CHAPTER ONE

COST OF ACCIDENTS: WHY SAFETY IS IMPORTANT

MAJOR TOPICS

- Costs of Accidents
- Accidental Deaths in the United States
- Accidents versus Other Causes of Death
- Work Accident Costs and Rates
- Time Lost Because of Work Injuries
- Deaths in Work Accidents
- Work Injuries by Type of Accident
- Death Rates by Industry
- Parts of the Body Injured on the Job
- Chemical Burn Injuries
- Heat Burn Injuries
- Estimating the Cost of Accidents

Accidents and the corresponding damage they cause to employees, property, equipment, and morale can have a detrimental effect on a construction company's profit and loss statement. Although it can be difficult to measure precisely the economic impact of accidents, the impact is significant.

There is a long history of debate in this country concerning the effect of accidents on industry (the workers and the companies) and the cost of preventing accidents. Historically, the prevailing view was that accident-prevention programs were too costly. The more contemporary view is that the accidents are too costly and that **accident prevention** makes sense economically. As a result, accident prevention, which had been advocated on a moral basis, is now justified also in economic terms.

Accidents are the fourth leading cause of death in this country after heart disease, cancer, and strokes. This ranking is based on all types of accidents, including motor vehicle accidents, **drownings**, fires, **falls**, **natural disasters**, and work-related accidents.

Although deaths from natural disasters tend to be more newsworthy than workplace deaths, their actual impact is substantially less. For example, natural disasters cause fewer than 100 deaths per year on average. **Workplace accidents**, on the other hand, cause more than 10,000 deaths every year in the United States.[1] The following quote from the National Safety Council (NSC) puts workplace accidents and deaths in the proper perspective, notwithstanding their apparent lack of newsworthiness.

> While you make a 10-minute speech—two persons will be killed and about 170 will suffer a disabling injury. Costs will amount to $2,800,000. On the average, there are 11 accidental deaths and about 1,030 disabling injuries every hour during the year.[2]

This chapter provides prospective and practicing construction professionals with the information they need to have a full understanding of workplace accidents and their effect on industry in the United States, which helps professionals to play a more effective role in keeping both management and labor focused appropriately on safety and health in the workplace.

COST OF ACCIDENTS

To gain a proper perspective on the economics of workplace accidents, we must view them in the context of all accidents. The overall cost of accidents in the United States is approximately $800 billion annually. This includes **lost wages**, **medical expenses**, **insurance administration**, **fire-related losses**, **property damage**, and **indirect costs**.

Figure 1–1 breaks down this overall amount by categories of accidents, and Figure 1–2 breaks them down by cost categories. In Figure 1–1, workplace accidents rank second, behind motor vehicle accidents, in cost. Figure 1–2 shows that the

Motor vehicle accidents	$722
Workplace accidents	48
Home accidents	18
Public accidents	12

FIGURE 1–1 Accident costs in a typical year by accident type (in billions of dollars).

Wages lost	$38
Medical expenses	24
Insurance administration	29
Property damage (motor vehicle)	27
Fire losses	10
Indirect losses for work accidents	23

FIGURE 1–2 Accident costs in a typical year by categories (in billions of dollars).

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Clearly, accidents on and off the job cost U.S. industry dearly. Every dollar spent responding to accidents is a dollar that could have been reinvested in modernization, employee training, and other competition-enhancing activities.

ACCIDENTAL DEATHS IN THE UNITED STATES

Accidental deaths in the United States result from a variety of causes, including motor vehicle accidents, falls, **poisoning**, drowning, fire-related injuries, **suffocation** (ingested object), firearms, **medical complications**, air transport accidents, injuries from machinery, **mechanical suffocation**, and the impact of falling objects. The NSC periodically computes death totals and **death rates** in each of these categories. The statistics for a typical year are as follows:

- *Motor vehicle accidents.* As the leading cause of accidental deaths in the United States every year, this category includes deaths resulting from accidents involving mechanically or electrically powered vehicles (excluding rail vehicles) that occur on or off the road. In a typical year, there are approximately 47,000 deaths from motor vehicle accidents in the United States.
- *Falls.* This category includes all deaths from falls except those associated with transport vehicles. For example, a person who is killed as a result of falling while boarding a bus or train would not be included in this category. In a typical year, there are approximately 13,000 deaths in the United States from falls.
- *Poisoning.* This category is divided into two subcategories: (1) poisoning by solids and liquids and (2) poisoning by gases and vapors. The first category includes deaths that result from the ingestion of drugs, medicine, recognized solid and liquid poisons, mushrooms, and shellfish; it does not include poisoning from spoiled food or *Salmonella* species. The second category includes deaths caused by incomplete combustion (e.g., gas vapors from an oven or unlit pilot light) or from carbon monoxide (e.g., exhaust fumes from an automobile). In a typical year, there are approximately 6,000 deaths in the first category and 1,000 in the second.
- *Drowning.* This category includes work-related and nonwork-related drowning incidents, but excludes those associated with floods or other natural disasters. In a typical year, there are approximately 5,000 deaths from drowning in the United States.
- *Fire-related injuries.* This category includes deaths from burns, asphyxiation, and falls, as well as from being struck by falling objects in a fire. In a typical year, there are more than 4,000 deaths resulting from fire-related injuries in the United States.
- *Suffocation (ingested object).* This category includes deaths from the ingestion of an object that blocks the air passages. In many such deaths, the ingested object is food. In a typical year, there are approximately 4,000 such suffocation deaths in the United States.
- *Firearms.* This category includes deaths that result when recreational activities or household accidents that involve firearms result in death. For example, a person killed in the home while cleaning a firearm would be included in this category; however, a person killed in combat would not be included. In a typical year, there are approximately 2,000 deaths in this category in the United States.
- *Others.* This category includes deaths resulting from medical complications arising out of mistakes made by health-care professionals, air transport injuries, interaction with machinery, mechanical suffocation, and the impact of falling objects. In a typical year, there are more than 14,000 deaths overall in these subcategories.[3]

ACCIDENTS VERSUS OTHER CAUSES OF DEATH

Although there are more deaths every year from heart disease, cancer, and strokes than from accidents, these causes tend to be concentrated among people at or near retirement age. Among people 37 years of age or younger—prime working years—accidents are the number one cause of death. Figure 1–3 summarizes the causes of death for persons from 25 to 44 years of age. Note that the leading cause is accidents.

Figure 1–3 shows that accidents represent a serious detriment to productivity, quality, and competitiveness in today's workplace. Yet accidents are the one cause of death and injury that companies can most easily control. Although it is true that companies may have some success in decreasing the incidence of heart disease and stroke among their employees through activities such as wellness programs, their impact in this regard is limited. However, employers can have a significant impact on preventing accidents.

Accidents	27,500
Motor vehicle	16,500
Poison (solid, liquid)	2,700
Drowning	1,500
Falls	1,100
Fire related	900
Cancer	20,300
Heart disease	16,000

FIGURE 1–3 Number of deaths, by cause, in a typical year in workers aged 25 to 44 years.

WORK ACCIDENT COSTS AND RATES

Workplace accidents cost employers millions every year. For example, one company—the steel-making division of USX—once paid a $3.25 million fine to settle numerous health and safety violation citations.

This example shows the cost of fines only. In addition to fines, employers incur costs for safety corrections, medical treatment, survivor benefits, death and burial costs, and a variety of indirect costs. Clearly, work accidents are expensive. However, the news is not all bad. The trend in the rate of accidents is downward.

Work **accident rates** in this century are evidence of the success of the safety movement in the United States. As the amount of attention given to workplace safety and health has increased, the accident rate has decreased. According to the NSC,

> Since 1912 accidental work deaths per 100,000 population have been reduced 81 percent, from 21 to 4. In 1912, an estimated 18,000 to 21,000 workers' lives were lost. Now, in a workforce more than triple in size and producing 11 times the goods and services, there are approximately 10,000 work deaths annually.[4]

As Figure 1–1 shows, the cost of these 10,000 work deaths and **work injuries** in 2001 was $48.5 billion. This translates into a cost of $420 per worker in the United States. It translates further into $610,000 per death and $18,000 per disabling injury.[5]

Although statistics are not available to document the supposition, many safety and health researchers believe that the major cost of accidents and injuries on the job results from damage to morale. Employee morale is a less tangible factor than measurable factors, such as **lost time** and medical costs. However, it is widely accepted among management professionals that few factors affect productivity more than employee morale. Employees with low morale do not produce up to their maximum potential, which is why so much time and money are spent every year to help supervisors and managers learn different ways to help improve employee morale.

Since few things are so detrimental to employee morale as seeing a fellow employee injured, accidents can have a devastating effect. Whenever an employee is injured, his or her colleagues silently think, "that could have been me," in addition to worrying about the employee. Morale is damaged even more if the injured employee is well-liked and other employees know his or her family.

TIME LOST BECAUSE OF WORK INJURIES

An important consideration when assessing the effect of accidents on industry is the amount of time lost due to work injuries.[6] According to the NSC, approximately 35 million hours are lost in a typical year as a result of accidents. This is actual time lost from disabling injuries and does not include additional time lost for medical checkups after the injured employee returns to work. Accidents that occurred in previous years often continue to cause lost time in the current year.

DEATHS IN WORK ACCIDENTS

Deaths on the job have decreased markedly over the years. However, they still occur. For example, in a typical year, there are 10,400 work deaths in the United States. The causes of death in the workplace vary. They include those related to motor vehicles, falls, electric current, drowning, fires, air transport, poison, water transport, machinery, falling objects, rail transports, and mechanical suffociation.[7] Figure 1–4 gives a complete breakdown of the percentages for the various categories of causes.

WORK INJURIES BY TYPE OF ACCIDENT

Work injuries can be classified by the type of accident from which they result. The following are the most common causes of work injuries:

- Overexertion
- Impact accidents
- Falls
- Bodily reaction (to chemicals)
- Compression
- Motor vehicle accidents
- Exposure to radiation or caustic chemicals
- Rubbing or abrasions
- Exposure to extreme temperatures

Overexertion, the result of employees working beyond their physical limits, is the leading cause of work injuries. According to the NSC, almost 31 percent of all work injuries are caused by overexertion. The second leading cause, **impact accidents**, involves a worker being struck by or against an object. The next most prominent cause of work injuries is falls.[8] The remaining accidents are distributed fairly equally among the other causes just listed.

SAFETY FACTS & FINES

Locking out machines before performing routine maintenance is critical. Failure to do so can result in serious injuries to workers, or even death. This is exactly what happened when a company in Kissimmee, Florida, failed to enforce its lockout policy. An employee was crushed to death while working on a machine that was still in operation. The company was fined $93,600 and charged with the following violations: (1) failure to enforce its lockout policy, (2) failure to train employees about lockout procedures, and (3) failure to implement machine-specific lockout procedures.

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Motor vehicle	37.2%
Falls	12.5%
Electric current	3.7%
Drowning	3.2%
Fire	3.1%
Air transport	3.0%
Poisons (solid, liquid)	2.7%
Poisons (gas, vapor)	1.4%
Water transport	1.6%
Other	31.6%

FIGURE 1–4 Percentage of total work deaths attributable to selected causes for a typical year.

DEATH RATES BY INDUSTRY

A variety of agencies and organizations, including the Bureau of Labor Statistics, National Center for Health Statistics, and NSC, collect data on death rates within industrial categories.[9] Such information can be used in a variety of ways, not the least of which is in assigning workers' compensation rates. The most widely used industrial categories are agriculture, including farming, forestry, and fishing; mining and quarrying, including oil and gas drilling and extraction; construction; manufacturing; transportation and public utilities; trade, both wholesale and retail; services, including finance, insurance, and real estate; and federal, state, and local government.

When death rates are computed on the basis of the number of deaths per 100,000 workers in any given year, the industry categories rank as follows (from highest death rate to lowest):

1. Mining and quarrying
2. Agriculture
3. Construction
4. Transportation and public utilities
5. Government
6. Manufacturing
7. Services
8. Trade

The construction industry ranks third in workplace deaths, but first in workplace injuries. The rankings sometimes change slightly from year to year. For example, agriculture and mining and quarrying may exchange the first and second ranking in any given year. This is also true at the lowest end of the rankings, with services and trade. However, generally, the ranking is as shown.

PARTS OF THE BODY INJURED ON THE JOB

To develop and maintain an effective safety and health program, it is necessary to know not only the most common causes of death and injury but also the parts of the body most frequently injured. According to the NSC,

> Disabling work injuries in the entire nation total approximately 1.75 million annually. Of these, about 10,400 are fatal and 60,000 result in some permanent impairment. Injuries to the back occur most frequently, followed by thumb and finger injuries and leg injuries.[10]

Typically, parts of the body prone to injury are as follows (from most frequent to least):

1. Back
2. Legs and fingers
3. Arms
4. Trunk
5. Hands
6. Eyes, head, and feet
7. Neck, toes, and body systems

This ranking shows that one of the most fundamental components of a safety and health program should be instruction on how to lift without hurting the back.

CHEMICAL BURN INJURIES

Chemical burn injuries are a special category with which prospective and practicing construction professionals should be familiar. The greatest incidence of chemical burns occurs in construction and manufacturing.[11]

The chemicals that frequently cause burn injuries include acids and alkalies; soaps, detergents, and cleaning compounds; solvents and degreasers; calcium hydroxide (a chemical used in cement and plaster); potassium hydroxide (an ingredient in drain cleaners and other cleaning solutions); and sulfuric acid (battery acid). Almost 46 percent of all chemical burn injuries occur while workers are cleaning equipment, tools, and vehicles.[12]

What is particularly disturbing about chemical burn injuries is that a high percentage of them occur despite the use of personal protective equipment (PPE), the provision of safety instruction, and the availability of treatment facilities. In some cases, the PPE is faulty or inadequate. In others, it is not properly used, despite instructions.

SAFETY FACTS & FINES

Failure to properly dispose of hazardous materials can be an expensive mistake for construction companies. It can also subject construction professionals to criminal charges. A construction company in Pensacola, Florida, was fined $100,000 and its site superintendent was sentenced to five years of probation when a woman died from exposure to rodent poison left behind at a job site. The site superintendent had been ordered to remove the rodent poison from the job site, but had failed to do so. The company and the site superintendent were charged with failure to properly dispose of hazardous materials.

Preventing chemical burn injuries presents a special challenge to construction professionals. The following strategies are recommended:

- Familiarize yourself, the workers, and their supervisors with the chemicals that will be used and the inherent dangers.
- Secure the proper PPE for each type of chemical that will be used.
- Provide instruction on the proper use of PPE, and then make sure that supervisors confirm that the equipment is used properly every time.
- Monitor workers who are wearing PPE, and replace the equipment when it begins to show wear.

HEAT BURN INJURIES

Heat burn injuries present a special challenge to construction professionals in the modern workplace. The most frequent causes are flame (includes smoke inhalation injuries), molten metal, petroleum asphalt, steam, and water. The most common activities associated with heat burn injuries are welding, cutting with a torch, and handling tar or asphalt—all common activities in construction.[13]

Construction professionals who understand the following negative factors that contribute to heat burn injuries in the workplace are in a better position to prevent heat burn injuries.

- Employer has no health and safety policy regarding heat hazards.
- Employer fails to enforce safety procedures and practices.
- Employees are not familiar with the employer's safety policy and procedures concerning heat hazards.
- Employees fail to use or improperly use PPE.
- Employees have inadequate or worn PPE.
- Employees work in too small a space.
- Employees attempt to work too fast or are pushed to work too fast.
- Employees are careless.
- Employees have poorly maintained tools and equipment.[14]

These factors should be carefully considered by construction professionals when developing accident-prevention programs. Employees should be familiar with the hazards, know the appropriate safety precautions, and have and use the proper PPE. Construction professionals should monitor to ensure that safety rules are being followed and that PPE in good condition is being used correctly.

ESTIMATING THE COST OF ACCIDENTS

Even decision makers who support accident prevention must consider the relative costs of such efforts. Clearly, accidents are expensive. However, to be successful, safety-minded construction professionals must be able to show that accidents are more expensive than their prevention. To do this, they must be able to estimate the cost of accidents. The procedure for estimating costs set forth in this section was developed by Professor Rollin H. Simonds of Michigan State University, working in conjunction with the Statistics Division of the NSC.

Cost Estimation Method

Professor Simonds states that, to have value, a cost estimate must relate directly to the specific company in question. Applying broad industry cost factors does not suffice. To arrive at company-specific figures, Simonds recommends that costs associated with an accident be divided into *insured* and *uninsured* costs.[15]

Determining the insured costs of accidents is a simple matter of examining accounting records. The next step involves calculating the uninsured costs. Simonds recommends that accidents be divided into the following four classes:

- *Class 1 accidents.* Lost workdays, permanent partial disabilities, and temporary total disabilities
- *Class 2 accidents.* Treatment by a physician outside of the company's facility
- *Class 3 accidents.* Locally provided first aid, property damage of less than $100, or the loss of fewer than eight hours of work time
- *Class 4 accidents.* Minor injuries that do not require the attention of a physician, result in property damage of less than $100, and cause less than eight hours of work to be lost[16]

Average uninsured costs for each class of accident can be determined by pulling the records of all accidents that occurred during a specified period and sorting the records according to class. For each accident in each class, record every cost that was not covered by insurance. Compute the total of these costs by class of accident and divide by the total number of accidents in that class to determine an average uninsured cost for each class, specific to the particular company.

Figure 1–5 is an example of how the average cost of a selected sample of Class I accidents can be determined. In this example, there were four Class 1 accidents in the pilot study. These four accidents cost the company a total of $554.23 in uninsured costs or an average of $138.56 per accident. Using this information, accurate cost estimates of an accident and accurate predictions can be calculated.

Other Cost Estimation Methods

The costs associated with workplace accidents, injuries, and incidents fall into broad categories, such as the following:

- Lost work hours
- Medical costs
- Insurance premiums and administration
- Property damage
- Fire losses
- Indirect costs

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- Medical costs
- Insurance premiums and administration
- Property damage
- Fire losses
- Indirect costs

Class of Accident	Accident Number							
Class 1	1	2	3	4	5	6	7	8
Cost A	16.00	6.95	15.17	3.26				
Cost B	72.00	103.15	97.06	51.52				
Cost C	26.73	12.62	—	36.94				
Cost D	—	51.36	—	38.76				
Cost E	—	11.17	—	24.95				
Cost F	—	—	—	13.41				
Cost G	—	—	—	—				
Total	114.73	185.25	112.23	142.02				
Grand Total: $554.23								
Average Cost per Accident: $138.56 (grand total 4 number of accidents)								
Signature: Date:								

FIGURE 1–5 Uninsured costs worksheet form.

Calculating the direct costs associated with lost work hours involves compiling the total number of lost hours for the period in question and multiplying the hours times the applicable loaded labor rate. The loaded labor rate is the employee's hourly rate plus benefits. Benefits vary from company to company, but typically inflate the hourly wage by 20–35 percent. A sample of cost-of-lost-hours computation follows:

Employee hours lost (fourth quarter) × Average loaded labor rate = Cost

386 × $13.48 = $5,203.28

In this example, the company lost 386 hours due to accidents on the job in the fourth quarter of its fiscal year. The employees who actually missed time at work formed a pool of people with an average loaded labor rate of $13.48 per hour ($10.78 average hourly wage plus 20 percent for benefits). The average loaded labor rate multiplied times the lost hours reveals an unproductive cost of $5,203.28 to this company.

By studying records that are readily available in the company, a construction professional can also determine medical costs, insurance premiums, property damage, and fire losses for the time period in question. All of these costs taken together result in a subtotal cost. This figure is then increased by a standard percentage to cover indirect costs to determine the total cost of accidents for a specific time period. The percentage used to calculate indirect costs can vary from company to company, but 20 percent is a widely used figure.

Summary

The approximate cost of accidents in the United Sates is $150 billion annually. This includes the direct and indirect costs of accidents that occur on and off the job.

The leading causes of accidental deaths in the United States are motor vehicle accidents, falls, poisoning, drowning, fire-related injuries, suffocation, firearm injuries, medical complications, air transport accidents, machinery-related injuries, mechanical suffocation, and the impact of falling objects.

The leading causes of death in the United States are heart disease, cancer, and stroke. However, these causes are concentrated among people at or near retirement age. Among people aged 37 and younger, accidents are the number one cause of death. Since 1912, the number of accidental work deaths per 100,000 population has declined by 81 percent—from 21 to 4. The leading causes of death in work accidents are motor vehicle-related, falls, electric current, drowning, fire-related and air transport-related injuries, poisoning, and water transport-related injuries.

Approximately 35 million work hours are lost annually as a result of accidents. This is actual time lost from disabling injuries and does not include additional time lost to medical checkups after the injured employee returns to work.

The leading causes of work injuries are overexertion, impact accidents, falls, bodily reaction, compression, motor vehicle accidents, exposure to radiation and caustic chemicals, rubbing or abrasions, and exposure to extreme temperatures.

When death rates are computed on the basis of the number of deaths per 100,000 workers, the industry categories are ranked as follows (from highest death rate to lowest): mining and quarrying, agriculture, construction, transportation and public utilities, government, manufacturing, services, and trade.

Typically, injuries to specific parts of the body are ranked by frequency as follows (from most frequently injured to least): back; legs and fingers; arms; trunk; hands; eyes, head, and feet; and neck, toes, and body systems.

The chemicals most frequently involved in chemical burn injuries include acids and alkalies; soaps, detergents, and cleaning compounds; solvents and degreasers; calcium hydroxide; potassium hydroxide; and sulfuric acid.

The most frequent causes of heat burn injuries are flame, molten metal, petroleum, asphalt, steam, and water.

Key Terms and Concepts

Accident prevention
Accident rate
Accidents
Chemical burn injuries
Death rates
Drowning
Falls
Fire-related losses
Heat burn injuries
Impact accidents
Indirect costs
Insurance administration
Lost time
Lost wages
Mechanical suffocation
Medical complications
Medical expenses
Natural disasters
Overexertion
Poisoning
Property damage
Suffocation
Work injuries
Workplace accidents

Review Questions

1. What are the leading causes of death in the United States?
2. When the overall cost of an accident is calculated, what elements make up the cost?
3. What are the five leading causes of accidental deaths in the United States?
4. What are the leading causes of death in the United States of people between the ages of 25 and 44?
5. Explain how today's rate of accidental work deaths compares with the rate in the early 1900s.
6. What are the five leading causes of work deaths?
7. What are the five leading causes of work injuries by type of accident?
8. When death rates are classified by industry type, what are the three leading industry types?
9. Rank the following body parts according to frequency of injury from highest to lowest: neck, fingers, trunk, back, and eyes.
10. Name three chemicals that frequently cause chemical burns in the workplace.
11. Identify three factors that contribute to heat burn injuries in the workplace.

Critical Thinking and Discussion Activities

1. "Nobody can prove with hard data that accidents cost the construction industry more than all of these safety and health regulations we have to deal with," said Mike Flint, CEO of Flint Construction Company. As a recent graduate with a degree in construction technology, you are the newest member of Flint's staff. You are worried about what you have seen at the company's various job sites. There are flagrant safety violations occurring at all of Flint's job sites. In your opinion, it is only a matter of time before a tragedy occurs. What should you say to your CEO to try to convince him that establishing a comprehensive safety and health program makes good business sense?
2. You have made your case about developing a comprehensive safety and health program to your CEO, Mike Flint (see Case 1 above). It is two weeks later, and he has called you into his office to discuss your proposal further. Clearly, Flint has been thinking about what you told him earlier. This time he says, "You claim that back and hand injuries are typically the most common injuries in construction. I believe in zeroing in on the heart of the problem. Why not develop a safety program that targets back and hand injuries and leave out all of these other components you say we need?" You are pleased to have made some progress, but are still concerned that a narrowly focused program might leave the company vulnerable in several other critical areas. What should you do? Start small and hope to expand the program over time, or try once again to convince Flint that a more comprehensive program is needed. Explain your reasoning either way.

Application Activities

1. Find a construction company in your community that will work with you and do the following: (1) determine the most common types of accidents that occur in this company each year and (2) determine the amount of time lost annually because of work injuries.
2. Find a construction company in your community that will work with you or conduct a research project in the library to determine how a specific company calculates the annual cost of accidents.
3. Find an insurance company in your community that provides workers' compensation coverage for construction companies. Meet with a representative of the company and determine the following: (1) What are the most frequently reported injuries when construction workers file claims? and (2) What are the most costly types of claims they receive from construction workers?

Endnotes

1. National Safety Council, *Accident Facts* (Chicago: NSC, 2008), 37.
2. Ibid., 25.

The chemicals most frequently involved in chemical burn injuries include acids and alkalies; soaps, detergents, and cleaning compounds; solvents and degreasers; calcium hydroxide; potassium hydroxide; and sulfuric acid.

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Endnotes

1. National Safety Council, *Accident Facts* (Chicago: NSC, 2008), 37.
2. Ibid., 25.
3. Ibid., 4–5.
4. Ibid., 34.
5. Ibid., 35.
6. Ibid.
7. Ibid., 36.
8. Ibid.
9. Ibid., 37.
10. Ibid., 38.
11. Ibid., 39.
12. Ibid., 40.
13. Ibid., 41.
14. Ibid.
15. National Safety Council, *Accident Prevention Manual: Administration and Programs*, 12th ed. (Chicago: NSC, 2001), 158.
16. Ibid.

CHAPTER TWO

ROLES OF CONSTRUCTION PERSONNEL IN SAFETY AND HEALTH

MAJOR TOPICS

- Safety and Health Team in Construction
- Contractors and Safety
- Managers and Other Professionals and Safety
- Supervisors and Safety
- Employees and Safety
- Safety and Health Professionals
- Certification of Safety and Health Personnel

SAFETY AND HEALTH TEAM IN CONSTRUCTION

Although one or more people can be given the primary responsibility for coordinating, facilitating, and directing a company's safety and health activities, all construction personnel share the responsibility for safety. At construction sites, safety is and must be a "team sport." The **safety and health team** consists of at least the following players: contractors, managers and other professional personnel, supervisors, and employees or subcontractors. To this group, some companies add one or more **safety and health professionals** (Figure 2–1).

CONTRACTORS AND SAFETY

Contractors, as the owners of the company, bear the ultimate responsibility for safety and health on their job sites. Contractors are responsible for the following: (1) setting a **prosafety tone** for the company, (2) establishing a complete **commitment to safety and health** from the top down, and (3) ensuring that **sufficient resources** are provided to support a comprehensive, company-wide safety effort. By letting their managers and supervisors know that they expect safe and healthy job sites, contractors set a tone for the company that ensures that safety and health will be high priorities. By including safety and health in the company's strategic plan, contractors can establish the necessary commitment on the part of all employees. By providing the resources necessary to support company-wide safety and health programs, contractors ensure that the safety and health program is properly staffed and sufficiently funded.

Members of the Safety and Health Team
✓ Managers and other professionals
✓ Supervisors
✓ Employees and subcontractors
✓ Safety and health professionals

FIGURE 2–1 Safety on the job is a "team sport."

MANAGERS AND OTHER PROFESSIONALS AND SAFETY

In companies of sufficient size, contractors have a staff of management personnel and other professional personnel. Management positions may include the following: project managers, financial managers and accountants, marketing representatives, purchasing agents, cost accountants, human resources personnel, and office managers. Other professional personnel may include engineers, designers and drafting technicians, estimators, expeditors, and architects.

Managers and other professionals are responsible for setting a positive example related to safety and health and for translating the commitment of the contractor into everyday practice. This is accomplished by the following types of actions:

1. **Developing job descriptions** that make safety and health part of every employee's job
2. **Developing performance appraisal forms** that contain safety and health criteria
3. **Rewarding safe behavior** on the job by making it an important factor in promotions and pay raises
4. Developing work procedures that emphasize safety and health
5. **Recognizing safe work behavior** as a part of company incentive programs
6. Ensuring that the company has a comprehensive and effective safety and health program
7. Keeping up-to-date with the latest Occupational Safety and Health Administration (OSHA) standards and regulations related to construction
8. Effectively communicating safety and health information to all employees and subcontractors

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8. Effectively communicating safety and health information to all employees and subcontractors

SUPERVISORS AND SAFETY

Supervisors in the construction industry play a critical role in establishing and maintaining safe and healthy job sites. Supervisors are the first level of management; they interact with employees on job sites more frequently than do higher-level managers, other professional personnel, and contractors. Safety is an everyday, hands-on responsibility for supervisors. Safety- and health-related responsibilities of supervisors fall into the following categories of activity: training, accident prevention, accident investigation, and reporting.

Training Responsibilities of Supervisors

Supervisors are interested primarily in the type of training that is appropriate for their employees. Generally speaking, such training should cover the following subjects:

- **Orientation** to the organization's safety policy and principles
- **General housekeeping procedures**
- Emergency procedures
- Proper use of equipment
- Orientation to hazardous materials present and proper handling of these materials.

The method of instruction used can range from simple one-on-one conversations between supervisor and employee to group discussions and formal instruction. Instruction may be provided directly by supervisors or by individuals designated by supervisors.

Accident-Prevention Responsibilities of Supervisors

Accident prevention requires an ongoing program, consisting of a variety of techniques. Here are some techniques supervisors can use to prevent accidents on their job sites:

- *Involve all employees in an ongoing hazard-identification program.* Employees should be empowered to identify hazards associated with their work and to make recommendations for eliminating them.
- *Involve employees in developing safe job procedures.* Once hazards are identified, supervisors and employees should work together to find productive but safe ways to perform the job in question.
- *Teach employees how to properly use personal protective equipment (PPE), and monitor to make sure they do.* Ensure that employees learn how to use appropriate PPE before beginning a job. Supervisors should also make sure that employees follow through and apply what has been learned. When pressed to meet a deadline, the natural human tendency is to take shortcuts. Shortcuts taken in relation to PPE can cause accidents. Therefore, supervisors must monitor as well as train.
- *Teach employees good housekeeping practices, and require adherence to these practices.* One of the most effective ways to prevent accidents is to maintain a clean, organized, orderly workplace. These things result from good housekeeping. Supervisors should teach good housekeeping, and monitor to ensure it is practiced.
- *Teach employees the fundamentals of safe work practices (e.g., safe lifting, proper dress, use of safety glasses).* General safe work practices are perhaps the most important practices to remember. Some of the most common accidents result from simple mistakes, such as improper bending and lifting. Supervisors should monitor general work practices closely.

Accident Investigation and Reporting

In spite of a supervisor's best prevention efforts, accidents may still occur. It is essential to determine the cause. Why did the accident happen? Answering this question is the purpose of an **accident investigation**. By investigating the cause of an accident, supervisors may be able to prevent a reoccurrence. For this reason, it is also important to conduct the investigation immediately. Time can obscure the facts, the accident scene can change, witnesses can forget what they saw, or unrelated factors can creep in and obscure what really happened.

Figure 2–2 is a checklist that supervisors can use as a guide in conducting on-the-spot accident investigations. This checklist helps supervisors determine if the accident was caused by factors that could have been prevented and what those factors are. Occasionally, the cause is the failure

Checklist for On-the-Spot Accident Investigations

- What was the injured employee doing at the time of the accident?
- Had the injured employee received proper training in the task before being asked to perform it?
- Was the injured employee authorized to use the equipment or perform the task involved in the accident?
- Were other employees present at the time of the accident? If so, who are they, and what were they doing? (Interview them *separately* as soon as possible after the accident.)
- Was the task in question being performed according to properly approved procedures?
- Was proper personal protective equipment being used, and were work procedures being followed at the time of the accident?
- Was the injured employee new to the job in question?
- Was the process, equipment, or system that was involved new? Old? Properly maintained?
- Was the injured person being supervised at the time of the accident?
- Has a similar accident occurred before? If so, were corrective measures recommended? Were they implemented?
- Are there obvious factors that led to the accident or that could have prevented the accident?

FIGURE 2–2 Guidelines for conducting on-the-spot accident investigations.

of employees to observe mandatory safety precautions. When this is the case, remember that the purpose of accident investigation is to prevent future accidents, not to assign blame.

The Accident Report. Once the investigation has been completed, an **accident report** should be written.

An accident report is a comprehensive summary of all the pertinent facts about an accident.

The report format can follow the investigation checklist in Figure 2–2, unless a company uses a standard accident report form. Regardless of the format, supervisors should remember several rules when writing accident reports, including the following:

- Be brief and stick to the facts.
- Be objective and impartial.
- Be comprehensive: Do not leave out facts.
- State clearly what employees and what equipment were involved.
- List any procedures, processes, or precautions that were not being observed at the time of the accident.
- List causal factors and any contributing factors.
- Make brief, clear, concise recommendations for corrective measures.

EMPLOYEES AND SAFETY

The good efforts of contractors, managers, other professionals, and supervisors are to no avail if the individual employee refuses to cooperate. A safety and health policy does not prevent accidents unless employees accept it. Safe and healthy work practices do not prevent accidents unless they are put to use on the job. Ensuring a safe and healthy job site requires the concerted efforts of all members of the team, and employees are critical team members. It is not enough to simply know the rules related to safety; the rules must also be followed. Following the rules related to safety and health on the job site is the responsibility of the individual employee. It is not enough to simply avoid causing accidents on the job site. Employees must also play a positive, proactive role in helping to prevent accidents that might be caused by other employees.

SAFETY AND HEALTH PROFESSIONALS

An important member of the safety and health team is the safety and health professional (safety manager or safety engineer). Companies that are large enough sometimes employ a safety and health manager at an appropriate level in the corporate hierarchy. The manager's position in the hierarchy is an indication of the company's commitment and priorities.

In times past, construction companies with a highly placed safety and health manager were rare. However, passage of the Occupational Safety and Health Act (OSH Act) in 1970 began to change this. The OSH Act, more than any other single factor, put teeth in the job descriptions of safety and health professionals. OSHA standards, onsite inspections, and penalties have encouraged a greater commitment to safety and health. Environmental, liability, and workers' compensation issues and the growing awareness that providing a safe and healthy job site is the right thing to do from both an ethical and a business perspective have also had an impact.

The job of the safety and health manager is complex and diverse. Figure 2–3 is an example of a job description for such a position. The description attests to the diverse nature of the job. Duties include hazard analysis, accident reporting, standards compliance, record keeping, training, and emergency planning.

CERTIFICATION OF SAFETY AND HEALTH PERSONNEL

Professional certification is an excellent way to establish credentials in the construction safety and health field. The most widely pursued accreditations are as follows:

- **Certified Safety Professional (CSP)**, which is awarded by the Board of Certified Safety Professionals (BCSP)
- **Certified Professional Ergonomist (CPE)**, which is awarded by the Board of Certification in Professional Ergonomics (BCPE)

Certified Safety Professional

To qualify as a CSP, applicants must follow these steps:

1. Apply to the BCSP
2. Meet an academic requirement

SAFETY FACTS & FINES

Bypassing safety guards and devices on powered machines is as bad as not using them in the first place, and the consequences can be just as negative. In fact, the fines for bypassing can be even higher than those assessed for not having proper machine guards. A company in Birmingham, Alabama, found this out when it was fined $154,000 for allowing employees to bypass safety switches on machines. OSHA inspected the company—on the basis of a complaint filed by union representatives. The company had been cited for the same type of violation in the past.

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1. Apply to the BCSP
2. Meet an academic requirement
3. Meet a professional safety experience requirement
4. Pass the Safety Fundamentals examination
5. Pass the Comprehensive Practice examination.[1]

Academic Requirement. The model educational background for a candidate for CSP is a baccalaureate degree in safety from a program accredited by the Accreditation Board for Engineering and Technology (ABET). Because many people enter the safety profession from other educational backgrounds, candidates for the CSP may substitute other degrees plus professional safety experience for an accredited baccalaureate degree in safety. A CSP candidate must meet one of the following minimum educational qualifications:

- Associate degree in safety and health
- Baccalaureate degree in any field

Experience Rquirement. In addition to the academic requirement, CSP candidates must have four years of professional safety experience in addition to any experience used to meet the academic requirement. Professional safety experience must meet all of the following criteria to be considered acceptable by the BCSP:

- The professional safety function must be the primary function of the position. Collateral duties in safety are not considered the primary function.
- The position's primary responsibility must be the prevention of harm to people, property, and the environment, rather than responsibility for responding to harmful events.
- The professional safety function must be at least 50 percent of the position's duties.
- The position must be full time (defined by BCSP as at least 35 hours per week).

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Paine and Patterson, Inc. (PPI)
Commercial Construction
Vacancy Announcement

Position Title: Safety and Health Manager

Position Description: The Safety and Health Manager is responsible for establishing, implementing, and managing the company's overall safety and health program. The position reports to the CEO. Specific duties include the following:

- Establish and maintain a comprehensive company-wide safety and health program.
- Assess and analyze all jobs, processes, and materials for potential hazards.
- Work with appropriate personnel to develop, implement, monitor, and evaluate accident-prevention and hazard-control strategies.
- Ensure company-wide compliance with all applicable laws, standards, and codes.
- Coordinate the activities of all members of the company's safety and health program.
- Plan, implement, and broker, as appropriate, safety- and health-related training.
- Maintain all required safety- and health-related records and reports.
- Conduct accident investigations as necessary.
- Develop and maintain a company-wide Emergency Action Plan (EAP).
- Establish and maintain an ongoing safety promotion effort.
- Analyze the company's products from the perspectives of safety, health, and liability.

Qualifications Required: The following qualifications have been established by the management team—with input from all levels and all departments.

- *Minimum Education.* Applicants must have an associate of science or applied science degree in construction safety or closely related field.
- *Preferred Education.* Applicants with a baccalaureate degree in any of the following major fields of study will be given priority: construction safety and health, construction technology, construction management, construction engineering technology, or a related field. Degree programs in these fields must include at least one credit course in construction safety and health.

FIGURE 2–3 Safety and health manager job description.

SAFETY FACTS & FINES

It is not just companies that can be penalized for poor safety and health conditions. In certain cases, responsible individuals in those companies can also be held accountable—with penalties including prison time. A company in Elk Grove, California, was fined $1.9 million by the Environmental Protection Agency (EPA), and its owner was sentenced to 80 months in prison for improper storage of hazardous chemicals. The company had dumped more than 160,000 gallons of waste oil into the ground. In addition, EPA inspectors found another 1,000 drums of oil on company property, many of them rusted and leaking.

- The position must be at the professional level. This is determined by evaluating the degree of responsible charge and reliance by peers, employers, or clients and by the person's ability to defend analytical approaches used in professional practice and the recommendations made for controlling hazards through engineering or administrative controls.
- The position must have an acceptable breadth of duties. This is determined by evaluating the variety of hazards about which a candidate must advise and the range of skills involved in recognizing, evaluating, and controlling hazards. Examples of these skills include analysis, synthesis, design, investigation, planning, administration, and communication.

Examination Requirements. The process to achieve the CSP designation typically involves passing two examinations: Safety Fundamentals and Comprehensive Practice.

- *Safety Fundamentals examination.* The Safety Fundamentals examination covers basic knowledge appropriate to professional safety practice. Candidates who meet the academic standard (achieve 48 points through an associate or a baccalaureate degree plus experience) may sit for the Safety Fundamentals examination. Upon passing this examination, candidates receive the Associate Safety Professional (ASP) title to denote their progress toward the CSP.
- *Comprehensive Practice examination.* All CSP candidates must acquire 96 points and pass the Comprehensive Practice examination. To take this examination, a candidate must meet both the academic and experience requirements and have passed or have had waived the Safety Fundamentals examination. The total credit for academic degrees at all levels plus the months of professional safety experience must equal or exceed 96 points. After passing this examination, a candidate receives the CSP title. The address, telephone number, and website for the BCSP is as follows:

  Board of Certified Safety Professionals
  208 Burwash Avenue
  Savoy, IL 61874
  (217) 359-9263
  http://www.bcsp.org

Certified Professional Ergonomist

The examination for CPE is administered by the BCPE.[2] Details concerning the examination are provided in the following paragraphs. To take the examination, individuals must meet the following requirements.

- *Academic requirements.* Applicants should have graduated from a regionally accredited college or university with a masters degree or equivalent in one of the correlative fields of ergonomics, such as biomechanics, human factors and ergonomics, industrial engineering, industrial hygiene, kinesiology, psychology, or systems engineering. Not everyone trained in these fields necessarily has the capabilities required for certification. The board uses other criteria to determine whether an applicant's ergonomics education has been sufficiently broad.
- *Work experience.* Applicants must have completed at least four years of ergonomic work experience. Appropriateness of work experience is determined from the applicant's employment history and evidence of participation in projects requiring ergonomic expertise.
- *Work product.* One work sample must be submitted with the application. This work sample must demonstrate a breadth of ergonomic knowledge and the ability to use ergonomic methods successfully. The work sample must demonstrate, at a minimum, the candidate's capabilities in the application of ergonomic principles to the design of a product, system, or work environment. Allowable work products are technical reports, design papers, analysis reports, evaluation reports, patent applications, or a thorough written description of the project.

Associate Level Certification

The Associate Ergonomics Professional (AEP) category is a precursor to the CPE designation and is available to a candidate who fulfils the following criteria:

- Meets the education requirements for BCPE certification
- Has passed Part 1 of the examination (on basic knowledge of human factors and ergonomics)
- Is currently working toward fulfilling the BCPE requirement of four years of practical experience as a human factors and ergonomics professional.

Baccalaureate Degree Certification

A credential is available that recognizes a candidate for achieving the following levels of knowledge, skills, and experience in ergonomics practice:

- A baccalaureate degree from a recognized university (related field)
- At least 200 hours of ergonomics training
- At least two full years of practicing ergonomics
- A satisfactory score on the four-hour, two-part, multiple-choice examination on ergonomics foundations and ergonomics practice methods.

Contact information for the BCPE is as follows:

Board of Certification in Professional Ergonomics
P.O. Box 2811
Bellingham, WA 98227-2811
(360) 671-7601
http://www.bcpe.org

- The position must be at the professional level. This is determined by evaluating the degree of responsible charge and reliance by peers, employers, or clients and by the person's ability to defend analytical approaches used in professional practice and the recommendations made for controlling hazards through engineering or administrative controls.
- The position must have an acceptable breadth of duties. This is determined by evaluating the variety of hazards about which a candidate must advise and the range of skills involved in recognizing, evaluating, and controlling hazards. Examples of these skills include analysis, synthesis, design, investigation, planning, administration, and communication.

Examination Requirements. The process to achieve the CSP designation typically involves passing two examinations: Safety Fundamentals and Comprehensive Practice.

- *Safety Fundamentals examination.* The Safety Fundamentals examination covers basic knowledge appropriate to professional safety practice. Candidates who meet the academic standard (achieve 48 points through an associate or a baccalaureate degree plus experience) may sit for the Safety Fundamentals examination. Upon passing this examination, candidates receive the Associate Safety Professional (ASP) title to denote their progress toward the CSP.
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Summary

The safety and health team in a construction company, depending on the size of the company, may include the following: the contractor, managers, various professional personnel, supervisors, subcontractors, employees, and health and safety professionals. Contractors are responsible for setting a prosafety tone for the company, establishing commitment, and providing sufficient resources to support a comprehensive safety program.

Managers and other professionals are responsible for setting a positive example and for translating the commitment of the contractor into everyday practice. Supervisors are key players on the safety team of a construction company. Their responsibilities include the following: training, accident prevention, and accident investigation and reporting. Employees are responsible for following safety rules and regulations and for playing a proactive role in helping to prevent accidents. Some construction companies are large enough to employ safety and health professionals (managers or engineers). When this is the case, the health and safety professional is the management-level employee who is assigned primary responsibility for establishing, implementing, operating, and evaluating the company's safety and health program.

Key Terms and Concepts

Accident report
Accident investigation
Certified Professional Ergonomist (CPE)
Certified Safety Professional (CSP)
Commitment to safety and health
Developing job descriptions
Developing performance appraisal forms
General housekeeping procedures
Orientation
Prosafety tone
Recognizing safe work behavior
Rewarding safe behavior
Safety and health professionals
Safety and health team
Sufficient resources

Review Questions

1. List the "players" who might be part of the safety and health team for a large construction company.
2. What are the responsibilities of contractors related to safety and health?
3. What are the safety and health responsibilities of managers and other professionals in a construction company?
4. Describe the training responsibilities of supervisors in construction companies.
5. What are the accident-prevention responsibilities of supervisors in construction companies?
6. Define the term *accident report.*
7. List five rules to follow when writing accident reports.
8. What are the employee's safety and health responsibilities?
9. Explain the responsibilities of safety and health professionals in construction companies.
10. How does one go about becoming a Certified Safety Professional?

Critical Thinking and Discussion Activities

1. "I think we put too much responsibility on the shoulders of management when it comes to maintaining safe job sites," said one student of safety and health. "After all, you can't make an employee work safely. If an employee fails to follow the rules and gets hurt, that's his problem." "It's true that you can't make an employee work safely, but management should still be responsible for establishing, implementing, and enforcing a safety program," responded another student. Join this debate. What is your opinion?
2. "I don't see how you can say that safety is a team sport in those companies that hire safety and health professionals," argued one safety and health student. "If you have a safety manager, everyone is going to expect him or her to be responsible for safety." "That's not true," said another student. "The safety and health manager is just the team captain. Everybody else is still a player and has a job to do." Join this debate. What is your opinion? Will companies have trouble getting all employees to take responsibility for safety if they hire safety managers or engineers?

Application Activities

1. Identify a construction company in your community that will cooperate with you in completing this activity. How is safety handled? Is it a team sport? Do safety-related responsibilities appear in job descriptions? Is safe behavior on the job evaluated? Is it rewarded?
2. Identify a construction company in your community that employs a full-time safety and health manager or engineer. Interview this individual. What are his or her duties? Who does the safety manager or engineer report to? What are the major responsibilities listed in this individual's job description?

Endnotes

1. Board of Certified Safety Professionals (BCSP), *The CSP and Specialty Certifications* (July 2008), 1–6. http://www.bcsp.org/.
2. Board of Certified Professional Ergonomists (BCPE), *BCPE—Frequently Asked Questions* (July 2008), 1–5. http://222.bcpe.org.

CHAPTER THREE

ACCIDENT CAUSATION THEORIES

MAJOR TOPICS

- Domino Theory of Accident Causation
- Human Factors Theory of Accident Causation
- Accident/Incident Theory of Accident Causation
- Epidemiological Theory of Accident Causation
- Systems Theory of Accident Causation
- Combination Theory of Accident Causation
- Behavioral Theory of Accident Causation

Why do accidents occur in construction? Some of the most common contributing factors are as follows: (1) physical hazards, (2) environmental hazards, (3) human factors, (4) lack of safety regulations or poor ones, and (5) poor communication within, between, and among the various trades working at a construction site. There are known contributing factors, but they do not explain why accidents happen. Accidents should not be viewed as inevitable just because hazards exist. For every accident that occurs, there is a cause.

Every year, work-related accidents cost the United States almost $50 million.[1] This figure includes costs associated with lost wages, medical expenses, insurance costs, and indirect costs. The number of persons injured in workplace accidents in a typical year is 3 per 100 persons working in construction.[2] In the U.S. workplace, there is one accidental death approximately every 51 minutes and one injury every 19 seconds.[3]

Why do accidents happen? This question has concerned safety and health experts for decades because, to prevent accidents, we must know why they happen. Over the years, several theories of accident causation have evolved that attempt to explain why accidents occur. Models based on these theories are used to predict and prevent accidents.

The most widely known theories of accident causation are the **domino theory**, **human factors theory**, **accident/incident theory**, **epidemiological theory**, **systems theory**, **combination theory**, and **behavioral theory**. This chapter provides practicing and prospective construction professionals with the information they need to fully understand and apply these theories.

DOMINO THEORY OF ACCIDENT CAUSATION

Herbert W. Heinrich, an official with the Travelers Insurance Company, was an early pioneer of accident prevention and workplace safety. In the late 1920s, after studying the reports of 75,000 workplace accidents, Heinrich concluded that

- 88 percent of workplace accidents are caused by **unsafe acts** committed by fellow workers,
- 10 percent of workplace accidents are caused by unsafe conditions, and
- 2 percent of workplace accidents are unavoidable.[4]

Heinrich's study laid the foundation for his **Axioms of Industrial Safety** and his theory of accident causation, which came to be known as the domino theory. So much of Heinrich's theory has been discounted by more contemporary research that it is now considered outdated. However, since some of today's more widely accepted theories can be traced back to Heinrich's theory, students of construction safety should be familiar with his work.

Heinrich's Axioms of Workplace Safety

Heinrich summarized what he thought health and safety decision makers should know about accidents in 10 statements which he called *Axioms of Industrial Safety*. These axioms can be paraphrased as follows:

1. Injuries result from a completed series of factors—one of which is the accident itself.
2. An accident can occur only as the result of an unsafe act by a person or a physical or mechanical hazard, or both.
3. Most accidents are the result of **unsafe behavior** by people.
4. An unsafe act by a person or an unsafe condition does not always immediately result in an accident or injury.
5. The reasons why people commit unsafe acts can serve as helpful guides in selecting corrective actions.
6. The severity of an accident is largely fortuitous, and the accident that caused it is largely preventable.