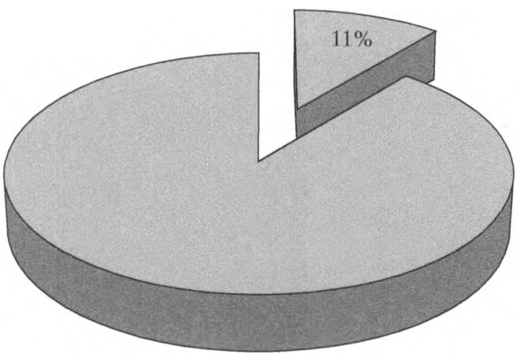
CHAPTER 7

Buildings and Facilities



Percentage of OSHA General Industry citations addressing this subject

We now turn to the business of examining hazards in various categories, highlighting applicable standards and suggesting methods of bringing about change to eliminate or reduce hazards. Most enterprises begin with a building in which to conduct operations, and this is an appropriate beginning for the examination of hazards. The enterprise is fortunate if its management considers hazards and applicable safety and health standards during its building design stages.

Safety standards for buildings, whether they be municipal, state, or federal, are usually called *codes*. For the most part, building codes apply to the construction of new buildings or to their modification. Thus, although building codes change constantly, those buildings built or remodeled before a particular change in the code are not required to be torn down and rebuilt or remodeled according to the new code. Needless to say, most buildings in existence do not meet the latest provisions of current building codes.

Some federal standards for buildings have been applied to all buildings, regardless of age. The standards have included matters of relative permanence such as floors, aisles, doors, numbers, and locations of exits and stairway lengths, widths, riser design, angle, and vertical clearance. Industry's objection has been that such standards are unfair, not only because they apply to existing buildings, but also because they are vague and generally worded. However, despite these problems, industries have undertaken a large number of retrofit programs to update their buildings and facilities to satisfy federal standards.

In the defense of federal standards for buildings and facilities stands the fact that some of the most frequent categories of worker injuries and fatalities arise from improper building design, lack of guardrails, and problems with exits. Building equipment is designed and built without sufficient thought about the worker who must have access to this equipment to clean, maintain, repair, replace light bulbs, or otherwise service the buildings or facilities. Some workers work even in locations where they would be unable to escape in event of fire. Aisle widths are often set up arbitrarily, without giving thought to clearance between moving machinery and personnel.

Federal standards pertaining to buildings and facilities include the following categories:

- Walking and working surfaces
- Means of egress
- Powered platforms, manlifts, and vehicle-mounted work platforms
- General environmental controls

A few provisions of these standards generate almost all of the problems. This chapter will now single out those individual provisions and analyze each to determine what the safety and health manager should do to alleviate hazards and conform to standards.

WALKING AND WORKING SURFACES

One does not normally call a floor a *walking* or *working surface*, so why do the standards writers select such a complicated bit of jargon? This question is answered by reflecting on the hazardous locations in which people work. To be sure, many accidents, especially slips and falls, occur on floors, but consider the other walking and working surfaces, for instance, mezzanines and balconies. Then there are the even more hazardous platforms, catwalks, and scaffolds. Not to be forgotten are ramps, docks, stairways, and ladders.

Guarding Open Floors and Platforms

The most frequently cited standard in the walking-and-working-surfaces subpart is indeed one of the most frequently cited standards in all of the OSHA standards. It is repeated here in its entirety, owing to its importance.

OSHA standard 1910.23—Guarding floor and wall openings and holes

(c) Protection of open-sided floors, platforms, and runways

(1) Every open-sided floor or platform 4 feet or more above adjacent floor or ground level shall be guarded by a standard railing [or the equivalent as specified in paragraph (e)(3) of this section] on all open sides, except where there is entrance to a ramp, stairway, or fixed ladder. The railing shall be provided with a toeboard wherever, beneath the open sides,

(i) Persons can pass,
(ii) There is moving machinery, or
(iii) There is equipment with which falling materials could create a hazard.

To many people, 4 feet seems an innocuous height, but the reason for this illusion is that they are thinking of jumping, not falling. Almost everyone has *jumped* without injury from elevations of more than 4 feet, but few adults experience a *fall* from that height without injury. A surprising number of *fatalities* result from falls at heights of only 8 feet. National Safety Council estimates place falls third, after workplace violence, as one of the leading causes of work-related fatalities (Accident, 1993).

The illusion of safety of platforms in the range 4–14 feet has led to complacency on the part of building and facility designers as well as of safety and health managers. To stand on the extreme point of a precipice overlooking the Grand Canyon without a guardrail would seem foolhardy to the average person. However, many "average persons" would think nothing of standing on the unguarded top of a tank 10 feet high. An unexpected event in such a situation can easily result in the worker taking a reflex action that results in a fatal fall.

One such fall is discussed in Case Study 7.1.

CASE STUDY 7.1

A worker who was disassembling a conveyor system was not using fall protection equipment. He fell from a height of 22 feet onto a concrete floor and later died from the injuries he sustained. The company was cited for failure to employ fall protection equipment (Inspection Report, 2016)

The top of a tank, in the example cited earlier, was considered a *working surface* to be reckoned with by the facility designer. This is an important thing to remember. Even if the surface is the top of a tank, or even the top of a piece of equipment that is in the process of being manufactured, it may act as a temporary walking and working surface. However, in unusual temporary situations, there are other ways to provide temporary fall protection for workers, as will be seen in Chapter 18.

Another problem area is the protection of personnel from falls from loading docks. A few loading docks are slightly less than 4 feet high, and the issue is thereby avoided. Some safety and health managers have had the area immediately adjacent to the dock built higher to comply with standards, but this is of dubious value in preventing injuries. Others have installed temporary, removable railings, and some have used chain-type gates. The chain-type gates do not qualify as "standard railings," but have sometimes been accepted as a practical substitute in an attempt to deal with the hazard in the face of a difficult situation.

A rooftop is, of course, a walking and working surface for roofing workers. This raises the question of whether guardrails, fall protection, or some other type of protection is needed along perimeters of rooftops on which persons are working. A provision of the OSHA Construction Standard specifies *catch platforms*, unless

1. the roof has a parapet;
2. the slope of the roof is flatter than 4 inches in 12 inches;
3. the workers are protected by a safety belt attached to a lifeline;
4. the roof is lower than 16 feet from the ground to the eaves.

The term *standard railings* mentioned in the platform guarding standard is further clarified by federal standards, and salient features are shown in Figure 7.1. Certain reasonable deviations from the specifications shown in Figure 7.1 are permitted. For instance, some other material in place of the midrail is permitted, provided that the alternative material provides protection equivalent to the midrail. In addition, the height of the railing does not have to be exactly 42 inches. Railings of 36-inch height are acceptable if they do not present a hazard and are otherwise in compliance. This avoids the necessity of tearing down good railings and rebuilding to meet current codes, as has actually been done by some employers, as shown in Figure 7.2.

One type of railing that is definitely not standard, but still can afford reasonable protection in some cases, is lines of parallel ductwork or pipes along the otherwise exposed sides. In many cases, parallel ductwork or pipes completely eliminate the hazard of the otherwise open-sided floor, platform, or runway. In fact, one might argue that such a floor, platform, or runway is not even "open-sided," provided that the parallel structure is sufficiently rigid.

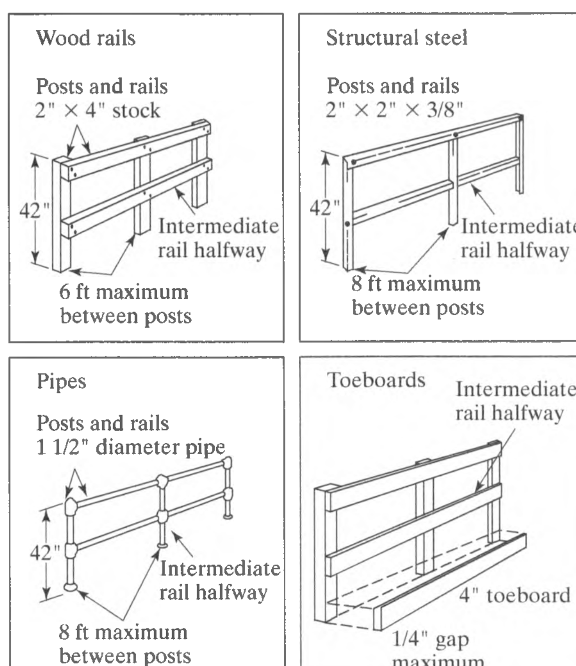


FIGURE 7.1

Standard railings (*Source*: NIOSH).

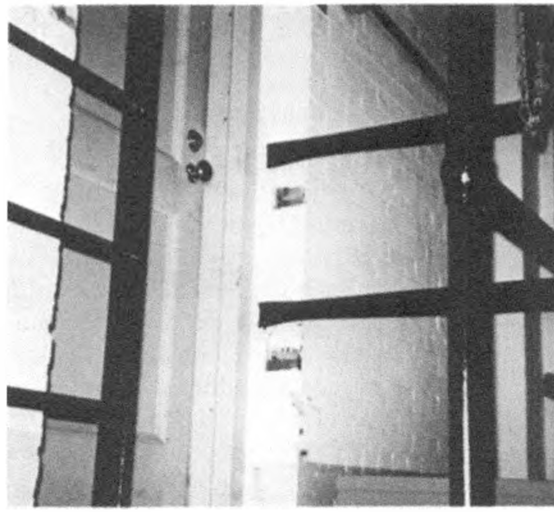


FIGURE 7.2

New guardrails. Some employers tore down their guardrails and rebuilt them 3 or 4 inches higher just to meet OSHA's standard in the early years of OSHA enforcement. Note the paint marks on the wall where the old guardrail had been attached. OSHA has since relaxed its rule somewhat.

In OSHA standard 1910.23(c)(1) quoted earlier, three conditions are enumerated, any one of which calls for a *toeboard.* Toeboards are vertical barriers along the exposed edges of the walking or working surface to prevent falls of *materials.* A standard toeboard is 4 inches high and leaves no more than a 1/4-inch gap between the floor and the toeboard. If the toeboard is not of solid material, its opening must not be greater than 1 inch.

Although 4 feet is the maximum height for open platforms in general, special situations require protection *regardless* of the height of the walking or working surface. Examples are open pits, tanks, vats, and ditches. When the hazardous opening size is small, it may be more practical to place a removable cover over the opening than to place a guardrail around it. Some safety and health managers have saved their firms a great deal of money by calling attention to this alternative. Another special situation is walking and working surfaces adjacent to dangerous equipment, where standard railings are appropriate.

Floors and Aisles

Judging by the level of OSHA enforcement activity, the most important consideration for floors and aisles is not how they are built, but how they are maintained. Federal standards for housekeeping require areas to "be kept clean and orderly and in a sanitary condition." The obvious question is "How is the safety and health manager to know what constitutes 'clean and orderly and in a sanitary condition'?" There is no clear-cut answer to this question, but some information can be gleaned from past cases of OSHA citations.

Example 7.1

In the railroad yard area of a steel manufacturing industry, piles of debris such as railroad ties and cables were lying about close to the track and presented tripping hazards to employees who must work in the area of the tracks. A complicating factor was that some of the debris was hidden by weeds.

Example 7.2

Dangerous accumulations of grain dust were found in many locations in a grain elevator. The dust was sufficiently concentrated so as to represent a health hazard to cleanup personnel and present a serious explosion hazard. Since the condition had been cited before, the citation was established as "serious and repeat," and the penalty was set at $10,000.

Example 7.3

A cluttered workshop had obstructions that some of the employees had to step over or go around to do their jobs.

Example 7.4

Leaking hydraulic cylinders dripped oil on the floor in a work area. No one was responsible for cleaning up the leaked oil.

Some conditions might *look* bad, but not represent a hazard. In one example, an OSHA compliance officer wrote a citation for piles (approximately 2 feet high) of sawdust around a planer and jointer in a woodworking shop. However, the company resisted the citation because few employees would be in the area, and those few would be more inconvenienced than endangered. The company won its case.

It is also recognized that it is necessary in the course of many jobs for objects and materials to lie about in the work area. This is especially true of repair and disassembly work, and also of construction. What is generally considered excessive is material accumulation in the immediate work area in quantities in excess of what is actually required to do the given job, or scrap material lying hazardously about the work area in excess of a day's accumulation.

A prime measure of whether a housekeeping program is inadequate is the number of accidents such as trips and falls occurring in the area. Note that the preceding sentence is worded negatively in that too many accidents suggest an inadequate program, but "no accidents on record" does not prove that the work area is *free* of hazards. For every accident that is on file in the plant, the wise safety and health manager will have documented what steps have been taken to remove or reasonably reduce the offending hazard, whatever that hazard has been determined by analysis to be.

Finally, safety and health managers can look to their own industries for guidance. Any reasonable person knows that the definition of "clean and orderly and in a sanitary condition" is different in a foundry than in a pharmaceuticals plant. For example, the aviation industry has strict standards to avoid the entrance of foreign objects into engines. Therefore, high standards are in place for organization and housekeeping as can be seen in Figures 7.3 and 7.4. All areas are neat and orderly. Tools each have a location, and one can immediately notice if a tool is missing. If the industry has any work-practice guidelines, as put forth by trade associations, for

FIGURE 7.3

Clean and orderly aisles (*courtesy*: Pratt & Whitney).

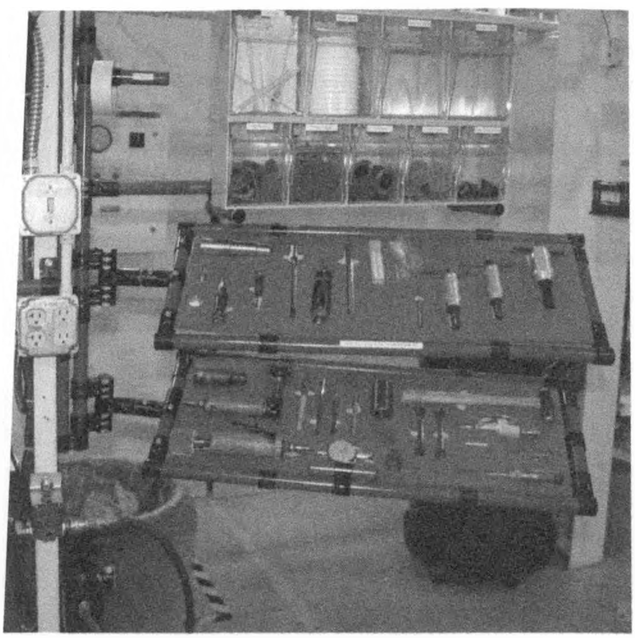


FIGURE 7.4

Organized tool trays (*courtesy*: Pratt & Whitney).

instance, these guidelines would be very helpful in illustrating what is reasonable for a given industry.

The general housekeeping standard is targeted at a very common hazard and a very frequent source of workers' compensation claims: slips and falls. So important is this hazard to insurance companies that they sometimes have research facilities to study tribology (Lorenzi, 1995). "Tribology" is the study of the phenomena and mechanisms of friction, lubrication, and wear of surfaces in relative motion (Geller, 2003). The concept applies to the study of trips and falls as well (Lepedes, 1978).

Water on the floor is a problem in many industries, and constant surveillance becomes necessary to assure that the floor is kept clean and dry. In the design phase of buildings and facilities, attention to the problem of wet processes will suggest slopes and floor drainage systems to alleviate the problem. Another helpful device is to use a false floor or mat to provide a dry standing place for the worker who must work in a wet process.

Some buildings are not built to facilitate cleaning. The floors in others not only are poor from a cleaning standpoint but also present trip hazards, such as protruding nails, splinters, holes, or loose boards.

Trip hazards due to uneven floors can result in serious injury. In one case in a steel mill, a difference of 1–3 inches existed at a point where a grating and a plate came together in the floor. The employee who worked in the area had the job of guiding red-hot steel butts from the end of a roller line. A fall could have brought the employee into contact with the red-hot butts of steel.

Aisles are important, and standards for aisles specify that permanent aisles be kept clear of hazardous obstructions and that they be appropriately marked. Ironically, the more clearly the aisles are marked, the more noticeable will be clutter or materials allowed to accumulate in the aisles. Conversely, the more materials or obstructions are kept clear for forklifts or other travel, the more obvious will be the misuse of an aisle that is not appropriately marked.

There is a lesson to be learned from the irony just described. There is a tendency among safety and health managers to go out all over the plant, indiscriminately laying out aisles, and then to take pride in marking them according to appropriate standards. It is human nature for some managers to want to show everyone that they are taking positive action to enhance safety and comply with established standards. The unfortunate result is that aisles can become too regimented and so much time is then spent policing them that production efficiency is lost. In fact, the effect on safety and health can thus become negative, with employer and employee alike wanting to say, "Do we really need that safety and health manager in the plant?" Aisle-marking procedures are a prime illustration of the principle that overzealous safety and health action can do more harm than good. Every time a decision is made to mark an aisle, the safety and health manager should stop and ask the question, "Can we keep this aisle free of material or other obstructions?"

Conspicuously absent from federal standards for aisles is a specific minimum width for aisles. State codes that reflect the National Fire Protection Association's Life Safety Code often specify a minimum exit access width of 28 inches. However, the federal code is silent on this point except to use the language "sufficient safe clearances shall be allowed." Aisles in forging-machine areas receive special attention: "sufficient width to permit the free movement of employees." However, this standard also does not specify an actual minimum width dimension. These two standards are therefore good examples of "performance standards."

The OSHA aisle-marking standard has left a mark of its own on industry. The term "appropriately marked" originally meant black or white or combinations of black and white for aisles. Untold thousands of dollars were spent by industries switching from the yellow stripes widely used for aisles to OSHA-acceptable white stripes. However, the white striping used was not as durable, and frustrated facilities superintendents would return in desperation to the more durable yellow stripe in order to maintain any stripe at all. The black-and-white rule became more and more unpopular until OSHA finally revoked the aisle color code as superfluous. In summary, the safety and health manager should be sure that aisles are well marked, but the choice of color for the marking stripe is of little importance. Thus, the aisle-marking standard was formerly a specification standard but is now a performance standard.

The discussion about floors thus far has concerned guarding of openings, surfaces, maintenance, and appropriate markings. Nothing has been said about the structural design of the floor itself or whether the floor can withstand the loads applied to it. One is reminded of the eight-story vehicle parking building in which the eighth floor collapsed on the seventh. The seventh floor was well constructed but was unable to withstand the shock load of the falling eighth floor, and from then on, all the floors came down like dominoes. An even more grim reminder was the Kansas City hotel tragedy of 1981, mentioned in Chapter 3. Almost no one really pays attention to whether a floor is overloaded. Earlier editions of this book referred to structural collapse of buildings to be so remote and rare that few people ever worry about the problem. Sadly, that statement will never again be true after the tragic events of September 11, 2001, when terrorist attacks caused the collapse of the twin World Trade Center towers in New York City.

Federal standards require marking plates for floor loads approved by the "building official." One of the chief complaints from industry safety and health managers is that the floor-loading standard does not explain its use of the term *building official.* Confusion over this term has led to phone calls to various agencies in attempts to identify some *public* official to come to the facility to make an engineering determination to use as a basis for the floor-load marking plates. Since the term "building official" is not defined, a better course of action for the safety and health manager is to secure the services of a competent professional engineer either inside or outside the company. This would show a good-faith effort to comply with the standard and would virtually eliminate the possibility of a hazard.

Floor-load marking plates are of little value if they are ignored by employees. Adherence to floor-load limits is an administrative or procedural matter and thus calls for vigilance in order to maintain compliance. A good system of records and inventories can make weights and locations part of the database of an overall management information system. If this system is computerized, the computer can monitor loads at all times and print out a warning message in the unlikely event that a distribution of inventories exceeds a floor-load limit.

Such a computerized system may seem to be an overreaction to the problem, and, in fact, it would be an overreaction for most companies small to medium in size. However, in a large-scale computerized warehouse system, the floor-load monitoring system would represent such a small sideline to the overall computerized operating monitor that it would require only a few seconds of computer time per month. The system could be programmed to print out status reports monthly or, on an exception basis, whenever loads exceed or perhaps approach limits. The monthly status reports would be preferable to the exception reports because the monthly status reports would provide evidence of positive adherence to approved standards.

A word of caution is in order here. If there actually exists a violation of floor-load limits in the plant, no fancy computerized information system is going to hide it. Manual calculations can be used to determine whether a floor-load limit has been exceeded, and symptoms such as crushed, bent, or cracked floor members can be as embarrassing as they are hazardous.

The whole problem of floor and aisle design and maintenance is magnified by the use of mechanical handling equipment such as forklift trucks. Forklifts both aggravate the problems and at the same time become more of a hazard themselves whenever problems with floors exist. This problem will be revisited in Chapter 14.

Stairways

Building codes and standards for stairs are well established, but many factories and businesses have stairways that do not meet codes. If the stairways have four or more risers, they need standard railings or handrails and must be kept clear of obstructions. Note the use of the words *handrail* and *railing*. They are not the same. A handrail, as used in this standard, is a single bar or pipe supported on brackets from a wall to furnish a handhold in case of tripping. A railing, however, is a vertical *barrier* erected along the exposed sides of stairways and platforms to prevent falls. A handrail and railing may, of course, be combined into the same unit, but the two terms are not interchangeable.

The OSHA standard is very flexible on the subject of the placement of stairway landings, using such language as "avoid" (long flights of stairs), and "consideration should be given to."

The placement of stairway landings is a safety consideration. Most people think that the purpose of stairway landings or platforms is to give the climber a chance to rest, and it is true that this is a supplemental purpose. However, the main purpose of the stairway landing is to shorten the distance of falls, and thus landings play an important role in building and facilities safety. Extremely long flights of stairs are obviously more dangerous than stairs interrupted by landings. To be effective, landings must be no less than the width of the stairway and a minimum of 30 inches in length measured in the direction of travel.

Ladders

Ladders are not the simple devices most people think they are. Design is critical—the construction should be neither too strong nor too weak. A weak ladder is obviously dangerous, but a ladder that is overdesigned is difficult or impossible to handle safely. A long, heavy ladder can be as much a hazard when it is carried as when it is climbed. It is easy to see why ladders must be manufactured to exacting standards.

Most firms buy ladders from reputable ladder manufacturers, and the safety and health manager can be quite sure that the ladders were constructed properly in the first place. What is more important to industrial safety is how the ladders are used and maintained. Defective ladders must be either repaired or destroyed, and while awaiting either fate, they must be tagged or marked "Dangerous; Do Not Use." Personal interviews with safety and health managers have indicated that they often saw defective ladders in half rather than risk the possibility of a defective ladder being returned to service. When a job needs to be done and there is no regular ladder in sight, the temptation is too great for maintenance or other personnel to remove the danger tag and make immediate use of a defective ladder. At best, a repair job on a portable ladder usually does not look very good and will likely arouse suspicion even if the ladder is safe. It takes a good engineer to convince anyone that the repaired ladder is just as good as new, even if the engineer has been able to convince himself or herself.

Portable metal ladders share common hazards with portable wooden ladders; a major difference, however, is the fact that metal ladders conduct electricity. Many workers are aware of the increased hazards of electrocution present when using metal ladders. Rubber or otherwise nonconducting feet are a good precaution on metal ladders, but the hazard is still present. The rubber feet should not be allowed to give rise to complacency.

Whether the portable ladder is made of wood or metal, it is the way in which the ladder is used that will chiefly determine its safety. Almost everyone knows the admonition that it is unsafe to ascend or descend a ladder with the climber facing away from the ladder. Less obvious is the fact that portable ladders are typically not designed to be used as platforms or scaffolds, and they become very weak if used at angles close to horizontal.

A common error in the use of ladders is to use ladders that are too short. For instance, when accessing a roof, the ladder needs to extend at least 3 feet above the upper point of support. For ordinary stepladders, the top should not be used as a step. Another foolish practice is to place ladders on boxes, barrels, or other unstable bases to obtain additional height. Some people even try to splice short ladders together to make longer ones.

The first consideration in the use of a portable ladder is its condition, especially the rungs. Next to the hazard of broken rungs, the greatest hazard probably is a ladder that slips or tips because it is insecurely positioned. The proper slant is 4 feet vertical to 1 foot horizontal. A safe practice is to tie off the ladder at the top so that it cannot tip or slide down. This is not always practical, however, and alternative solutions can solve the slipping problem. Sometimes a ladder can be made stable by positioning it where the structure of the wall or building limits its movement and makes the ladder safe. Another solution is to use nonslip bases, but this method may not work on some surfaces, such as oily, metal, concrete, or slippery surfaces. Metal ladders, in particular, may be subject to slipping and need to be equipped with good safety shoes. Safety shoes are as much to prevent slipping as they are to prevent electrocution. Even spikes may be useful on some surfaces to make the footing secure. If the ladder is used without safety shoes on a hard, slick surface, the ladder needs a footladder board to prevent slipping.

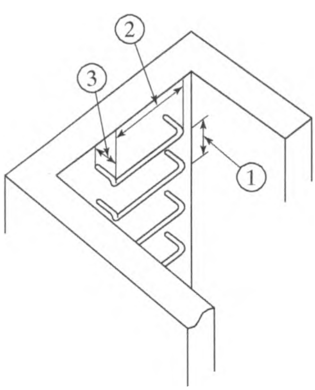
Fixed Ladders

From a safety and health standpoint, fixed ladders require a somewhat different approach than portable ladders. With portable ladders, the emphasis is on care and correct use, as just discussed. With fixed ladders, the emphasis is on design and construction. It is beyond the scope of this book to specify all of the details of fixed-ladder design. If fixed ladders need to be constructed, the designer should follow the detailed specifications laid out in established standards, not this book.

This book seeks only to alert safety and health managers the problems they may encounter with existing fixed ladders. Some fixed ladders may have been constructed long ago or perhaps without the benefit of standards. It is the duty of the safety and health manager to alert the company if fixed ladders are found to be incorrectly constructed. The safety and health manager can then recommend that design details be followed when the ladders are rebuilt.

Some knowledge of fixed-ladder design principles is necessary, however, if the safety and health manager is to know how to recognize common problems found. For brevity, this book selects some easy-to-observe problems with fixed-ladder design, illustrated in Figure 7.5. The rung offset is to prevent the foot from sliding off the end of the rung. Other means, such as siderails, would also be acceptable.

Long unbroken lengths of fixed ladders are dangerous, and ladder standards prescribe breaking the long lengths and separating successive lengths of the ladder by an offset equipped with a landing platform. Such offsets are required every 30 feet of unbroken length. When the fixed ladder is more than 20 feet long, but less than 30 feet long, protective cages are needed. However, many safety and health managers do not realize that there is an alternative to installing ladder cages. On tower, water tank, and chimney ladders over 20 feet in unbroken length, ladder safety devices may be used in lieu of cage protection. Ladder safety devices usually take the form of a combination of fixed equipment on the ladder and personal equipment worn by the climber. One type uses a trolley that moves along a fixed rail. The trolley is attached to the climber's belt. The trolley moves easily up or down the rail when the climber ascends or descends, but a brake engages that stops the trolley in the event of a fall. One thing to watch carefully with a rail-and-trolley device is to ensure that the device is equipped to deal with ice on the rail if the ladder is located in a climate where ice is a possibility (most outdoor locations in the United States). The safety problem with ice on the rail is somewhat indirect; the trolley simply cannot move along the ice-covered rail, making the system useless. However, this is when the safety device is most needed. The problem is not without solution because there are deicing devices for trolley systems. Safety and health



1. Distance between rungs not more than 12 inches and uniform.
2. Minimum rung length is 16 inches.
3. Back clearance minimum is 7 inches. This dimension is the most frequently violated, according to frequency of OSHA citation.

FIGURE 7.5

Easy-to-recognize problems with fixed ladders; all three are required by OSHA. Note the rung offset to prevent the foot from slipping off (based on OSHA standards).

managers should choose their protection systems with care, however, being sure to consider all factors, including the problem of icing, in order to avoid later embarrassment and wasted investment on the part of the company. An example rail-and-trolley ladder safety device system is illustrated in Figure 7.6.

Dockboards

A dockboard, or bridge plate, provides a temporary surface over which loads can be transported, particularly during the loading or unloading of a cargo vehicle. One of the main safety hazards with these boards is that they may shift while in use. It is also possible that the surfaces connected by the dockboard can shift, such as when the cargo vehicle itself moves. Finally, the dockboard itself may not be strong enough to carry the load.

EXITS

Exits are usually considered doors to the outside and from a safety standpoint are considered a means of escape, especially from fire. Such thinking is accurate, but incomplete. The safety and health manager should enlarge the concept by using the more general term *means of egress* to include the following:

1. The way of exit access
2. The exit itself
3. The way of exit discharge

By considering means of egress instead of simply exits, the safety and health manager can analyze the entire building to determine whether every point in the building has a continuous and unobstructed way of travel to a public way. In this way,

FIGURE 7.6

Example of ladder safety device system.

one must think of such building facilities as stairways, intervening rooms, locked interior doorways, and limited-access corridors. Outside the building one must think of yards, exterior storage of materials, fences, courtyards, and shrubbery. One thinks of shrubbery and landscaping as affecting neither safety nor health. However, employees might escape a burning building (or perhaps a building with a ruptured chlorine gas line) through an exit door, only to find outside that the exit empties into a courtyard tightly confined by a fence, dense shrubbery, or other obstruction.

Almost every safety and health manager at some time during his or her career encounters the embarrassment of an exit that is *locked.* This can be a two-edged problem because many safety and health managers are also responsible for plant security. In many cases, the only practical solution is to provide panic bars or other mechanisms for locking doors from outside entry while maintaining free and unobstructed egress from the inside. Where unauthorized exit can be as much a security problem as unauthorized entry, the automatic-alarm-sound type of door may be the only alternative. Facilities designers are turning more and more to the use of unlocked, automatic-alarm-sounding emergency exit doors. Even more frequently encountered than locked exits are exits that are cluttered or blocked by obstructions or impediments. Stacks of material obstructing the door or way of travel defeats the purpose of the exit.

If anyone ever doubted the importance of the OSHA requirement to keep exits unlocked and clear, that doubt was swept away by the tragedy that occurred in Hamlet, North Carolina the morning of September 3, 1991. In one of the worst industrial accidents in U.S. history, 25 people were killed and another 56 were injured in a fire that swept through the Imperial Foods poultry processing plant (Labar, 1992). The inferno was put out in only 35 minutes, but it had already done its damage. The 30,000-square-foot building, a converted 1920s vintage ice cream plant, was virtually windowless, and when the lights went out soon after the outbreak of the blaze, the 90 workers present were scrambling through a maze of production processing equipment in the dark trying to find a way out. To prevent product theft and to keep out flies, reportedly seven of the nine exit doors were routinely locked or bolted from the outside. The tragedy closed the plant permanently, and three members of top management were indicted for 25 counts each of involuntary manslaughter. The three indicted were the owner of the company, which is now bankrupt; the owner's son, who was working in the plant as operations manager; and the plant manager.

In the same year as the Hamlet fire, a Tyson Foods plant in North Little Rock, Arkansas, had a similar fire caused by a hydraulic line on a cooker. This plant had many safety factors in the building design as well as practiced evacuation drills and accountability measures. In this instance, while the building had millions of dollars in damage, not one of the 115 employees was injured. The vastly different outcomes of two very similar events show the importance of fire safety code and a well-practiced emergency action plan (Chicken Processing Plant Fires, 1991).

The entire nation will ever be more acutely aware of the importance of exits and building egress after the tragedy of September 11, 2001, when both colossal towers of the World Trade Center collapsed.

Americans with Disabilities Act

Attention to buildings and facilities assumed increased significance with passage of the Americans with Disabilities Act (ADA) in 1990. This law mandated that employers make reasonable accommodation for handicapped employees rather than deny them employment. This means that many changes to walking and working surfaces, exits, drinking water fountain levels, rest rooms, and other facilities become mandatory instead of voluntary. Often, the safety and health manager has been assigned the responsibility for compliance with ADA, if for no other reason than the fact that he or she has been accustomed to dealing with compliance problems with other federal regulations, such as OSHA standards.

ADA is being taken seriously by industry and public institutions as well. Expert consultants in building compliance for handicapped access can be retained to conduct an audit of facilities. Some of these consultants are themselves handicapped and derive their livelihood by visiting facilities in their wheelchairs and touring the building to check facilities for handicapped access. When a handicapped person in a wheelchair attempts to gain access to a building or its facilities, such as water fountains or rest rooms, and is unable to do so, a convincing case can be made to justify capital improvements in buildings and facilities. At the same time, the safety and health manager should assure that OSHA as well as ADA standards are considered in the redesign of buildings and facilities.

ILLUMINATION

The subject of lighting was mentioned earlier. Lighting, or the lack of it, can be a safety hazard, but there is no code for minimum safe lighting except for specialized areas. For instance, if forklift trucks are operated in the plant area, the minimum general lighting level is 2 lumens per square foot unless the forklift trucks themselves have lights. Every exit sign should be suitably illuminated by a reliable light source giving a value of not less than five footcandles on the illuminated surface. This is not to say that the exit sign must be the kind that is *internally* lighted. An alternative to be considered is artificial lighting *external* to the sign. In addition, there is nothing wrong with relying on *natural* illumination (sunlight) on the exit sign in an amount not less than five footcandles. Natural illumination can be a problem, however, if the area is accessed on second or third shifts. Incidentally, five footcandles is not very much illumination. Most plant areas are normally lit by much greater levels of illumination.

In the General Industry standard adopted as the national consensus standard in the early days of OSHA, there was no general lighting standard. However, the omission seems to be an oversight on OSHA's part. More than a decade later, OSHA promulgated a standard for "Hazardous Waste Operations and Emergency Response," commonly known as the HAZWOPER standard, discussed earlier in Chapter 5. The HAZWOPER standard focused on special emergency operations, but a little-known provision of this standard had to do with minimum illumination levels. Table 7.1 delineates these minimum illumination levels and is taken directly from the HAZWOPER standard. Review of the table clearly reveals that it was originally conceived to be a general table of illumination levels, not just a special table for HAZWOPER operations.

TABLE 7.1 Minimum Illumination Intensities in Footcandles

Illumination (footcandles)	Illumination (lux[a])	Area or operations
5	50	General site areas
3	30	Excavation and waste areas, accessways, active storage areas, loading platforms, refueling, and field maintenance areas
5	50	Indoors: warehouses, corridors, hallways, and exitways
5	50	Tunnels, shafts, and general underground work areas (exception: minimum of 10 footcandles is required at tunnel and shaft heading during drilling, mucking, and scaling. Mine Safety and Health Administration approved cap lights shall be acceptable for use in the tunnel heading)
10	100	General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms)
30	300	First-aid stations, infirmaries, and offices

[a] The specified values in the OSHA standard are in footcandle units. Metric equivalents in lux are included here for the convenience of the user. Since 1 footcandle = 10.76 lux, the metric conversions result in fractional values, not whole numbers. For convenience, a conversion factor of 1 footcandle to 10 lux has been used.

Source: OSHA Standard 29 CFR 1910. Subpart H, Table H-1.

For instance, the table specifies levels for "warehouses," "general shops," "barracks," "dining rooms," and "offices," all of which describe areas that might be associated with general employment, not only "emergency response" operations. OSHA has not seen fit to attempt to promulgate a general illumination standard for all workplaces. Instead, the agency has adopted such a standard within specific standards only. Another example standard that contains the illumination minimums (Table 7.1) is the OSHA Construction standard.

Work has been done by such other standards agencies as ANSI and the Illumination Engineering Society (IES) to provide recommended lighting for various tasks. Tasks are rated according to complexity and the type of task. The more complex the task, the greater amount of light recommended. It should be noted that as lights age, the illumination level may deteriorate from the rated value. Care should be taken in the preparation of maintenance schedules to ensure replacement intervals that maintain necessary illumination levels.

MISCELLANEOUS FACILITIES

Maintenance Platforms

The importance of planning for maintenance activities when constructing a new building was pointed out earlier in this chapter. Many modern buildings have built-in, safe suspension systems for exterior window cleaning and other exterior maintenance. Maintenance workers for buildings not so equipped are less fortunate and typically work from suspended scaffolds of the same type as construction scaffolds, which are discussed in Chapter 18. Not only are the maintenance workers less fortunate but so are the employers of these workers and the safety and health managers who must worry about the safety of the scaffolds, the proper securing of scaffolds on the roof of the building, and other items governed by applicable standards.

Safety and health managers who do find that their buildings are equipped with powered platforms for exterior maintenance should direct most of their attention to how these platforms are being used and maintained, not how they are made. The manufacturer of such equipment would normally be very careful to adhere strictly to standards when fabricating the powered maintenance platform. Typical problems with these platforms are missing guardrails, missing toeboards, missing side mesh, disabled safety devices, and inadequate inspections or records of inspections.

Regarding the equipment itself, some companies have been tripped up for not having load-rating plates on the platform. The load rating must be stated in letters at least $\frac{1}{4}$ inch in height. The wire rope suspending the platform must also be marked with a metal tag stating its maximum breaking strength and other data, including the month and year the ropes were installed.

Workers on some types of powered platforms need to wear safety belts; on other types, they are safe without the belts. A platform supported by four or more wire ropes can be so designed that the working platform will maintain its normal position even if one rope fails. However, many powered platforms are suspended by only two wire ropes and will tip dangerously if one of the ropes fails. One of the more dangerous types of platform is known as "type T," and workers on these platforms must wear safety belts attached by lifelines. If the platform qualifies as type T, it will upset with a single wire rope failure, but it will not fall to the ground. Therefore, the lifeline may be attached either to the building structure or to the working platform. Compare this to construction industry standards (Chapter 18), which require that lifelines be secured to an anchorage or structural member instead of to the scaffold.

Public-utilities workers and tree trimmers often use platforms that are vehicle mounted, such as aerial baskets, aerial ladders, boom platforms, and platform-elevating towers. Again the majority of accidents arise from improper use of the platform rather than from equipment failure or design. This is even more true of the vehicle-mounted platforms than of the building-mounted models discussed earlier.

The most serious hazard with vehicle-mounted platforms is contact with high-voltage power lines, and this kills workers every year. This hazard is so severe that a safety distance must be maintained at all times—except, of course, in the case of electric utility companies who by the nature of their work must approach closer. For safety, the utility companies must insulate aerial devices that work closer than the standard safety distance. For nonutility companies, the accepted standard is a 10-foot distance in the case of a 40-kilovolt line, for example. Different line voltages may need higher or lower safety distances, and these distances are covered in more detail in Chapter 18 in the discussion of mobile cranes.

Sometimes, special sensors called *proximity warning devices* are installed on the boom to warn the operator when the basket is too close for safety. However, these warning devices do not provide positive protection and thus should not be considered an excuse for moving the boom closer to the line than authorized minimums.

Workers in aerial baskets often fail to wear a body belt and lanyard attached to the boom. Adding to the fall hazard is the possibility of unexpected contact with an object that might strike and perhaps sweep the worker out of the basket or off the platform.

Case Study 7.2 tells the story of just such an accident.

CASE STUDY 7.2

A 24-year-old worker was riding along a highway in an aerial lift truck bucket while the truck was moving 1.9 miles from one work location to another. The worker was replacing insulators at various locations along the line. Along the way the bucket encountered a low-hanging insulated communication cable that physically pulled the worker from the bucket, resulting in a fatal fall.

Echoing the hazards avoidance principles of Chapter 3, such unusual hazards point to the importance of training for personnel who work in aerial baskets. Other unsafe procedures are failure to secure the aerial ladder before traveling, climbing or sitting on the edge of the basket, or improvising a work position other than the floor of the basket.

Elevators

Elevators are everywhere, but when can you remember one falling? The catastrophic fall of an elevator is such a horrifying thought that the public long ago set up regulations for safe elevators. Jurisdiction was placed within the states, and most states administer elevator inspections through "labor" or "labor and industry" commissions. Next time you ride in an elevator, look at the certificate of inspection posted inside the elevator car.

Elevators must be inspected both when new (or altered) and periodically thereafter. Many states even require construction permits from the authorized elevator inspection agency before elevator construction is begun. Elevator operating permits and fees are also required by some states. Not every inspector must be an agency official, but state licensing procedures for elevator inspectors may be applicable.

Manlifts are used as elevators, but unlike elevators, there are federal standards for manlifts. Manlifts are much cheaper and more efficient than elevators for many plant operations and are thus sometimes used instead of elevators. As can be seen in Figure 7.7, however, a manlift is inherently more hazardous than an elevator. It is ironic that elevators—which are safer than manlifts—are governed by strict state inspection, licensing, permits, and approvals. With manlifts, though, it is up to the safety and health manager to interpret general standards and identify hazards. It is apparent from Figure 7.7 that the biggest hazards with manlifts are getting on and getting off. Exit is essential because the belt is continuous, and to stay on the belt past the top or bottom floor would be either impossible or extremely hazardous.

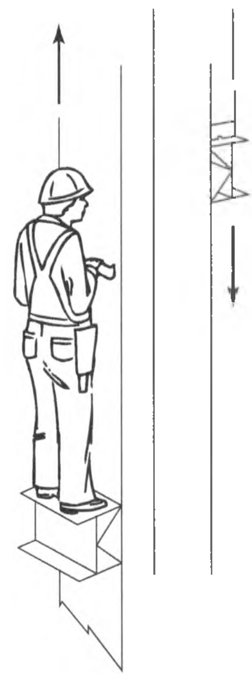


FIGURE 7.7

Manlift: a continuously moving belt on which workers may ride both up and down.

Boilers

Steam boilers and pressure vessels are so safe today that most people do not even think about them. It has not always been that way. Although steam boilers are not as popular today for building heating systems, many are still in use; in addition, industrial processes use hundreds of thousands of boilers and pressure vessels. So, the lack of familiarity with boiler accidents is not because the boilers themselves are rare—it is the accidents that are rare. When an accident does occur, the energy released by the explosion is so devastating that it usually produces a catastrophe.

The extreme hazard of an unsafe boiler led to the early regulation and safeguarding of these vessels. As with elevators, the historical development of boiler codes has placed their jurisdiction within the states. State control has been very effective in keeping boiler accidents to an absolute minimum.

The safety and health manager needs to ensure that boilers and pressure vessels in the plant are being inspected and that state procedures are being followed. One question that immediately comes to mind is "What pressure vessels are covered by the regulations?" Most states exempt containers for liquefied petroleum gases (LPG), as these are covered by other regulations. The same can generally be said of vessels approved by the Department of Transportation for public highway transportation of liquids and gases under pressure. Some states also exempt vessels used in connection with the production, distribution, storage, or transmission of oil or natural gas. Note, however, that the foregoing does not exempt refineries or chemical plants that produce petroleum *products*. In the industry, the term *oil production* refers to the drilling and extraction, or "mining," of petroleum, not its refining. The only way to be sure about exemptions in a given state is to check with that state's agency of authority.

The time to stop and think about regulations for boiler and pressure vessel safety is whenever such a vessel is to be purchased, installed, modified, moved, or sold. Welding on such vessels may weaken them and is scrutinized carefully by the inspector, although welding is not absolutely prohibited. Even hot-water storage containers should be installed or reinstalled by persons properly licensed to do the work.

SANITATION

The sanitation of lunchrooms seems straightforward and obvious, but sanitation decisions can be trickier than they appear. If a decision is made to allow employees to eat in the plant, principles of hygiene must be observed. The safety and health manager should be sure that a sufficient number of waste receptacles is provided to avoid over filling. However, before going overboard, the safety and health manager should realize that too *many* waste receptacles can be provided also. If too many receptacles are provided, maintenance personnel will become lax about emptying containers that receive little use, resulting in additional sanitation problems.

The presence of toxic materials complicates the whole problem of food service, consumption, and storage. Certainly, food and beverages must not be stored in areas where they will be exposed to toxic materials. This rule may seem obvious, but the safety and health manager should consider not only the plant cafeteria or lunchroom but also the employee who brings snacks from home and stores them in areas in which they could be exposed to toxic materials.

Some toxic materials, such as lead, are particularly susceptible to exposure by ingestion during food consumption. Some toxic materials, such as vinyl chloride and arsenic, are of such concern that there are strict, specific standards for their control. Toxic substances will be discussed in more detail in Chapter 9.

SUMMARY

Safety and health managers who are willing to plan ahead can save their companies a great deal of money by heeding building and facility codes *before* commencing construction or expansion of plant space. Planning ahead is the key to compliance with standards for floors, aisles, exits, and stairways. Guardrails, ladders, and platforms may be added, but they too deserve some advance consideration to ensure that installations meet requirements.

Safety and health managers need to be careful not to get too enthusiastic and provide for too many aisles or exits. An extra aisle or exit that is improperly maintained or marked can easily lead to problems and indeed is not even in the interest of safety.

The subject of buildings and facilities may not be the most exciting topic for the safety and health manager's attention. However, even ordinary matters such as housekeeping and sanitation deserve careful consideration and judgment to promote safety and health at reasonable cost. The passage of the ADA has increased the responsibility of safety and health managers in the area of buildings and facilities.

EXERCISES AND STUDY QUESTIONS

7.1 What is the height of a standard railing for walking and working surfaces?

7.2 A portable ladder is needed to climb onto a rooftop 14 feet high. How long should the ladder be?

7.3 What are the two principal federal requirements for aisles in industrial plants?

7.4 Explain why the title for a major OSHA subpart is "Walking and Working Surfaces" instead of simply "Floors." Name 10 different walking and working surfaces.

7.5 What is deceptive about the danger of an open-sided floor or platform only 4 feet high?

7.6 Suppose that in your plant, welders must stand on top of a 10-foot-high tank to complete manufacturing operations. What should be done, if anything, to protect them from falling?

7.7 What is the purpose of a toeboard?

7.8 Explain under what conditions, and how, roofing workers should be protected from fall hazards.

7.9 When must an open-sided floor or platform be equipped with a railing?

7.10 When would OSHA require guarding for a service pit for use in vehicle maintenance? How would you guard such a pit?

7.11 Explain how poor housekeeping could result in an OSHA citation that classifies the violation as "serious."

7.12 As a safety and health manager, how would you deal with the problem of housekeeping?

7.13 What are the most important considerations around aisle markings? Why might they be important to an OSHA investigator?

7.14 Explain the difference between a handrail and a railing.

7.15 Describe the purposes and requirements for stairway landings.

7.16 Describe important points to consider in safety with portable ladders.

7.17 Under what conditions are ladder cages specified? When may alternative ladder safety devices be used? What are the advantages and disadvantages of these devices?

7.18 Define the term *means of egress.*

7.19 What are the biggest problems with exits?

7.20 What are vehicle-mounted work platforms? What are their chief hazards?

7.21 Explain how either too many or too few waste receptacles can lead to sanitation problems.

7.22 Describe the case history in which locked exits resulted in multiple fatalities, criminal indictments, company bankruptcy, and the permanent closing of a plant.

7.23 Are "boilers" obsolete in today's industry? Explain.

7.24 Name some types of pressure vessels that are generally exempt from state regulations for boilers.

7.25 Is the OSHA standard for aisle width a *specification standard* or a *performance standard*? Explain your reasoning.

7.26 Discuss the problem that is associated with promulgation of federal standards for building code issues.

7.27 What is "tribology," and in what way is it important to occupational safety and health?

7.28 Compare the Life Safety Code standard with the OSHA standard for aisle width in industrial plants. Which is worded more in performance language and which is worded more in specification language?

7.29 In what way has OSHA's aisle-marking standard changed from specification to performance wording?

7.30 Explain the purpose of a "footladder board."

7.31 Explain why it is acceptable in general industry to secure the worker lifeline to the scaffold itself if the scaffold is "type T."

7.32 Is it OK for just anyone to install a hot-water tank? Why or why not? Explain.
7.33 Explain the difference in the application of a building "code" and a safety "standard."
7.34 Explain the irony surrounding the problem of the appropriate marking of aisles. What remedy can be recommended to resolve this irony?
7.35 Identify performance-type language in the specification of aisles.
7.36 Is the standard for marking the stripes on aisles a specification standard or performance standard? Has it always been this way? Explain the history of this standard.
7.37 How can shrubbery and landscaping become a safety issue?
7.38 What is a greater problem with aerial platforms than equipment failure?
7.39 An unsafe boiler is extremely hazardous. Why are they rarely an issue with regard to safety?
7.40 What is the disadvantage of depending on proximity-warning devices for workers in aerial baskets working near overhead powerlines?
7.41 Workers in aerial baskets are exposed to what extra fall hazard?
7.42 An obvious hazard to workers in aerial baskets is contact with high-voltage lines. However, even if the line is insulated, the worker is exposed to what hazard?

RESEARCH EXERCISES

7.43 Check the Internet for details about the Imperial Foods disaster in 1991.
7.44 Check the Internet for details about the Triangle Shirtwaist disaster in 1911. What lessons could have been learned from this disaster that would have prevented the Imperial Foods disaster 80 years later?

STANDARDS RESEARCH QUESTIONS

7.45 Research current statistics reported by the National Safety Council to determine the current rank of "falls" as an accidental cause of death on the job.
7.46 The maintenance of aisles is an important consideration in controlling the hazards of work areas. Find the OSHA General Industry standard for aisle maintenance and determine its citation frequency using the Companion Website database.
7.47 Search the OSHA General Industry standard for the provision prohibiting locked exits. Determine whether it is frequently cited by searching the Companion Website database. Are any of the citations for locked exits contested by the employer?