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SAFETY AND HEALTH STANDARDS

PLAINTIFF'S EXHIBIT
209

For Contractors performing Federal Supply Contracts under the Walsh-Healey Public Contracts Act

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UNITED STATES DEPARTMENT OF LABOR
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The progress and achievements that have been evident in the field of industrial safety have been a source of satisfaction to both State and Federal Governments. It is generally recognized, however, that there is still a sizeable job to be accomplished and the Department of Labor desires to lend all possible assistance to industry in continuing this progress toward maintenance of safe and healthful work places.

The standards in this bulletin are minimum standards only, and have been developed primarily as a guide to contractors in complying with the safety and health provisions of the Walsh-Healey Public Contracts Act. I am fully aware that many States and industrial establishments have developed codes and standards that are broader and more comprehensive. It is good to know that these higher standards will be applied in most establishments with Government contracts. Where safety has lagged behind the general progress, I trust that this bulletin will prove useful as a beginning in the development of standards and programs designed to improve the safety and health of workers in those areas and industries.

I have therefore arranged to have copies of this bulletin made available upon request. They may be obtained from any of the Wage and Hour and Public Contracts Divisions offices throughout the country.

Maurice J. Tobin

Secretary of Labor

FOREWORD

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PART I.—SAFETY AND HEALTH PROGRAMS PAY DIVIDENDS

Hard, cold statistics on industrial accidents in the United States tell a tragic and revealing story. These figures deal with the number of people killed and injured in industrial accidents. Sometimes figures are used to estimate the billions of dollars that are lost by management and by workers and their families as a result of accidents.

But there are no statistics on the human suffering, sorrow, and misery which follow deaths and injuries into the homes of American workers, even though the human tragedy which stalks after industrial accidents affords the most impelling reason for intelligent safety programs.

Although the most important consideration in any safety program is the safety and well-being of the worker and the protection of his family from want, another driving force behind industrial safety programs is the cost of accidents in terms of money and human resources—a tragic economic waste.

A third reason for undertaking good safety programs applies primarily to contractors performing on certain Government supply contracts of $10,000 or more subject to the safety requirements of the Walsh-Healey Public Contracts Act. Part I represents in briefest form basic information drawn from the day-by-day practice of managements whose safety performance deserves top-grade ranking in terms of the elimination of employee injuries. While more information could well have been included, this presentation was purposely limited to a few major items for greater emphasis.

A. ACCIDENT COSTS

Accidents are expensive. They constitute a serious wastage of our human and material resources. Substantial savings of both can be made by preventing accidents. They can be prevented by appeals to the emotions and by persistent day-by-day effort to enlist on the side of safety the ever-present desire and necessity that every management has for reducing waste.

Everyone can easily see that accident costs are wholly waste. It is not so easy to see how large are these wastes. Compensation and medical costs (spoken of as direct costs) are obvious. It has, however, taken careful studies by experienced cost accountants and industrial executives to show how large are the other costs (spoken of as indirect costs). It is now clear that on the average the indirect costs of accidents in industry are not less than four times the direct costs. The items of cost that are likely to be present in each case of accidental injury are:

1. Compensation.
2. Medical expense.
3. Lost time of injured employee.
4. Lost time of fellow employees who stop work:
   - *(a)* To aid injured worker.
   - *(b)* Out of sympathy or curiosity.
   - *(c)* For other incidental reasons.
5. Time of foreman, executives, or other staff personnel:
   - *(a)* Assisting injured employee.
   - *(b)* Investigating cause of accident.
   - *(c)* Arranging for continuance of injured employee's work.
   - *(d)* Selecting, training, or breaking in new employee.
   - *(e)* Preparing accident report.
   - *(f)* Attending hearings on injury (serious or contested cases).
6. Lost production due to upset, shock, or diverted interest of workers.
7. Lost production due to stoppage of machine or process in charge of injured person.
8. Damage to machine, equipment, or material directly occasioned by the accident.
9. Spoiled product or material due to emotional upset of fellow workers.
10. Lessened effectiveness of injured employee for a period after his return to work.
11. Business or good will lost through failure to fill order on time, lost bonuses, payment of forfeits for nondelivery, etc.
12. Legal expense, court fees, expense of preparation of case, settlements, judgments, etc., in cases contested at law.
13. The employer's share of the loss and expense to society in each case of death or continued loss in earning power.

B. MANAGEMENT'S PART IN HEALTH AND SAFETY

Safety work in industry must begin at the top. Since every kind of work that men do involves some degree of hazard, each produces its share of injuries. But by the proper attention to safety almost all injuries can be prevented in any kind of work and in any occupation. Management's desire to eliminate injuries should be strong enough to make their prevention a vital part of all activities. Prevention must receive continuous attention along with such matters as cost, quality, and production.

Very briefly, the more important definite things that the management should do to prevent accidents may be set down as follows:

1. Provide safe plant and equipment.
2. Safeguard all machinery.
3. Place no new machinery or equipment in operation unless full attention has been paid to its safety.
4. Plan and arrange all processes and operations with careful attention to safety.
5. Maintain a system of inspection to discover correctible hazards.
6. Maintain safety-minded supervision.
7. Train, educate, and stimulate its employees to follow safe methods of work and take a sincere interest in the safety of themselves and their fellow workers.
8. Investigate all accidents to determine how best to prevent a recurrence.
9. Make a full report to the proper authorities of all cases of injury.

C. THE WORKER'S PART IN HEALTH AND SAFETY

Safety is everybody's business. Every employee should, of course, be always alert to the possibilities of injury. Management can do only part of the job. Each worker should faithfully cooperate with his management in all safety programs. Some of the ways in which his help is most necessary are:

1. Faithfully using all safeguards provided.
2. Studying and carefully following safety rules and safety instructions.
3. Working earnestly on safety committees or other safety activities to which he may be assigned.
4. Seeking always for the safe way of working on each job or activity.
5. Watching out always for the safety of his fellow men.
6. Reporting all hazardous conditions of which he learns.

D. HEALTH AND SAFETY COMMITTEES

A safety committee when properly set up and maintained can be an extremely effective tool for accident prevention. The functions of such a committee should include the responsibility for periodic inspections of the plant; review and approval of inspection reports; analysis of causes of accidents for the purpose of submitting recommendations to prevent recurrence of similar accidents; instructing new employees or workers transferred to unaccustomed tasks to the hazards of their work, and promoting the education of all employees in safety practices. The committee should meet at least monthly and keep a written record of the number and nature of its recommendations; the number carried out; the number incompleted; and the number not acted upon. The members of the committee should be selected from the various departments and should be changed at regular intervals.

The advisable committee set-up depends chiefly upon the size of the establishment but other factors have a bearing, such as the progress that has been made in safeguarding the plant when committee work is started, the size and relationship of the various departments or plant units, the type of business (manufacture, construction, transportation, public utilities, etc.). However, at least the following fundamentals should be met in forming the committee or committees decided upon:

(a) Each committee should be so made up as to have standing appropriate to its field of work. For instance, a main or governing committee should include such key executives as master mechanic and production manager. A workers' committee should be made up of members well known to and having the respect of their fellow workmen.

(b) The committee membership should encompass the maximum in knowledge of the methods, practices, and conditions in the plant, undertaking, or group represented.

(c) The committee should be as small as is consistent with the above requirements. A committee of three functions more effectively than one of five. The larger the committee the more the debate and the less the action.

When a committee is formed, certain matters of policy and procedure should be definitely set forth in writing. Written instructions should cover at least:

(a) Scope of committee activity.
(b) Extent of committee authority.
(c) Procedure as to:
  (1) Time and place of meetings.
  (2) Frequency of meetings.
  (3) Order of business.
  (4) Records to be kept.
  (5) Attendance requirements.

A committee will take its work seriously in proportion to management's attitude toward it.

A management that sets up a committee to accomplish a specific purpose, makes it clear that it wants results and gives effective executive supervision to its activities, will get satisfactory results therefrom. Effective committee conduct of safety work in the absence of executive leadership is possible only when committee members have unusual initiative and determination to advance the cause of safety. In such instances they often convert the nonsafety-minded management. Sometimes the "salesman" of safety, failing to arouse adequate management interest, can accomplish his purpose by getting a safety committee organized and aid it to plan a program that will interest the top management, thus at the same time getting safety work started.

E. ACCIDENT INVESTIGATION

It is obvious that every case of disabling injury should be carefully investigated to find out how to prevent a recurrence. In theory every accident, whether it yields an injury or not, should be investigated also, but this would involve such a heavy volume of work that few managements would find it practical. Good practice is to investigate all cases of disablement, all other happenings involving the probability of serious injury, and cases of repeated injury to an individual.

The investigations must be made by persons who are intelligent, painstaking, and keenly safety-minded. Usually an accident has more than a single cause. A combination of circumstances was necessary to bring it about. The employer should try to correct every condition or circumstance that might lead to injury. He should particularly not be content to stop with finding the human fault or failure that was involved, for in almost every case, both a material and a human fault will be found. If the material fault or lack is corrected, the human fault or lack usually fails to produce injury. Of course, effort should be made to correct the human fault also. Usually correction of the material or mechanical fault involves expense so that the constant temptation is to blame the individual at fault and let the matter end there. That is not in the best interests of safety, and the tendency to take that course must continuously be resisted.

F. ACCIDENTS ARE PREVENTABLE

An excellent definition of "accident" is that it is an "unexpected occurrence," that is, unplanned for or unforeseen. Occasionally, human injury is involved and we have an accidental injury which is what we really mean when we say "accident." If each bit of work done in industry could be properly planned and then carried out exactly as planned, there would be no unexpected occurrences and therefore no human injuries. Numerous establishments, large and small, in each branch of industry have by planning, foresight, and care eliminated at least 9 out of every 10 injuries that otherwise would have been suffered by their workers and have profited by so doing.

PART II.—REQUIREMENTS

Records of Injury Frequency Rate

Every person who is or shall become a party to a Government contract which is subject to the provisions of the Walsh-Healey Public Contracts Act and the regulations thereunder, or who is performing or shall perform any part of such contract subject to the provisions of such act or regulations, shall maintain injury frequency rates as defined herein and such rates shall be calculated quarterly on a calendar basis commencing the first of January of each year.

Such records shall be kept on file for at least three years after the date of entry thereon and shall be made available for inspection by authorized representatives of the Secretary of Labor.

Frequency Rate

Injury-frequency rates are the primary measures of the incidence of work injuries. The lack of comparability inherent in simple injury totals, arising from variations in employment and operating time, is overcome by expressing the injuries in terms of a standard unit of exposure. By definition, the standard comparison injury-frequency rate is the average number of disabling work injuries per million employee-hours worked. Expressed as a formula it is:

$$\text{Frequency Rate} = \frac{\text{Number of disabling injuries multiplied by } 1{,}000{,}000}{\text{Total number of employee-hours worked}}$$

What Injuries To Count

A disabling work injury is defined as any injury incurred in the course of and arising out of employment, which:

(1) Results in death, or

(2) Results in any degree of permanent physical impairment, regardless of whether or not any time is lost from work, or

(3) Renders the injured person unable to work at any regularly established job, which is open and available to him, throughout the hours of his regular shift on any day after the day of injury, including Sundays, holidays, and days on which the plant is shut down.

The injuries described in items 1 and 2 of this definition are commonly spoken of as "death cases" and "permanent disability" cases. Death cases usually are readily identified. Permanent disabilities likewise are usually easy to identify. It is necessary, however, to remember that permanent disabilities include not only all injuries involving the amputation of any part of the body, but also all injuries which result in the complete or partial loss of use of any body part or function of the body. For example, the partial loss of vision or a permanently stiff arm resulting from a poorly healed fracture would be counted as permanent impairments just as you would count an injury involving the amputation of a finger or a foot. Most permanent disability cases involve the loss of considerable time. Occasionally, however, there are hardy individuals who experience a minor permanent disability, such as the amputation of the end of a finger, and return to work on the same day or the following day. Regardless of the fact that no recorded time was lost, these cases should be counted if there actually is any residual permanent impairment of any body part or body function.

The third category of disabling injuries is referred to as "temporary-total disabilities." They are "temporary" disabilities because they do not result in death or any form of permanent impairment. In other words, they are injuries from which the injured person eventually recovers with no lasting ill effects. At the same time, they are "total" disabilities because they render the injured person totally unable to work at any regular job for a period of time equivalent to at least one full shift on any day after the day of injury. The important things to remember in connection with these injuries are: (1) Time lost on the day of injury is not considered in determining whether or not an injury is disabling; (2) the inability to work must continue throughout the hours of the worker's regular shift on at least one day; but, (3) this inability to work may occur on any day after the injury, not necessarily on the next day, and not necessarily on a day on which he would normally be expected to work.

The reference in the definition to a regularly established job means that you are not permitted to exclude an injury from the count of disabling injuries if the injured person returns to a specially created easy job which was designed simply to get him back to work without loss of time.

It should also be noted that under the definition of a disabling injury the reportability of an injury for injury-statistics purposes is in no way related to the eligibility of the injured person for workmen's compensation payments. In case of doubt as to whether or not an injured person is able to work, the attending physician's decision is final.

Establishments participating in the Bureau of Labor Statistics' quarterly work-injury survey and retaining on file copies of each completed report on Form BLS 1417 or 1417-A will be considered as complying with the requirement regarding the maintenance of injury-frequency rates.

For every-day use, the frequency rate affords the best measure of performance because each accident might easily, "but for the grace of God," have been very serious or fatal, and therefore the constant effort must be to prevent every injury, not just the more serious ones. The following example shows how to figure the frequency rate.

During 1949 eighteen lost-time injuries occurred in a certain machine shop. The number of man-hours worked during the year totaled 216,000. What was the frequency rate? Substituting these numbers in the frequency rate formula we get:

$$F = \frac{18 \times 1{,}000{,}000}{216{,}000}$$

which gives a frequency rate of 83 plus. That is, the men in the shop suffered 83 lost-time injuries for every million man-hours they worked.

If the figure for man-hours is not available, a close enough estimate can usually be made by multiplying the average number of workers by the hours worked per week and the number of weeks worked for the period for which the frequency rate is being calculated.

Some people prefer to think of the frequency rate in terms of how long a person may expect to work on the average without getting hurt. If, in the above example, the shop worked a 40-hour week 50 weeks during the year, each man worked 2,000 hours in the year, and therefore in order to put in 216,000 hours there must have been an average of 108 men working. The 18 injuries averaged among these 108 men means that every sixth man was disabled during the year. Another way of putting it is that, on the average, each man could expect to be disabled once in 6 years. That is a very high injury rate for even the most hazardous work. Numerous plants in all branches of industry maintain frequency rates below 10 and often times below 5. A worker in a plant having a frequency rate of 5 is fortunate indeed for on the average he can expect to work three lifetimes—a whole century—for each disabling injury he suffers. He is undoubtedly much safer when at work than when not at work.

(For full detailed information on determining frequency rates see "American Stan-

dard", *Method of Compiling Industrial Injury Rates*, Z16.1.[1])

B. BUILDINGS AND EQUIPMENT

1. **Buildings.**—Buildings and all appurtenances thereto, including bridges, towers, balconies, runways, and platforms, should be structurally safe to prevent collapse.

2. **Floors.**—*(a)* No floor or platform should be so loaded as to have a factor of safety of less than four. That is, the weight placed upon a floor or platform should not exceed one-fourth of the breaking strength of the platform or floor.

(b) Floors, other than those resting directly on solid ground, when used for storage or for operations that might lead to overloading should be clearly posted to show maximum safe floor loads.

(c) All floor surfaces should be kept clean and dry and maintained in a smooth and reasonably nonslippery condition free from holes or projections that might cause tripping.

(d) Where the type of operation necessitates working on wet or slippery floor areas, such areas should be protected against slipping by the use of mats, grates, cleats, or other high friction floor coverings.

(e) Safe means of access, suited to conditions, should be provided to every overhead point to which employees are called upon to go in connection with their employment. Materials or objects should not remain unnecessarily on the floor surface in such places as will subject employees to the hazard of falls.

3. **Floor openings, wall openings, and elevated platforms.**—Floor openings, wall openings, and elevated platforms where there is a possibility of persons or material falling through should be provided with standard railing and toe boards, or with wood or metal covers. Where guard rails are advisable refer to Standards for *Railings, Toeboards, and Guards* as specified under Part II E, Machine Guarding.

4. **Stairways or Steps.**—*(a)* Riser height and tread width should be uniform in any given flight of stairs. Variations in riser height should not exceed 1/8 inch in the stair as constructed. Variation due to wear should not be allowed to exceed 1/4 inch. Riser height should not be over 8 inches and tread width exclusive of nosing not less than 9 inches. Preferred dimensions are: riser 7 inches, tread 11 inches plus 1 inch nosing, and width not less than 36 inches.

(b) Every stairway or steps of four or more risers should be equipped with a substantial smooth handrail from 30 inches to 36 inches high, measured vertically from the nose of the tread and placed on the left-hand side as one mounts the stair and on the open side, if any. If 5 feet or more in width, or open on both sides, the stairs should have a handrail on each side.

(c) Interior stairways or steps which are more than 8 feet wide should be divided by center rails into widths of not more than 8 feet nor less than 3 feet 8 inches.

(d) Exterior stairways or steps should have a handrail at each side, and if the stairway or steps are more than 88 inches wide, one or more intermediate handrails should be provided.

(e) Railings on open sides of stairways or steps should be provided with an intermediate rail at midheight, or with vertical members having a maximum spacing of 11 inches.

(f) Every stairway or steps should be maintained in good repair, free from protruding bolts, screws, and nails, and unnecessary material, dirt, and slippery conditions. Treads should be renewed when the surface, including the nosing, shows wear to the extent of 1/4 inch or more.

(g) Stairways should not be used for storage purposes, and any equipment should be so located that its presence or use will not unnecessarily obstruct or interfere with free passage.

(h) All metal treads should have a surface which will reasonably prevent slipping.

5. **Elevators.**—*(a)* Elevator inspection by a recognized elevator inspection service will be acceptable as evidence of satisfactory installation and maintenance. Hoistways, hatchways, elevator wells and wheel holes should be securely fenced, inclosed, or otherwise protected. (For details, see American Standard Safety Code for Elevators, Dumbwaiters, and Escalators.)

(b) Elevator machinery, electrical apparatus, or system wiring should be properly installed, guarded, and inspected.

6. **Illumination.**—Illumination adequate to permit all work activities to be carried on safely should be provided and maintained during all work periods. Minimum standards for illumination should be in conformance with the "American Standard," Recommended Practice of Industrial Lighting.

7. **Aisles and passageways.**—*(a)* Permanent aisles and passageways should be kept clear and in good repair. Where, due to lack of proper definition, such aisles and passageways become hazardous, they should be clearly defined by painted lines, curbings, or other methods of marking.

(b) Where industrial trucks are in customary use, one-way traffic aisles should be at least 2 feet wider than the widest vehicle. Two-way traffic aisles should be at least 3 feet wider than twice the width of the widest vehicle.

(c) There should be no obstructions across or in aisles that might cause tripping.

[1] Published by American Standards Association, 70 E. 45th St., New York City.

8. **Ladders.**—*(a)* Full compliance with the applicable provisions of the "American Standard", Safety Code for Wood Ladders, A14.1, is recommended.

(b) Rung spacing on each fixed ladder should be uniform. This includes the space between the top rung and the landing measured vertically from the top rung. Rungs of all ladders should be uniformly spaced, firmly secured and maintained in a sufficiently tight condition to prevent turning or other motion. Bent rungs of metal fixed ladders should be promptly replaced or repaired. Clearance at the back of rungs of fixed ladders should not be less than 6½ inches measured horizontally from any object.

(c) Fixed ladders should be secured with sufficient firmness and in such manner that they will be free from visible motion under normal conditions of use. Hand holds should be provided at the top of each fixed ladder so arranged that a person using them can conveniently retain a secure hold with either hand when stepping from the top rung of the ladder to the landing point or the reverse. Side rails should extend above landings at least 3 feet. No fixed ladder should have a slope outward, that is, from the vertical toward the climber, unless such sloping ladder or sloping part thereof is properly caged. Ladders in disrepair should be promptly repaired or removed from use.

(d) In the use of portable straight ladders, practicable precautions should be used. Every step ladder should be equipped with a spreader of a type that locks when the ladder is opened to hold it securely in the open position. Portable steps and saw horses should be of substantial construction with parts firmly secured and maintained in a safe state of repair.

9. **Overhead work.**—*(a)* Every overhead job that may have to be done in an establishment should be carefully considered and a safe means of doing it provided.

(b) Some of the more common "overhead" jobs with means of safeguarding are given below:

(1) *Nature of job.*—Devices that require only infrequent attention normally consisting of only simple servicing or adjustments. Examples: Valves in steam, air, or other supply lines; pressure reducers; overflow or other high level storage tanks; liquid level indicators; gauges; natural draft ventilators.

Suggested safeguards. — Portable ladders: Feet suited to floor surface; ladder of correct length, strength, and condition conveniently available, firm support (at top), security (of position), safety in placing ladder, safety of man on ladder (position, clearance from moving parts, electrical conductors, steam pipes, etc.).

Good practice provides fixed ladders or stairs to such equipment wherever reasonably possible.

Good design eliminates overhead locations to the maximum practicable extent.

(2) *Nature of job.*—Devices that require rather frequent (as weekly) servicing usually involving only minor attention or adjustment. Examples: Ring oiler (or equivalent) bearings, induction motors, storage tanks, exhaust fans.

Suggested safeguards.—Railed and toeboarded platforms reached by stairs should be provided wherever space and location permits. Fixed ladders are preferable to stairs steeper than will give a 10 inch rise and 8 inch tread (pitch about 51°). Where location prevents stair or fixed ladder, provide portable railed step or portable ladder suited to the purpose with hooks fixed to the rails to engage suitable supports at the platform.

(3) *Nature of job.*—Apparatus that requires daily or more frequent servicing. Examples: Control devices as governors, regulators, recorders, sight glasses, etc.

Suggested safeguards.—Every such point should be accessible by a platform and stair. In some cases they can be serviced from the floor. Example: Use of telescope to read thermometers on tall apparatus.

(4) *Nature of job.*—Equipment that requires relatively infrequent attention but which involves major cleaning or maintenance and repair work. Examples: Electric overhead traveling cranes (overhauling), steam boilers (retubing, cleaning tubes), stills, fractionating columns, digesters, etc.

Suggested safeguards. — Railed and toeboarded platforms reached by stairs wherever possible. Particularly in crane overhauls such platforms cut the cost of the work, result in better maintenance, and reduce the hazard, thus justifying very substantial expenditures for the platform. If fixed platforms are not practicable, provide substantial "knock-down" scaffolding (railed and toeboarded) kept for the purpose. In some cases wheeled platforms (wheels arranged to lock) are convenient.

(5) *Nature of job.*—Apparatus out of doors. (Assignable to above classes but listed here because of the special hazards due to wind, ice, cold, etc.) Example: Sprinkler tanks, oil storage tanks, derricks, coal unloaders, dust collectors, advertising signs, flood lights.

Suggested safeguards.—All outdoor tanks should be equipped with fixed ladders and self-draining platforms (if needed) to give safe access to manholes, etc. Means of access to bearings, etc., on derricks and coal unloaders must be suited to conditions. Never omit ladder rails or allow ladder to have reverse slope; provide adequate hand holds and foot supports.

(6) *Nature of job.*—Maintenance activities, as window cleaning and reglazing, paint-

ing, replacing lights, painting masonry, oiling, and other work on overhead shafting.

Suggested safeguards. — Window cleaning equipment should conform to the "American Standard," Safety Code for Window Cleaning.

Long spout oil cans can be used instead of ladders. The practice of oiling running overhead machinery is rarely carefully planned. When done from a crane, a railed platform should be provided and careful precautions taken to guard against insufficient clearance. Extension fittings should be used to give adequate clearance from moving parts.

10. **Housekeeping and order.**—*(a)* Satisfactory control requires careful consideration of such factors as tonnage and volume of materials to be handled, the amounts required at the successive steps of the process, allowance of the spaces necessary, and the methods to be used in handling and transporting the materials and articles.

(b) Methods of piling should be worked out for each class of materials or articles. Points commonly of importance are:

(1) *Height of pile.*—This is dependent upon the character of the material and the consequent danger of toppling, the means used in piling and removal, the traffic nearby, and interference with sprinkler operation. When the nature of the material is suitable, it should be so piled as to be interlocking.

(2) *Strength of support.*—Allowable floor loads should be posted.

(3) *Evenness of support and its continued stability.*—This condition often exists in yard piling where uneven ground or moisture may cause toppling, and on first floors or in basements where floors may slope or flooring sag.

(4) *Location.*—Aisle traffic or the presence of work benches or machines may make it necessary to limit the height of material to be piled in a safe manner.

(5) *Piling small articles.*—Containers suited to the nature of the articles are commonly used. These usually take the form of wheeled or truck pick-up containers that receive the articles from work bench or machine. A useful modification for such articles are small cans or trays that themselves may be stacked.

(6) *Pipe or other long stock.*—Suitable racks aid handling. Projecting ends should be protected by location, railings, or barriers.

(c) Remove, or bend over in such a manner as to make them harmless, all projecting nails in kegs, barrels, boards, or boxes allowed to remain about the work place.

(d) Waste disposal provisions should be made for the orderly collection and disposal of all scrap debris, empty bottles, etc.; special provisions suited to the nature of the substance in question should be made for the disposal of poisonous and obnoxious substances.

11. **Yards and grounds.**—In plant yards and grounds, safety measures include:

(1) Proper drainage.

(2) Clearance signs to warn of limit clearances.

(3) Derails and bumper blocks.

(4) Traffic control signs to warn pedestrian, vehicular, and railroad traffic.

(5) Proper coverings or rails for open pits, tanks, vats, ditches, etc.

12. **Materials.** — *(a)* Materials, wherever stored, should be piled, stacked, or racked in a manner designed to prevent tipping, falling, collapsing, rolling, or spreading. Racks, bins, planks, sleepers, bars, strips, blocks, and sheets should be used where necessary to make the piles stable. Materials and objects that are stored in overhead places should be secured so that they will not fall and cause injury to persons below.

(b) All hazardous chemicals should be distinctively marked to indicate their nature.

13. **Compressed Gases.**—*(a)* Cylinders containing compressed gases should not be unduly exposed to the heat of stoves, radiators, or furnaces. Where cylinders are stored in the open, they should be protected from accumulations of snow and ice and from the sun where high temperatures occur.

(b) Heat increases the pressure within the cylinder, or it may melt the fusible safety plugs, which in acetylene cylinders melt at a temperature of approximately 210° to 220°F. Should a valve become frozen, it should be thawed out with warm (not scalding) water. Open flames should not be used for this purpose under any circumstances.

(c) Cylinders should preferably be stored in an upright position. In many plants, cylinders are held upright by straps or chains to prevent their falling over. This is particularly important with acetylene cylinders.

(d) Empty cylinders should be plainly marked EMPTY, and the valves should be closed. The empty cylinders should be segregated from full cylinders and returned to the manufacturer as soon as practicable.

(e) The recommendations of the National Fire Protection Association and State and municipal laws and regulations should be closely observed in regard to the storage of compressed gas cylinders. Cylinders should never be allowed to fall or otherwise receive shock.

14. **Special precautions for oxygen cylinders.**—(a) Great care must be exercised in handling oxygen to prevent contact of oxygen under pressure with oils, greases, organic lubricants, rubber, or other materials of an organic nature in order to prevent explosion. The following recommendations of the Compressed Gas Association should be observed:

(1) Never permit oil, grease, or readily combustible materials to come in contact with oxygen cylinders, valves, regulators, gauges, or fittings.

(2) Never lubricate regulators, fittings, or gauges with oil or any other combustible substance.

(3) Never handle oxygen cylinders or apparatus with oily hands or greasy gloves or rags.

(4) Always clear the particles of dust and dirt from the opening to each cylinder by slightly opening and closing the valve before applying any fitting to the cylinder.

(5) Never permit oxygen to enter the regulator suddenly. Open the valve slowly. When opening the valve, point the face of the gauge on regulator away from the operator.

(6) Never drape an oxygen cylinder with any material such as wearing apparel, rags, etc.

(7) Never use oxygen fittings, valves, regulators, or gauges for any other service except oxygen.

(8) Users should never mix gases of any type in an oxygen or any other cylinder.

(9) Never use oxygen from a cylinder except through a pressure reducing regulator.

(10) Never attempt to use regulators which are in need of repair or cylinders having valves which do not operate properly.

(11) Never attempt to repair defective oxygen equipment unless properly qualified by knowledge and experience.

15. **Flammable liquids.**—Materials such as paints, lacquers, thinners, gasoline, and naptha should be stored and handled with provisions for safety suited to the material and the conditions of its use. They should also be covered or stored in an approved type of safety container suitable to the nature of the material.

16. **Explosives.** — Explosives should be stored in approved type explosive magazines which are bulletproof, ventilated, and located at distances from other buildings as required under the American Table of Quantity and Distance. For details, refer to U. S. Bureau of Mines Information Circular 7307 on "Surface Storage of Explosives" and Information Circular 7380 on "Safe Storage, Handling, and Use of Commercial Explosives."

17. **Spontaneous ignition.**—Proper precautions should be taken in connection with storage of materials which may cause spontaneous ignition. Rooms in which there may be explosive concentrations of dust, gases, or vapors should have explosion-proof electrical fixtures and equipment in accordance with the provisions of the National Electrical Code relating to hazardous locations.

18. **Electrical equipment.**—The following general information should be used in conjunction with the National Electrical Safety Code, National Bureau of Standards Handbook H30:

(a) General protection.—Where practicable, transformers, control boards, and other accessories should be placed in special rooms to which only authorized persons have access. If the use of a separate room is not feasible, enclosures should be built around those parts of electrical equipment having exposed conductors. Enclosures made of metal should be effectively grounded.

Warning signs should be displayed near exposed current-carrying parts and in specially hazardous areas, such as high voltage installations. Signs should be large enough to be read easily and they should be so placed as to be visible from all approaches to the danger zones. They should be displayed in as many languages as needed.

Suitable insulating mats or platforms of substantial construction and providing good footing shall be placed on floors and, if necessary, on the frames of the machines having exposed live parts of more than 150 volts to ground, so that the operator or persons in the vicinity cannot readily touch such parts unless standing on the mats, platforms, or insulating floors.

(b) Grounding.—Fixed equipment or appliances having exposed metal frames should be grounded under any of the following conditions:

(1) If operated at more than 150 volts to ground, regardless of location.

(2) If located where exposed grounded surfaces, as plumbing fixtures or conductive floor and wall can be reached by a person while touching the metal parts of equipment.

(3) If located in hazardous areas.

The grounding of portable equipment should follow that of fixed equipment except (1) electrically heated appliances exempted by administrative authority, and (2) motors if positively guarded under all conditions. It is recommended, however, that motors always be grounded.

(c) Ground connections.—Ground connections should be of copper, and the combined resistance of the grounded wire and the connection with the ground should not exceed 3 ohms for waterpipe connections nor 25 ohms for artificial grounds. The actual ground circuit resistance should be kept as far as possible below the maximum permissible limits.

Where a grounding wire is exposed to mechanical injury, it should be protected by conduit connected at both ends to the grounding wire or by other substantial enclosure. If the enclosure is of metal, it also should be grounded.

(d) Transformers.—These should preferably be located outside of buildings, and surrounded by an enclosure of grounded metal at least 8 feet high. If a building wall forms a

part of such an enclosure, all windows in the wall should be screened or barred.

Transformers inside buildings should be placed in ventilated fireproof vaults having raised sills across the doorways to prevent the escape of leaking oil. Floors and floor drains should be so arranged that oil will quickly collect in drainage or storage systems provided for the purpose. Air vents should be so designed as to close automatically in case of fire. It may be advisable to provide equipment for introducing fire extinguishing material into transformer cases or vaults. Doors to transformer enclosures or vaults should be kept securely locked, and only authorized personnel should be permitted to enter such areas.

(e) Plant wiring.—All wiring should be in accordance with the National Electrical Code and also with local codes or requirements.

(f) Over-current devices.—The safe current-carrying capacity of conductors is determined by their size, the material of which they are made, and the manner in which they are installed. If forced to carry more than the maximum safe load, or limited as to heat dissipation, excessive heating results. Fuses or other over-current devices should be installed in every circuit, and they should be of a size and type that will interrupt the current flow when it exceeds the capacity of the conductor. Protection of this kind, both for personnel and for equipment, is one of the important features of any electrical installation.

(g) Drop and extension cords.—Extension cords should be of a type approved by the Underwriters Laboratories, Inc., and they should be labeled to show that they meet all requirements of the National Electrical Code. They should be inspected regularly. Kinking or excessive bending of the cords should be avoided to prevent breaking of the wire strands. Broken strands may pierce the insulating covering and become shock or short-circuit hazards.

(h) Lamp fixtures and equipment.—For locations where there are flammable gases or dusts, lamps should be installed only in fixtures especially designed to prevent lamp breakage and to prevent ignition of the flammable material. Equipment should be of explosion-proof design.

(i) Maintenance.—Switches should always be tagged or locked in the open position before starting work. If a lock is used for which keys are available to other members of the organization, the switch should also be tagged in such a way as to identify the individual authorized to remove the lock. If two or more employees are working independently on the same circuit, each should affix his own lock or tag to the switch.

When the switch cannot be locked out, especially if it is located in an open work area, it is advisable to station a watchman near the switch to see that it is not disturbed while the work is in progress. Warnings should be given to all operators affected before opening a circuit and again before closing the circuit after the job is completed.

19. **Tools.**—*(a)* Each employer should heed the safe condition of the tools used by his employees, whether furnished by him or by them, and make every reasonable effort to insure that such tools are suited both by safe design and construction to the work to be done.

(b) Each employer should institute and maintain a definite system of tool inspection and repair suited to conditions.

(c) Tools in disrepair should not be used.

(d) All powered tools which might cause injury through continued operation should the operator lose his hold, should be equipped with the so-called "dead man" type of control (or the equivalent) whereby the power is automatically cut off when the operator loses his hold.

(e) Portable electric power tools should be equipped with ground wires to maintain at all times an effective ground on the noncurrent carrying parts of the tool.

C. FIRE PREVENTION AND PROTECTION

1. **Building egress.**—*(a)* All buildings in which persons are employed, or are assembled for any purpose, should be provided with safe and proper ways of egress or means of escape from fire, sufficient for the use of all persons accommodated or assembled within the building. Such ways of egress should be kept free from obstructions, and in good repair and ready for use at all times. (The provisions of the "American Standard," Building Exits Code, A9.1, should be followed.)

(b) All buildings or establishments of two or more stories in height should be provided with more than one way of egress or escape from fire, said ways of egress being so located and in such positions as to prevent the trapping of persons in the building. Such ways of egress may lead to adequately constructed and properly maintained fire escapes on the outside of the building or to inside stairways, provided with proper hand rails, and satisfactory for emergency use. Such stairways should preferably be fire resistant and lead directly to the outside at grade level. All exit doors should swing in the direction of exit, and should open in such manner as not to obstruct passageways or corridors used as way of egress and escape from fire or panic. No chairs or seats, fixtures, chutes, materials, or equipment should block or in any way jeopardize the use of ways and means provided for egress. All exit doors and windows used as means of egress in case of fire

or panic should be so arranged as to be always readily opened from the inside. Locks on doors and windows, if provided, should not require the use of a key to operate from the inside.

(c) All exits or means of egress as above specified should be plainly designated or marked by conspicuous signs or lights to identify the means of escape. Directional signs should be provided where needed. Ladders are not acceptable as fire escapes.

2. Fire extinguishing equipment.—*(a)* Equipment suitable to the conditions and hazards involved for the extinguishment of fires should be provided and maintained in an effective operating condition. The importance of a systematic inspection of these devices is emphasized. This equipment includes built-in equipment, such as automatic sprinkler, CO_2, and steam lines. Also hand-operated equipment, such as hose and portable fire extinguishers, sand pails, water barrels and pails and other equipment effectively located, mounted, and maintained.

(b) Aisles leading to, and areas in front of, all fire-extinguishing equipment should be open at all times, free and clear and unobstructed by materials, stock, and equipment of any kind.

(c) Classes of fires and recommended extinguishing equipment. Listed below are various classes of fires and the extinguishing equipment which is recommended in each case:

(1) *Class "A" fires.*—Fires in ordinary combustible materials where the quenching and cooling effects of quantities of water or solutions containing large percentages of water are of first importance.

Recommended extinguishing equipment.—Soda and acid, pump tank extinguishers or water barrels and buckets.

(2) *Class "B" fires.*—Fires in flammable liquids, greases, etc., where blanketing effect is essential.

Recommended extinguishing equipment.—Foam, carbon tetrachloride, CO_2, dry powder pressure-type extinguishers, sand buckets and scoops.

(3) *Class "C" fires.*—Fire in electrical equipment where the use of nonconducting extinguishing agent is of first importance.

Recommended extinguishing equipment.—Carbon tetrachloride, CO_2, dry powder pressure-type extinguishers.

D. PRESSURE VESSELS

1. Fired pressure vessels—*(a) Steam boilers.*—The safeguarding of steam-power boilers has been developed to such a high standard that it can be truly said that boiler explosions are entirely preventable, provided that boilers are:

(1) Constructed and installed in accordance with the Power Boiler Code of the American Society of Mechanical Engineers or equivalent standards. (Various States, cities, and the Federal Government have developed codes of similar excellence which, nevertheless, vary in some details from the ASME Code. Insurance companies which insure steam boilers against explosion generally apply the provisions of the ASME Code.)

(2) Operated by personnel whose competence entitles them to hold certificates granted by licensing authorities set up for the purpose.

(3) Regularly inspected by competent inspection personnel.

(b) Heating boilers and miscellaneous small boilers.—Most State boiler codes exempt boilers intended for low pressure (usually below 15 pounds). The violence with which even the smallest boiler can explode should not be underestimated. Every vessel, however small, in which water is heated can, if its normal outlet is closed or plugged up, become in fact a high-pressure steam generator, and, if its strength is exceeded will explode destructively. The recurring explosions of such low-pressure devices indicate a too widespread failure to keep this simple fact in mind. Therefore, the accident preventionist should take careful account of every fired water or steam vessel and make sure that:

(1) It is of safe construction for the pressures involved.

(2) It has adequate means of limitation of pressure, such as:

(a) A safety valve of adequate capacity.

(b) A disk or diaphragm that will fracture at a predetermined pressure.

(3) It is regularly inspected, competently operated, and properly maintained.

(c) Steam cookers, digesters, glue pots, etc.—All pressure vessels to which steam is supplied from an outside source should be designed, insofar as it is practical, for the maximum line pressure. Most of them are not, and on such vessels it is vitally important to install, in addition to the necessary pressure-reducing valve, a safety valve on the vessel itself or on the line between it and the pressure reducer. There should be no means of cutting off or bypassing this safety valve. Inspection and adequate maintenance of the vessel, including regular testing of the safety valve, are vital.

2. Compressed air machinery and equipment.—For the detailed operation of this type of equipment refer to "American Standard," Safety Code For Compressed Air Machinery and Equipment; however, the general rules listed below should be applied.

(a) Compressors.—(1) If a power-operated air compressor is driven by other than an electric motor (including those driven by series-wound direct-current motors), a speed governor should be installed on the prime mover to prevent racing of the latter from any cause. Such a speed governor should act independently of the unloader on the compressor.

(2) If the air compressor is engine or turbine driven, an auxiliary control to the governor should be installed to prevent racing when the unloader operates.

(3) Every air compressor should be equipped with an automatic mechanism so arranged that the compressor will automatically stop its air-compressing operation before the discharge pressure exceeds the maximum working pressure allowable under this code on the weakest portion of the system to which the compressor is connected.

(4) If this automatic mechanism is electrically operated, the actuating device should be so designed and constructed that the electrical contact or contacts cannot lock or fuse in a position that will cause the compressor to continue its air-compressing operation.

(b) Switches, and other electrical apparatus.—If the compressor is driven by an electric motor, all electrical switches and other electrical apparatus should be guarded as required by the National Electrical Safety Code and the National Electrical (Fire) Code.

(c) Belt, pulley, gear, and shaft guards.—All belts, pulleys, gears, flywheels, and shafts should be guarded as outlined in Part II E of these standards.

(d) Lubrication.—Specific requirements for lubricating oils are intentionally omitted from these standards. In the operation of air compressors, many of the troubles experienced can be traced to the use of a poor or unsuitable grade of oil in the air cylinders. The importance of good air cylinder oil is generally recognized by the leading manufacturers of equipment and of lubricants and it is therefore suggested that their recommendations be followed.

Air compressor cylinders should be lubricated by means of visible-flow forced-feed lubricators.

Only enough oil should be used to furnish satisfactory lubrication in order to avoid carryover to intercoolers, aftercoolers, receivers, and other parts of the system.

(e) Cooling.—Where water cooling is used, a visible indication of water flow should be provided.

(f) Operation and maintenance.—(1) Compressor valves should be inspected, checked for broken springs, and tested for tightness frequently and at regular intervals. Leaky valves should be made tight by repair or replacement. Accumulations of carbon or other foreign matter should be removed.

(2) Unloaders and governor controls on air compressors should be inspected at frequent and regular intervals and should be maintained in good working condition. Where emergency (overspeed) stops are installed, such devices should be tested at regular intervals to insure their operation within safe limits of overspeed.

(3) If the compressor is steam driven, the throttle valve should be closed and tagged, and the cylinder drain cocks should be opened, before starting repairs or other work on the compressor.

(4) If the compressor is motor driven, the line switch supplying the motor should be opened and tagged or locked before starting repairs or other work on the compressor.

(5) Under no circumstances should kerosene, gasoline, or other flammable solvents be introduced into the compressor cylinders, the piping, or the receiver. Soapy water or any suitable non-toxic, nonflammable solution may be used for cleaning such portions of the system.

(g) Aftercoolers.—(1) Aftercoolers should be designed to withstand safely the maximum pressure in the air discharge piping.

(2) The advantages to be gained by using aftercoolers are of sufficient importance to warrant consideration of such equipment on at least new installations. Aftercoolers reduce the temperature of the air discharged by the compressor to a point at which most of the moisture and oil vapor condenses and can be removed.

(3) The removal of the moisture tends to prevent water hammer in the air lines. The condensation of oil vapors tends to prevent their being carried over to pipe lines, receivers, and other parts of the systems.

(4) Where pipelines and receivers have become coated with oil because of improper lubrication of the compressor, explosive mixtures of air and oil vapor may be formed at high temperatures. Consequently overheating should be avoided and oil accumulation should be immediately removed.

(5) The use of aftercoolers tends to maintain more nearly uniform air temperatures on the discharge side of the system, thereby minimizing the strains resulting from alternate expansion and contraction of pipelines.

(h) Piping. — (1) *Installation.* — Piping should meet the requirements of the American Standard Code for Pressure Piping. In its installation, adequate provision should be made for expansion and contraction, and to counteract pulsation and vibration. Steam and air piping should be equipped with adequate traps or other means for removing liquid from the lines. Air discharge piping should be so installed that pockets where oil may accumulate are avoided.

(2) *Insulation.*—Steam piping should be adequately insulated where it is exposed to contact.

(3) *Compressor air intake.*—Provision should be made to prevent drawing air containing flammable or toxic gases, vapors, or dusts into the compressor, and to prevent steam, water, or waste of any sort from being blown

or drawn into the compressor intake. No valve should be installed in the air intake pipe to an air compressor.

(4) *Air-discharge piping.*—The air-discharge piping from the compressor to the air receiver should be at least as large as the discharge opening on the air compressor. Because the air-discharge pipe becomes hot, no wood or other flammable material should be permitted to remain in contact with it.

(i) Valves.—(1) Stop valves in the air line between the compressor and the air receiver are not recommended. In every case where a stop valve is so installed, one or more spring-loaded safety valves should be installed between the compressor and the stop valve. The total capacity of such safety valves should be sufficient to limit the pressure in the air discharge piping to 10 per cent above the relieving pressure of the safety valves on the air receiver.

(2) Any stop valve which may be installed in the air discharge piping should be so located that it can be inspected and cleaned at definite regular intervals. Stop valves should preferably be of the gate type and not of the globe type. If a globe valve is used it shall be so installed that the pressure is under the seat and that the valve will not trap condensation.

(3) Every steam-driven air compressor should be provided with a manually operable throttle valve in the steam supply line, in a readily accessible location.

(4) A stop valve should be installed between the air receiver and each piece of stationary utilization equipment at a point convenient to the operator thereof.

(5) A stop valve should be installed at each outlet to which an air hose may be attached.

(j) Receivers.—(1) *Construction.* Air receivers should be constructed in accordance with the 1937 Edition of the A.S.M.E. Code for Unfired Pressure Vessels.[2] The operating pressure should be based on a factor of safety of not less than 5. Inspection openings should be provided in all air receivers 18 inches or more in diameter.

(2) *Installation.*—Air receivers should be so installed that all drains, handholes, and manholes therein are easily accessible. Air receivers should be supported with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. Under no circumstances should an air receiver be buried underground or located in an inaccessible place. The receiver should be located as close to the compressor or aftercooler as is possible in order to keep the discharge pipe short. The receiver should be located in a cool place to facilitate the condensation of moisture and oil vapors.

[2] Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

(3) *Drains and traps.*—A drain pipe and valve should be installed at the lowest point of every air receiver to provide for the removal of accumulated oil and water. Adequate automatic traps may be installed in addition to drain valves. The drain valve on the air receiver should be opened and the receiver completely drained frequently and at such intervals as to prevent the accumulation of excess amounts of liquid in the receiver.

(4) *Gages and valves.*—Every air receiver should be equipped with an indicating pressure gage (so located as to be readily visible) and with one or more spring-loaded safety valves. The total relieving capacity of such safety valves should be such as to prevent pressure in the receiver from exceeding the maximum allowable working pressure of the receiver by more than 10 percent. No valve of any type should be placed between the air receiver and its safety valve or valves.

(k) Working space.—In the location of compressors and related equipment, provision should be made for safe access to all parts of the equipment for operation, maintenance, and repairs.

(l) Aisles.—Aisle space should be adequate, should be independent of work and storage areas, and should be defined by floor markings.

(m) Safety valves.—(1) All safety valves used should be constructed, installed, and maintained in accordance with the A.S.M.E. Code for Unfired Pressure Vessels.

(2) Safety appliances, such as safety valves, indicating devices, and controlling devices, should be constructed, located, and installed so that they cannot be readily rendered inoperative by any means, including the elements.

(3) All safety valves should be tested frequently and at regular intervals to determine whether they are in good operating condition.

E. MACHINERY GUARDING

1. **Railings and toeboards.**—Where standard railings and toeboards are specified in this manual they should conform to the following specifications:

(a) Railings should be 42 inches in height except where otherwise specified and should be equipped with toeboards unless the space between the lower rail and floor is filled with material as specified in "b".

(b) They should be of substantial construction, should be permanently fastened in place, and should be smooth and free from protruding nails, bolts, and splinters. An intermediate rail should be provided between the top rail and the floor, unless this space is filled with substantial wire mesh, expanded metal, or other suitable material.

(c) If constructed of pipe, the inside diame-

ter of the pipe should not be less than 1-1/4 inch.

(d) If constructed of metal shapes or bars, each part should have a cross section at least equal in strength to that of a 1-1/2- by 3/16-inch angle iron.

(e) If constructed of wood, the posts should not be smaller than the sizes commercially known as 2- by 4-inch or 3- by 3-inch. The top rail should be at least as large as the size known as 2- by 4-inch. The intermediate rail should not be smaller than the size commercially known as 1- by 4-inch.

(f) Posts and uprights should be spaced not more than 8 feet apart.

(g) Toeboards should be at least 5-1/2 inches in height and be constructed of wood, metal, metal grill with openings not exceeding 1 inch or other suitable material.

(h) Intermediate rails and toeboards, and top rails which are attached to the side of the posts, should be placed on the side of the posts away from the engine, belt, floor opening, etc., to be guarded, so that any blow or pressure against them will be taken up by the posts instead of tending to push the rails away from the posts.

2. **Guards.** *(a)* If guards are made of wire mesh, perforated or expanded metal, crossed strips or bars of wood or metal, etc., the width or diameter of the holes should not exceed 2 inches. If parallel strips or bars of wood or metal are used, the space between them should not exceed 1 inch. There should be no openings more than 1/2 inch in width or diameter within 4 inches of any gear, belt, pulley or flywheel, or other dangerous moving part. Wood slats should be smooth and free from splinters, and the holes in perforated or expanded metal should be free from sharp cutting edges.

(b) The supporting frames should be of substantial construction, such as angle iron, varying from 1 by 1 by 1/8 inch to 1-1/2 by 3/16 inch, or iron pipe with inside diameter varying from 3/4 inch to 1-1/2 inch, according to the weight of the filling material, the size of the panels, and the exposure of the guard to collision with trucks, etc. Any panel which measures more than 42 inches in both width and length should be substantially supported across its narrowest dimension at intervals of not more than 42 inches.

(c) The filling material should be bolted, riveted, or otherwise securely attached to the frame in such a manner that no sharp points or edges will be exposed. Bolts should be at least 3/16 inch in diameter and should be spaced not more than 10 inches apart. Flat bars or strips used for clamps should not be smaller than 3/4 by 1/8 inch if of iron, or 1 by 1 inch if of wood. Perforated or sheet metal may be spotwelded to angle iron frames.

(d) The thickness of material used for guards should not be less than is specified in the following table:

Material	A Clearance from moving part at all points	B Largest mesh Opening allowable	C Minimum gauge (U. S. Standard) or thickness
Woven wire	Under 4 inches	½ inch	−#16.
	4–15 inches	2 inches	−#12.
Expanded metal	Under 4 inches	½ inch	−#18.
	4–15 inches	2 inches	−#13.
Perforated metal	Under 4 inches	½ inch	−#20.
	4–15 inches	2 inches	−#14.
Sheet metal	Under 4 inches		#22.
	4–15 inches		#22.
Wood or metal strip crossed	Under 4 inches	½ inch	Wood ¾ inch, metal #16.
	4–15 inches	2 inches	Wood ¾ inch, metal #16.
Wood or metal strip not crossed	Under 4 inches	½ inch width	Wood ¾ inch, metal #16.
	4–15 inches	1 inch width	Wood ¾ inch, metal #16.
Solid wood[1]			

[1] If plywood is used it should be not less than ⅝ inch thick and not less than 3 ply.

(e) Guards should be securely and permanently fastened in place, except as otherwise specifically provided.

3. **Belts, pulleys, etc.**—*(a)* All vertical and inclined belts should be completely enclosed or effectively guarded. However, belts that are 1 inch or less in width need be guarded only to 6 inches from the nip point.

(b) All V-belts regardless of shape, size, position, or running speed should be completely enclosed or effectively guarded.

4. **Vertical and inclined belts.**—*(a)* If the guard is within 4 inches of a belt or pulley, it should extend from the floor or platform level to a height of at least 6 feet. If the guard is within 15 inches but not within 4 inches of the belt or pulley it should extend from the floor or platform level to a height of at least 5 feet except in each case as follows:

(1) If any part of a pulley is more than 5 feet but less than 7 feet above the floor or platform level the guard should extend to the top of the pulley but need not exceed a height of 7 feet above the floor or platform level. This also applies to clutches.

(2) If the top of any pulley is not more than 5 feet above the floor, the guard need not extend above a point midway between the top of the pulley and a height of 5 feet, provided that in no case should it extend less than 42 inches above the floor unless it covers the top as well as all sides of the belt and pulley, in which case there should be no requirement as to height.

(3) If it is an overhead belt, the guard may be a basket or box, suspended from above and extending across the bottom of the pulley and all around the pulley to a height of 6 feet except where the top of the pulley exceeds such height when the guard should extend to the top of the pulley but need not exceed 7 feet.

(b) Where no pulley hazard is involved, a standard railing placed not less than 15 inches or more than 20 inches from the belt, measured horizontally from the top of the railing, will be considered a sufficient guard.

(c) If the belt is inclined, the height of the guard or distance of the guard or railing from the belt should be such that the vertical clearance between the floor and the lower run of the belt at any point outside of the guard or railing, should not be less than 6 feet 6 inches.

5. **Horizontal belts.**—*(a)* Where both runs of the belt are within 7 feet of the floor or platform level, the guard should extend at least 15 inches above the upper run or to a height of 7 feet above the floor. In no case should the guard extend less than 42 inches above the floor, except that if it covers the top as well as all sides of the belt and pulley, there should be no requirement as to height.

(b) Where the upper run of the belt is more than 7 feet above the floor or platform level and the lower run is within 7 feet of the floor, the pulleys should be guarded on sides and outer face to a height of 7 feet above the floor or platform level, and the belt guard between the two pulleys should extend at least 15 inches above the lower run, but need not exceed a maximum of 7 feet and should be a minimum of 42 inches above the floor or platform level unless completely enclosed. Unless the guards extend across the inner face of each pulley to a height of seven feet, the guard for the lower run of the belt should be carried to the same height as the pulley guards at all points within 15 inches horizontally from the inner face of either pulley.

(c) Where pulleys are so located and of such dimensions as to permit passage between the upper and lower runs of the belt, the space between the pulleys should be completely barred or should be provided with a passageway substantially guarded on sides and top and bottom.

6. **Cone pulleys and belts.**—*(a)* Cone pulley belts more than 2-1/2 inches in width should be equipped with mechanical belt shifters and all cone pulley belts should be guarded to a point 3 inches above the nipping point of the belt and pulley and not less than 3 feet 6 inches from the floor or platform where any part of the lower cone is less than 3 feet above the floor or platform level.

(b) Where both upper and lower cones are within 7 feet of the floor or platform level, as for example on some vertical drill presses and other machines and for which conditions are such that mechanical belt shifters are not required and none are furnished, the belt and cone pulleys should be guarded as specified in Part II E 2 above with a hinged self closing section to permit shifting.

(c) All belts regardless of width should be provided with belt shifters when joined together with a metallic or other form of fastener which by construction or wear will constitute a hazard.

7. **Machine control.**—*(a)* Every machine should be equipped with a loose pulley, clutch switch, or other adequate means readily accessible for the purpose of stopping the machine quickly.

(b) Machines on which two or more persons work should be equipped with one or more controls so located that more than one of these persons can quickly disconnect the machine from the source of power.

(c) Machines operated from a number of different places should be provided with readily accessible means for shutting off the power and means of locking controls to protect men working on the machines against unexpected starting.

8. **Belt shifters.**—*(a)* Every set of tight and loose pulleys should be equipped with a permanent belt shifter so located as to be within easy reach of the operator. The belt shifter should be so constructed as to make it impossible for the belt to creep from the loose pulley to the tight pulley.

(b) Every belt shifter should be equipped with an interlocking device which will prevent accidental shifting.

(c) Where overhead belt shifters are not located directly over a machine or bench, the shifting lever should be cut off 6 feet 6 inches above floor level.

9. **Pulleys—Location on shafting.**—(*a*) Every pulley near a shaft hanger, shaft bearing, or other fixed object should be placed so as to allow a side clearance at least 1/2 inch greater than the width of the belt between the pulley and the nearest part of such shaft hanger, shaft bearing, or other fixed object or a guard should be placed adjacent to the pulley to prevent the belt from running off on the side next to the shaft hanger, shaft bearing, or other fixed object.

(b) Where pulleys must be closer together on the shaft than the width of the wider belt plus 1/2 inch, the pulleys should be guarded so that the belt on either pulley cannot run off between the pulleys.

10. **Gears.**—All gears should be solidly enclosed, except that gears without spokes or holes in the web may be guarded by a band guard with flanges extending beyond the root of the teeth.

11. **Keys and keyseats.**—*(a)* Every projecting key in revolving shafting where exposed to contact, should be cut off or enclosed.

(b) Every keyseat in revolving shafting, where exposed to contact, should be filled or enclosed.

12. **Flywheels and shafting.**—*(a) Flywheel guards.*—Flywheels located so that any part is six (6) feet or less above the floor or platform should be guarded in one of the following ways:

(1) *With a standard railing.*—The railing must be placed not less than six (6) inches nor more than twenty (20) inches from the wheel, provided that it should be not less than fifteen (15) inches from the spokes of wheel or projections. If wheel extends into pit or within two (2) inches of the floor, a standard toeboard should be installed. If passage over journal or bearing is necessary, the passageway should be provided with a standard railing and toeboard.

(2) *With an enclosure of sheet, perforated, or expanded metal or woven wire.*—When such guard is placed less than six (6) inches from wheel, it should be not less than six (6) feet high, except if flywheel is less than six (6) feet high, the guard should be not less than the height of the wheel from the floor. In no case should guard be less than three (3) feet six (6) inches high unless wheel is completely enclosed, including the top. Where clearance of guard from flywheel at any point is under four (4) inches, the largest mesh or opening allowable should not be more than one-half (1/2) inch. Where such clearance is from four (4) to fifteen (15) inches, largest mesh or opening allowable should not be greater than two (2) inches.

(3) Flywheels, with smooth rims, five (5) feet or less in diameter, other than wheels having solid web centers, where the preceding methods cannot be applied, should be provided with a disc having a smooth surface and edge attached to the flywheel in such a manner as to cover the spokes of the wheel on the exposed side. The disc may be four (4) inches smaller in radius than the radius of the inner surface of the wheel if it is desired to provide space for bar in turning over the wheel. Keys and other dangerous projections not covered by disc should be cut off or covered.

(4) An adjustable guard may be used where it is necessary to start engine or for making adjustments.

(5) A slot opening for jack bar will be permitted.

(6) Spokes of pulleys, balance wheels, or flywheels other than on a prime mover, the bottom of which is six (6) feet or less above the floor or other working level should be protected by filling in the spokes or by guarding as required for belts.

(b) Shafting.—All exposed parts of transmission shafting six (6) feet or less from floor or working platform should be protected by a stationary casing enclosing shafting completely. Horizontal shafting may be guarded by a trough enclosing sides and top or sides and bottom of shafting as location requires.

Shafting under bench machines should be enclosed by a stationary casing or by a trough at sides and top, or sides and bottom, as location requires. The sides of the trough should come within at least 6 inches of the underside of the table, or if shafting is located near floor, within 6 inches of floor. In every case the sides of trough should extend at least 2 inches below or above the shafting as the case may be.

Revolving shafting and spindles forming part of and integral with individual machines where such part creates a hazard should be enclosed or covered.

13. **Presses.**—*(a) Preferred guarding methods.*—Protection from the dies of every press, except hot-metal presses, should be provided by means of the following:

(1) Complete enclosure, or

(2) Full automatic feed, or

(3) Semiautomatic feed with ram enclosure, or

(4) Limited opening (3/8 inches) between dies.

The maximum width of opening in the enclosure or between the enclosure and working surface shall be not greater than shown in the following table:

Distance of opening from nip point (inches)	*Maximum width of opening (inches)*
0 to 2½	⅜
2½ to 3½	½
3½ to 5½	⅝
5½ to 6½	¾
6½ to 7½	⅞
7½ to 8½	1¼

(b) Alternative guarding methods.—Only in case none of the methods in *(a)* above can be applied, then a device which will reasonably prevent injury by contact with dies should be installed as follows:

(1) A two-hand tripping device for each person engaged in the operation of a single press, so designed and arranged as to prevent tying, wedging, or otherwise securing one handle or button and operating the press with one hand only, or

(2) An interlocking gate guard operated by the tripping device of the press, which interposes a barrier on the front and sides of the ram before the plunger descends and will not permit the press to operate until the hand or hands of the operator have been removed from the danger zone, or

(3) A sweep or gate guard with the sweep arm, or gate interconnected to the ram and so designed and constructed as to sweep the hands of the operator from the die zone as the ram descends; with each single sweep arm provided with a flag or barrier attached thereto so that the operator cannot reach behind the sweep, or

(4) A pull-out protective device attached to the operator's hands or arms and connected to the ram, or outer slide of the press in such a way that the operator's hands or fingers will be withdrawn from the danger zone as the ram or outer slide descends; and designed so that where the open distance between the top of the work and the lower extremity of the punch is less than 2 inches that the multiplying action of this guard should be such that the hands will be withdrawn a safe distance from the nip point during the first quarter of the stroke.

(c) Special hand tools should be accepted only as an accessory to the guards listed herein and not as a substitute for any guard.

(d) Guards which are attached to the ram and which move downward so that the operator's hand or fingers may be caught between the gate and lower die should not be used.

(e). Where the speed of the ram is so slow that the operator might beat the ram on the down stroke after the press has been tripped, no device should be used which permits the insertion of the hands until the completion of the downward stroke without stopping the ram.

(f) Every hand-fed power press should be equipped with: (1) An arrangement which disconnects the treadle or hand-operated lever from the clutch mechanism after each stroke, or (2) A device that will, within its own action, automatically lock the clutch mechanism into place so that the press cannot make a second stroke until the treadle or hand lever is again pressed to its lowest position, or (3) By some other method which will accomplish the result outlined above; unless the danger zone protection is such that the guard remains in its protective position during the second stroke of the press.

(g) Platen presses.—Platen presses with or without mechanical power should be provided with one of the following: (1) An automatic feed which does not require the operator's hand to be placed between the platen and bed, or an automatic stop which will prevent the platen from closing if the hand or hands of the operator are caught between the platen and the bed, or (2) A guard, gate or sweep motion, which will throw the operator's hands out of the way as the press closes. If, of the type which lifts the hands out of the danger zone, the guard should rise at least 4 inches above the platen as the press closes and should descend by gravity or by mechanical means. The guard should be arranged so that it will prevent a shear between the guard and the top of the platen, or (3) Any other device that will prevent the platen from fully closing before the operator's hands are removed from between the platen and the bed.

14. **Abrasive wheels.**—The following standards for the operation of abrasive wheels should be supplemented by the "American Standard," Safety Code for the Use, Care, and Protection of Abrasive Wheels, to insure that full safety measures are taken in their operation:

(a) Handling.—All grinding wheels are breakable and some are very fragile. Great care should be exercised in handling and storage to prevent damage which might cause a wheel to fly apart when brought up to speed. The following rules which are based on experience, should always be observed:

(1) Handle wheels carefully to prevent dropping or bumping.

(2) Do not roll wheels (hoop fashion).[3]

(3) Use trucks or suitable conveyors which will provide proper support for all transporta-

[3] Exemption to (2) and (3): Where it is impractical to comply with (2) and (3) because of large size of wheel, danger of damage when rolling the wheel will be minimized if floor is smooth, clean and free from obstructions. The use of a strip of rubber or cork matting will further reduce the danger.

tion of wheels which cannot be carried by hand.[3]

(4) Stack wheels carefully on trucks. Do not pile heavy castings or tools on top of them, nor permit wheels to topple over.

(b) Storage.—Suitable racks, bins or drawers should be provided to accommodate the various types of wheels used. Wheel storage rooms should not be subject to extreme temperatures, and should always be kept dry.

(c) Inspection.—Immediately after unpacking, all wheels should be closely inspected to make sure that they have not been injured in transit or otherwise. As an added precaution, wheels should be tapped gently (while suspended) with a light implement, such as the handle of a screw driver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked, they should not be used. Wheels must be dry and free from sawdust when applying the test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

(d) Rigidity, supports.—Grinding machines should be sufficiently heavy and rigid as to minimize vibration.

Where practical, the machines should be securely mounted on substantial floors, benches, foundations or other adequate structures.

(e) Guards. — Every stationary abrasive wheel and portable wheels used in stationary position should be equipped with guards of the hood type strong enough to withstand the shock of a bursting wheel. A hood type or band guard strong enough to withstand the shock of a bursting wheel should be used on every portable wheel where the operation and the nature of the work will permit.

(f) Spindle. — The spindle and nut and flange projection, if any, should be guarded.

(g) Mountings and fastenings.—Hoods should be so mounted as to maintain proper alignment with the wheels, and the strength of the fastenings should exceed the strength of the hood.

(h) Dust exhaust provisions.—Hoods on machines used for dry grinding and other operations where dust is produced should have provisions made for connection to an exhaust system. For detailed recommendations reference is made to "American Standard" for Grinding, Polishing and Buffing Equipment Sanitation (Z43).

(i) Exposures permitted.—(1) *Bench and floor stands.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as bench and floor stands should not exceed 90° or one-fourth of the periphery. This exposure should begin at a point not more than 65° above the horizontal plane of the wheel spindle.

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure should not exceed 125°. This exposure should begin at a point not more than 65° above and extend to a point not more than 60° below the horizontal plane of the wheel spindle.

(2) *Cylindrical grinders.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cylindrical grinding machines should not exceed 180°. This exposure should begin at a point not more than 65° above the horizontal plane of the wheel spindle.

(3) *Surface grinders and cutting machines.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cutting machines and on surface grinding machines which employ the wheel periphery should not exceed 150°. This exposure should begin at a point not less than 15° below the horizontal plane of the wheel spindle.

(4) *Swing frame and portable grinders.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as swing frame and portable grinding machines should not exceed 180°, and the top half of the wheel should be protected at all times.

(5) *Top grinding.*—In operations where the work is ground on the top of the wheel, the exposure of the grinding wheel periphery should be as small as practicable, with a maximum exposure of 60°.

(j) Exposure adjustment.—Hoods of the type described in (1) and (2) under "Exposure Permitted," where the operator stands in front of the opening, should be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in (1) and (2) should never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top should never exceed 1/4 inch.

(k) Work rests.—Work rests should be kept adjusted close to the wheel with a maximum distance of 1/8 inch to prevent the work from being caught between the wheel and the rest. The work rest should be securely clamped after each adjustment. The adjustment should not be made while the wheel is in motion.

15. **Miscellaneous machine guarding.**—*(a) Revolving, oscillating or reciprocating parts of engines and other machines:*

(1) Every projecting set screw in moving parts, where exposed to contact, should be guarded.

(2) Cranks or crank discs, crank shafts connecting rods, where exposed to contact, should be guarded.

(3) Eccentrics and cams, where exposed to contact, should be guarded.

(4) Machine parts having a reciprocating or oscillating motion such that a shearing or crushing hazard is created should be guarded.

(5) Any moving part of a machine which at any time leaves a space of less than 18 inches between it and any fixed object not a part of the machine, or between it and a moving or stationary part of any other machine should be guarded.

(b) Oiling devices.—All machines lubricated while in motion and having lubricating devices so located as to make it hazardous to reach them should be equipped with an automatic oiling device or some equally efficient means to protect the oiler.

Machines shut down for oiling or maintenance should be marked, locked or otherwise protected so as to prevent starting the machine while such work is in progress.

(c) Projecting parts on shafts.—Every projecting part on a revolving shaft such as a collar, clamp, pin, coupling, oiling device, etc., where exposed to contact (which should include exposure while oiling machinery in motion) should be guarded.

(d) Revolving stock.—All revolving stock projecting from machines should be guarded by pipe enclosure or other means to prevent contact with the stock.

(e) Noise reduction.—It is desirable to reduce to the minimum the noise incident to the operation of machines especially where there are a number placed close to each other.

16. **Fans.**—The blades of every fan open to contact should be guarded in accordance with Part II E of these standards except that fans more than seven feet above the floor or working level need not be guarded providing the blades cease to revolve before any work of a character which would expose any person to contact with such fan is permitted. This standard also applies to the ordinary office fan.

17. **Revolving drums and cylinders.**—*(a)* Revolving barrels, drum or other containers, where exposed to contact should be guarded by an enclosure or standard guard rail in accordance with Part II E of these standards.

(b) Tanning drums, where exposed to contact, should be guarded by an enclosure built in accordance with guarding as specified under Part II E, to a height of 6 feet.

(c) Every drum or other revolving container, which must be loaded or unloaded should be equipped with a brake or lock which will enable the operator to lock the drum while loading or unloading it.

18. **Counterweights, tension weights and springs.**—*(a)* Every counterweight, where exposed to contact, should be enclosed or equipped with a safety chain that will prevent the weight from falling to a distance of less than 7 feet from the floor or working level.

(b) Every tension weight exposed to contact should be enclosed or securely fastened to the tension bar.

(c) All springs should be guarded or otherwise equipped to eliminate any hazard due to breakage of spring or failure of the mounting.

19. **Lathes and automatic screw machines.**—Chucks and face plates should be free from projections, and dogs, if used, should be of the safety type only—circular in shape with no projections beyond the periphery.

Chip guards to catch flying chips, particularly in the case of high speeds used in the softer metals should be provided.

Rotating stock in turret lathes and automatic screw machines should be completely enclosed in pipe long enough to contain the longest stock used.

Suitable shields and oil catchers should be provided to prevent slipperiness from the oil thrown from automatic screw machines.

(a) Drill presses.—All projections on the rotating spindle, and as much of the spindle itself as possible should be guarded.

Spindle drive belts when in range of the operator's head or body, should be guarded against both contact and breakage.

(b) Drop hammers.—Every drop hammer, the operation of which requires the hands to be placed between the dies, should be provided with a positive stop that will prevent the descent of the hammer until the operator's hands are withdrawn.

A shield or screen should be provided for every drop hammer except where guarded by location when the operation is such that sparks or scales are liable to be thrown off.

On every board drop hammer a substantial guard should be provided around the board above the roll to prevent the board falling in case the board breaks or comes loose from the ram.

(c) Planers and shapers (metal).—The spaces between the ways of planer frames should be filled in smoothly with heavy sheet metal to eliminate the shear hazard.

Where clearance from fixed objects is inadequate, men may be caught by the stroke of planer or shaper; in such cases space to allow for the maximum possible stroke should be railed off in such manner as to give protection without creating a shear hazard between the railing and the planer table or the work carried on it.

(d) Metal shears.—There are two main types of metal shears—alligator and squaring. The latter may be either power or foot-operated. All should be guarded.

(1) *Alligator shears.*—These shears are used to cut rods, bars, strap, etc. They are

arranged to run continuously, the material being inserted as the jaw opens. In cutting short pieces the operator is likely to get his fingers under the knife. Also, he may stumble or trip in handling the stock and get caught. Many injuries occur through lack of care in sorting out hard metal which might fly when cut or throw chips from itself or from the knife. If fairly uniform material is handled, mechanical feed can readily be devised. In junk yards, however, this is not feasible. Even in such cases it is usually feasible to guard this machine by running a heavy U-shaped metal strap horizontally around the moving (upper) jaw with the lower edge of the strap just far enough above the cutting edge of the fixed jaw to allow the material to be inserted under it.

(2) *Squaring shears.*—Injuries usually result from the fact that where the operator's foot is on the treadle he is in poor balance, with the added fact that the necessary angle set of the knife is likely, with thick material or a dull knife, to draw the material under it and the operator's hand with it.

Squaring shears either mechanical, foot or hand power, and fed by hand, shall have the knives substantially guarded. This guard may be a fixed barrier, set not more than three-eighths (3/8) inch above the table or the material being sheared. Automatic clamps shall be acceptable as guards when cut-outs are filled in so that the fingers of the operator cannot enter the danger zone.

F. WOODWORKING MACHINES

1. **Band saw or band knife.**—Band wheels of band saws or band knives and all parts of the blade should be enclosed or guarded except the part between the guide and table that is necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than 20 U. S. Standard Gauge. If other material is used, the guard should be of equal strength and firmness.

2. **Band resaw.**—Band wheels of band resaws and all portions of the blade should be enclosed or guarded except the portion between the guide and table that is necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than No. 20 U. S Standard Gauge. If other material is used, the guard should be of equal strength and firmness. The feed rolls should be enclosed, except such part as may be necessary to feed stock.

3. **Cork cutter.**—*(a) Circular knife type.*—A hood should be provided that will cover the knife at all times to at least the depth of the cutting edge. The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the knife, or it may be a fixed or manually adjusted hood or guard, provided the space between the bottom of the guard and the material being machined does not exceed 3/8 inch at any time.

The exposed parts of the cutter blade under the table should be guarded.

(b) Band knife type.—Band wheels of band knives and all parts of the blade should be enclosed except that part between the guide and the table that is necessary for the thickness of the material being cut. If a metal guard is used, it should be not less than No. 20 U. S. Standard Gauge. If other metal is used, it should be of equal strength and firmness.

4. **Circular rip saws.**—A hood should be provided that will cover the saw at all times to at least the depth of the teeth.

The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the saw, or it may be a fixed or manually adjusted hood or guard, provided the space between the bottom of the guard and the material being cut does not exceed 3/8 inch at any time.

The hood or other guard should be so designed as to prevent a "kick-back" or a separate attachment that will prevent a "kick-back" should be provided. Non-kickback devices should be effective for all thicknesses of materials that are cut.

Except when grooving, dadoing or rabbeting, a spreader should be provided and fastened securely at the rear of saw in alignment with saw blade. It should be slightly thinner than the saw kerf and slightly thicker than the saw disc.

The exposed part of the saw blade under the table should be guarded.

5. **Self-feed circular rip saws.**—A hood or guard should be provided that will cover the saw at all times at least to the depth of the teeth. The hood or guard need not rest upon the table nor upon the material being cut, but should extend to a line not more than 3/8 inch above the plane formed by the bottom of the feed rolls.

The feed rolls should be enclosed, except such part as may be necessary to feed stock.

A spreader should also be provided and fastened securely at the rear of saw in alignment with saw blade, except where a roller wheel is provided back of the saw. The spreader should be slightly thinner than the saw kerf and slightly thicker than the saw disc. Non-kickback dogs shall be provided in front of the saws.

The exposed part of the saw blade under the table should be guarded.

6. **Self-feed band rip saws.**—Band wheels of self-feed band rip saws and all portions of the blade should be enclosed or guarded except the portion between the guide and table that is

necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than No. 20 U. S. Standard Gauge. If other material is used, the guard should be of equal strength and firmness.

The feed rolls should be enclosed, except such part as may be necessary to feed stock.

7. **Circular cross cut saws.**—A hood should be provided that will cover the saw at all times at least to the depth of the teeth.

The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the saw, or it may be a fixed or manually adjusted hood or guard provided the space between the bottom of the guard and the material being cut does not exceed 3/8 inch at any time. This rule should not be applied to circular cross cut saws with stationary tables where the saw moves forward when cutting.

Circular cross cut saws with stationary tables where the saw moves forward when cutting should have a hood or guard securely fastened to the table that will cover the saw in all positions. The hood or guard should extend at least two inches in front of the saw teeth, when the saw is in its back position.

The exposed part of the saw blade under the table should be guarded over its entire travel.

8. **Swing cut-off saws.**—A guard should be provided that will cover the saw, and such guard should adjust itself to the thickness of the stock being cut.

There should be an effective device to return the saw automatically to the back of the table when released at any point of its travel.

If a counterweight is used, all bolts supporting the bar and weight should be provided with cotter pins. A bolt should be put through the extreme end of the counterweight bar to prevent dropping of weight, or where the weight does not enclose the rod, a safety chain should be attached to it to prevent dropping.

Limit chains or other positive stops should be provided to prevent the saw from swinging beyond the front edge of the table.

9. **Circular resaws.**—A hood should be provided that will cover the saw at all times, except where the material is being cut.

A spreader should also be provided and fastened securely at the rear of saw in alignment with the saw blade, except where a roller wheel is provided back of saw. The spreader should be slightly thinner than the saw kerf and slightly thicker than the saw disc.

Feed rolls should be enclosed except such part as may be necessary to feed stock.

Non-kickback dogs across the full width of the table should be provided.

10. **Portable circular saws.**—Portable circular saws should be provided with a hood that will cover the saw teeth at all times except where the material is being cut.

11. **Jointer or buzz planers.**—A cylindrical cutting head should be provided.

A guard which adjusts automatically over the cutting head should be provided. All exposed parts of cutting head should be guarded.

Where equipped with automatic feed, the feeding mechanism should be guarded.

Where knives are exposed beneath the table, they should be guarded.

12. **Combination woodworking machines.**—Each point of operation of any tool should be guarded as required for such tool in a separate machine. The drive should be so arranged that only the tool in use would be operating.

13. **Automatic lathes.**—A hood or cover should be provided enclosing the cutter blades, except at the contact points, while the stock is being cut.

14. **Mortising machines.**—Mortising machines, except hollow chisel mortisers, should be provided with thumb stops at each side of the chisel.

15. **Chain mortisers.**—These should be guarded by enclosure on top.

16. **Moulders, matchers, and stickers.**—These should be guarded with hoods or other enclosures that should be so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

17. **Panel raisers.**—Panel raisers should be guarded with hoods or other enclosures so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

18. **Planers.**—Planers should be guarded with hoods or other enclosures so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

19. **Drum sanders.**—The exposed parts of the drum, except that portion where the material comes in contact with the abrasive surfaces, should be guarded.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

20. **Shapers.**—The cutting heads of wood shapers should be provided with a guard that will prevent the hands of the operator from coming in contact with the knives. This rule need not apply when templates are used, which will effectively keep the operator's hands away from the knives or when shaping stock large enough to accomplish the same purpose.

21. **Tenoners.**—Tenoners should be provided with hoods or other enclosures so arranged and maintained as to guard effectively all cutting parts and saws.

22. **Wood heel turning machines.**—Wood heel turning machines should be provided with a

guard or shield in front of the cutters except while it is necessary to expose a part of the cutter while turning stock.

23. **Stave jointers.**—The upper half of the rotating head or disc carrying the knives of stave jointers should be provided with a cover over the sides and front.

24. **Veneer clipper or slicers.**—Veneer clippers or slicers should be provided with prong guards or shields, both in front and back of the knife, so arranged that the hands of the operator and the man taking away, cannot be caught.

G. CRANES AND HOISTS

1. **Overhead trolleys and monorails.**—Every overhead trolley and every monorail crane should be constructed so as to prevent it leaving the track at any point except that where, because of necessity for removal, trolleys cannot be so constructed, an additional guard rail should be installed which will prevent the trolley from falling if it leaves the tracks. If removable sections are provided in the guard rail, they should be so arranged that they will drop into place by gravity immediately upon release after removal of trolley.

2. **Cranes.**—The recommendations contained herein should apply to power-driven overhead traveling cranes, storage bridges, gantry cranes and portal cranes, and modifications of these types which retain their fundamental features.

(a) Bumpers.—A bumper should be provided at each end of the trolley. It should be fastened to the bridge girder, or, if the rail is prevented from sliding lengthwise, it may be fastened to the rail. A bumper engaging the tread of the wheel should be of a height at least equal to the radius of the wheel. Bumpers engaging other parts of the crane are acceptable.

(b) Buffers.—If there is more than one trolley on the same bridge girders, buffers or cushioning devices should be provided. If there is more than one crane on the same runway, buffers or cushioning devices should be provided at both ends of the bridges.

(c) Fenders.—Bridge trucks and trolley trucks should be equipped with fenders which extend below the top of the rail and project in front of the truck wheels.

(d) Brakes.—Each independent hoisting unit of a crane should be equipped with two braking means except worm-geared hoists, the angle of whose worm is such as to prevent the load from accelerating in the lowering direction.

One brake should be applied directly to the motor shaft or some part of the reducing gear, and may be either electrically operated, or mechanical. The other brake may be either mechanical or electrical. If mechanical it should lock the load when hoisting is stopped, and should also control the speed during lowering so as to prevent undue acceleration. Electric dynamic braking for direct-current and electric braking for alternating-current hoists may be used to control the lowering speed.

Each brake should be capable of sustaining one and one-half times the rated load.

Worm-geared hoists referred to in these standards should have at least one electrically operated or mechanical brake.

On cage-operated cranes with the cage mounted on the bridge girders, a foot brake to properly retard and stop the motion of the bridge should be capable of retarding at the rate of 1 foot per second while full load is being carried.

(e) Lubrication.—Lubricating devices should be arranged so that they can be reached without danger to the oiler. They should also be arranged so that it is not necessary to remove any guards or other parts for lubrication purposes.

(f) Collector wires.—Collector wires should be guarded when they can be readily contacted.

3. **Crane footwalks.**—If sufficient headroom is available on cage-operated cranes, a footwalk should be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the tops of the girders. To give sufficient access to the opposite side of the trolley, there should be provided either a footwalk mounted on the trolley, a footwalk or platform in the building, or a footwalk on the opposite side of the crane at least twice the length of the trolley.

If possible, footwalks should be located so as to give a headroom of not less than 78 inches. Otherwise a headroom of not less than 48 inches may be used.

If it is not possible to provide a headroom of 48 inches or more, footwalks should be omitted from the crane, and a stationary platform built at the edge of the runway to be used by workmen when making repairs, or else a landing stage built alongside the crane when repair work is done.

4. **Cranes—Stairways.**—Every overhead traveling crane operated from a cage should be provided with a stairway or fixed ladder between the cage and the crane footwalk, and between the cage and the floor.

Stairways should be equipped with rigid and substantial metal handrails as described in Part II B and should be at an angle of not more than 50° with the horizontal. A suitable emergency exit should be provided where hazards justify such precautions.

A warning signal such as a gong, siren or bell should be provided on all traveling cranes.

5. **Crane cages—Enclosures.**—*(a) Indoor cranes.*—The cage floor of every indoor overhead traveling crane should be solid except that grating with openings not exceeding ½ inch in

width may be provided where necessary for vision.

The sides of the cage of every indoor overhead traveling crane should be enclosed as follows:

(1) Solid to a height of 42 inches, or

(2) With not less than No. 10 wire screen with mesh openings not greater than 3 inches, to a height of 42 inches, with toeboard, or

(3) With a standard guard rail and toeboard.

(b) Outdoor cranes.—The cage of every outdoor traveling crane should be fully enclosed with windows on three sides of the cage. The windows should give ample vision for operators and may be fixed at the front and back but should have the side windows arranged to open. The door should swing inward or should slide, and should be arranged to close automatically. A temperature reasonably comfortable for the operator should be maintained in cold weather.

(c) Trolley conductors.—Trolley conductors should be so located or so guarded that persons entering or leaving the cage are not likely to come into contact with them.

6. **Hoists.**—*(a) Limit switches.*—Each overhead electric or air-operated hoist motor should be equipped with an effective limit switch so placed and arranged as to disconnect the motor and apply the brake in time to stop the motor before the hook passes the highest point of safe travel.

(b) Brakes.—Each electric or air-operated hoist motor should be provided with an electrically or mechanically operated brake so arranged that the brake will be applied when the power is cut off from the hoist. This brake should have sufficient holding power to sustain not less than one and one-half times the rated load.

The hoisting drum of all hand power hoists should be equipped with an effective brake, and should be provided with a ratchet and pawl of sufficient strength to hold the load in any position.

(c) Capacity marking.—The rated load of each hoist, in pounds or tons, should be legibly marked on the hoist or load block.

(d) Control equipment.—Operating controls should be marked to indicate the resultant direction of travel.

7. **Cables, ropes, and chains.**—Chains, ropes, cables, hooks, rings, slings, and other devices and accessories used for hoisting and lifting should not be subjected to greater working loads than recommended by their manufacturers. They should be frequently inspected and should be renewed when inspection reveals unsafe conditions.

Bolts or nails should not be used to connect, splice, or shorten chains. Knots should not be tied in the chain.

A hoist cable should be considered unsafe and should be renewed when because of broken wires, wear, rust, undue strain, or other cause the strength of the cable becomes reduced 25 percent. Hoist cables will be considered unsafe when upon inspection 10 percent or more of the total number of wires are broken in a length equal to eight diameters of the cable.

Crane hoist cable should be lubricated and inspected at frequent intervals. Proper lubrication adds much to their durability.

PART III—HEALTH REQUIREMENTS

A. MEDICAL SERVICES

1. **Accident and sickness, including first aid.**—*(a) First aid.*—It is the duty of the employer to see that some individual is available, during all periods of plant operation, who has been trained to administer first aid, and to handle the emergencies which may arise out of accidents and injuries to workers.

Employees—ideally all of them—should be encouraged to take the time-tested basic Red Cross course in first aid. Selected employees should be encouraged to take advanced and teachers' courses, if industrial preparation for disaster is to be adequate.

First-aid facilities and services should be used only for the intended purpose of first aid, and should not in any way take the place of necessary experienced care and treatment by a physician.

In the absence of a physician, emergency first aid should be given by the nurse, or in her absence by a trained first-aid worker, under the recommended procedures of the American Red Cross, as authorized and posted by the plant physician.

Where females are employed, cots in adequate number should be provided and so located, placed, or screened as to provide the necessary privacy for those using same.

*Eye first aid.**—Where the workers' eyes are exposed to injurious chemical materials, such as acids, caustics, etc., suitable facilities for quick drenching or flushing of the eyes, such as the fountain-type wash bowl, should be provided *within the workroom,* for immediate emergency use.

Emphasis should be given to the early use of the eye specialist (ophthalmologist), in injuries

*Guide-lines should be established for both emergency and later treatment of eye injury and occupational disease, with the advice of a qualified ophthalmologist. These should include standard criteria for the use of specialist services, and standing orders in writing should be posted governing such services.

to the cornea, and to the deeper structures of the eye. The eye must be regarded as the most exposed, most easily injured, most sensitive, and most valuable of the special sense organs.

It must be considered that the most minor eye injury can most quickly develop the most dangerous complications. Removal of foreign bodies under the lids should be done with extreme care, and removal of particles driven into the cornea (transparent front of the eye), should be done only by the plant physician, if skilled in this work, or by the eye specialist.

B. ENVIRONMENTAL CONDITIONS AND PERSONAL SERVICES

1. **Control of atmospheric contaminants.**—*(a)* Workers shall not be exposed to concentrations of atmospheric contaminants hazardous to health.

The most recent values for maximum concentrations as recommended by the American Conference of Governmental Industrial Hygienists shall be used as a guide in appraising occupational health hazards, and in evaluating controls.

Maximum concentrations shall not be used as the sole criterion for establishing evidence of hazard to health or well-being, but the evaluation of a possible hazard shall also be subject to other pertinent factors, such as the nature of the contaminant, and the frequency and duration of exposure, or clinical evidence of harmful effects.

(b) Control of atmospheric contaminants may be accomplished by any of the following methods:

(i) Substitution of a less toxic material for the material contaminating the workroom atmosphere.

(ii) Exhaust ventilation so that the contaminant is removed from the workroom atmosphere.

(iii) Isolation of the operation, so that the contaminant does not enter the general workroom atmosphere in hazardous concentrations, provided that any worker who is exposed to a health hazard by entering the isolated area shall be furnished personal protection in accordance with the provisions of this code. (See sec. 6, hereafter.)

(iv) Enclosure of the operation, so that the contaminant does not escape into the workroom atmosphere in hazardous concentrations.

(v) Change the process or operating method (such as by wet methods, the use of foams, colloids, etc.), so that the hazard is controlled.

(vi) Increase of general ventilation, so that the contaminant is diluted to a safe concentration.

(c) The most recent values for maximum concentrations as recommended by the American Conference of Governmental Industrial Hygienists should be used as a guide in appraising occupational health hazards and in evaluating control. Maximum concentrations should not be used as the sole criterion for establishing evidence of hazard to health or well-being, but the evaluation of a possible hazard should also be subject to other pertinent factors such as the nature of the contaminant and the frequency and duration of the exposure or clinical evidence of harmful effects. The following are examples:

MAXIMUM ALLOWABLE CONCENTRATIONS

Threshold limit values, adopted April 1950, at Chicago, Ill., American Conference of Governmental Industrial Hygienists

GASES AND VAPORS

[Parts per million; 1 percent=10,000 p. p. m.]

Substance	*P. p. m.*	*Substance*	*P. p. m.*	*Substance*	*P. p. m.*
Acetaldehyde	200	Cellosolve	200	Ethyl benzene	200
Acetic acid*	10	Cellosolve acetate	100	Ethyl bromide	200
Acetic anhydride	5	Chlorine	1	Ethyl chloride	1,000
Aceton	500	2-Chlorobutadiene	25	Ethylene chlorohydrin	5
Acrolein*	0.5	Chloroform	100	Ethylene dichloride	75
Acrylonitrile	20	1-Chloro-1-nitropropane	20	(1,2-Dichloroethane) Ethylene oxide	100
Ammonia*	100	Cyclohexane	400	Ethyl ether	400
Amylacetate	200	Cyclohexanol	100	Ethyl formate	100
Iso-Amyl alcohol*	100	Cyclohexanone	100	Ethyl silicate	100
Aniline	5	Cyclohexene	400	Formaldehyde	5
Arsine	0.05	Cyclopropane (propene)	400	Gasoline	500
Benzene (benzol)*	35	o-Dichlorobenzene	50	Heptane	500
Bromine*	1	1,1-Dichloro-1-nitro ethane	10	Hexane	500
1,3-Butadiene	1,000	1,2-Dichloropropane (propylene dichloride)	75	Hydrogen chloride*	5
n-Butanol	100	Dichlorotetrafluoroethane (Freon-114)	1,000	Hydrogen cyanide	10
2-Butanone	250	Dimethylaniline	5	Hydrogen fluoride	3
n-Butyl acetate	200	Dimethylsulfate	1	Hydrogen selenide	0.05
Butyl cellosolve	200	Dioxane	100	Hydrogen sulfide	20
Carbon dioxide	5,000	Ethyl acetate	400	Iodine	1
Carbon disulfide	20	Ethyl alcohol	1,000	Isophorone	25
Carbon monoxide*	100			Mesityl oxide	50
Carbon tetrachloride*	50				

*Recommended lower concentration, but not specific value.

GAS AND VAPORS—Continued

Substance	P. p. m.
Methanol	200
Methyl acetate	200
Methyl propanone (pentanone)	200
Monochlorobenzene	75
Monofluorotrichloro-methane (Freon-11)	1,000
Mononitrotoluene	5
Naphtha (coal tar)	200
Naphtha (petroleum)*	500
Nickel carbonyl	1
Nitrobenzene	1
Nitroethane	100
Nitrogen oxides (other than N_2O)	25
Nitroglycerin	0.5
Nitromethane	100
2-Nitropropane	50
Octane	500
Ozone*	1
Pentane	1,000
Pentanone (Methyl propanone)	200
Phosgene	1
Phosphine	0.05
Phosphorus Trichloride	0.5
iso-Propanol	400
Propene (cyclopropane)	400
Propyl acetate	200
Propylene dichloride (1,2-dichloropropane)	75
iso-Propyl ether	500
Stibine	0.1
Stoddard solvent*	500
Styrene monomer	200
Sulfur chloride	1
Dichlorodifluoromethane (Freon-12)	1,000
1,1-Dichloroethane	100
1,2-Dichloroethane (ethylene dichloride)	75
1,2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromethane	500
Dichloromonofluoromethane (Freon-21)	1,000
Methyl bromide	20
Methyl butanone	100
Methyl cellosolve	25
Methyl cellosolve acetate	25
Methyl chloride	100
Methylcyclohexane	500
Methylcyclohexanol	100
Methycyclohexanone	100
Methyl formate	100
Methyl isobutyketone	100
Sulfur dioxide	10
1,1,2,2-Tetrachloroethane	5
Tetrachloroethylene	100
Toluene	200
Toluidine	5
Trichloroethylene*	100
Turpentine	100
Vinyl chloride	500
Xylene	200

*Recommended lower concentration, but not specific value.

TOXIC DUSTS, FUMES, AND MISTS

[Milligrams per cubic meter of air]

Substance	Mg./cu. m.
Antimony	0.5
Arsenic	0.5
Barium	0.5
Cadmium	0.1
Chlorodiphenyl	[illegible]
Chromic acid and chromates as CrO_3*	0.1
Cyanide as CN	5
o-Dinitrocresol	0.2
Dinitrotoluene	1.5
Fluoride	2.5
Iron oxide fume	15
Lead	0.15
Magnesium oxide fume	15
Manganese	6.1
Mercury	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
Selenium, as Se	0.1
Sulfuric acid*	1.0
Tellurium	0.1
Tetryl	1.5
Trichloronaphthalene	5
Trinitrotoluene	1.5
Zinc oxide fume	15

*Recommended lower concentration, but not specific value.

MINERAL DUSTS

[Million particles per cubic foot of air]

Substance	M. p. p. c. f.
Alundum	50
Asbestos	5
Carborundum	50
Dust (nuisance, no free silica)*	50
Mica (below 5 percent free silica)	50
Portland cement	50
Talc	20
Silica:*	
High (above 50 percent free SiO_2)	5
Medium (5 to 50 percent free SiO_2)	20
Low (below 5 percent free SiO_2)	50
Slate (below 5 percent free SiO_2)	50
Soapstone (below 5 percent free SiO_2)	20
Total dust (below 5 percent free SiO_2)	50

*Recommended lower concentration, but not specific value.

RADIATIONS

Material or radiation	Radiant energy
Gamma (milliroentgen per week)	300
X-ray (milliroentgen per week)	300
Radon (curies per cubic meter)	**10–8
Thoron (curies per cubic meter)	10–8

**10–8 curies = 370 disintegrations per second = —0.01 microgram radium.

Substances being studied	Values not established
Asphalt fumes and dust	Diethylene glycol.
Beryllium (0.005 mg/cu.m.)	Dipropylene glycol.
DDD	Ethylene glycol.
DDT	Propylene glycol.
Ketene	Triethylene glycol.
Monochloromonobromomethane.	

2. **Infectious agents.**—Measures shall be provided to eliminate or control the transmission of infectious diseases through processing or handling industrial products or wastes.

3. **General ventilation and temperature requirements.**—*(a)* Outside air shall be provided to all workrooms at the rate of 15 cubic feet per minute per person, or one and one-half air changes per hour, whichever is greater. In most instances, leakage through walls, doors, and windows will produce at least one and one-half air changes per hour.

(b) Air circulated in any workroom shall be supplied through air inlets arranged, located,