Published more than ten years ago, the first edition of Accident/Incident Prevention Techniques provided clear, comprehensive guidance on how to mitigate the cost, in personnel and to the bottom line, of accidents/incidents in the workplace. Significantly revised and updated, this Second Edition takes its place as the A to Z hands-on guide to the responsibilities, principles, tools, and techniques involved in accident investigative planning and preparation.

Written by safety expert Charles D. Reese, the book details the tried and true techniques used by the occupational safety and health community for many years. It also presents the best theoretical methods to help those responsible for occupational safety to develop the best prevention initiative for them and their workforce. Based on the premise that all businesses and industries must face the reality that occupational accidents and illnesses will transpire and the results of these events will have a negative impact on the company’s bottom line, the book provides practical examples, easy-to-implement processes, numerous illustrations, and usable forms throughout.

See What’s New in the Second Edition
- Topics such as safety culture and behavior-based safety
- Expanded coverage of some topics such as analysis tools and accident investigation
- Updated statistical data, sources, and contacts
- Updated changes in regulations and compliance
- Relevance with current trends and issues in accident prevention

By investigating the various methods and equipment used in system safety applications, the book covers myriad accident/incident prevention techniques, and supplies the illustrations and tools that allow readers to begin to develop and build a safety and health program in their workplace. The author draws on his more than 30 years of experience to supply a template for the development of an effective safety and health program.
Second Edition

Accident/Incident Prevention Techniques
This book is dedicated to the working men and women of this country who every day risk their health and well-being in the workplace to provide the goods and services needed by the people of the United States and other countries.
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Preface

*Accident/Incident Prevention Techniques*, Second Edition is based on the premise that all types of businesses and industries must face the reality that accidents and incidents that result in occupational injuries and illnesses will in most cases transpire at their business or facility. The results of these events have economic, legal, and human impact on the company’s bottom line. In most situations, the impact is usually negative.

With this said, anything that a corporation or company can do to prevent these events will in most instances result in positive outcomes for that company.

The causes of occupationally related accidents or incidents are most often the result of some form of energy or agent being released. Seldom is there one single cause for accidents and incidents. There are many contributing factors that combine to become the root causes of occupational accidents and incidents.

Because employers and safety and health professionals are faced with multiple causal factors for these occupational happenings, they must utilize multiple approaches to prevent the occurrence of accidents and incidents. These range from prevention program development, to behavioral approaches, acceptable best prevention techniques, sophisticated analysis methods, engineering controls, and personal protection for the workers. The approach taken by employers and safety and health professionals will include a combination of prevention approaches that best meets the needs of their unique industry or business. The approach used will be tailored to meet their needs.

Thus, *Accident/Incident Prevention Techniques* provides the plethora of techniques and tools needed to structure a prevention approach to meet the needs of corporations and companies. These techniques are those that have been found to work in the past, as well as an intermingling of the best theoretical methods. It is laced with practical examples and tools to help those responsible for occupational safety and health develop the best prevention initiative for them and their workforce.

This book is a single-source guide of techniques and approaches to prevent the occurrence of occupational injuries and illnesses.
Acknowledgments

I appreciate the courtesy extended to me by the following organizations and individuals:

National Aeronautical and Space Administration
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United States Department of Energy
Mine Safety and Health Administration
Robert Franko
David Kline
Steve Austin
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About the Author

For 30 years Dr. Charles D. Reese has been involved with occupational safety and health as an educator, manager, or consultant. In Dr. Reese’s early beginnings in occupational safety and health, he held the position of industrial hygienist at the National Mine Health and Safety Academy. He later assumed the responsibility of manager for the nation’s occupational trauma research initiative at the National Institute for Occupational Safety and Health’s (NIOSH) Division of Safety Research. Dr. Reese has played an integral part in trying to ensure that workplace safety and health are provided for all those within the workplace. As the managing director for the Laborers’ Health and Safety Fund of North America, his responsibilities were aimed at protecting the 650,000 members of the laborers’ union in the United States and Canada.

Dr. Reese has developed many occupational safety and health training programs, which run the gamut from radioactive waste remediation to confined space entry. He has written numerous articles, pamphlets, and books on related safety and health issues.

Dr. Reese, professor emeritus, was a member of the graduate and undergraduate faculty at the University of Connecticut, where he taught courses on OSHA regulations, safety and health management, accident prevention techniques, industrial hygiene, ergonomics, and environmental trends and issues. As professor of environmental/occupational safety and health, he coordinated the bulk of the environmental, safety, and health efforts at the University of Connecticut. He is called upon to consult with industry on safety and health issues, and is often asked for expert consultation in legal cases.

Dr. Reese also is the principal author of the following:

*Handbook of OSHA Construction Safety and Health (Second Edition)*
*Material Handling Systems: Designing for Safety and Health*
*Annotated Dictionary of Construction Safety and Health*
*Occupational Health and Safety Management: A Practical Approach (Second Edition)*
*Office Building Safety and Health*
*Accident/Incident Prevention Techniques (Second Edition)*

The Four-Volume Set Entitled: *Handbook of Safety and Health for the Service Industry:
  Volume 1: Industrial Safety and Health for Goods and Materials Services*
  Volume 2: Industrial Safety and Health for Infrastructure Services*
  Volume 3: Industrial Safety and Health for Administrative Services*
  Volume 4: Industrial Safety and Health for People-Oriented Services*
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1 Introduction

The objectives of Healthy People 2020 have not changed but will experience some modifications. The 2020 objectives for work-related injuries will be to

- Reduce death from work-related injuries
- Reduce nonfatal work-related injuries
- Reduce work-related assaults
- Reduce work-related homicides
- Reduce occupational needle-stick injuries among hospital-based health-care workers

Although progress was made regarding occupation injuries and trauma deaths, new data and goal projections are not available for 2020 at this time. The 2010 goals for injuries, trauma deaths, and needle-stick injuries achieved approximately 50% of the goals while assaults goals did not make progress. The following paragraphs set out the baselines for 2010.

Healthy People 2010 Objectives from the U.S. Department of Health and Human Services (DHHS) has made the facts available relevant to occupational injuries and illnesses. Every five seconds a worker is injured. Every ten seconds a worker is temporarily or permanently disabled. Each day, an average of 137 persons die from work-related diseases, and an additional 17 die from workplace injuries on the job. Each year, about 70 youths under 18 years of age die from injuries at work and 70,000 require treatment in a hospital emergency room. In 1996, an estimated 11,000 workers were disabled each day due to work-related injuries. That same year, the National Safety Council estimated that on-the-job injuries cost society $121 billion, including lost wages, lost productivity, administrative expenses, health care, and other costs (National Safety Council Injury Facts, 2010). A study published in July 1997 reports that the 1992 combined U.S. economic burden for occupational illnesses and injuries was an estimated $171 billion (U.S. Department of Commerce, www.commerce.gov, 2001).

A number of data systems and estimates exist to describe the nature and magnitude of occupational injuries and illnesses, all of which have advantages as well as limitations. In 1996, information from death certificates and other administrative records indicated that at least 6,112 workers died from work-related injuries (Bureau of Labor Statistics, www.bls.gov, 2000). No reporting system for national occupational chronic disease and mortality currently exists in this country. Therefore, scientists and policymakers must rely on estimates to understand the magnitude of occupational disease generated from a number of data sources and published epidemiologic (or population-based) studies. Estimates generated from these sources are generally thought to underestimate the true extent of occupational disease, but the scientific community recognizes these estimates as the best available information. Such compilations indicate that an estimated 50,000 to 70,000 workers die each
year from work-related diseases. A further discussion on occupational disease is found in Chapter 23.

Current data collection systems are not sufficient to monitor disparities in health-related occupational injuries and illnesses. Efforts will be made over the coming decade to improve surveillance systems and data points that may allow evaluation of health disparities for work-related illnesses, injuries, and deaths. Data from the National Institute for Occupational Safety and Health’s (NIOSH) National Traumatic Occupational Fatalities Surveillance System (NTOF), based on death certificates from across the United States, demonstrate a general decrease in occupational mortality over the 15-year period from 1980 to 1994. However, the number and rates of fatal injuries from 1990 through 1994 remained relatively stable (at over 5,000 deaths per year and about 4.4 deaths per 100,000 workers). Motor vehicle-related fatalities at work, the leading cause of death for U.S. workers since 1980, accounted for 23 percent of deaths during the 15-year period. Workplace homicides became the second leading cause of death in 1990, surpassing machine-related deaths. While the rankings of individual industry divisions have varied over the years, the largest number of deaths is consistently found in construction, transportation, public utilities, and manufacturing, while those industries with the highest fatality rates per 100,000 workers are mining, agriculture/forestry/fishing, and construction. Data from the Bureau of Labor Statistics (BLS), Department of Labor, indicate that, for nonfatal injuries and illnesses, incidence rates have been relatively stable since 1980. The rate in 1980 was 8.7 per 100,000 workers and 8.4 per 100,000 workers in 1994. Incidence varied between a low of 7.7 per 100,000 workers (1982) and a high of 8.9 per 100,000 workers (1992) over the 15-year period of 1980 to 1994.

The toll of workplace injuries and illnesses continues to harm our country. Six million workers in the United States are exposed to workplace hazards ranging from falls from elevations to exposures to lead. The hazards vary depending upon the type of industry (e.g., manufacturing) and the types of work being performed by workers (e.g., welding).

The consequences of occupational accidents or incidents have resulted in pain and suffering, equipment damage, exposure of the public to hazards, lost production capacity, and liability. Needless to say, these occupationally related accidents or incidents have a direct impact on profit, which is commonly called the “bottom line.”

**WHY INJURY PREVENTION?**

There are very real advantages for those trying to address injury prevention, advantages that do not exist when trying to address illnesses prevention; these include

- Injuries occur in real-time with no latency period (an immediate sequence of events).
- Accident or incident outcomes are readily observable (must only reconstruct a few minutes or hours).
- Root or basic causes are more clearly identified.
- It is easy to detect cause-and-effect relationships.
- Injuries are not difficult to diagnose.
- Injuries are highly preventable.
Debate over use of the term “accidents” versus “incidents” has been a long and continuing one. Although these terms are used as virtually interchangeable in the context of this book, you should be aware of the distinction between the two. Accidents are usually defined as unexpected, unplanned, and uncontrollable events or mishaps. These undesired events result in personal injury, or property damage, or equipment failure, or some combination thereof. An incident is all of the previous as well as adverse production effects. Accidents are a subset of incidents (see Figure 1.1).

This definition of an accident undermines the basic philosophy of this book, that we can control these types of events or mishaps. This is why we spend time identifying hazards and determining risks with the probability that a hazard will result in an accident with definable consequences. Thus, striving for a safe workplace, where the associated risks are judged to be acceptable, is a goal of safety. This will result in freedom from circumstances that can cause injury or death to workers, and damage to or loss of equipment or property. This is essentially a definition of safety.

The approach to this is that we can control factors that are the causative agents of accidents. We can prevent accidents by using the tools provided within these pages.

**ACCIDENT/INCIDENT PREVENTION PROCESS**

An accident/incident prevention process is as simplistic as it sounds. Within the text of this book the elements are provided for such a process. On the people side of this process, employers must commit themselves and all facets of management. The leadership for this process comes from management. This does not mean that the workforce should not be part of the process. The involvement of employees must be incorporated into the process in order to elicit a commitment and buy-in to the prevention effort. This is an important motivational factor for employees.

Another major area is the identification, ranking, and controlling of risk. This part of the process is paramount when faced with serious hazards that can be catastrophic
events. Analysis of events and hazards using such tools as root cause analysis helps provide the solution part of the process. From these efforts, standard or safe operating procedures as well as safe performance standards can be developed to standardize safe production.

Constant evaluation and measurement are utilized to oversee progress regarding prevention so that improvement and updating of the process can occur.

Communication is critical in providing feedback to all involved on areas that have improved and those that need further attention. Reinforcement should be used to convey what has been working effectively to prevent incidents and implement any corrective action while continuing to evaluate. Update and improve the accident/incident prevention process.

COMPREHENSIVE ACCIDENT PREVENTION

Accident prevention is very complex due to interactions that transpire within the workplace (see Figure 1.2). These interactions are between

1. Workers
2. Management
3. Equipment and machines
4. Environment

![Interactive factors in accident prevention](image_url)

**FIGURE 1.2** Interactive factors in accident prevention.
The interaction between workers, management, equipment and machinery, and the workplace environment separately are complex enough by themselves. More complexity transpires when they are blended together to become a workplace. But physical environment is not the only environment impinging on the accident prevention efforts within companies. The social environment is also an interactive factor, and one that encompasses our lives at work and beyond. Government entities establish rules and regulations and leave their mark on the workplace. Other entities in the social arena provide pressures in the workplace, such as unions, family, peer pressure, friends, associates, etc. This extends the interactions that must be attended to in order to successfully prevent accidents.

ACCIDENT PREVENTION

Prevention of occupational related accidents/incidents is the law. The Occupational Safety and Health Act of 1970 (OSHA) requires employers to provide a workplace free from hazards that could cause serious harm or death. Beyond that, it makes good business sense to prevent accident/incidents. More and more companies have come to realize that the OSHA is a helpmate, not a hindrance, to their accident/incident prevention initiative. The Occupational Safety and Health Administration (OSHA) sets the foundation and assumes the role of law enforcer, allowing the employer to not be viewed as the bad guy to his or her employees. Employers can deflect responsibility to OSHA.

As business competition has increased, loss control has been seen as a logical place to curtail costs, especially direct losses from equipment damage, medical costs, and workers’ compensation premiums. Prevention of accidents results in real, observable savings. Safety experts approximate the hidden cost of accidents as being conservatively five to ten times the direct cost incurred. Hidden costs include lost production, retraining, and supervisor’s time lost, just to name a few.

ACCIDENT PREVENTION BENEFITS

You can expect many benefits from preventing occupational accidents/incidents. Some of the benefits you might expect are

- Reduced industrial insurance premium costs
- Reduced indirect costs of accidents
- Fewer compliance inspections and penalties
- Avoidance of adverse publicity from deaths or major accidents
- Reduced litigation and legal settlements
- Lower employee payroll deductions for industrial insurance
- Reduced pain and suffering by injured workers
- Reduced long-term or permanent disability cases
- Increased potential for retrospective rating refunds
- Increased acceptance of bids (more jobs)
- Improved morale and loyalty from individual workers
- Increased productivity from workers
- Increased pride in company personnel
Although this not an all-inclusive list, it certainly provides a snapshot of why you should undertake a loss control effort for occupationally related incidents.

PREVENTING OCCUPATIONAL ACCIDENTS/INCIDENTS

Throughout the years since the advent of OSHA’s regulatory controls, some companies have been more successful than others at preventing worker-related accidents/incidents. These companies have placed occupational safety and health on an equal footing with production. They have developed programs, used accident-prevention techniques, and applied the principles of motivation to safety. In doing so, they often have devised their own unique approach, specific to their industry. One example of this is Dupont’s SAFE program. The successes these companies have experienced have made them the shining examples of how safety can become a part of the cultural and philosophical approach of businesses.

Each industry is somewhat different. What works well for one company may not duplicate or replicate at other companies without tailoring to fit the unique needs of the latter. Uniqueness is often used as an excuse to not take action. Excuses include, “Our industry is different,” or “It won’t work in our industry.” Generally, these are seen as lame excuses and a way of saying that they just don’t want to try to make safety a priority. The principles of preventing accidents are applicable to any industry setting if one desires to make accident prevention an integral part of doing business.

NOTHING NEW IN PREVENTION

There is nothing earthshakingly new in the accident/incident prevention arena. Basic accident/incident prevention techniques espoused in this book have been used and modified over decades. Few, if any, dramatically new approaches have been devised using more modern techniques. Thus, accident investigation has always been accident investigation, no matter the words used. However, the tools and processes utilized for accident prevention have experienced modification and evolution as accident prevention has become an integral part of the loss control initiatives of companies.

HOW MUCH PREVENTION?

Workplaces have hazards that present a risk of injury or illness from the dangers that exist. At times, the hazards cannot be removed and the dangers exist and can result in an accident. Risk is the probability of an accident occurring. The amount of risk that you deem acceptable will do much to define the extent of your injury prevention effort. Risk related to safety and health is often a judgment call. But, even a judgment call can be quantified if you develop criteria and place value upon them. Fine (1973) has provided a mathematical model for conducting a risk assessment that results in a numerical value that can be used to compare potential risks from accidents.

Fine’s first component is a risk score that compiles numerical values related to consequences, exposure, and probabilities. To calculate a risk score, extract the rating values from the Justification Formula Rating Summary Sheet found in Table 1.1.
### TABLE 1.1

Justification Formula Rating Summary Sheet

<table>
<thead>
<tr>
<th>Factor</th>
<th>Classification</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consequences</td>
<td>Catastrophe; numerous fatalities; damage over $1,000,000; major disruption of activities</td>
<td>100</td>
</tr>
<tr>
<td>Most probable result of the potential accident:</td>
<td>Multiple fatalities; damage $500,000 to $1,000,000</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Fatality, damage $100,000 to $500,000</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Extremely serious injury (amputation, permanent disability); damage $1000 to $100,000</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Disabling injury; damage up to $1000</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Minor cuts, bruises, bumps; minor damage</td>
<td>1</td>
</tr>
<tr>
<td>Exposure</td>
<td>Hazard-event occurs:</td>
<td></td>
</tr>
<tr>
<td>The frequency of occurrence of the hazard event:</td>
<td>Continuously (or many times daily)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Frequently (approximately once daily)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Occasionally (from once per week to once per month)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Usually (from once per month to once per year)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rarely (it has been known to occur)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Remotely possible (not known to have occurred)</td>
<td>0.5</td>
</tr>
<tr>
<td>Probability</td>
<td>Complete accident sequence:</td>
<td></td>
</tr>
<tr>
<td>Likelihood that accident sequence will follow to completion:</td>
<td>Is the most likely and expected result if the hazard-event takes place</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Is quite possible, not unusual, has an even 50/50 chance</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Would be an unusual sequence or coincidence</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Would be a remotely possible coincidence</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Has never happened after many years of exposure, but is conceivably possible</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Practically impossible sequence (has never happened)</td>
<td>0.1</td>
</tr>
<tr>
<td>Cost Factor</td>
<td>Over $50,000</td>
<td>10</td>
</tr>
<tr>
<td>Estimated dollar cost of proposed corrective action:</td>
<td>$25,000 to $50,000</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>$10,000 to $25,000</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>$1,000 to $10,000</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>$100 to $1,000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>$25 to $100</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Under $25</td>
<td>0.5</td>
</tr>
<tr>
<td>Degree of Correction</td>
<td>Hazard positively eliminated, 100%</td>
<td>1</td>
</tr>
<tr>
<td>Degree to which hazard will be reduced:</td>
<td>Hazard reduced at least 75%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Hazard reduced 50% to 75%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Hazard reduced by 25% to 50%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Slight effect on hazard (less than 25%)</td>
<td>6</td>
</tr>
</tbody>
</table>
The values derived are placed in the Risk Score Formula. Then you would calculate a risk score.

\[
\text{Risk Score Formula} = \text{Consequences} \times \text{Exposure} \times \text{Probability}
\]

Once you have a risk score, you should compare it to the following criteria to determine the need for action. If the score is between

- 18 and 85, the hazard should be eliminated without delay, but the situation is not an emergency.
- 90 and 200, this is urgent and requires attention as soon as possible.
- 270 and 1,500, this score requires immediate corrective action. All activity should be discontinued until the hazard is removed or reduced.

A risk score will not necessarily garner support for the removal or reduction of a potential hazard. The questions asked are, “How much will it cost?” and “How much hazard reduction will be derived from fixing the dangerous situation?” Fine (1973) went beyond the risk score and developed a Justification Formula. The formula includes factors for cost and the degree of correction. The resulting rating values for the cost and degree of correction factor can be extracted from Table 1.1. The Justification Formula is as follows:

\[
\text{Justification Formula} = \frac{\text{Consequences} \times \text{Exposure} \times \text{Probability (Risk Score)}}{\text{Cost Factor} \times \text{Degree of Correction}}
\]

For a Critical Justification Rating greater than 10, fixing the hazard is justified. For a score of less than 10, fixing the hazard is not justified.

Any time you can quantify something, you have a better chance of proving your point or gaining acceptance for it. Most managers and others pay more attention to numbers that support a case for risk reduction than to rhetoric.

Thus, when discussing risks related to occupational safety and health, being able to determine a value that equates to the degree of risk gives each company a measure for deciding how much risk it is willing to assume. This is best accomplished using a quantitative approach as discussed previously.

**RISK CONTROL**

The key to risk control is to prevent exposure of those who could be at risk. In the workplace it is not possible to have no exposure if anything is going to get done. It is important to limit the potential exposure or amount of exposure. The basic principles of protection from radiation exposure provide the foundation for risk control. The three elements of exposure control are distance, time, and shielding. Distance provides the best mechanism to prevent exposure. Distance can be physical distance or remote distance where robotics can provide the distance and limit the
exposure. Time is an exposure limiter and a mechanism that allows employers to spread exposure over several workers. The time part of the work cycle that allows for minimal risk exposure to transpire is during a shift when fewer employees are present to be exposed. Often, second and third shifts are times when fewer workers are present. Shielding is frequently considered the least acceptable approach to risk control. Barriers or personal protective equipment should be the risk control of last resort. With occupational safety and health, other approaches to risk control are often employed.

Many ways to control hazards have been used over the years but usually these can be broken down into five primary approaches. The preferred ways to do this are through engineering controls, awareness devices, predetermined safe work practices, and administrative controls. When these controls are not feasible or do not provide sufficient protection, an alternative or supplementary method of protection is to provide workers with personal protective equipment (PPE) and the know-how to use it properly.

**ENGINEERING CONTROLS**

When a hazard is identified in the workplace, every effort should be made to eliminate it so that employees are not harmed. Elimination may be accomplished by designing or redesigning a piece of equipment or process. This could be the installation of a guard on a piece of machinery that prevents workers from contacting the hazard. The hazard can be engineered out of the operation. Another way to reduce or control the hazard is to isolate the process, such as in the manufacture of vinyl chloride used to make such items as plastic milk bottles, where the entire process becomes a closed circuit. This will result in no one being exposed to vinyl chloride gas, which is known to cause cancer. Thus, any physical controls that are put in place are considered the best approach from an engineering perspective. Keep in mind that you are a consumer of products. Thus, at times you can leverage the manufacturer to implement safe-guards or safety devices on products that you are looking to purchase. Let your vendor do the engineering for you or do not purchase their product. This may not always be a viable option. To summarize the engineering controls that can be used, the following may be considered:

- Substitution
- Elimination
- Ventilation
- Isolation
- Process or design change

**AWARENESS DEVICES**

Awareness devices are linked to the senses. They are warning devices that can be heard and seen. They act as alerts to workers but create no type of physical barrier. They are
found in most workplaces and carry with them a moderate degree of effectiveness. Such devices include

- Backup alarms
- Warning signals both audible and visual
- Warning signs

**Work Practices**

Work practices concern the ways in which a job task or activity is done. This may mean that you create a specific procedure for completing the task or job. It may also mean that you implement special training for a job or task. It also presupposes that you might require inspection of the equipment or machinery prior to beginning work or when a failure has occurred. An inspection should be done prior to restarting the process or task. It may also require that you require a lockout/tagout procedure be used to create a zero potential energy release.

**Administrative Controls**

A second approach is to control the hazard through administrative directives. This may be accomplished by rotating workers, which allows you to limit their exposure, or having workers only work in areas when no hazards exist during that part of their shift. This applies particularly to chemical exposures and repetitive activities that could result in ergonomically related incidents. Examples of administrative controls are

- Requiring specific training and education
- Scheduling off-shift work
- Worker rotation

Management controls are needed to express the company’s view of hazards and their response to hazards that have been detected. The entire program must be directed and supported through the management controls. If management does not have a systematic and set procedure for addressing the control of hazards in place, the reporting/identifying of hazards is a waste of time and dollars. This goes back to the policies and directives and the holding of those responsible accountable by providing them with the resources (budget) for correcting and controlling hazards. Some aspects of management controls include

- Policies
- Directives
- Responsibilities (line and staff)
- Vigor and example
- Accountability
- Budget

The attempt to identify worksite hazards and address them should be an integral part of your management approach. If the hazards are not addressed in a timely
Personal Protective Equipment

Personal Protective Equipment (PPE) includes a variety of devices and garments to protect workers from injuries. You can find PPE designed to protect the eyes, face, head, ears, feet, hands and arms, and the whole body. PPE includes such items as goggles, face shields, safety glasses, hard hats, safety shoes, gloves, vests, earplugs, earmuffs, and suits for full-body protection.

When employees must be present and engineering or administrative controls are not feasible, it will be essential to use PPE as an interim control and not a final solution. For example, safety glasses may be required in the work area. Too often, PPE usage is considered the last thing to do in the scheme of hazard control. PPE can provide added protection to the employee even when the hazard is being controlled by other means. However, there are drawbacks to the use of PPE, including:

- Hazard still looms
- Protection dependent on worker using PPE
- PPE may interfere with performing task and productivity
- Requires supervision
- Is an ongoing expense

Personal protective equipment includes the following:

- Eye and face protection (29 CFR 1910.133)
- Respiratory protection (29 CFR 1910.134)
- Head protection (29 CFR 1910.135)
- Foot and leg protection (29 CFR 1910.136)
- Electrical protective equipment (29 CFR 1910.137)
- Hand protection (29 CFR 1910.138)
- Respiratory protection from tuberculosis (29 CFR 1910.139)

Ranking Hazard Controls

In determining which hazard control procedures have the best chance of being effective, it is useful to have some sort of a ranking of them along a continuum. The five hazard controls that were espoused in the earlier part of this chapter are ranked in Figure 1.3. This should assist you in determining which control, if you have a choice of more than one, would be most effective for your purposes. The ranking goes from most effective to least effective.

Structuring Accident/Incident Prevention

Structuring should begin with a written safety and health program. There is a need to assess your accident/incident history and develop a good accident and injury
Elimination or Substitution
- Change the process to eliminate human interaction
- Elimination of pinch points (increase clearance)
- Automated material handling

Engineering Controls (Safeguarding Technology)
- Mechanical hard stops
- Barriers
- Interlocks
- Presence sensing devices
- Two-hand controls

Awareness Means
- Lights, beacons, and strobes
- Computer warnings
- Signs
- Painted markings on floors, etc. for restrictive areas or envelopes
- Beepers
- Alarms
- Horns
- Public address systems
- Labels

FIGURE 1.3 Ranking the effectiveness of hazard controls.
**Training and Procedures**

(Administrative Controls)

- Training
- Job rotation
- Off-shift scheduling of work
- Safe job procedures
- Safety equipment inspections/audits
- Lockout/tagout

**Personal Protective Equipment**

- Safety eyewear (face shield, etc)
- Hearing protection (ear plugs or muffs)
- Fireproof clothing
- Gloves
- Safety shoes
- Respirators
- Whole body protection (Tyveks, etc.)
reporting and investigation procedure. Once you have sufficient data to identify your hazards, determine the potential interventions that will prevent the occurrence of injuries. The interventions, chosen for implementation, are the accident prevention processes and techniques you feel will help prevent mishaps. These interventions become a part of your accident prevention program. They may be processes or applications of accident prevention techniques such as job safety observations or actual physical changes (engineering) to equipment or facilities. Your safety and health program should culminate with follow-up evaluation procedures to determine the effectiveness of your loss control program.

KNOW WITH WHOM YOU ARE DEALING

You must understand the culture of the work environment before you can intelligently implement any type of program aimed at the workforce. You need to know and understand the values, attitudes, and perceptions held by the workforce relevant to job safety and health. This will afford the opportunity to place into action a motivational plan relevant to preventing accidents and incidents in your unique workplace.

DETERMINING THE CAUSE OF ACCIDENTS

The causes of the specific types of accidents/incidents that have occurred within your workplace must be assessed. The approach you wish to use in the assessment and analysis process depends greatly on your familiarity with and the types of occurrences that have transpired in your workplace. Analyses covered in this book are root cause, causal factor, change, and barrier analysis.

This is not a finite listing, as other, more complex approaches such as Management Oversight and Risk Tree Analysis (MORT), failure mode and effect analysis, and the aspects of system safety engineering are not covered within the scope of this book. These approaches can be found in many other books and articles.

ACCIDENT PREVENTION TECHNIQUES

Accident prevention techniques, such as job hazard analysis, safe operating procedures, and job safety observations, have their application to specific jobs within the workplace. In general, they aim to address and identify existing or potential work-related hazards. These types of accident prevention techniques are emphasized in this book. Most books addressing accident prevention techniques usually emphasize specific job hazards and their prevention, such as fire safety and machine guarding. This particular book places only minor emphasis on specific job hazards.

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United States Department of Labor, Mine Safety and Health Administration. Accident Prevention, Safety Manual No. 4, Beckley, WV: U.S. Department of Labor, revised 1990. This page intentionally left blank
Chapter 2: Safety and Health Programs


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3 Chapter 3: Accident/Incident Investigation


4 Chapter 4: Hazard Recognition and Avoidance


FIGURE 4.1 Hazard identification helps determine risk and danger. This page intentionally left blank
Chapter 5: Accountability and Responsibility


Chapter 6: Motivating Safety and Health


FIGURE 6.2 Flowchart for applying the principles of motivation.


Wieneke, R. E., et al., Los Alamos National Laboratory, Success in Behavior-Based Safety at Los Alamos National Laboratory’s Plutonium Facility. Los Alamos, NM: 2002. This page intentionally left blank
Chapter 7: Accident/Incident Analysis


Chapter 8: Root Cause Analysis


9 Chapter 9: Causal Factor Analysis


Chapter 10: Change Analysis


11 Chapter 11: Barrier Analysis


12 Chapter 12: Job Safety/Hazard Analysis


United States Department of Labor, Mine Safety and Health Administration, Safety Observation (MSHA IG 84). Beckley, WV: U.S. Department of Labor, revised 1991. This page intentionally left blank
Chapter 15: Safety and Health Audits


TABLE 15.5 (continued)

Regulatory Compliance Checklist Lockout/Tagout Safety Checklist

Are specific procedures established for lockout/tagout utilization during shift change? [29 CFR 1910.147 (E)(4)] ______ ______

If outside contractors are working on-site, do our personnel ensure compliance with lockout/tagout procedures? [29 CFR 1910.147 (f)(2)] ______ ______

Periodic Inspections

Are periodic inspections of lockout/tagout procedures conducted at least annually? [29 CFR 1910.147 (c)(6)(i)] ______ ______

Are inspections conducted by a supervisor or authorized employee, other than the person using the lockout/tagout procedure? [29 CFR 1910.147 (c)(6)(i)(A)] ______ ______

Does the inspection include a review, between the inspector and the authorized/affected employees, of their responsibilities under the lockout/tagout program? [29 CFR 1910.147 (c)(6)(i)(D)] ______ ______

Are inspections certified and recorded? [29 CFR 1910.147 ______ ______
As a minimum, do the inspections include the date of inspection, the employee and inspector names, and the equipment on which the lockout/tagout procedures are being used? [29 CFR 1910.147 (c)(6)(ii)]
16 Chapter 16: Fleet Safety Program


FIGURE 17.2 Preventive maintenance can help prevent costly repairs like this.


FIGURE 17.3 This chapter is applicable to all over-the-road vehicles like this delivery truck and not just long-haul trucks.
Chapter 18: Special Emphasis Programs

Chapter 19: Using Safety and Health Consultants


21 Chapter 21: Analyzing Accident Data


23 Chapter 23: Health Hazard Prevention


25 Chapter 25: Safety Hazards


