests can provide an excellent tool for measuring exposure to certain pesticides.

Employees should be advised about the health hazards associated with pesticides to which they are exposed. They should be advised on safe work practices and handling procedures and the use of personal protective equipment if necessary. Emergency procedures for treating accidental exposures to each specific pesticide should be reviewed with employees periodically, as a minimum, annually.

PLASTICS AND PLASTICIZERS

Plastic materials fall into two broad categories: thermoplastic materials, which can be softened repeatedly by the application of heat; and thermosetting materials, which undergo a chemical change when heated and cannot be reshaped again. The thermoplastics are the larger of the two groups and include polyolefins (polyethylenes, polypropylene), polyvinyl chloride, and polystyrene. Among the thermosetting resins, the most important are phenolformaldehyde, urea-formaldehyde, epoxies, unsaturated polyesters, and polyurethanes.

In addition to the toxicity that may be related to the plastic per se, the toxicity of additives such as catalysts, dyes, fillers, stabilizers, and plasticizers should be considered.

The raw materials for plastics production come from crude oil. Plastics are all polymers, which are formed from monomers. In addition, plastics require catalysts such as metals, peroxides, and solvents. Dyes and fillers such as asbestos, diatomite, mica, and sand are used for color and texture, and may, by themselves, be considered potentially hazardous materials. Stabilizers are used, and plasticizers are added for ease of shaping. It is usually the stabilizers, plasticizers, and monomers that are the most hazardous to employees. However, if polymers are heated excessively, the decomposition products may also be toxic.

You should identify all raw materials, intermediates, and final products at your workplace, and determine their airborne concentrations and modes of entry into the body. A list of common substances associated with plastics manufacturing has been included at the end of this chapter.

When potential problems have been identified, they should be studied in detail to determine their extent. A large part of this evaluation should include air sampling; this evaluation should be made by an industrial hygienist or by an employee or other person specifically trained in the techniques of air sampling. Samples obtained should be evaluated on a continuing basis by an accredited or certified (or both) industrial hygiene laboratory. The air sampling will indicate employee exposure and the need to control exposures.

By instituting appropriate engineering and administrative controls, airborne concentrations and other exposures (skin contact, ingestion) can be reduced to acceptable levels. Engineering controls include:

- —local exhaust ventilation (hoods or process enclosures),
- —general ventilation,
- —control of fire and explosion, or
- —a combination of the above.

Administrative controls include:

- —eliminating a hazardous material or substituting a less toxic one;
- —alterating process or handling procedures;
- —controlling cleanup procedures;
- —controlling waste collection and disposal;
- —limiting employee exposure by alternating workshifts, offering more rest periods, etc.

When administrative and engineering controls are inadequate, personal protection should be provided for employees. Since many of these materials affect the skin in some way, protective clothing (e.g., overalls, labcoats, shoecovers, gloves), or creams, or both should be used. Where materials may splash or vaporize and get into the eyes, goggles or face shields should be worn. Respirators should be used where air sampling indicates that concentrations of airborne contaminants are excessive. Refer to the chapter on personal protective equipment for more specific information on selection and use.

Eye, skin, and respiratory tract irritation; skin sensitization; eye and skin burns; polymer fume fever (symptoms similar to flu); allergy of the lungs; and liver cancer can result from excessive exposure to plastics and plasticizers. Contact with resins or plastics before polymerization can lead to dermatitis.

If you have a physician present at your establishment, he or she should be aware of employee exposure to plastics and plasticizers and should be conducting appropriate examinations and tests on employees to determine what effect, if any, the exposure is having on their health. If you use an outside medical facility, you should be certain that the staff there is aware of the plastics and plasticizers present at your establishment. Recommended tests include forced vital capacity (FVC), and forced expiratory volume for 1 second (FEV_1), and their ratio (FEV_1/FVC) for employees exposed to a pulmonary irritant. Other tests will depend on the specific plastics or plasticizers to which employees are exposed.

Advising employees about the hazards of working with plastics and related materials is essential to the maintenance of their health and safety. Since exposure to even minute amounts of some of these materials (e.g., TDI, vinyl chloride) may cause serious health effects, it is essential that employees know what the effects are, how to recognize them, and how to minimize their exposure.

Your establishment might use materials other than those listed above. If you are uncertain as to whether a particular substance contains plastics or plasticizers, check with the manufacturer, refer to a suitable reference book, or contact a knowledgeable person. For more specific guidance, refer to the section of this manual listing sources of information and consultation.

COMMON SUBSTANCES IN PLASTICS MANUFACTURING

Thermo Sets, including:
—aminos (urea and melamine)
—expoxys (ethoxylin)
—phenolics
—polyesters (and alkyds)
—polyurethanes
—silicones

Thermoplastics, including:
—acetals
—acrylics
—acrylonitrile, butadiene, styrene
—cellulosics (cellulose acetate, propionate, butyrate)
—fluoro plastics
—polyvinyl chloride
—polyvinyl alcohol
—nylons
—polycarbonates
—polyethylene
—polystyrene
—polyvinylindene chloride
—polysylenes

Plasticizers, including:
—Phthalates
dimethyl phthalate
dethyl phthalate
isophthalic acid
—Phosphates
tri-ortho-cresyl phosphate (TOCP)
tri-para-cresyl phosphate (TPP)
tributyl phosphate (TBP)
tri-isobutyl phosphate
chlorinated paraffins
chlorinated biphenyls

Stabilizers, including:
—lead salts
—barium
—cadmium
—benzophenones
—organonickel compounds
—phenols

"Inert" Fillers and Fibrous Reinforcements, including:
—silica
—asbestos
—talc
—mica
—glassflakes and fibers
—lead
—beryllium
—molybdenum
—boron
—sapphire

Foaming Agents, including:
—aliphatic hydrocarbons
—methyl chloride
—methylene chloride
—trichloroethylene

Other materials, including:
—toluene diisocyanate (used in production of polyurethane foams)

Catalysts, including:
—organic peroxides - polystyrene

BIOLOGICAL AGENTS

Occupations in which employees may be exposed to infectious agents include scientific research, hospital work, agriculture, and those endeavors involving handling of animals or plant products. New production facilities involving the industrial use of biological organisms have arisen. These highly sophisticated techniques are usually monitored by qualified biohazard safety officers. Infections can range from mild to fatal. Individual susceptibilities often vary.

In research and hospital work, an up-to-date listing should be kept of all disease organisms known to be present. Where disease organisms are not normally present but outbreaks may occasionally occur, such as in meat-packing plants, it is important to be aware of symptoms that various organisms produce so that action may quickly be taken. Infective organisms can generally be classified as one of five types: bacterial, viral, rickettsial, fungal, and parasitic.

Increasing use of viral vectors in the production of deoxyribonucleic acid (DNA) molecules by both researchers and production facilities, while not ordinarily considered infectious agents, must be thought of as potentially harmful.

Here are some infections often encountered in different occupations:

—Brucellosis. A bacterial disease contracted by beef and pork packing workers.

—Anthrax. A disease caused by bacterial spores that come from animal hides or hairs.

—Erysipeloid. A bacterial infection resulting from contact with infected animals, mainly fish.

—Tularemia. Bacterial infection from infected rabbits.

—Newcastle disease. A viral disease caused by a virus coming from chickens and turkeys.

—Ornithosis. A viral disease of birds that may be transmitted to humans.

—Arborvirus. A tick-transmitted disease causing febrile infections.

—Coccidioidomycosis. A disease caused by infection of the lungs with pathogenic fungi. Infection among construction workers can result from clearing or digging infected soil.

Infective agents gain entrance into the body by ingestion, through the skin and mucous membranes, and through the respiratory tract. If employees are exposed to dusts from any of these agents, refer to the chapter on organic dusts.

One of the most effective methods of controlling infectious agents is through good sanitation and strict adherence to rules for proper handling. Gloves and other protective clothing are effective in some situations. Respirators should be used if dusts are present. See the chapter on personal protective equipment for more specific information.

If you have a physician present at your establishment, he or she should be aware of employee exposure to infectious agents and should be giving the proper inoculations, tests, and examinations to determine what effect, if any, the exposure is having on employees' health. If you use an outside medical facility, you should be certain that the physicians there are aware of the infectious agents present at your establishment. TB tests should be given regularly to exposed employees. All scratches and even minor lacerations should be reported and treated promptly with appropriate followup. Tests for the presence of antibodies in the blood are often used to identify past exposure to infectious agents. Facilities working with infectious agents should have a full-time biohazard safety officer (BHO) available for consultation and liaison with regulatory agencies.

As part of their specialized training, employees working with infectious agents should be instructed in proper handling procedures and personal protection. In addition, the symptoms of diseases resulting from exposure to each agent should be known by employees.

Employees working in research labs and hospitals should have all necessary inoculations. Regular tests for other disease-causing organisms such as TB should be required. Strict rules on the handling of disease producing organisms should be developed and adhered to.

In work where employees handle animal matter, a regular testing program to ensure that the material is disease free should be established. Should an infection result, procedures to be followed with regard to medical care of employees and for destruction of diseased material should be developed.

PHYSICAL AGENTS

TEMPERATURE EXTREMES

Cold

The sensation of cold itself is an accurate warning of potential danger since, without protective clothing, the human body can tolerate very little exposure. The body does not adjust physically to cold and does not acclimatize itself as it does to heat. The body has only two mechanisms for maintaining internal temperature in response to cold. First, the blood vessels supplying the skin, hands, and feet constrict so less blood flows to the body surface and less heat is lost. Second, the body shivers, or engages in rapid muscular contractions, which generates heat and helps maintain inner body temperature. Rapid muscle contractions associated with cold exposure make work requiring any skill difficult.

Employees with stiff, numb, or cold hands and feet cannot perform manual tasks with appropriate or adequate dexterity or skill. Extended or severe exposure to cold can result in frostbite, severe muscle damage, and possible effects on the brain. Continued exposure can cause lung disease, circulatory disease of the hands, and arthritis, and increase the possibility of viral and bacterial infections due to lowered resistance.

Exposure hazards are dependent upon temperature, relative humidity, wind movement (velocity), duration of exposure, and the protective clothing being used. Cooling of exposed flesh increases rapidly as wind movement (velocity) increases. High humidity or dampness (sweat) can accumulate in workers' clothing causing chilling as the moisture evaporates.

Some jobs that might present cold exposure are:

—meatpacking,
—ice companies,
—work in refrigerators, and
—outdoor construction work and other outdoor work.

A program should be set up to monitor cold environments so that employees will not be expected to work under severe cold conditions. An employee trained in measurement techniques should be in charge of monitoring temperature, humidity, and wind chill factors.

Indoor areas will require special measurement equipment for monitoring. Outdoor areas can be monitored with equipment or by consulting local weather bureaus. The responsible physician or outside medical consultants should specify conditions that would be considered hazardous to employees.

Generally, the answer to controlling exposure to cold is to supply heat where possible. In areas that require a cold environment, administrative controls, or personal protective clothing, or both should be used as stated earlier. The body, however, does not acclimatize itself to cold. An acclimatization program can be expected to prevent some cold related health problems, e.g., employees continuously exposed to cold develop local acclimatization in their hands as the blood flow to them increases. Work should be designed to minimize cold exposure, and there should be convenient areas of warmth or protection. Whenever possible, work should be done away from the cold environment and then moved to the cold environment as necessary. There should be rotation of workers where possible, rest periods in warm places, and warm beverages. Other precautions that should be taken for working in a cold area are:

—Only people with medical clearance should be allowed to work in these areas.
—Several layers of light clothing rather than one heavy layer should be worn.
—Clothing should be designed to allow venting of moisture from perspiration and should be kept clean and dry.
—Windbreakers should be used wherever possible.
—Gloves should be worn at below zero temperatures. Body contact with metal surfaces should be avoided; tools with wooden handles are preferable.
—Clothing should not be so tight as to restrict circulation.

—Thermal type respirators should be worn by those bothered when breathing very cold air (respiratory and cardiac problems).
—Workers should avoid entering a cold environment if perspiring.
—Close checks should be made on all body extremities for numbness or skin stiffness. Employees should monitor each other for patches of white or greying skin, an indication of frostbite.

Education of employees should include the proper use and care of personal protective clothing and thermal respirators. They should be instructed to recognize symptoms of excessive exposures and apply immediate first aid treatment. They should be aware that exposure to cold is known to have a synergistic effect in combination with vibration.

Because each employee will react differently to cold environments, all employees should learn their limit of exposure and be advised of temperature, windchill index, etc., whenever conditions may be hazardous to their health.

Heat

The effects of heat in producing emotional or physical stress and strain on humans are quite complex and cannot be evaluated by air temperature alone. The amount of water in the ambient air as well as the rate of air flow must be known. It is often difficult to accurately determine whether continued exposure will merely make employees uncomfortable or if it will actually produce significant ill-effects. Although fluctuations of 3° C above or 2° C below workers' body temperature will impair their performances, exceeding this 5° C range presents a health hazard. In many establishments, climatic heat during summer months significantly contributes to any heat stress already experienced from hot industrial processes. This heat, plus heat generated by the body's own metabolism, may be substantial and can directly contribute to a number of ill-effects.

The human body exchanges heat with the environment in one of three ways:

— Conduction—direct heat transfer between the body and a hot or cold object.
— Convection—transfer of heat due to the movement of air past the body.
— Radiation—the transfer of thermal energy between individuals and their surroundings where surface temperatures differ from skin temperatures. (The terms infrared, radiated heat, and radiant heat are often erroneously used synonymously.)

The body maintains a heat balance through metabolism, evaporation, and respiration. The most efficient of these is evaporation. As perspiration evaporates into the air, it takes heat away from the skin, which helps compensate for the heat generated by metabolism. When the humidity of the air is excessive, the skin's evaporation potential is decreased; this may prevent the body from giving up the necessary amount of heat. On the other hand, increased air movement over the skin will usually increase the evaporation rate if the air temperature is less than that of the skin, or the air is not saturated with water vapor, or both. The following should be considered factors that contribute to heat stress:

—radiant heat sources,
—high temperatures,
—high humidity,
—heavy work loads, and
—absence of air movement.

If heat stress conditions are suspected or if employee complaints regarding fatigue or heat exhaustion indicate a problem, heat stress evaluations should be conducted by a qualified industrial hygienist. He or she may make measurements and evaluations of wet bulb, dry bulb, and globe temperatures; air movement (velocity); and work load.

Engineering and administrative controls can then be adopted to reduce heat stress. The following are examples of engineering controls:

— corrugated or flat aluminum sheets to be used to shield radiant heat from ovens and hot equipment;
— heat exchanging screens made of iron or steel with a stream of water flowing over them;
— reflective clothing to be used in extremely hot environments;
— general ventilation to be used to increase air movement. Although air conditioning or ventilation systems are very helpful, air movement does not have an effect on radiant heat.

The body can compensate for excessive exposures to heat through a process called acclimatization, which results in a change in pulse rate and blood pressure. This takes many days and depends upon age, physical condition, heat exposure, and activity. The responsible physician can prescribe medication that can assist rapid acclimatization.

Proper acclimatization of exposed employees is very important. After approximately 10 days of increasing exposures, a healthy employee will gain an increased "tolerance" to heat stress. The beneficial effects of acclimatization will be maintained only if there is continual exposure to heat. Absence from heat exposure for more than a week will make an individual more susceptible again to ill-effects.

The use of salt (under a physician's direction) and adequate water intake will replenish moisture and salt lost through sweating. A cool water supply can also absorb some of the excess body heat and is more palatable to employees. Warning signs reading HEAT STRESS AREA should be appropriately located. Allowing rest periods in cool areas at regular time intervals is an effective way to help prevent heat related illnesses.

Heat exposure can cause heat strain, cramps, exhaustion, or stroke and results in decreased job performance and a noticeable increase in job related accidents. Workers may also experience fatigue and irritable sensations that can affect their home and work life.

If you have a physician present at your establishment, he or she should be aware of employee heat exposure and should be conducting appropriate medical tests and examinations to determine what effects, if any, this is having on employee health. If you use an outside medical facility, you should be certain that the physicians there are aware of heat exposure at your establishment and are examining employees for signs of heat stress or hypersusceptibility to heat stress.

Each employee exposed to a hot environment should be given training in health and safety procedures including:

- information regarding proper water replacement;
- instruction in recognizing heat disorders and illnesses including dehydration, exhaustion, heat cramps, prickley heat, and heat stroke;
- information concerning heat acclimatization;
- information concerning salt replacement must come from the physician responsible.

RADIATION

IONIZING RADIATION

Ionizing radiation is energy in the form of particles (alpha, beta, neutron) or waves (X- or gamma rays) emitted from radioactive materials or radiation producing machines or both. This radiation causes ionization (separating atoms into ions) of atoms that make up living tissues and results in cellular changes and possible genetic defects that will affect future generations. At the time of exposure, an individual generally cannot sense the absorption or energy and, thus, cannot easily recognize the danger.

Radiation can be present in different forms and can originate from different sources. Identification of these is necessary to properly assess the hazards and determine the necessary protection. The five major kinds of radiation are: alpha particles, beta particles, X-rays, gamma rays, and neutrons. The biological effects of these ionizing radiations depend upon several factors, including:

—type of radiation,
—energy of the radiation,
—time period over which the radiation is received,
—relative biological effectiveness (RBE),
—time/dose endpoint of exposure,
—area of body exposed.

Radiation may enter the body by passing through the skin and may damage the skin as well as internal tissues and organs, if sufficient energy is absorbed. This type of exposure is generally referred to as external exposure. It may result from:

—X-rays (from sources such as an X-ray machine, electron microscope when improperly used, X-ray diffraction unit, accelerator);
—gamma rays (from sources such as cobalt-60, cesium-137, radium-226, iridium-192, iodine-131, accelerators);
—high energy beta particles (such as those from phosphous-32, strontium-yttrium-90);
—neutrons (from sources such as nuclear reactors, accelerators, neutron sources).

Generally, alpha particles pose no external hazard (i.e., they don't penetrate the skin). High energy particles (e.g., protons, electrons) present special problems and should also be considered as external hazards.

If the radioactive material is sealed so that only the radiation (alpha, beta, X- or gamma ray, neutron) leaves the source and the radioactive material itself (e.g., cobalt-60, strontium-90) doesn't leak out of the sealed container, then the primary hazard is an external one; that is, the radioactive material is external to the body. Other radiation sources that fall into this category are radiation producing machines such as X-ray machines and accelerators.

If the radioactive material is unsealed, an additional hazard exists, i.e., the possibility of inhaling or ingesting radioactive material from the air, beverages, food, or cigarettes. This may result from hands or other objects becoming contaminated during the course of handling the radioactive material. The main concern here is that once a radioactive material enters the body there is very little that can be done to remove it. Hence, the damage to the body may occur over a period of years. The main line of defense in this case is to prevent the release of radioactive material into the air or water, or onto the hands or other objects. This can be done by use of glove boxes, ventilation hoods, gloves, and laboratory coats. This is particularly important since radioactive materials that pose a minor problem, because their radiation does not penetrate the skin when they are outside the body (e.g., carbon-14, tritium, plutonium-239, polonium-210, other alpha and beta emitters), are much more toxic when they're inhaled or ingested.

To minimize employee exposure to external radiation, limiting the length of exposure is very important. If the exposure rate is 100 milliroentgens per hour (m^R/hr), then after 1 hour an employee would have been exposed to 100 milliroentgens of either X-ray or gamma radiation. If the time of the worker's exposure was reduced to a half an hour, then the exposure would be halved, or 50 milliroentgens (exposure rate × time of exposure = total exposure).

Another important method of reducing radiation exposure is by increasing the distance between the radiation source and the individual. If one doubles the distance between the source and the individual, the exposure is reduced by a factor of 4. (Radiation level is inversely proportional to the square of the distance between the source and the point of measurement.) A sealed radiation source should never be picked up by hand. Tongs or some other device should be used to increase the distance between the radiation source and the individual.

A third method of reducing exposure is

shielding (placing a material such as lead or concrete between the individual and the source). Generally, this control technique requires an individual with technical training in shield design such as a health physicist or an industrial hygienist. Persons with this background may be found by contacting consulting firms in these specialities, professional societies (e.g., Health Physics Society, American Industrial Hygiene Association), universities, or your parent company or insurance company. It is also possible for an employee who has adequate background to receive special training through short courses in shielding design.

Radiation levels should be measured using a meter that is accurately calibrated and suitable for the type of radiation present. Instruments for measurement include:

—ionization chamber,
—Geiger-Mueller counter,
—proportional counter,
—solid state detector,
—scintillation counter, or
—filter paper smears of surfaces coated with radioactive material and counted by one of the instruments mentioned above.

These measurements can be used to assess the hazard potential and determine the proper type of control.

Personal monitoring devices should be used to measure doses of radiation for all potentially exposed employees. Film badges are used for beta, X-ray, or gamma radiation; special badges are also available to record neutron radiation. These badges are worn over a period of time and are used to estimate the accumulated dose of radiation to the whole body or to certain parts of the body. A direct reading dosimeter—a combination of an electroscope and ionization chamber—is also used to measure accumulated doses of X-ray or gamma radiation. Other specialized instruments are available for other types of radiation and for mixed radiation fields. A newer method called TLD (Thermo-Luminescent Dosimetry) is also gaining in popularity for measurement of some types of radiation.

Internal radiation doses from alpha and beta emitters are more difficult to measure. Estimates can be obtained by taking air samples in breathing zones of employees and then measuring the radioactivity in the samples. Body wastes (e.g., urine) can also be analyzed, or whole body counts (i.e., radioactivity in the body is measured) may be used to monitor internal radiation exposure.

All operations involving radionuclides result in radioactive materials that may no longer be suitable for use. These wastes must be handled properly so as not to create a health hazard. The two major methods for control of wastes are dilution and dispersion into air or water. Although disposal of low level dispersable wastes is legally permissible under supervised conditions, the quantities must be carefully scrutinized as required by state and federal regulatory agencies.

When controls such as time, distance, shielding, and ventilation are not adequate, personal protective equipment may be required. If airborne radioactive materials are present, either the filter type or self-contained breathing apparatus type respirators may be required. The specific type of respirator to be used will depend upon the type of radioactive material involved and its physical and chemical form. Gloves should be used in the handling of unsealed radioactive materials. Sealed sources should never be picked up by hand. Protective leaded aprons may be needed, depending upon X-ray or gamma radiation levels. Protective clothing should never be worn outside of the radiation area. See the chapter on personal protective equipment for more information.

Maintenance of records showing individuals' accumulated total doses is a legal requirement and is essential to minimizing exposure. These records should help determine the relationship of radiation exposure to health and should be correlated with diagnostic or medical therapy radiation levels. If accumulated doses are high, those workers should be transferred to areas of lower exposure potential. High-risk individuals (particularly pregnant women) should not be exposed to ionizing radiation, or their exposure should be kept to a minimum safe level.

If you have a physician present at your establishment, he or she should be aware of employee exposure to radiation and should be conducting appropriate examinations and tests to determine what effect, if any, the exposure is having on employees' health. If you use an outside medical facility, you should be certain that the physicians there are aware of the radiation present at your establishment.

Regular examinations should be performed on radiation workers including urine (internal exposure) and blood tests. Eye and skin exams may also be indicated in some cases. Whole body counting can be performed for detection of many internal radionuclides.

Since exposure to radiation doses can depend greatly upon a person's knowledge of the associated hazards and proper precautions, employees should be trained in the biological effects of radiation, safe handling of radioactive materials, the proper use of the proper protective equipment, and emergency procedures.

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Nonionizing Radiation

Nonionizing radiation includes all electromagnetic radiation that cannot, during its absorption, transmit enough energy to break up the atoms of living tissue. This radiation can come from a number of different sources such as sunlight, different types of lamps, or extremely hot objects. Most often, exposure to sources such as sunlight are relatively harmless with proper protection. However, many sources of nonionizing radiation, if not properly controlled, can cause injury to various parts of the body particularly to the skin, muscles, internal organs, and eyes.

Nonionizing radiation includes ultraviolet light, visible light (covered in the section on lighting), infrared light, microwaves, radar, radio, TV, and energy emissions. These are all electromagnetic radiation resulting from moving electric charges. The types of radiation can be described according to three distinguishing characteristics:

—Strength—intensity of source or amount of energy transmitted.

—Frequency—number of cycles per second (hertz) for the electromagnetic waves.

—Wavelength—the shortest distance between consecutive similar points on the same wave train.

Conventionally, ultraviolet, visible, and infrared rays are described in terms of wavelength (meters). Radiowaves, microwaves, and electric power waves are described in terms of frequency (hertz, cycles/second). The higher the frequency of the radiation, the shorter the wavelength and the higher the energy transmitted. Because of the differences in form of nonionizing radiation, each type must be identified and quantified.

The following is a list of some possible sources of and uses for each kind of nonionizing radiation and the parts of the body potentially affected.

—*Ultraviolet,* skin and eyes
- sunlight
- arc welding
- germicidal lamps
- black light lamps
- incandescent lamps
- lasers

—*Infrared,* eyes and body temperatures
- industrial operations involving temperatures of 1000° Kelvin (K) to 8000° K (e.g., hot metals, glass blowing, paint and enamel drying, and welding).

—*Microwaves,* body tissues and eyes
- radio broadcasting
- television broadcasting
- radar
- microwave ovens
- alarm systems
- freeze drying
- wood drying
- concrete curing
- therapeutic diathermy

—*Lasers,* eyes and skin
- cutting
- welding
- drilling
- surveying

Although ultrasound (sound above 20,000 hertz) is simple mechanical vibration at frequencies above human audibility (not electromagnetic radiation), it is considered to be nonionizing radiation and can be a health hazard if employees come into direct contact with an ultrasonic emitter. Common sources are certain medical diagnostic and treatment instruments, cleaning devices, and mixing devices.

The above list names some possible sources of nonionizing radiation. Your establishment might have sources other than those listed. If you are uncertain, you should call in an expert or consult with a hot-line.

The measurement of radiation levels is complex, and the procedure varies according to particular radiation sources in question. Because overexposure to nonionizing radiation may not be easily recognized, professionals experienced in measurement techniques should evaluate conditions where any nonionizing radiation may be present.

Engineering or administrative controls or both can then be professionally designed to suit your needs. Engineering controls will vary with different types of radiation. Microwave control can be accomplished by barriers, shielding, and process enclosures. The materials used should adequately stop or absorb microwaves. Ultraviolet radiation is easily controlled by shielding; ordinary window glass will filter out much of the radiation. Lasers should be shielded from visibility. Physical barriers using spectral and diffuse reflection should be used to keep employees from coming into contact with laser beams. Electrical interlocks on process enclosures or radiation source enclosures will protect employees from overexposure. Administrative controls include limiting time of exposure in any way compatible with the work process and posting proper warning signs for those wearing medical devices.

When administrative and engineering controls do not maintain safe exposure levels for employees, some kind of personal protective equipment should be used. Employees near lasers, ultraviolet, or infrared sources should wear protective eyeglasses at all times, if other controls leave the slightest possibility of exposure. Ultraviolet and microwave radiation exposures can be controlled by the use of protective clothing. The chapter on personal protective equipment should be referred to for details.

If you have a physician present at your establishment, he or she should be aware of employee exposure to nonionizing radiation and should be monitoring employees to determine what effect, if any, the exposure is having on their health. If you use an outside medical facility, you should be certain that the physicians there are aware of nonionizing radiation at your establishment. Eye and skin examinations are recommended for exposed employees.

Employee education is important in helping them to control their exposure to nonionizing radiation. An ongoing education program should be designed to:

- —keep employees aware of hazards of nonionizing radiation,
- —help employees recognize physical impairments or effects of exposure to nonionizing radiation,
- —instruct employees on the proper use of personal protective equipment,
- —make employees aware of the safety features of each device and operation.

NOISE

A noise hazard is defined as any unwanted sound and covers the range of sound that is implicated in harmful effects. Noise can be classified as wide band, narrow band, and impulse noise. An example of wide band noise can be found in the weaving room of a textile mill and in jet aircraft operations. Narrow band noise examples are that from circular saws, planers, or power cutting tools and rotating turbine generators. The firing of a gun is an example of a nonrepetitive impulse noise. The effects of noise on humans are not well defined, but it is known that noise can cause:

—temporary and permanent hearing loss,
—stress and stress related illnesses (psychological and physiological),
—decreased job performance from interference with communication and disruption of concentration,
—increased blood pressure.

Hearing loss, which is recognized as the most serious side effect of noise, has been measured more accurately than have the other effects, for which the data are not as conclusive.

The objectives of a hearing conservation program can be accomplished if it includes the following functions:

—identifies noisy areas and controls employee exposures in those areas, and
—gives audiometric examinations to employees to detect individuals who are experiencing hearing loss so that preventive measures can be taken.

Performing these functions is not a simple matter and demands specially trained individuals. It is important that you and your employees recognize that there may be noise hazards at your establishment and that you acquire the services of professionals or have employees trained in these disciplines.

In order to evaluate your potential noise problems you must first identify noise sources (e.g., machinery, systems, and any related equipment) and then determine employees' exposures to the noise. If there are any areas of your establishment where noisy equipment is located that have not been evaluated for noise levels and employee exposure, a survey should be conducted by consultants or employees specially trained in noise measurement.

Once a noise problem has been identified through proper measurement procedures, engineering or administrative controls or both can be instituted to reduce exposure. Engineering controls are used to lower noise levels at their source or at the hearing point of all potentially exposed employees or both. Some examples of engineering controls include:

—acoustical enclosures of noisy equipment,
—acoustical absorption material on ceilings and walls to minimize sound wave reflection,
—machine maintenance to reduce noise levels,
—acoustical barriers to interrupt transmission of noise from one area to another.

It is important to remember that engineering controls cannot be used without an accurate analysis of the noise and its source or sources. Therefore, a trained noise control specialist should analyze the problem and design controls based on the analysis. Without this, you can waste vast amounts of money and effort.

Administrative controls differ from engineering controls in that they are not aimed toward controlling noise levels, but toward controlling employee exposures by limiting their time in noisy areas (e.g., rotating workshifts, scheduling rest periods, etc.). Undoubtedly the most effective and desirable control is to specify that any new equipment purchased and installed meet low noise level requirements.

When engineering or administrative controls or both do not adequately reduce the noise level and the degree of employee exposure, personal ear protectors can be used. These should be viewed only as an interim measure, however, and not as the final solution to noise problems.

The actual amount of noise reduction that will result from using the different types of personal ear protectors varies according to the noise characteristics and the design and fit of the ear protector. The following are examples of the types of noise attenuators that can be used:

—Earplugs—which are inserted into the ear canal and remain in place without additional support.
—Semi-insert plugs—which close the entrance to the ear canal without actually entering it and are held in place by a headband. These are usually part of a communications system and have a small receiver in them.
—Earmuffs—which cover the entire outer ear and are generally held in place by a headband.

Measurement of environmental noise has little relevance unless it is evaluated in terms of its effect upon the hearing of individual employees. This can be properly accomplished only through the use of audiometric examinations.

Your program of audiometric testing should begin before each employee's first assignment to a noisy work area. Only in this way can the extent of hearing loss from occupational noise be determined. A history of the employee's past exposure to noise should be taken at the time of the initial audiometric examination.

Here are some recommended guidelines to follow in conducting a proper audiometric program:

—*Staff.* Audiometric examinations can be performed by a nurse, technician, or employee specifically trained in audiometry. Evaluation of any abnormal results should be made by a physician or audiologist familiar with your audiometric program. In the event that your establishment does not have in-plant medical staff, you should consider using an outside clinic.

—*Frequency of testing.* Preferably, an annual audiometric examination should be given to all employees exposed to noisy areas whether of not they have been wearing personal noise attenuators.

Since many noisy situations are controllable, employees should be informed of the effects of noise on their health and the importance of effective controls and protection.

VIBRATION

Vibration can result from a wide variety of processes and situations. Almost everyone feels vibrations during each day whether it occurs while riding a train, driving a car, or using a hand drill. The effects of exposure to vibrations are highly variable and in some cases, depending upon the characteristics of the vibration (intensity and frequency), can be very significant. Some of the more common health conditions resulting from vibration exposure are motion sickness, stomach and digestive problems, loss of visual ability, bone and joint injuries, and blood circulation problems. Some of these symptoms may be aggravated by a cold environment. Psychological problems such as uneasiness, fatigue, and irritability can affect both on-the-job performances and family life. Vibration is also a common source of noise; therefore, controlling vibration may often reduce excessive noise levels.

Vibration on an individual can be classified in two ways:

—"whole-body" vibration in which the entire body is subjected to mechanical vibration (e.g., truck drivers), and
—"segmental" vibration in which only a part of the body is affected (e.g., jackhammer operator's hands).

Determining whether vibration problems exist in your establishment is not a simple problem. The following table is a list of some typical vibration problems. See also "Occupational Diseases."[1] If there are any similar operations in your establishment, a detailed investigation should be initiated to detect and correct problems.

Vibration measurements should be taken where exposure may be excessive. Because of the complicated nature of this type of measurement, only a professional with experience and expertise in vibration measurement should be employed to conduct the survey.

Complaints about vibration may be the best indication of problems. Measurements should be taken as a followup on complaints to determine the severity of the problem and the kinds of controls that might be used.

Although many different control measures are available, they should only be prescribed by professionals with expertise in this area. Some controls often used are:

—Reducing the mechanical disturbance causing the vibration.
—Isolating the source of vibration from radiating surfaces with which employees might come in contact.
—Reducing vibration by:
- making mechanical structures connected to vibrating bodies less rigid, such as using flexible piping or conduit where possible;
- using properly installed vibration isolators on machinery mountings;
- stiffening, bracing, or increasing the mass of the vibrating body;
- damping the vibration by the use of felts or mastics.

Administrative controls that limit exposure by job rotation or reduced time/shift may also prove helpful.

Different individuals have different tolerance levels for vibration. If you have a physician present at your establishment, he or she should be aware of employee exposure to vibration and should be conducting the appropriate medical tests and examinations to determine what effect, if any, the exposure is having on their health. If you use an outside medical facility, you should be certain that the physicians there are aware of true vibration exposure. Medical screening should be carried out, especially for arthritics or for those with primary Raynaud's disease.

[1] Occupational Diseases: A Guide to Their Recognition. M. M. Key, A. F. Henschel, J. Butler, R. N. Ligo, I. R. Tabershaw, and L. Ede, Editors. DHEW (NIOSH) 77-181. National Institute for Occupational Safety and Health, Cincinnati, OH. 45226. 1977.

BAROMETRIC PRESSURE CHANGES

Conditions hazardous to employees can result either from abnormally high (hyperbaric) atmospheric pressure, such as that encountered by underwater divers or tunnel and caisson workers, or from abnormally low (hypobaric) atmospheric pressure, such as that encountered by aviators flying at high altitudes. The hazards associated with high pressure exposure are the "bends," tooth pain and damage, and aseptic bone necrosis. Hazards associated with exposure to low atmospheric pressure are emphysema, hypoxia (inadequate oxygen content of inhaled air), and oxygen poisoning. These physical disorders can be prevented by maintaining a program of proper work procedures.

Most health hazards from abnormal atmospheric pressure do not generally arise primarily from the exposure itself (except for high altitude workers), but from quick changes in pressure, i.e., compression and decompression. The main factors determining these hazards are the pressure, time of exposure to the pressure, and the rate of change in pressure. It is these factors that must be controlled to prevent injuries. The higher the pressure, the shorter the period of safe exposure.

To minimize occurrence of injuries resulting from abnormal pressures, compression and decompression should be very strictly controlled so that the concentrations of gases in the bloodstream (i.e., oxygen and nitrogen) change very gradually. If procedures are not strictly followed, the effects on workers can range from minor pain and discomfort to extreme pain, permanent injury to body organs, or possible death if not properly treated in time.

Exposure to extremes of atmospheric pressures should be controlled through a program set up and supervised by professionals with extensive experience in compression and decompression procedures.

For caisson workers, decompression control is usually achieved by use of decompression chambers or "manlocks." Also, helium can be added, giving a high partial pressure in the air breathed, thus displacing the nitrogen and reducing the chances of the "bends" during decompression.

In aviation work, controls in the form of pressurized cabins or oxygen masks are used to lessen decompression hazards. These are generally used for high altitudes since in altitudes below 9,500 feet little, if any, control should be necessary for normal individuals. For others working at high altitudes for long periods, some special procedures may be required.

An effective medical screening and monitoring program is extremely important in protecting employees from health hazards associated with abnormal atmospheric pressure. If you have a physician present at your establishment, he or she should be aware of employee exposure to abnormal pressure. If you use an outside medical facility, you should be certain the staff is aware of employee exposure to abnormal pressures so that they can conduct the appropriate medical screening and monitoring.

Certain physical conditions can make employees more susceptible to injuries from compression and decompression. Overweight people are more susceptible to pressure hazards and need longer decompression times. Records of physical exams, including X-rays, can be used to detect the condition known as aseptic bone necrosis that may occur after many years of exposure to incomplete decompression. Workers with fever or illness, especially colds, should not go through compression or decompression.

An educational program should be used to continually advise employees of safe work practices and assist them in recognizing symptoms of improper decompression. Employees should be aware of the consequences of shortening decompression time, and should know emergency procedures for treatment of the bends. Awareness of more subtle symptoms of improper decompression, such as skin itching and rash, will help avoid more serious conditions.

PSYCHOLOGICAL HAZARDS

Each person has psychological characteristics that result from previous experiences, such as battle, age, sex, genetic inheritance, and state of physical health. Often workplace conditions can aggravate mental health—a boss who is overbearing, a job that is boring, a feeling of underutilization, lack of opportunity to advance, excessive job demands, fatigue from a secondary job, being responsible for another worker, or lack of social support from co-workers.

Failure of management to provide rehabilitation services after injury or illness often manifests itself when the worker does return. This is true also of lay-off or termination or transfer of the worker.

Effects of psychological hazards vary as widely as there are human beings. American Indians, for example, can apparently tolerate working high steel with little or no psychological reaction whereas others cannot tolerate heights over one story. Type A personalities may show greater strain than type B. A defensive person may differ from a nondefensive one. Education and socioeconomic status can alter psychological effects.

Perhaps the most studied psychological hazard is shift work (see Bibliography). Briefly, shift work systems can alter worker health by changing sleep patterns, creating circadian variables affecting temperature, pulse, blood pressure, urine flow, and, secondarily, even certain blood chemistries. Shift work also alters patterns of social interaction and tends to cause decreased feelings of cohesiveness in the work force. Marriage relationships may be upset by shift work depending upon the spouse's attitude. On the positive side, however, there is greater opportunity for increased earnings, a chance to further formal education, and increased participation in certain community activities.

Women may face additional problems from psychological hazards such as altered menses, leg cramps, and unsatisfactory domestic relations. If the woman worker is raising children, workplace stress can complicate this responsibility.

There is probably no better way to control psychological problems than by administrative controls. Personal protective equipment and engineering controls, except to redesign production processes, can do little to alleviate psychological stress. Administrative controls and especially early detection of stress, strain, and health effects provide a way to prevent untoward events from becoming more serious. Since much of psychological stress is cumulative, often over many years of poor psychological environment, attention to early warnings are sometimes dramatically effective: periodically administering "satisfaction" questionnaires; scheduling gripe sessions with neutral third parties; obtaining consultation to humanize the workplace; changing the environment to fit the person; changing the person to fit the environment.

Scientists throughout the world are continuing studies to find ways of reducing poor worker health resulting from psychological hazards. The very nature of the variety of human responses precludes simple answers. As this field of knowledge is fundamental to all working environments, employers and employees might wish to seek additional information.

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EUROPEAN INDUSTRIES IN WHICH CLINICAL EVIDENCE OF OVEREXPOSURE OF WORKERS TO VIBRATION HAS BEEN REPORTED[1]

Industry	Type of vibration	Common vibration sources
Agriculture	Whole body	Tractor operation
Boiler making	Segmental	Pneumatic tools
Construction	Whole body Segmental	Heavy equipment vehicle, pneumatic drills, jackhammers, etc.
Diamond cutting	Segmental	Vibrating hand tools
Forestry	Whole body Segmental	Tractor operation chain saws
Foundries	Segmental	Vibrating cleavers
Furniture manufacture	Segmental	Pneumatic chisels
Iron and steel	Segmental	Vibrating hand tools
Lumber	Segmental	Chain saws
Machine tools	Segmental	Vibrating hand tools
Mining	Whole body Segmental	Vehicle operators rock drills
Riveting	Segmental	Hand tools
Rubber	Segmental	Pneumatic stripping tools
Sheet metal	Segmental	Stamping equipment
Shipyards	Segmental	Pneumatic hand tools
Stone dressing	Segmental	Pneumatic hand tools
Textile	Segmental	Sewing machines, looms
Transportation (operators and passengers)	Whole body	Vehicle operation

[1]The Industrial Environmental—Its Evaluation and Control. DHEW (NIOSH) 74-117. National Institute for Occupational Safety and Health, Cincinnati, OH. 45226. 1973.