Reading Assignment

Each year, work-related accidents cost the United States almost $50 billion.1 This figure includes costs associated with lost wages, medical expenses, insurance costs, and indirect costs. The number of persons injured in industrial place accidents in a typical year is 7,128,000, or 3 per 100 persons per year.2 In the 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 decision makers for decades, because in order 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, the human factors theory, the accident/incident theory, the epidemiological theory, the systems theory, the combination theory, and the behavioral theory. This chapter provides practicing and prospective safety professionals with the information they need to understand fully and apply these theories.

Domino Theory of Accident Causation

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

88 percent of industrial accidents are caused by unsafe acts committed by fellow workers;

10 percent of industrial accidents are caused by unsafe conditions;

2 percent of industrial 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 So much of Heinrich's theory has been discounted by more contemporary research that it is now considered outdated.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, because some of today's more widely accepted theories can be traced back to Heinrich's theory, students of industrial safety should be familiar with his work.

Heinrich's Axioms of Industrial Safety

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

Injuries result from a completed series of factors, one of which is the accident itself.

An accident can occur only as the result of an unsafe act by a person and/or a physical or mechanical hazard.

Most accidents are the result of unsafe behavior by people.

An unsafe act by a person or an unsafe condition does not always immediately result in an accident/injury.

The reasons why people commit unsafe acts can serve as helpful guides in selecting corrective actions.

The severity of an accident is largely fortuitous, and the accident that caused it is largely preventable.

The best accident prevention techniques are analogous with the best quality and productivity techniques.

Management should assume responsibility for safety because it is in the best position to get results.

The supervisor is the key person in the prevention of industrial accidents.

In addition to the direct costs of an accident (e.g., compensation, liability claims, medical costs, and hospital expenses), there are also hidden or indirect costs.5

According to Heinrich, these axioms encompass the fundamental body of knowledge that must be understood by decision makers interested in preventing accidents. Any accident prevention program that takes all 10 axioms into account is more likely to be effective than a program that leaves out one or more axioms.

Heinrich's Domino Theory

Perhaps you have stood up a row of dominoes, tipped the first one over, and watched as each successive domino topples the one next to it. This is how Heinrich's theory of accident causation works. According to Heinrich, there are five factors in the sequence of events leading up to an accident. These factors can be summarized as follows:

Ancestry and social environment. Negative character traits that may lead people to behave in an unsafe manner can be inherited (ancestry) or acquired as a result of the social environment (e.g., alcoholism).

Fault of person. Negative character traits, whether inherited or acquired, are why people behave in an unsafe manner and why hazardous conditions exist.

Unsafe act/mechanical or physical hazard. Unsafe acts committed by people and mechanical or physical hazards are the direct causes of accidents.

Accident. Typically, accidents that result in injury are caused by falling or being hit by moving objects.

Injury. Typical injuries resulting from accidents include lacerations and fractures.6

Heinrich's theory has two central points: (1) injuries are caused by the action of preceding factors and (2) the removal of the central factor (unsafe act/hazardous condition) negates the action of the preceding factors and, in so doing, prevents accidents and injuries.

Heinrich's Theory and Corrective Action

The Three "Es" of safety—engineering, education, and enforcement—(Chapter 1) work well in taking corrective action in conjunction with Heinrich's theory. The engineering component recommends that hazards be controlled through better product design or process improvements. The education component recommends training workers on all aspects of safe work practices and management on their role in providing a safe working environment. The enforcement component recommends that safety professionals, managers, supervisors, and fellow workers act immediately when someone is observed ignoring safe work practices. Safety rules and procedures have no value unless they are followed, and they will not be followed unless they are enforced.

Domino Theory in Practice

Construction Products Company (CPC) is a distributor of lumber, pipe, and concrete products. Its customers are typically small building contractors. CPC's facility consists of an office in which orders are placed and several large warehouses. Contractors place their orders in the office. They then drive their trucks through the appropriate warehouses to be loaded by CPC personnel.

Because the contractors are small operations, most of their orders are also relatively small and can be loaded by hand. Warehouse personnel go to the appropriate bins, pull out the material needed to fill their orders, and load the materials on customers' trucks. Even though most orders are small enough to be loaded by hand, many of the materials purchased are bulky and cumbersome to handle. Because of this, CPC's loaders are required to wear such personal protection gear as hard hats, padded gloves, steel-toed boots, and lower-back-support belts.

For years, CPC's management team had noticed an increase in minor injuries to warehouse personnel during the summer months. Typically, these injuries consisted of nothing worse than minor cuts, scrapes, and bruises. However, this past summer had been different. Two warehouse workers had sustained serious back injuries. These injuries have been costly to CPC both financially and in terms of employee morale.

An investigation of these accidents quickly identified a series of events and a central causal behavior that set up a domino effect that, in turn, resulted in the injuries. The investigation revealed that CPC's warehouses became so hot during the summer months that personal protection gear was uncomfortable. As a result, warehouse personnel simply discarded it. Failure to use appropriate personal protection gear in the summer months had always led to an increase in injuries. However, because the injuries were minor in nature, management had never paid much attention to the situation. It was probably inevitable that more serious injuries would occur eventually.

To prevent a recurrence of the summer-injury epidemic, CPC's management team decided to remove the causal factor—failure of warehouse personnel to use their personal protection gear during the summer months. To facilitate the removal of this factor, CPC's management team formed a committee consisting of one executive manager, one warehouse supervisor, and three warehouse employees.

The committee made the following recommendations: (1) provide all warehouse personnel with training on the importance and proper use of personal protection gear; (2) require warehouse supervisors to monitor the use of personal protection gear more closely; (3) establish a company policy that contains specific and progressive disciplinary measures for failure to use required personal

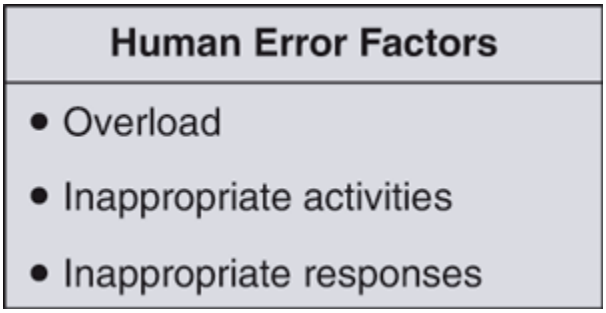
protection gear; and (4) implement several heat reduction measures to make warehouses cooler during the summer months.

CPC's management team adopted all the committee's recommendations. In doing so, it removed the central causal factor that had historically led to an increase in injuries during the summer months.

Human Factors Theory of Accident Causation

The human factors theory of accident causation attributes accidents to a chain of events ultimately caused by human error. It consists of the following three broad factors that lead to human error: overload, inappropriate response, and inappropriate activities (see Figure 3–1). These factors are explained in the following paragraphs.

Figure 3–1 Factors that cause human errors.



Overload

Overload amounts to an imbalance between a person's capacity at any given time and the load that person is carrying in a given state. A person's capacity is the product of such factors as his or her natural ability, training, state of mind, fatigue, stress, and physical condition. The load that a person is carrying consists of tasks for which he or she is responsible and added burdens resulting from environmental factors (noise, distractions, and so on), internal factors (personal problems, emotional stress, and worry), and situational factors (level of risk, unclear instructions, and so on). The state in which a person is acting is the product of his or her motivational and arousal levels.

Inappropriate Response and Incompatibility

How a person responds in a given situation can cause or prevent an accident. If a person detects a hazardous condition but does nothing to correct it, he or she has responded inappropriately. If a person removes a safeguard from a machine in an effort to increase output, he or she has responded inappropriately. If a person disregards an established safety procedure, he or she has responded inappropriately. Such responses can lead to accidents. In addition to inappropriate responses, this

component includes workstation incompatibility. The incompatibility of a person's workstation with regard to size, force, reach, feel, and similar factors can lead to accidents and injuries.

Inappropriate Activities

Human error can be the result of inappropriate activities. An example of an inappropriate activity is a person who undertakes a task that he or she doesn't know how to do. Another example is a person who misjudges the degree of risk involved in a given task and proceeds based on that misjudgment. Such inappropriate activities can lead to accidents and injuries. Figure 3–2 summarizes the various components of the human factors theory.7

Figure 3–2 Human factors theory.

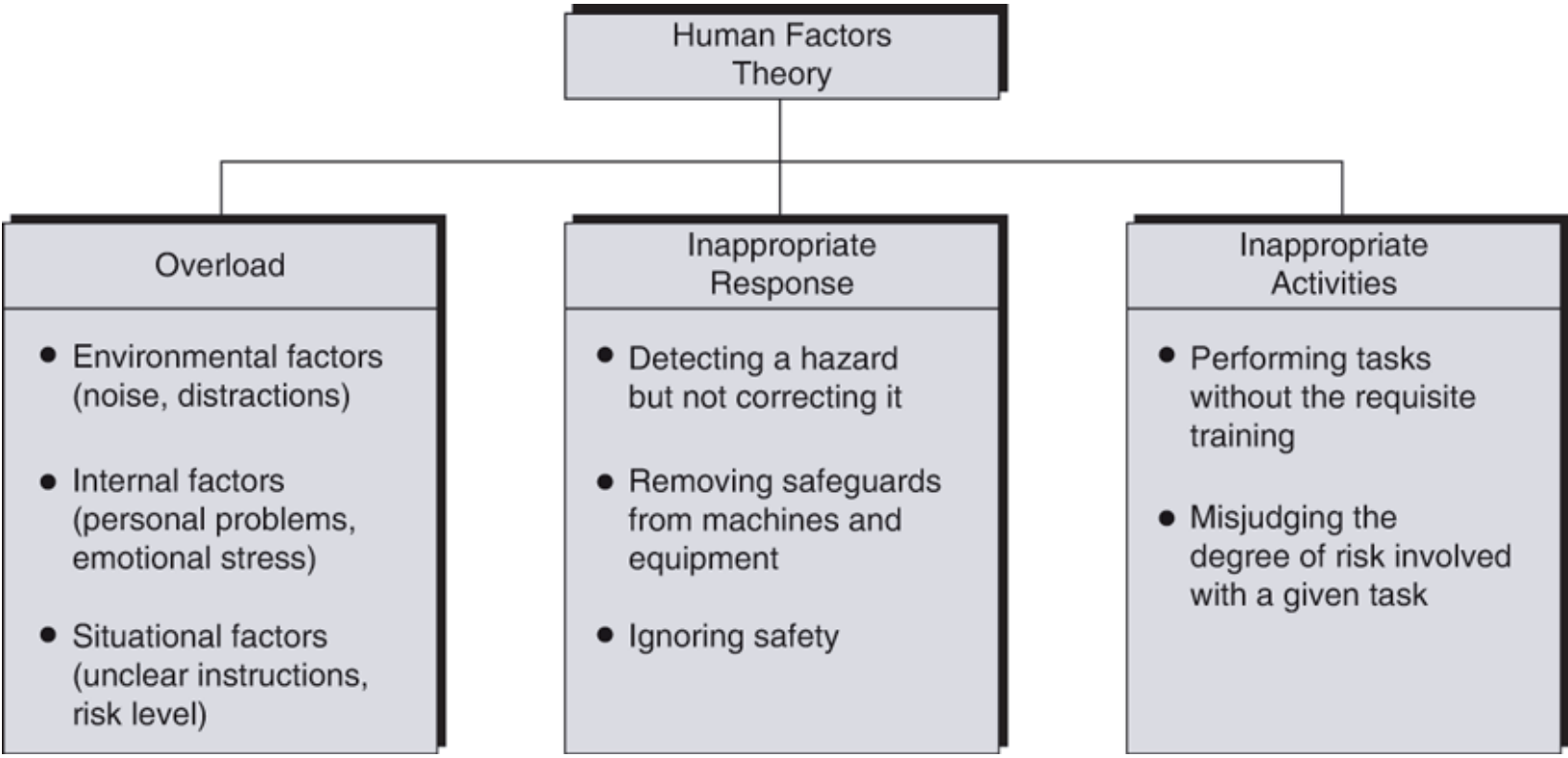


Figure 3–2 Full Alternative Text

Human Factors Theory in Practice

Kitchenware Manufacturing Incorporated (KMI) produces aluminum kitchenware for commercial settings. After 10 years of steady, respectable growth in the U.S. market, KMI suddenly saw its sales triple in less than six months. This rapid growth was the result of KMI's successful entry into European and Asian markets.

The growth in sales, although welcomed by both management and employees, quickly overloaded and, before long, overwhelmed the company's production facility. KMI responded by adding a second shift of production personnel and approving unlimited overtime for highly skilled personnel. Shortly after the upturn in production, KMI began to experience a disturbing increase in accidents and injuries. During his accident investigations, KMI's safety manager noticed that human error figured prominently in the accidents. He grouped all the human errors identified into three categories: (1) overload; (2) inappropriate response; and (3) inappropriate activities.

In the category of overload, he found that the rush to fill orders was pushing production personnel beyond their personal limits in some cases, and beyond their capabilities in others. Stress, insufficient training of new employees, and fatigue, all contributed to the overload. In the category of inappropriate response, the safety manager determined that many of KMI's production personnel had removed safeguards from their machines in an attempt to speed up production. All the machines involved in accidents had had safeguards removed.

In the category of inappropriate activities, the safety manager found that new employees were being assigned duties for which they weren't yet fully trained. As a result, they often misjudged the amount of risk associated with their work tasks.

With enough accident investigations completed to identify a pattern of human error, the safety manager prepared a presentation containing a set of recommendations for corrective measures for KMI's executive management team. His recommendations were designed to prevent human error–oriented accidents without slowing production.

Safety Fact

Pregnancy and Work

Strenuous physical work and pregnancy can be a dangerous combination. Too much strenuous labor can result in a miscarriage. The types of work to be avoided by pregnant employees include the following:

Standing for more than three hours per day

Operating machinery that vibrates

Lifting heavy loads

Working in extremes of hot or cold

Shift work and workstations that require awkward postures can also put pregnant employees at risk. The third trimester is the most risk-intensive time during pregnancy.

Accident/Incident Theory of Accident Causation

The accident/incident theory is an extension of the human factors theory. It was developed by Dan Petersen and is sometimes referred to as the Petersen accident/incident theory.8 Petersen introduced such new elements as ergonomic traps, the decision to err, and systems failures, while retaining much of the human factors theory. A model based on his theory is shown in Figure 3–3.

Figure 3–3 Accident/incident theory.

Figure 3–3 Full Alternative Text

In this model, overload, ergonomic traps, or a decision to err leads to human error. The decision to err may be conscious and based on logic, or it may be unconscious. A variety of pressures such as deadlines, peer pressure, and budget factors can lead to unsafe behavior. Another factor that can influence such a decision is the "It won't happen to me" syndrome.

The systems failure component is an important contribution of Petersen's theory. First, it shows the potential for a causal relationship between management decisions or management behavior and safety. Second, it establishes management's role in accident prevention as well as in the broader concepts of safety and health in the workplace.

Following are just some of the different ways that systems can fail, according to Petersen's theory:

Management does not establish a comprehensive safety policy.

Responsibility and authority with regard to safety are not clearly defined.

Safety procedures such as measurement, inspection, correction, and investigation are ignored or given insufficient attention.

Employees do not receive proper orientation.

Employees are not given sufficient safety training.

Accident/Incident Theory in Practice

Poultry Processing Corporation (PPC) processes chickens and turkeys for grocery chains. Poultry processing is a labor-intensive enterprise involving a great deal of handwork. A variety of different knives, shears, and cleavers are used. Much of the work is monotonous and repetitive. Selected parts of the overall process must be done in cold conditions.

PPC has gone to great lengths to ensure that workstations are ergonomically sound, that personal protection gear used is appropriate, and that adequate precautions are taken to prevent illness and injuries. As a result, PPC is an award-winning company in the area of workplace safety and health.

Consequently, the poultry-processing industry was shocked when a class action lawsuit was filed against PPC on behalf of over 50 employees, all of whom claimed to be suffering from carpal tunnel syndrome (CTS). Because of PPC's excellent safety and health record, most observers felt sure that the company would be vindicated in the end.

The company's policies and procedures relating to safety and health were investigated thoroughly by consultants brought in by both PPC and the attorney for the plaintiffs. Over 100 witnesses gave depositions, and several preliminary hearings were held. By the time the trial finally rolled around, both sides had accumulated mountains of paper and filing cabinets full of evidence. Then, suddenly and without advance notice, PPC offered a substantial financial settlement, which the plaintiffs accepted.

It was one of PPC's outside consultants who discovered what had caused the increased incidence of CTS. The company had always used a centralized approach to managing safety and health. Responsibility for such tasks as measurement, inspection, correction, and investigation was assigned to the safety manager, Joe Don Huttle. Huttle had an excellent record during his 20 years in the poultry-processing industry, with the last 5 years spent at PPC. In fact, he was so well respected in the industry that his peers had elected him president of a statewide safety organization. This, as it turned out, is where PPC's troubles began.

When Huttle took it over, the safety organization had experienced a three-year decline in membership and was struggling to stay afloat financially. He had been elected as "the man who could save the organization." Intending to do just that, Huttle went right to work. For months at a time, he worked seven days a week, often spending as much as two weeks at a time on the road. When he was in his office at PPC, Huttle was either on the telephone or doing paperwork for the safety organization.

Within six months, he had reversed the organization's downhill slide, but not without paying a price at home. During the same six-month period, his duties at PPC were badly neglected. Measurement of individual and group safety performance had come to a standstill. The same was true of inspection, correction, investigation, and reporting.

It was during this time of neglect that the increased incidence of CTS occurred. Safety precautions that Huttle had instituted to guard against this particular problem were no longer observed properly once the workers realized that he had stopped observing and correcting them. Measurement and inspection may also have prevented the injuries had Huttle maintained his normal schedule of these activities.

PPC's consultant, in a confidential report to executive managers, cited the accident/incident theory in explaining his view of why the injuries occurred. In this report, the consultant said that Huttle was guilty of applying "it won't happen here" logic when he made a conscious decision to neglect his duties at PPC in favor of his duties with the professional safety organization. Of course, the employees themselves were guilty of not following clearly established procedures. However, because Huttle's neglect was also a major contributing factor, PPC decided to settle out of court.

Epidemiological Theory of Accident Causation

Traditionally, safety theories and programs have focused on accidents and the resulting injuries. However, the current trend is toward a broader perspective that also encompasses the issue of industrial hygiene. Industrial hygiene concerns environmental factors that can lead to sickness, disease, or other forms of impaired health.

This trend has, in turn, led to the development of an epidemiological theory of accident causation. Epidemiology is the study of causal relationships between environmental factors and disease. The epidemiological theory holds that the models used for studying and determining these relationships can also be used to study causal relationships between environmental factors and accidents or diseases.9

Figure 3–4 illustrates the epidemiological theory of accident causation. The key components are predispositional characteristics and situational characteristics. These characteristics, taken together,

can either result in or prevent conditions that may result in an accident. For example, if an employee who is particularly susceptible to peer pressure (predispositional characteristic) is pressured by his coworkers (situational characteristic) to speed up his operation, the result will be an increased probability of an accident.

Figure 3–4 Epidemiological theory.

Figure 3–4 Full Alternative Text

Epidemiological Theory in Practice

Jane Andrews was the newest member of the loading unit for Parcel Delivery Service (PDS). She and the other members of her unit were responsible for loading 50 trucks every morning. It was physically demanding work, and she was the first woman ever selected by PDS to work in the loading unit. She had gotten the job as part of the company's upward mobility program. She was excited about her new position because within PDS, the loading unit was considered a springboard to advancement. Consequently, she was eager to do well. The responsibility she felt toward other female employees at PDS only intensified her anxiety. Andrews felt that if she failed, other women might not get a chance to try in the future.

Before beginning work in the loading unit, employees must complete two days of training on proper lifting techniques. The use of back-support belts is mandatory for all loading dock personnel. Consequently, Andrews became concerned when the supervisor called her aside on her first day in the unit and told her to forget what she had learned in training. He said, "Jane, nobody wants a back injury, so be careful. But the key to success in this unit is speed. The lifting techniques they teach in that workshop will just slow you down. You've got the job, and I'm glad you're here. But you won't last long if you can't keep up."

Andrews was torn between following safety procedures and making a good impression on her new supervisor. At first, she made an effort to use proper lifting techniques. However, when several of her coworkers complained that she wasn't keeping up, the supervisor told Andrews to "keep up or get out of the way." Feeling the pressure, she started taking the same shortcuts she had seen her coworkers use. Positive results were immediate, and Andrews received several nods of approval from fellow workers and a "good job" from the supervisor. Before long, Andrews had won the approval and respect of her colleagues.

However, after two months of working in the loading unit, she began to experience persistent lower-back pain. Andrews felt sure that her hurried lifting techniques were to blame, but she valued the approval of her supervisor and fellow workers too much to do anything that might slow her down. Finally, one day while loading a truck, Andrews fell to the pavement in pain and could not get up. Her

back throbbed with intense pain, and her legs were numb. She had to be rushed to the emergency room of the local hospital. By the time Andrews checked out of the hospital a week later, she had undergone major surgery to repair two ruptured discs.

Jane Andrews's situation can be explained by the epidemiological theory of accident causation. The predispositional factor was her susceptibility to peer pressure from her coworkers and supervisor. The applicable situational factors were peer pressure and the priorities of the supervisor. These factors, taken together, caused the accident.

Limitations of Event-Chain Accident Causation Theories

The accident causation theories presented up to this point—Heinrich's domino, human factors, accident/incident, and epidemiological theories—all fall into the broad category of event-chain theories. Event-chain theories explain accident causation in terms of:

multiple events that occur in a sequence;

events that are linked by direct relationships between and among causal factors but ignore indirect relationships;

events that involve human error, component failure, and/or energy-related factors.

All of these event-chain theories have value, but they also have shortcomings—shortcomings that safety and health professionals should be aware of. These shortcomings include the following:

They neglect broader social and organizational factors.

They do not adequately account for physical context, social context, personal values, or the dynamics of work processes when assessing human error.

They neglect human adaptation (the tendency of more experienced workers to behave in ways that involve higher levels of risk).

The shortcomings of event-chain theories of accident causation led to the development of additional theories that attempt to take a more holistic approach to the analysis of accident causation. These additional theories are explained in the remainder of this chapter.

Systems Theory of Accident Causation

A system is a group of regularly interacting and interrelated components that together form a unified whole. This definition is the basis for the systems theory of accident causation. This theory views a situation in which an accident may occur as a system is composed of the following components: person (host), machine (agency), and environment.10 The likelihood of an accident occurring is determined by how these components interact. Changes in the patterns of interaction can increase or reduce the probability of an accident.

For example, an experienced employee who operates a numerically controlled five-axis machining center in a shop environment may take a two-week vacation. Her temporary replacement may be less experienced. This change in one component of the system (person/host) increases the probability of an accident. Such a simple example is easily understood. However, not all changes in patterns of interaction are this simple. Some are so subtle that their analysis may require a team of people, each with a different type of expertise.

The primary components of the systems model are the person/machine/environment, information, decisions, risks, and the task to be performed.11 Each of the components has a bearing on the probability that an accident will occur. The systems model is illustrated in Figure 3–5.

Figure 3–5 Systems theory model.

Figure 3–5 Full Alternative Text

As this model shows, even as a person interacts with a machine within an environment, three activities take place between the system and the task to be performed. Every time a task must be performed, there is the risk that an accident may occur. Sometimes the risks are great; at other times, they are small. This is where information collection and decision making come in.

Based on the information that has been collected by observing and mentally noting the current circumstances, the person weighs the risks and decides whether to perform the task under existing circumstances. For example, say a machine operator is working on a rush order that is behind schedule. An important safety device has malfunctioned on his machine. Simply taking it off will interrupt work for only five minutes, but it will also increase the probability of an accident. However, replacing it could take up to an hour. Should the operator remove the safety guard and proceed with the task or take the time to replace it? The operator and his supervisor may assess the situation

(collect information), weigh the risks, and make a decision to proceed. If their information was right and their assessment of the risks accurate, the task will probably be accomplished without an accident.

However, the environment in which the machine operator is working is unusually hectic, and the pressure to complete an order that is already behind schedule is intense. These factors are stressors that can cloud the judgment of those collecting information, weighing risks, and making the decision. When stressors are introduced between points 1 and 3 in Figure 3–5, the likelihood of an accident increases.

Discussion Case

What Is Your Opinion?

"All accidents, one way or another, are the result of human error." "No, accidents are the result of a combination of things. I like the combination theory." "You're both wrong. Accidents are best explained by the domino theory." So the debate went in Dr. Jameson's class at Burton State University. What is your opinion concerning the various theories of accident causation?

For this reason, the following five factors should be considered before beginning the process of collecting information, weighing risks, and making a decision:

Job requirements

The workers' abilities and limitations

The gain if the task is successfully accomplished

The loss if the task is attempted but fails

The loss if the task is not attempted12

These factors can help a person achieve the proper perspective before performing the above-mentioned tasks. It is particularly important to consider these factors when stressors such as noise, time constraints, or pressure from a supervisor may tend to cloud one's judgment.

Systems Theory in Practice

Precision Tooling Company (PTC) specializes in difficult orders that are produced in small lots, and in making corrections to parts that otherwise would wind up as expensive rejects in the scrap bin. In short, PTC specializes in doing the types of work that other companies cannot, or will not, do. Most of PTC's work comes in the form of subcontracts from larger manufacturing companies. Consequently, living up to its reputation as a high-performance, on-time company is important to PTC.

Because much of its work consists of small batches of parts to be reworked, PTC still uses several manually operated machines. The least experienced machinists operate these machines. This causes two problems. The first problem is that it is difficult for even a master machinist to hold to modern tolerance levels on these old machines. Consequently, apprentice machinists find holding to precise tolerances quite a challenge. The second problem is that the machines are so old that they frequently break down.

Complaints from apprentice machinists about the old machines are frequent. However, their supervisors consider time on the old "ulcer makers" to be one of the rites of passage that upstart machinists must endure. Their attitude is, "We had to do it, so why shouldn't you?" This was where things stood at PTC when the company won the Johnson contract.

PTC had been trying for years to become a preferred supplier for H. R. Johnson Company. PTC's big chance finally came when Johnson's manufacturing division incorrectly produced 10,000 copies of a critical part before noticing the problem. Simply scrapping the part and starting over was an expensive solution. Johnson's vice president for manufacturing decided to give PTC a chance.

PTC's management team was ecstatic! Finally, they had an opportunity to partner with H. R. Johnson Company. If PTC could perform well on this one, even more lucrative contracts were sure to follow. The top managers called a company-wide meeting of all employees. Attendance was mandatory. The CEO explained the situation as follows:

Ladies and gentlemen, we are faced with a great opportunity. I've just signed a contract with H. R. Johnson Company to rework 10,000 parts that their manufacturing folks produced improperly. The rework tasks are not that complicated, but every part has got to go through several manual operations at the front end of the rework process. This means our manual machining unit is going to have to supply the heroes on this job. I've promised the manufacturing VP at Johnson that we would have his parts ready in 90 days. I know that's a lot to do in so short a period of time, but Johnson is in a real bind here. If we can produce on this one, they won't forget us in the future.

This put PTC's apprentice machinists on the spot. If PTC didn't perform on this contract, it would be their fault. They cursed their old machines and got to work. The CEO had said the rework tasks would not be "that complicated," but, as it turned out, the processes weren't that simple either. The problem was tolerances. Holding to the tolerances specified in the Johnson contract took extra time and a special effort on every single part. Before long, the manual machining unit was behind schedule, and management was getting nervous. The situation was made even worse by the continual breakdowns and equipment failures experienced. The harder the unit supervisor pushed, the more stressed the employees and machines became.

Predictably, it wasn't long before safety procedures were forgotten, and unreasonable risks were being taken. The pressure from management, the inexperience of the apprentice machinists, and the constant equipment failures finally took their toll. In a hurry to get back on schedule, and fearing that his machine would break down again, one machinist got careless and ran his hand into the cutter on his milling machine. By the time the machine had been shut down, his hand was badly mutilated. In the aftershock of this accident, PTC was unable to meet the agreed-upon completion schedule. Unfortunately, PTC did not make the kind of impression on H. R. Johnson's management team that it had hoped.

This accident can be explained by the systems theory. The person–machine– environment chain has a direct application in this case. The person involved was relatively inexperienced. The machine involved was old and prone to breakdowns. The environment was especially stressful and pressure packed. These three factors, taken together, resulted in this serious and tragic accident.

Combination Theory of Accident Causation

There is often a degree of difference between any theory of accident causation and reality. The various models presented with their corresponding theories in this chapter attempt to explain why accidents occur. For some accidents, a given model may be very accurate. For others, it may be less so. Often the cause of an accident cannot be adequately explained by just one model or theory. Thus, according to the combination theory, the actual cause may combine parts of several different models. Safety personnel should use these theories as appropriate both for accident prevention and accident investigation. However, they should avoid the tendency to try to apply one model to all accidents.

Combination Theory in Practice

Crestview Grain Corporation (CGC) maintains 10 large silos for storing corn, rice, wheat, barley, and various other grains. Because stored grain generates fine dust and gases, ventilation of the silos is important. Consequently, all of CGC's silos have several large vents. Each of these vents uses a filter similar to the type used in home air conditioners that must be changed periodically.

There is an element of risk involved in changing the vent filters because of two potential hazards. The first hazard comes from unvented dust and gases that can make breathing difficult, or even dangerous. The second hazard is the grain itself. Each silo has a catwalk that runs around its inside circumference near the top. These catwalks give employees access to the vents that are also near the top of each silo. The catwalks are almost 100 feet above ground level, they are narrow, and the guardrails on them are only knee high. A fall from a catwalk into the grain below would probably be fatal.

Consequently, CGC has well-defined rules that employees are to follow when changing filters. Because these rules are strictly enforced, there had never been an accident in any of CGC's silos—that is, not until the Juan Perez tragedy occurred. Perez was not new to the company. At the time of his accident, he had worked at CGC for over five years. However, he was new to the job of silo maintenance. His inexperience, as it turned out, would prove fatal.

It was time to change the vent filters in silo number 4. Perez had never changed vent filters himself. He hadn't been in the job long enough. However, he had served as the required "second man" when his supervisor, Bao Chu Lai, had changed the filters in silos 1, 2, and 3. Because Chu Lai was at home recuperating from heart surgery and would be out for another four weeks, Perez decided to change the filters himself. Changing the filters was a simple enough task, and Perez had always thought the second-man concept was overdoing it a little. He believed in taking reasonable precautions as much as the next person, but in his opinion, CGC was paranoid about safety.

Perez collected his safety harness, respirator, and four new vent filters. Then he climbed the external ladder to the entrance–exit platform near the top of silo number 4. Before going in, Perez donned his respirator and strapped on his safety harness. Opening the hatch cover, he stepped inside the silo onto the catwalk. Following procedure, Perez attached a lifeline to his safety harness, picked up the new vent filters, and headed for the first vent. He changed the first two filters without incident. It was while he was changing the third filter that tragedy struck.

The filter in the third vent was wedged in tightly. After several attempts to pull it out, Perez became frustrated and gave the filter a good jerk. When the filter suddenly broke loose, the momentum propelled Perez backward and he toppled off the catwalk. At first it appeared that his lifeline would hold, but without a second person to pull him up or call for help, Perez was suspended by only the lifeline for over 20 minutes. He finally panicked, and in his struggle to pull himself up, knocked open the buckle of his safety harness. The buckle gave way, and Perez fell over 50 feet into the grain below. The impact knocked off his respirator, the grain quickly enveloped him, and Perez was asphyxiated.

The accident investigation that followed revealed that several factors combined to cause the fatal accident—the combination theory. The most critical of these factors were as follows:

Absence of the supervisor

Inexperience of Perez

A conscious decision by Perez to disregard CGC's safety procedures

A faulty buckling mechanism on the safety harness

An unsafe design (only a knee-high guardrail on the catwalk)

Behavioral Theory of Accident Causation

The behavioral theory of accident causation and prevention is often referred to as behavior-based safety (BBS). BBS has both proponents and critics. One of the most prominent proponents of BBS is E. Scott Geller, a senior partner of Safety Performance Solutions, Inc., and a professor of psychology. It is appropriate that Geller is a professional psychologist because BBS is the application of behavioral theories from the field of psychology to the field of occupational safety.

According to Geller, there are seven basic principles of BBS: (1) intervention that is focused on employee behavior; (2) identification of external factors that will help understand and improve employee behavior (from the perspective of safety in the workplace); (3) direct behavior with activators or events antecedent to the desired behavior, and motivation of the employee to behave as desired with incentives and rewards that will follow the desired behavior; (4) focus on the positive consequences that will result from the desired behavior as a way to motivate employees; (5) application of the scientific method to improve attempts at behavioral interventions; (6) use of theory to integrate information rather than to limit possibilities; and (7) planned interventions with the feelings and attitudes of the individual employee in mind.13

Those who have studied psychology will recognize BBS as an innovative and practical application of standard behavioral theory to the field of occupational safety. These theories are relevant in any situation in which certain types of human behaviors are desired while others are to be avoided. Positive reinforcement in the form of incentives and rewards is used to promote the desired (safe) behaviors and to discourage undesirable (unsafe) behaviors.

Behavioral Theory in Action

Mark Potter is the safety manager for Excello Corporation. Several months ago, he became concerned because employees seemed to have developed a lax attitude toward wearing hard hats. What really troubled Potter was that there was more than the usual potential for head injuries because of the type of work done in Excello's plant, and he had personally witnessed two near misses in less than a week. An advocate of BBS, he decided to take an innovative approach in turning around this unsafe behavior pattern.

His first step was to remove all the old "Hard Hat Area" signs from the plant and replace them with newer, more noticeable signs. Then he scheduled a brief seminar on head injuries and cycled all employees through it over a two-week period. The seminar took an unusual approach. It told a story of two employees. One was in a hospital bed surrounded by family members he did not even recognize. The other was shown enjoying a family outing with happy family members. The clear message of the video was "the difference between these two employees is a hard hat." These two activities were the antecedents to the behavior he hoped to produce (all employees wearing hard hats when in a hard hat area).

The video contained a powerful message and it had the desired effect. Within days, employees were once again disciplining themselves to wear their hard hats (the desired behavior). The consequence was that near misses stopped, and no head injuries have occurred at Excello in months. The outcome of this is that Excello's employees have been able to continue enjoying the fruits of their labor and the company of loved ones.

Individual Factors and Accident Causation

One of the most pernicious causes of accidents on the job is chemicals—but not the kind industrial hygienists generally concern themselves with.14 The chemicals alluded to here are the illicit drugs and alcohol used by employees. Drugs and alcohol are the root cause or contributing cause of many accidents on the job every year. Consequently, safety professionals need to be on guard for employees who are drug and alcohol abusers.

This is why so many companies implement drug-free workplace programs. In fact, since 1989 federal contractors have been required to do so. Such programs typically include the following components: drug-free workplace policy, supervisory training, employee education, employee assistance programs (EAPs), and alcohol and drug testing.

Establishing drug-free workplace programs is typically the responsibility of the human resources department. However, safety and health professionals should be aware of the workplace problems that can be caused by alcohol and drug abuse. Further, if a cross-functional team of representatives from various departments is convened by the human resources department for the purpose of

developing a drug-free workplace program, the chief safety and health professional for the organization should be a member of that team. An invisible problem in today's workplace is clinical depression. People who suffer from clinical depression are seriously impaired, and, as a result, they pose a clear and present safety risk to themselves, fellow workers, and their employer.15 Mental health professionals estimate that up to 10 percent of the adult population in the United States suffers from clinical depression. This translates to 1 in every 20 people on the job.

The causes of clinical depression are many and varied, but the most common causes are biological (too few or too many of the brain chemicals known as neurotransmitters), cognitive (negative thought processes), genetic (family history of depression), and concurring illnesses (strokes, cancer, heart disease, Alzheimer's, and other diseases can increase the incidence of depression).

Warning Signs

Safety and health professionals are not mental health professionals and should not attempt to play that role. However, they should be alert to the warning signs of clinical depression in employees. These signs are as follows:

Persistent dreary moods (sadness, anxiety, nervousness)

Signs of too little sleep

Sleeping on the job or persistent drowsiness

Sudden weight loss or gain

General loss of interest, especially in areas of previous interest

Restlessness, inability to concentrate, or irritability

Chronic physical problems (headaches, digestive disorders, etc.)

Forgetfulness or an inability to make simple decisions

Persistent feelings of guilt

Feelings of low self-worth

Focus on death or talk of suicide

Safety and health professionals who recognize any or all of these symptoms in an employee should avoid the natural human tendency to help the employee deal with the problems. Rather, the appropriate action is to get the employee into the hands of competent mental health professionals right away. The best way to do this is to approach the employee's supervisor and recommend that he or she refer the employee to the organization's EAP or to the human resources department. Other individual factors that can be the cause or a contributing cause of accidents in the workplace include obesity, fatigue, memory, and personality. Obesity not only restricts the movement and potential reaction time of individuals, which can, in turn, cause accidents, but also can be a major contributing factor in overexertion-related accidents. Obesity has become such an all-pervasive problem in the United States that this potential cause of accidents is treated in greater detail in a separate section later in this chapter.

Fatigue can cause or be a contributing factor in accidents because it impairs judgment, attention, and reasoning power. Memory can be a causal factor in accidents when a worker simply forgets to employ the safe work learned. Personality can contribute causally to accidents in several ways. Some people have personalities that lend themselves to following safety rules and employing safe work practices while others have personalities that lend themselves to laxity in these areas. Some people are hot-tempered and prone to act rashly. Others are curious and, as a result, prone to disregard safe work practices and experiment. Some people are attentive, while others are prone to let their minds wander. The list of personal factors that can affect workplace safety, although not infinite, is long.

Sources of Help

Because clinical depression in employees has become such an all-pervasive problem that increases the risk of accidents and injuries on the job, safety and health professionals need to learn all they can about this problem and keep up-to-date with the latest information concerning it. The following sources may help:

Employee Assistance Professionals Association, 703-522-6272, www.eapa.org.

National Institute of Mental Health, 800-421-4211, www.nimh.nih.gov.

National Mental Health Association, 800-969-NMHA, www.nmha.org.

An accident is any unplanned event that interrupts the completion of activity and that may or may not involve human injury or property damage. The term incident refers to that which did not cause injury or property damage but had the potential to. The term "near miss" is sometimes used in place of the term "incident."1 When accidents occur in the workplace, they should be investigated. Reasons for conducting accident investigations include the following:

Determine the cause so that future accidents can be prevented

Fulfill any applicable legal and/or regulatory requirements

Determine the cost of the accident

Determine compliance with applicable safety regulations

Provide information for processing workers' compensation claims2

This chapter gives prospective and practicing safety and health professionals the information they need to conduct thorough, effective accident investigations and prepare comprehensive accident reports.

Types of Accident Investigations

There are accident reports and there are accident-analysis reports. An accident report is completed when the accident in question represents only a minor incident. It answers the following questions: who, what, where, and when. However, it does not answer the why question.3 An accident report can be completed by a person with very little formal investigation and reporting training or experience. Supervisors often complete accident reports which, in turn, might be used later as part one of a more in-depth accident report. The Occupational Safety and Health Administration's (OSHA) Form 301 can be used for accident reports (Figure 8–1).

Figure 8–1 OSHA's Form 301.

Source: OSHA's Form 301, Occupational Safety and Health Administration

Figure 8–1 Full Alternative Text

Figure 8–1 is OSHA's Form 301—"Injury and Illness Incident Report." Although organizations may develop customized accident report forms (as explained later in this chapter), Form 301 is required any time a recordable work-related injury or illness occurs. Hence, Form 301 is to be used even if an organization develops a more comprehensive accident report form that calls for more comprehensive information.

An accident-analysis report is completed when the accident in question is serious. This level of report should answer the same questions as the regular accident report plus one more—why. Consequently, it involves a formal accident analysis. The analysis is undertaken for the purpose of determining the root cause of the accident. Accident analysis requires special skills and should be undertaken only by an individual with those skills. There are two reasons for this. First, the accident analysis must identify the actual root cause or the company will expend resources treating only symptoms or, even worse, solving the wrong problem. Second, serious accidents are always accompanied by the potential for litigation. If there might be legal action as a result of an accident, it is important to have a professional conduct the investigation even if it means bringing in an outside consultant.

How can safety and health professionals determine when an accident report is sufficient and when an accident-analysis report is called for? Accident reports are called for when the accident in question is a minor incident that did not result in any of the following circumstances: death, loss of consciousness, medical treatment beyond first aid, more than one additional day of lost work beyond the day of the accident, or any kind of modifications to the injured employee's work duties beyond those that might occur on the day of the accident.

Accident-analysis reports are called for when any of the following circumstances result from the accident in question: death, loss of consciousness, professional medical treatment beyond first aid, one or more days of lost work over and above any time lost beyond the day of the accident, or any modifications to the injured employee's work duties beyond those that might occur on the day of the injury.

When to Investigate

Of course, the first thing to do when an accident takes place is to implement emergency procedures. This involves bringing the situation under control and caring for the injured worker. As soon as all emergency procedures have been accomplished, the accident investigation should begin. Waiting too long to complete an investigation can harm the results. This is an important rule of thumb to remember. Another is that all accidents, no matter how small, should be investigated. Evidence

suggests that the same factors that cause minor accidents cause major accidents.4 Further, a near miss should be treated like an accident and investigated thoroughly.

There are several reasons why it is important to conduct investigations immediately. First, immediate investigations are more likely to produce accurate information. Conversely, the longer the time span between an accident and an investigation, the greater the likelihood of important facts becoming blurred as memories fade. Second, it is important to collect information before the accident scene is changed and before witnesses begin comparing notes. Human nature encourages people to change their stories to agree with those of other witnesses.5 Finally, an immediate investigation is evidence of management's commitment to preventing future accidents. An immediate response shows that management cares.6

What to Investigate

The purpose of an accident investigation is to collect facts. It is not to find fault. It is important that safety and health professionals make this distinction known to all involved. Fault finding can cause reticence among witnesses who have valuable information to share. Causes of the accident should be the primary focus. The investigation should be guided by the following words: who, what, when, where, why, and how.

This does not mean that mistakes and breaches of precautionary procedures by workers go unnoted. Rather, when these things are noted, they are recorded as facts instead of faults. If fault must be assigned, that should come later, after all the facts are in.7

In attempting to find the facts and identify causes, certain questions should be asked, regardless of the nature of the accident:

What type of work was the injured person doing?

Exactly what was the injured person doing or trying to do at the time of the accident?

Was the injured person proficient in the task being performed at the time of the accident? Had the worker received proper training?

Was the injured person authorized to use the equipment or perform the process involved in the accident?

Were there other workers present at the time of the accident? If so, who are they, and what were they doing?

Was the task in question being performed according to properly approved procedures?

Was the proper equipment being used, including personal protective equipment?

Was the injured employee new to the job?

Was the process, equipment, or system involved new?

Was the injured person being supervised at the time of the accident?

Are there any established safety rules or procedures that were clearly not being followed?

Where did the accident take place?

What was the condition of the accident site at the time of the accident?

Has a similar accident occurred before? If so, were corrective measures recommended? Were they implemented?

Are there obvious solutions that would have prevented the accident?

A Five-Component Approach to Accident Investigation

Another approach to accident investigation that has gained widespread acceptance involved structuring the investigation questions according to five components: task-related questions, material-related questions, environment-related questions, personnel-related questions, and management-related questions.8 This approach is an excellent way to organize an accident investigation for systematically collecting information. The types of questions an investigator might ask in each of the components include the following:

Task-Related Questions

Were the proper safe-work procedures used?

Had conditions changed in ways that made normal procedures unsafe?

Were the appropriate tools and materials available?

Were the appropriate tools and materials used?

Were all safety devices engaged properly?

Were all safety devices working properly?

Were lockout or tagout procedures used where necessary?

Material-Related Questions

Was there an equipment failure? If so, what caused it?

Was the machinery involved poorly designed?

Were hazardous substances being used? If so, were they clearly and properly identified? Was there a less hazardous substitute that could have been used? Were workers trained the safe use of the hazardous material in question?

Was the raw material in use substandard in any way?

Was Personal Protective Equipment (PPE) used? Was it the right PPE for the situation? Was the PPE properly maintained and in good working order? Was the PPE properly worn? Were workers trained in the proper use of the PPE?

Environment-Related Questions

What were the weather conditions? Was it too hot or too cold? Was it wet or dry?

What was the state of housekeeping?

Was noise a problem?

Was there sufficient lighting?

Were toxic dusts, gases, or fumes present?

Were there obstacles or impediments in the worker's environment?

Personnel-Related Questions

Were workers properly trained to perform the tasks in question?

Were workers experienced in performing the tasks in question?

Were workers physically capable of performing the tasks in question?

Were workers fatigued?

Were workers in healthy physical condition?

Were workers overly stressed from work, personal, or other factors?

Management-Related Questions

Is there a safety policy with corresponding procedures? If so, were these things followed?

Were applicable safety procedures clearly communicated to all workers?

Were the safety procedures enforced?

Were workers properly trained? Supervised?

Had any hazards been identified before the work began? If so, had the appropriate steps been taken to eliminate or mitigate the hazards?

Were tools, equipment, and machinery properly maintained?

Had safety inspections been completed on a regular and systematic basis?

The questions listed under each of the five components are provided as examples. They are not comprehensive. There are other questions that could be asked under each of the five components.

The answers to these questions should be carefully and copiously recorded. You may find it helpful to dictate your findings into a microcassette recorder. This approach allows you to focus more time and energy on investigating and less on taking written notes.

Regardless of how the findings are recorded, it is important to be thorough. What may seem like a minor unrelated fact at the moment could turn out to be a valuable fact later when all the evidence has been collected and is being analyzed.

Common Causes of Accidents

Common causes of accidents can be categorized as follows: personal beliefs and feelings, decision to work unsafely, mismatch or overload, systems failures, traps, unsafe conditions, and unsafe acts.9 The common causes in each of these categories can help investigators determine the root cause of an accident.

Personal beliefs and feelings. Causes in this category include the following: individual did not believe the accident would happen to him or her; individual was working too fast, showing off, or being a know-it-all; individual ignored the rules out of contempt for authority and rules in general; individual gave in to peer pressure; and individual had personal problems that clouded his or her judgment.

Decision to work unsafely. Some people, for a variety of reasons, feel it is in their best interests or to their benefit to work unsafely. Hence, they make a conscious decision to do so.

Mismatch or overload. Causes in this category include the following: individual is in poor physical condition; individual is fatigued; individual has a high stress level; individual is mentally unfocused or distracted; the task required is too complex or difficult; the task required is boring; the physical environment is stressful (e.g., excessive noise, heat, dust, or other factors); the work in question is very demanding—even for an individual in good physical condition; and individual has a negative attitude (e.g., hostile, uncooperative, and apathetic).

Systems failure. Causes in this category consist of the various errors management makes that are not grossly negligent or serious and willful. Common causes in this category include lack of a clear policy; lack of rules, regulations, and procedures; poor hiring procedures; inadequate monitoring and inspections; failure to correct known hazards; insufficient training for employees; rules that are in place but are not enforced; no rewarding or reinforcement of safe behavior; inadequate tools and equipment provided; production requirements set too high; inadequate communication to employees of safety concerns, statistics, and rules; poor safety management; no or insufficient job safety analysis; and insufficient management support for safety.

Traps. Poor design of workstations and processes can create traps that, in turn, lead to unsafe behavior. Common causes in this category include defective equipment; failure to provide, maintain, and replace proper personal protective equipment; failure to train employees in the proper use of their personal protective equipment; overly complicated and confusing controls; poorly laid out work area; mechanical lifting equipment that is inadequate for the jobs required of it; uncontrolled hazards that might lead to slips and falls; excessive reaching, bending, stooping, and twisting; excessive contact pressure, vibration, or force; awkward postures that result from poor workstation or tool design; excessive temperature extremes; insufficient lighting; and insufficient ventilation.

Unsafe conditions. Common causes in this category include the following: unsafe condition created by the person injured in the accident; unsafe condition created by a fellow employee; unsafe condition created by a third party; unsafe condition created by management; unsafe condition knowingly overlooked by management; and unsafe condition created by the elements (e.g., rain, sun, snow, ice, wind, and darkness).

Unsafe acts. Common causes in this category include the following: individual chooses to ignore the rules; people are involved in horseplay or fighting; individual uses drugs or alcohol; individual uses unauthorized tools or equipment; individual chooses an improper work method; individual fails to ask for information or other resources needed to do the job safely; individual forgets a rule, regulation, or procedure; individual does not pay proper attention; and individual uses improper body mechanics.

Why Safety Professionals Need to Know the Common Causes of Accidents

The only way to make sure another accident does not happen for the same reason as the one being investigated is to identify the root cause of the accident in question and eliminate it. But finding the root cause of an accident can be like searching through fog. This is the bad news. The good news is that if safety professionals understand the more common causes of workplace accidents, this knowledge can clear away much of the fog and quickly narrow down the range of possibilities. Knowing the more common causes of workplace accidents means that safety professionals do not have to start from scratch every time they investigate. They already know what to look for and what not to look for. Knowing the common causes of workplace accidents can help narrow down the field of possibilities.

However, knowing common causes should never be allowed to lead investigators to make assumptions or to draw unwarranted conclusions. Investigations can take some surprising turns. However, investigating workplace accidents is similar to investigating automobile accidents. Investigators who look into automobile accidents are going to look first for signs of drunk or otherwise impaired driving, speeding, texting, and other common causes of automobile accidents. Even if these common causes are ruled out, the investigator is still closer to finding the actual cause because he or she has ruled out other possibilities. Part of finding what caused an accident is knowing what did not cause it.

Knowing the more common causes of accidents is like knowing the streets of a city. The individual who knows the streets well has an advantage over others who must consult a map, ask for directions, or enter data into their Global Positioning System (GPS). The more knowledge and experience people bring to an accident investigation, the better prepared they are to conduct the investigation. Knowing what to look for can be a major asset to an investigator. It can also prevent investigators from honing

on what seems to be an obvious cause and accepting it as the cause without doing a thorough investigation.

Who Should Investigate

Who should conduct the accident investigation? Should it be the responsible supervisor? The safety and health professional? A higher-level manager? An outside specialist? There is no simple answer to this question, and there is disagreement among professional people of goodwill.

In some companies, the supervisor of the injured worker conducts the investigation. In others, a safety and health professional performs the job. Some companies form an investigative team; others bring in outside specialists. There are several reasons for the various approaches used. Factors considered in deciding how to approach accident investigations include the following:

Size of the company

Structure of the company's safety and health program

Type of accident

Seriousness of the accident

Technical complexity

Number of times that similar accidents have occurred

Company's management philosophy

Company's commitment to safety and health

After considering all the variables listed above, it is difficult to envision a scenario in which the safety and health professional would not be involved in conducting an accident investigation. If the accident in question is very minor, the injured employee's supervisor may conduct the investigation, but the

safety and health professional should at least study the accident report and be consulted regarding recommendations for corrective action.

If the accident is so serious that it has widespread negative implications in the community and beyond, responsibility for the investigation may be given to a high-level manager or corporate executive. In such cases, the safety and health professional should assist in conducting the investigation. If a company prefers the team approach, the safety and health professional should be a member of the team and, in most cases, should chair it. Other members of the accident investigation team might include the following:

Employees with knowledge of the work in question

Member(s) of the safety committee

Union representative

Employees with experience in conducting accident investigations

Outside expert(s)

Local government representative10

Regardless of the approach preferred by a given company, the safety and health professional should play a leadership role in collecting and analyzing the facts and developing recommendations.

Conducting the Investigation

The questions in the previous section summarize what to look for when conducting accident investigations.

Isolate the Accident Scene

You may have seen a crime scene that was sealed off by the police. The entire area surrounding such a scene is typically blocked off by barriers or heavy yellow tape. This is done to keep curious onlookers from removing, disturbing, or unknowingly destroying vital evidence. The same approach should be used when conducting an accident investigation. As soon as emergency procedures have been

completed and the injured worker has been removed, the accident scene should be isolated until all pertinent evidence has been collected or observed and recorded. Further, nothing but the injured worker should be removed from the scene. If necessary, a security guard should be posted to maintain the integrity of the accident scene. The purpose of isolating the scene is to maintain as closely as possible the conditions that existed at the time of the accident.

Record All Evidence

It is important to make a permanent record of all pertinent evidence as quickly as possible. There are three reasons for this: (1) certain types of evidence may be perishable; (2) the longer an accident scene must be isolated, the more likely it is that evidence will be disturbed, knowingly or unknowingly; and (3) if the isolated scene contains a critical piece of equipment or a critical component in a larger process, pressure will quickly mount to get it back in operation. Evidence can be recorded in a variety of ways, including written notes, sketches, photography, videotape, dictated observations, and diagrams. In deciding what to record, a good rule of thumb is if in doubt, record it. It is better to record too much than to skip evidence that may be needed later, after the accident scene has been disturbed.

Photograph or Videotape the Scene

This step is actually an extension of the previous step. Modern photographic and videotaping technology has simplified the task of observing and recording evidence. Safety and health professionals should be proficient in the operation of a camera, even if it is just an instant camera, and a videotaping camera.

The advent of the digital camera has introduced a new meaning for the concept of "instant photographs." Using a digital camera in conjunction with a computer, photographs of accident scenes can be viewed immediately and transmitted instantly to numerous different locations. Digital camera equipment is especially useful when photographs of accident scenes in remote locations are needed.

Figure 8–2 Accident investigation checklist.

Figure 8–2 Full Alternative Text

Both still and video cameras should be on hand, loaded, and ready to use immediately should an accident occur. As with the previous step, a good rule of thumb in photographing and videotaping is if in doubt, shoot it. When recording evidence, it is better to have more shots than necessary than it is to risk missing a vital piece of evidence.

A problem with photographs is that, by themselves, they don't always reveal objects in their proper perspective. To overcome the perspective problem, place a familiar object in the photograph such as a ruler, coin, or even the photographer's finger. The added object will help viewers gain the right perspective on the subject of the photograph.

Identify Witnesses

In identifying witnesses, it is important to compile a witness list. Names on the list should be recorded in three categories: (1) primary witnesses; (2) secondary witnesses; and (3) tertiary witnesses. When compiling the witness list, ask employees to provide names of all three types of witnesses.

Interview Witnesses

Every witness on the list should be interviewed, preferably in the following order: primary witnesses first, secondary next, and tertiary last. After all witnesses have been interviewed, it may be necessary to reinterview witnesses for clarification or corroboration. Interviewing witnesses is such a specialized process that the next major section is devoted to it.

Following Up an Accident Investigation

As has already been noted, it is important to begin an accident investigation as soon as possible after an accident occurs. It is also important to follow up quickly once an accident investigation has been completed. Follow-up steps once an accident investigation is complete include the following:

Write the accident report (explained later in this chapter)

Develop a plan for corrective action

Implement the corrective-action plan

Monitor and evaluate the effectiveness of corrective actions

Adjust as necessary to ensure the cause of the accident has been eliminated

Incorporate changes into standard operating procedures for continual improvement of the workplace environment11

Interviewing Witnesses

The techniques used for interviewing accident witnesses are designed to ensure that the information is objective, accurate, as untainted by the personal opinions and feelings of witnesses as possible, and able to be corroborated. For this reason, it is important to understand the when, where, and how of interviewing the accident witnesses.

When to Interview

Immediacy is important. Interviews should begin as soon as the witness list has been compiled and, once begun, should proceed expeditiously. There are two main reasons for this. First, a witness's recollections will be best right after the accident. The more time that elapses between the accident and the interview, the more blurred the witness's memory will become. Second, immediacy avoids the possibility of witnesses comparing notes and, as a result, changing their stories. This is just human nature, but it is a tendency that can undermine the value of testimony given and, in turn, the facts collected. Recommendations based on questionable facts are not likely to be valid. Also, witnesses should be interviewed individually and separately, preferably before they have talked to each other.

Where to Interview

The best place to interview is at the accident scene. If this is not possible, interviews should take place in a private setting elsewhere. It is important to ensure that all distractions are removed, interruptions are guarded against, and the witness is not accompanied by other witnesses. All persons interviewed should be allowed to relate their recollections without fear of contradiction or influence by other witnesses or employees. It is also important to select a neutral location in which witnesses will feel comfortable. Avoid the "principal's office syndrome" by selecting a location that is not likely to be intimidating to witnesses.

How to Interview

The key to getting at the facts is to put the witness at ease and to listen. Listen to what is said, how it is said, and what is not said. Ask questions that will get at the information listed earlier in this chapter, but phrase them in an open-ended format. For example, instead of asking "Did you see the victim pull the red lever?" phrase your question as follows: "Tell me what you saw." Don't lead witnesses with your questions or influence them with gestures, facial expressions, tone of voice, or any other form of nonverbal communication. Interrupt only if absolutely necessary to seek clarification on a critical point. Remain nonjudgmental and objective.

The information being sought in an accident investigation can be summarized as who, what, when, where, why, and how (Figure 8–3). As information is given, it may be necessary to take notes. If you can keep your note-taking to a minimum during the interview, your chances of getting uninhibited information are increased. Note-taking can distract and even frighten a witness.

Figure 8–3 Questions to ask when interviewing witnesses.

Figure 8–3 Full Alternative Text

An effective technique is to listen during the interview and make mental notes of critical information. At the end of the interview, summarize what you have heard and have the witness verify your summary. After the witness leaves, develop your notes immediately.

Safety Fact

Where to Conduct Accident Interviews

To ensure that employees are willing to give accurate information, safety and health professionals should conduct accident interviews in the privacy of their office. Right? Not necessarily. Experience has shown that the best way to promote accuracy is to interview witnesses at the site of the accident. This puts the accident interview in context in a setting that will help stimulate the memory. To ensure privacy and confidentiality, interview witnesses one at a time, at the accident site.

A question that sometimes arises is, "Why not tape the interview?" Safety and health professionals disagree on the effectiveness and advisability of taping. Those who favor taping claim it allows the interviewer to concentrate on listening without having to worry about forgetting a key point or having to interrupt the witnesses to jot down critical information. It also preserves everything that is said for the record as well as the tone of voice in which it is said. A complete transcript of the interview also ensures that information is not taken out of context.

Those opposed to taping say that taping devices tend to inhibit witnesses so that they are not as forthcoming as they would be without taping. Taping also slows down the investigation while the taped interview is transcribed, and the interviewer wades through voluminous testimony trying to separate critical information from irrelevant information.

In any case, if the interview is to be taped, the following rules of thumb should be applied:

Use the smallest, most unobtrusive taping device available, such as a microcassette recorder.

Inform the witness that the interview will be taped.

Make sure the taping device is working properly and that the tape it contains can run long enough so that you don't have to interrupt the witness to change it.

Take time at the beginning of the interview to discuss unrelated matters long enough to put the witness at ease and overcome the presence of the taping device.

Make sure that personnel are available to transcribe the tapes immediately.

Read the transcripts as soon as they are available and highlight critical information.

An effective technique to use with eyewitnesses is to ask them to reenact the accident for you. Of course, the effectiveness of this technique is enhanced if the reenactment can take place at the accident site. However, even when this is not possible, an eyewitness reenactment can yield valuable information.

Safety Fact

Management Is the Cause

One of the most difficult situations that a safety and health professional will face is when an investigation reveals that management—through action or inaction—is the root cause of an accident. How does the safety professional look his or her boss in the eye and say, "You are at fault"? Remember two things when facing such a situation. First, focus on the condition that led to the accident rather than whose action or inaction caused the condition. You want the condition corrected, and you don't want a higher manager wasting time and effort covering up. Second, be tactful. Remember, tact means "driving in the nail without breaking the board." By handling such situations in this way, you may achieve two things, both of which are good: (1) a hazardous condition will be corrected and (2) you will win an important ally.

In using the reenactment technique, a word of caution is in order. If an eyewitness does exactly what the victim did, there may be another accident. Have the eyewitnesses explain what they are going to do before letting them do it. Then, have them simulate rather than actually perform the steps that led up to the accident.

Reporting Accidents

An accident investigation should culminate in a comprehensive accident report. The purpose of the report is to record the findings of the accident investigation, the cause or causes of the accident, and recommendations for corrective action.

OSHA has established requirements for reporting and record keeping. According to OSHA document 2056,

Employers of 11 or more employees must maintain records of occupational injuries and illnesses as they occur. Employers with 10 or fewer employees are exempt from keeping such records unless they are selected by the Bureau of Labor Statistics (BLS) to participate in the Annual Survey of Occupational Injuries and Illnesses.12

All injuries and illnesses are supposed to be recorded, regardless of severity, if they result in any of the outcomes shown in Figure 8–4. If an accident results in the death of an employee or hospitalization of three or more employees, a report must be submitted to the nearest OSHA office within eight hours. This rule applies regardless of the size of the company. Reporting locally within an organization for insurance, legal, prevention, and management purposes and reporting for OSHA purposes can be two different tasks. OSHA's reporting requirements were covered in Chapter 6. Reporting procedures in this section pertain to local in-house reporting.

Figure 8–4 OSHA record-keeping requirements.

Figure 8–4 Full Alternative Text

Accident report forms can vary from company to company. However, the information contained in them is fairly standard.13 Regardless of the type of form used, an accident report should contain at least the information needed to meet the record-keeping requirements set forth by OSHA. This information includes at least the following:

Case number of the accident

Victim's department or unit

Location and date of the accident or date that an illness was first diagnosed

Victim's name, social security number, gender, age, home address, and telephone number

Victim's normal job assignment and length of employment with the company

Victim's employment status at the time of the accident (i.e., temporary, permanent, full-time, part-time)

Case numbers and names of others injured in the accident

Type of injury and body part(s) injured (e.g., burn to right hand; broken bone, lower right leg) and severity of injury (i.e., fatal, first aid only required, hospitalization required)

Name, address, and telephone number of the physician called

Name, address, and telephone number of the hospital to which the victim was taken

Phase of the victim's work day when the accident occurred (e.g., beginning of shift, during break, and end of shift)

Description of the accident and how it took place, including a step-by-step sequence of events leading up to the accident

Specific tasks and activities with which the victim was involved at the time of the accident (e.g., task: mixing cleaning solvent; activity: adding detergent to the mixture)

Employee's posture or proximity related to his or her surroundings at the time of the accident (e.g., standing on a ladder; bent over at the waist inside the robot's work envelope)

Supervision status at the time of the accident (i.e., unsupervised, directly supervised, indirectly supervised)

Causes of the accident

Corrective actions that have been taken so far

Recommendations for additional corrective action

Discussion Case

What Is Your Opinion?

"Find out who is at fault and get rid of him," demanded the CEO. "I'm not going to have a careless employee running up our healthcare costs. It's tough enough trying to make a profit without some careless employee causing accidents. There will be a lawsuit, just you wait and see. We are going to be sued!" Gordon Jasperton, Clark Processing Company's safety director, bit his tongue and just listened. He had learned to let his boss vent before making a counterproposal. When the time seemed right, Jasperton said, "Sir, if we focus on finding an employee to blame, it's just going to make matters worse. I'll never get to the root of it that way." Whose approach is best in this case? What is your opinion?

In addition to these items, you may want to record such additional information as the list of witnesses; dates, times, and places of interviews; historical data relating to similar accidents; information about related corrective actions that were made previously but had not yet been followed up on; and any other information that might be relevant. Figure 8–5 is an example of an accident report form that meets the OSHA record-keeping specifications.

Figure 8–5 Sample accident report form.

Eight.7-1 Full Alternative Text

Note: Complete one form for each injured worker.

Eight.7-1 Full Alternative Text

Why Some Accidents Are Not Reported

There are several reasons why accidents go unreported. Be familiar with these reasons so that you can do your part to overcome them. The main reasons are as follows:

Red tape. Some people see the paperwork involved in accident reporting as red tape and, therefore, don't report accidents just to avoid paperwork.

Ignorance. Not all managers and supervisors are as knowledgeable as they should be about the reasons for accident reporting. Many are not familiar with OSHA's reporting specifications.

Embarrassment. Occasionally, people do not report an accident because they are embarrassed by their part in it. A supervisor who did not properly supervise or a manager who has not provided the proper training for employees may be embarrassed to file a report.

Record-spoiling. Some accidents go unreported just to preserve a safety record, such as the record for days worked without an accident.

Fear of repercussions. Some accidents go unreported because the people involved are afraid of being found at fault, being labeled accident prone, and being subjected to other negative repercussions.

No feedback. Some accidents go unreported because those involved feel filing a report is a waste of time. This typically happens when management does not respond to recommendations made in earlier accident reports.14

Clearly, these reasons for not reporting accidents present safety and health professionals with a challenge. To overcome these inhibitors, it is necessary to develop a simple reporting system that will not be viewed as too much bureaucratic paperwork to have to do. Safety and health professionals must educate personnel at all levels concerning the purpose of accident reporting and why it is important. An important step is to communicate the fact that fault finding is not the purpose. Another important step is to follow up to ensure that recommendations are acted on or that employees are made aware of why they aren't acted on. This helps ensure the integrity of the process.

Discipline and Accident Reporting

Fault finding is not the purpose of an accident investigation. However, an investigation sometimes reveals that an employee has violated or simply overlooked safety regulations. Should such violations be condoned?

There is a built-in dilemma here that modern safety and health professionals must be prepared to handle. On the one hand, it is important that fault finding not be seen as the purpose of an accident

investigation. Such a perception limits the amount of information that can be collected. On the other hand, if those workers whose behavior leads to accidents are not disciplined, the credibility of the safety program is undermined. The following procedures are recommended for handling this dilemma: Never discipline an employee because he or she had an accident. Always discipline employees for noncompliance with safety regulations.15

Such an approach applied with consistency will help maintain the integrity of both the accident investigation process and the overall safety program.

Who Is Responsible for Reporting?

OSHA is clear concerning what must be reported, but who is responsible for completing and filing accident reports? There are two answers to this question: a big-picture answer and a more specific answer. The big picture answer is as follows:

All employers are required to report to OSHA any work-related death. This must be done within eight hours of the incident.

All employers are required to report to OSHA any worker amputation, eye loss, or inpatient hospitalization. This must be done within 24 hours of the incident.

All employers must report to OSHA all fatal heart attacks that occur at work and motor vehicle deaths that occur in a construction work zone.

Employers with more than 10 employees and that are not classified as partially exempt must record serious work-related injuries and illnesses using OSHA forms 300, 300A, and 301 as appropriate.

From these requirements, it is clear that the big-picture answer to the question of "Who is responsible for reporting?" is the employer. OSHA holds the employer responsible for ensuring that its reporting requirements are complied with.

The more specific answer to the question of "Who is responsible for reporting?" is that employers may and often do delegate the job of reporting on accidents, injuries, and deaths to a member of the safety and health team. This individual then becomes responsible to the employer for completing and filing the necessary reports. But it is important to understand that while employers can delegate authority for completing reports to a member of the safety and health team or anyone else they

choose, doing so does not relieve them of their responsibility. Ultimately, responsibility for ensuring that OSHA reporting requirements are met rests with the employer. For information about OSHA's reporting requirements, go to www.osha.gov/recordkeeping

Chapter 3: Theories of Accident Causation, pp. 29–46

Chapter 8: Accident Investigation and Reporting, pp. 165–181

Unit Lesson

A primary focus of your work as a safety professional is to prevent injuries and illnesses from occurring in the

workplace. In many cases, the effectiveness of your safety efforts is measured by the injury and illness rates

for the location. This is often seen as a billboard somewhere in the facility touting the number of days that

have passed since the last OSHA recordable injury. Hopefully, most of you have worked for extended periods

of time without seeing any injuries or illnesses. If you work in the safety field for an extended period of time,

you will eventually see injuries and illnesses occur. For many of you, dealing with minor injuries can be a

regular part of your daily routine.

Many of the occupational injuries that occur are fairly minor in nature, not even rising to the level of being

OSHA recordable. Even these minor injuries cost companies in lost time from completing work tasks as well

as the time and costs related to first aid supplies or on-site medical staff. The primary efforts of many safety

professionals are prevention of more serious injuries and illnesses that result in lost time for employees and

increased injury and illness rates. Understanding some basic causes of accidents can assist you in

establishing programs to reduce both minor and major injuries and illnesses.

UNIT III STUDY GUIDE

Accident Causation Models

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Chapter 3 of the textbook presents some of the more common theories for why accidents occur. If you review

the various theories that are presented in the textbook, you will see that there are two basic root causes that

are discussed: human error and unsafe conditions. Basically, an employee does something unsafe, or the

process an employee is performing has an unsafe condition

inherently present. In many cases, these two causes interact

with each other. For example, a saw has a guard laying on the

bench, but it is not permanently installed. Employees are

supposed to attach the guard prior to using the saw, but some

employees skip the step because it is easier to perform the job

without the guard. When an employee amputates a finger using

the saw, the cause is a combination of an unsafe condition being

present and the employee not using the safeguard that was

present.

Both human factors and unsafe conditions can be evaluated to

determine the most common reasons present in a system.

Understanding why an individual acts in an unsafe manner or

why a facility would allow an unsafe condition to be present can

help you determine the most efficient methods to correct the

conditions and prevent injuries and illnesses. After all, if

employees are performing an operation in an unsafe manner

because that is how they were taught to perform the operation,

simply placing cut-proof gloves in the tool crib will probably have

very little effect on the unsafe acts.

Understanding why employees perform tasks in an unsafe manner requires an understanding of human

nature. The textbook contains a section on the human factors theory of accident causation (p.46) that

explains some of the reasons employees perform work in an unsafe manner. If you have worked in the safety field for any length of time, you can probably recall at least one worker who exhibited some of the factors discussed in the section.

One of the most common reasons given by employees for performing a task in an unsafe manner is “That is

how we have always done it, and no one has been hurt yet!” This excuse would fit into both the inappropriate

response and inappropriate activities categories of the human factors theory of accident causation. This is

probably one of the more difficult factors to overcome. The employee who typically says this has been

working in the job for a long time and is considered the “expert” on the task. Whenever new employees are

hired, they may be properly trained on the safe practices associated with the task but change their work

habits based on input from this expert. One interesting note is that if the so-called expert is injured, he or she

tends to blame the company for not providing a safe work area, even if he or she was performing the task

incorrectly.

Another common cause of human error is having employees performing a task for which they are improperly

trained. In many manufacturing settings, there is a lot of pressure to meet production numbers. Many times,

compensation for managers is based on meeting these production figures. In these cases, it sometimes

becomes a rush to get new employees on the production lines and working, and training suffers. Additionally,

even if employees have been trained properly for one task, they may be temporarily moved to another task

because of absences, and they have not been trained properly for that task. This cause would fit into the

inappropriate activities category of the human factors theory of accident causation.

Of course, in some cases the human factor that is associated with an unsafe act is related to a personal

problem. Employees who have personal problems at home may be distracted to the point that they do not

perform the task correctly. The personal problems could include marital stress, problems with their children, or

financial worries. They may have to work another job after they finish their primary job, leaving them fatigued.

Some employees also have problems with addictions to drugs, including alcohol. With the increase in opioid

addictions, there are more employees under the influence of drugs at workplaces today. These factors can

also be extremely difficult to detect and correct because of privacy laws.

Unsafe conditions can also have many different causes. In some cases, machines are old enough that they

do not have safeguards that are required on newer machines, and the employer chooses not to spend the

Some of the many theories of accident causation

(Goetsch, 2019)

Domino Theory

Human Factors Theory

Accident/Incident Theory

Epidemiological Theory

Systems Theory

Swiss Cheese Model

Behavioral Theory

money to update the safeguards. This is very common for noise exposures. Newer machines, such as

hydraulic presses, typically have some noise-deadening materials built in to reduce noise levels. Older

machines typically do not have as much noise-deadening materials, resulting in higher personal exposures.

There are noise-deadening materials that can be installed, but they can be expensive, and many employers

simply require workers to wear hearing protection. This is one reason noise-induced hearing loss is one of the

most frequent workers' compensation claims.

Another problem with unsafe conditions is the removal of safeguards to increase production. In most cases,

adding some type of machine guard will decrease the number of parts that can be produced. If a greater emphasis is placed on production than safety by management, the safeguards may be removed to increase production. In this case, the worker may be told “just be careful and you will not get hurt.” Take, for instance, the case of a worker who was missing the tips of three fingers from accidentally cycling a press with no guards while his fingers were in the press. A light curtain was installed so he could not put his hands into the press and cycle the press. He had used cardboard to block out areas of the press and allow his hands to go into the press to decrease the time it took to remove parts from the press.

Ergonomics is another area that can cause unsafe conditions. We will study ergonomics issues in more detail in Unit IV, but if the tools that an employee is required to use for a task are incompatible with his or her body, injuries can occur. Most machines and tools are manufactured for the average individual. Therefore, you will typically have some workers for whom the tools and machines are not designed properly.

A new area of science that is getting a lot of attention is genomics. Scientists are now able to analyze the gene sequences of individuals. Based on research, the genetic information can be used to predict the risks of certain diseases for individuals. How does this apply to accident causation? If we look at exposures to chemicals in the workplace, we typically see an uneven response to the exposures. In other words, some individuals report health symptoms that may appear quite severe, while others have no overt symptoms at all. This is due to the differences in susceptibility between individuals that can be related to genetic differences.

There are some scientists who predict that genetic testing can be used to predict who will develop specific illnesses as a result of exposure to specific compounds in a workplace. This practice is complicated because of privacy rules. Congress passed the Genetic Information Nondiscrimination Act of 2008 to protect individuals’ personal genetic information from employers and insurance companies.

A task that many safety professionals will have to perform is investigating accidents after they occur.

Investigating occupational accidents is similar to the investigations you see on TV shows. Basically, you are

trying to collect the facts associated with the accident. The methods you use to collect the facts may not be

the same as the methods used by other safety professionals. As long as you obtain the facts and can use

those facts to prevent the same accidents from occurring in the future, there is no right and wrong way to

investigate.

However, over the years, safety professionals have developed some basic steps for accident investigation. A

typical approach to an investigation is summarized in Chapter 8 of the textbook. Review that approach and

see if it resembles an investigation you have performed or are familiar with. What you should notice is that the

approach is similar to a basic crime scene investigation. You try to isolate the scene, record all evidence as

soon as possible, document what happened with photos/video, identify any witnesses, and interview the

witnesses (Goetsch, 2019).

Another important task for the safety professional is understanding when and to whom injuries and illnesses

should be reported. There are several potential situations when reporting is required. Of course, OSHA has

regulations that require the reporting of injuries and illnesses. Most of you are probably familiar with OSHA

recordable injuries and illnesses that must be recorded on the appropriate OSHA form and summarized each

year. However, there are also some injuries and illnesses that require you to notify OSHA (or state OSHA)

within eight hours. The instances were recently changed by OSHA and now include when an employee is

killed on the job, suffers a work-related hospitalization, amputation, or loss of an eye. The company or

corporation you work for may also have some internal reporting requirements.

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References

Genetic Information Nondiscrimination Act of 2008, Pub. L. No. 110–233, 122 Stat. 881 (2008).

https://www.eeoc.gov/statutes/genetic-information-nondiscrimination-act-2008

Goetsch, D. L. (2019). Occupational safety and health for technologists, engineers, and managers (9th ed.).

Pearson.

Suggested Reading

In order to access the following resources, click the links below.

The most effective accident investigations typically are well organized. Though brief, the following link

summarizes what the author believes are four critical stages to an accident investigation.

Incident investigations: Four critical stages. (2016, May). Professional Safety, 61(5), 19. https://search-proquest-com.libraryresources.columbiasouthern.edu/docview/1789356555?accountid=33337

In this unit, we also learned about human error as a contributing factor to accidents. The following article

reviews how making an immediate assumption of human error during an investigation can lead to errors in the

investigation.

Malhotra, S. (2018, January). Behavioral assumptions in root-cause analysis. Professional Safety, 63(1), 43–

44. https://search-proquest-com.libraryresources.columbiasouthern.edu/docview/1985534144?accountid=33337

One of the concepts we are learning about this week is causal factors. Sometimes, it is very difficult to

determine the root causes of accidents. The following presents some ideas about determining the root causes

of accidents.

Manuele, F. A. (2016, May). Root-causal factors: Uncovering the hows & whys of incidents. Professional

Safety, 61(5), 48–55. https://search-proquest-com.libraryresources.columbiasouthern.edu/docview/1789356418?accountid=33337

OSHA places a high level of emphasis on the need to perform accident investigations. Note that OSHA prefers the term incident instead of accident. The following link provides a guideline from OSHA on performing incident (accident) investigations. The document contains some excellent checklists that you can use for accident investigations.

Occupational Safety and Health Administration. (2015, December). Incident [accident] investigations: A guide for employers. United States Department of Labor. https://www.osha.gov/dte/IncInvGuide4Empl_Dec2015.pdf

Learning Activities (Nongraded)

Nongraded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.

The Bureau of Labor Statistics publishes the data that OSHA collects on injury and illness rates each year. The most recent data is listed on the BLS website. Click the link below, and review some of the spreadsheets from the last few years.

U.S. Bureau of Labor Statistics. (n.d.). Industry injury and illness data. https://www.bls.gov/iif/oshsum.htm

See if you can detect any trends in which industries have the highest injury and illness rates. Can you think of any of the theories of accident causation from Chapter 3 of the textbook that might explain why one industry