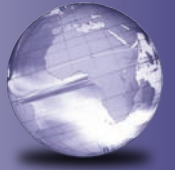


GLOBAL  
EDITION



# Occupational Safety and Health

*For Technologists, Engineers, and Managers*

EIGHTH EDITION



David L. Goetsch

ALWAYS LEARNING

PEARSON

# **OCCUPATIONAL SAFETY AND HEALTH**

**For Technologists, Engineers, and Managers**

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# OCCUPATIONAL SAFETY AND HEALTH

For Technologists, Engineers, and Managers

**Eighth Edition  
Global Edition**

**David L. Goetsch**

*Vice-President Emeritus and Professor  
Northwest Florida State College*

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# PREFACE

## BACKGROUND

The field of occupational safety and health has undergone significant change over the past three decades. There are many reasons for this. Some of the more prominent reasons include the following: technological changes that have introduced new hazards in the workplace; proliferation of health and safety legislation and corresponding regulations; increased pressure from regulatory agencies; realization by executives that workers in a safe and healthy workplace are typically more productive; health care and workers' compensation cost increases; increased pressure from environmental groups and the public; a growing interest in ethics and corporate responsibility; professionalization of health and safety occupations; increased pressure from labor organizations and employees in general; rapidly mounting costs associated with product safety and other types of litigation; and increasing incidents of workplace violence.

All of these factors, when combined, have made the job of the modern safety and health professional more challenging and more important than it has ever been. These factors have also created a need for an up-to-date book on workplace safety and health that contains the latest information needed by people who will practice this profession in an age of global competition and rapid technological change.

## WHY WAS THIS BOOK WRITTEN AND FOR WHOM?

This book was written to fulfill the need for an up-to-date, practical teaching resource that focuses on the needs of modern safety and health professionals practicing in the workplace. It is intended for use in universities, colleges, community colleges, and corporate training settings that offer programs, courses, workshops, and seminars in occupational safety and health. Educators in such disciplines as industrial technology, manufacturing technology, industrial engineering, engineering technology, occupational safety, management, and supervision will find this book both valuable and easy to use. The direct, straightforward presentation of material focuses on making the theories and principles of occupational safety and health practical and useful in a real-world setting. Up-to-date research has been integrated throughout in a down-to-earth manner.

## ORGANIZATION OF THE BOOK

The text contains 31 chapters organized into 5 parts, each focusing on a major area of concern for modern safety and health professionals. The chapters are presented in an order that is compatible with the typical organization of a college-level safety and health course. A standard chapter format is used throughout the book. Each chapter begins with a list of major topics and ends with a comprehensive summary. Following the summary, most chapters include review questions, key terms and concepts, and endnotes. Within each chapter are case studies to promote classroom discussion, as well as at least one safety fact or myth. These materials are provided to encourage review, stimulate additional thought, and provide opportunities for applying what has been learned.

## SUPPLEMENTS

To access supplementary materials online, instructors need to request an instructor access code. Go to [www.pearsonglobaledition.com/Goetsch](http://www.pearsonglobaledition.com/Goetsch) to register for an instructor access code. Within 48 hours of registering, you will receive a confirming e-mail including an instructor access code. Once you have received your code, locate your text in the

online catalog and click on the Instructor Resources button on the left side of the catalog product page. Select a supplement, and a login page will appear. Once you have logged in, you can access instructor material for all Pearson textbooks. If you have any difficulties accessing the site or downloading a supplement, please contact Customer Service at <http://247pearsoned.custhelp.com/>.

## HOW THIS BOOK DIFFERS FROM OTHERS

This book was written because in the age of global competition, safety and health in the workplace have changed drastically. Many issues, concerns, and factors relating specifically to modern workplace environments have been given more attention, greater depth of coverage, and more illumination here than other textbooks. Some of the areas receiving more attention and specific occupational examples include:

- The Occupational Safety and Health Act (OSH Act) and Occupational Safety and Health Administration (OSHA)
- Standards and codes
- Laws and liability
- Stress-related problems
- Life safety and fire hazards
- The evolving roles of health and safety professionals
- Health and safety training
- Human factors in safety
- Environmental issues and ISO 14000 standards
- Computers, robots, and automation
- Ethics and safety
- Bloodborne pathogens in the workplace
- MRSA in the workplace
- Product safety and liability
- Ergonomics and safety
- The relationship between safety and quality
- Workplace violence
- Workers' compensation
- Repetitive strain injuries (RSIs)
- Terrorism threats in the workplace
- Safety-first corporate culture
- Off-the-job safety

## NEW TO THIS EDITION

The eighth edition of *Occupational Safety and Health* is a major revision encompassing new regulations, revised regulations, and other new and updated material of importance to students of occupational safety and health. Specifically, the following revisions were made in the eighth edition:

- Chapter 1: New section covering the Return on Investment (ROI) in safety and health management was added as was a new example case about a factory fire in Bangladesh.
- Chapter 2: The section Death Rates by Industry was updated.
- Chapter 3: New material was added on Heinrich's theory and corrective action and on the limitations of event-chain accident causation theories.

- Chapter 6: This chapter was re-written to reflect changes to OSHA standards that have occurred since the seventh edition. Revisions made include a re-write of: OSHA's mission; coverage of federal, state, and local government personnel; how OSHA standards are developed; workplace inspection priorities; OSHA's whistleblower program; OSHA's severe violator enforcement program; OSHA assistance, services, and programs; and the section on OSHA's Maritime Standard. In addition, a new section on OSHA's stand on safety incentives was added.
- Chapter 7: Added material clarifying explaining when employees covered by Workers' Compensation can and cannot sue.
- Chapter 8: Added new material on the what and why of workplace accidents, the latest version of OSHA's Form 301, the team approach to accident investigations, how to add perspective to accident scene photographs, and how to follow-up an accident investigation.
- Chapter 10: Added new material on the repeal of OSHA's short-lived Ergonomic Program Standard and updated the statistics on the extent of MSDs and CTDs.
- Chapter 14: Added new material on minimum general requirements for machine safeguards. Added a new section titled "Permanent Electrical Safety Devices in Lockout/Tagout Programs."
- Chapter 15: Added new material on the new ANSI/NFSI B101.1 Standard for measuring wet SCOF traction, OSHA's Fall Protection Standard, and head protection (rating of hard hats). Added a new section titled "OSHA's Fall Protection Standard for Construction."
- Chapter 16: Added material on PPE for cold work environments.
- Chapter 18: Updated and expanded the "Electrical Hazards Self-Assessment." Added a new section titled "Permanent Electrical Safety Devices."
- Chapter 19: Added new material on flammable and combustible liquids.
- Chapter 20: Updated OSHA's Process Safety Management Guidelines and the section on Material Safety Data Sheets or MSDS (now Safety Data Sheets or SDS) and Global Harmonization of Hazard Communication (GHS). Added a new list of standards for Indoor Air Quality (IAQ) investigations and new sections titled "ASTM D7338: Guide for the Assessment of Fungal Growth in Buildings," "OSHA's Chemical Process Standard," "Environment Protection Agency (EPA) Risk Management Program," "Hazardous Materials Transportation Act (HMTA)," "OSHA Confined Space Standard," and "Nanoscale Materials and Industrial Hygiene."
- Chapter 22: Added new material on fit testing and a new section titled "Future of Hearing Conservation: Noise Reduction Rating."

## ABOUT THE AUTHOR

David L. Goetsch is Vice-President Emeritus of Northwest Florida State College and professor of safety, quality, and environmental management. In addition, Dr. Goetsch is president and CEO of the Institute for Organizational Excellence (IOE), a private consulting firm dedicated to the continual improvement of organizational competitiveness, safety, and quality. Dr. Goetsch is cofounder of The Quality Institute, a partnership of the University of West Florida, Northwest Florida State College, and the Okaloosa Economic Development Council.



## ACKNOWLEDGMENTS

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# INTRODUCTION

## SAFETY VERSUS HEALTH

The title of this book intentionally includes the words *safety* and *health*. Throughout the text, the titles “safety and health professional” and “safety and health manager” are used. This, too, is done by design. This approach underscores the point that the field of occupational safety has been broadened to encompass both safety and health. Consequently, managers, technical personnel, and engineers in this field must be knowledgeable about safety and health and be prepared to oversee a corporate program that encompasses both areas of responsibility.

Safety and health, although closely related, are not the same. One view is that safety is concerned with injury-causing situations, whereas health is concerned with disease-causing conditions. Another view is that safety is concerned with hazards to humans that result from sudden severe conditions; health deals with adverse reactions to exposure to dangerous, but less intense, hazards. Both of these views are generally accurate in portraying the difference between safety and health. However, the line between these two concepts is not always clearly marked.

For example, on the one hand, stress is a hazard that can cause both psychological and physiological problems over a prolonged period. In this case, it is a health concern. On the other hand, an overly stressed worker may be more prone to unintentionally forget safety precautions and thus may cause an accident. In this case, stress is a safety concern.

Because managers in this evolving profession are likely to be responsible for safety *and* health, it is important that they have a broad academic background covering both. This book attempts to provide that background.

This broadening of the scope of the profession does not mean that specialists in safety and health are not still needed. They are. Chapter 4 shows how today’s safety and health manager is a generalist who often heads a team of specialists such as safety engineers, health physicists, industrial hygienists, occupational nurses, occupational physicians, and risk managers. In order to manage a team of specialists in these various areas, safety and health managers must have the broad and comprehensive background that this book provides.

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# SAFETY AND HEALTH MOVEMENT, THEN AND NOW

## MAJOR TOPICS

- ▶ Developments before the Industrial Revolution
- ▶ Milestones in the Safety Movement
- ▶ Tragedies That Have Changed the Safety Movement
- ▶ Role of Organized Labor
- ▶ Role of Specific Health Problems
- ▶ Development of Accident Prevention Programs
- ▶ Development of Safety Organizations
- ▶ Safety and Health Movement Today
- ▶ Integrated Approach to Safety and Health
- ▶ New Materials, New Processes, and New Problems
- ▶ Rapid Growth in the Profession
- ▶ Return on Investment in Safety and Health Management

The **safety movement** in the United States has developed steadily since the early 1900s. In that time period, industrial accidents were commonplace in this country; for example, in 1907, more than 3,200 people were killed in mining accidents. Legislation, precedent, and public opinion all favored management. There were few protections for workers' safety.

Working conditions for industrial employees today have improved significantly. The chance of a worker being killed in an industrial accident is less than half of what it was 60 years ago.<sup>1</sup> According to the National Safety Council (NSC), the current death rate from work-related injuries is approximately 4 per 100,000, or less than a third of the rate 50 years ago.<sup>2</sup>

Improvements in safety until now have been the result of pressure for legislation to promote safety and health, the steadily increasing costs associated with accidents and injuries, and the professionalization of safety as an occupation. Improvements in the future are likely to come as a result of greater awareness of the cost-effectiveness and resultant competitiveness gained from a safe and healthy workforce.

This chapter examines the history of the safety movement in the United States and how it has developed over the years. Such a perspective will help practicing and prospective safety professionals form a better understanding of both their roots and their future.

## DEVELOPMENTS BEFORE THE INDUSTRIAL REVOLUTION

It is important for students of occupational health and safety to first study the past. Understanding the past can help safety and health professionals examine the present and future with a sense of perspective and continuity. Modern developments in health and safety are neither isolated nor independent. Rather, they are part of the long continuum of developments in the safety and health movement.

The continuum begins with the days of the ancient Babylonians. During that time, circa 2000 BC, their ruler, Hammurabi, developed his **Code of Hammurabi**. The code encompassed all the laws of the land at that time, showed Hammurabi to be a just ruler, and set a precedent followed by other Mesopotamian kings. The significance of the code from the perspective of safety and health is that it contained clauses dealing with injuries, allowable fees for physicians, and monetary damages assessed against those who injured others.<sup>3</sup> This clause from the code illustrates Hammurabi's concern for the proper handling of injuries: "If a man has caused the loss of a gentleman's eye, his own eye shall be caused to be lost."<sup>4</sup>

This movement continued and emerged in later Egyptian civilization. As evidenced from the temples and pyramids that still remain, the Egyptians were an industrious people. Much of the labor was provided by slaves, and there is ample evidence that slaves were not treated well—that is, unless it suited the needs of the Egyptian taskmasters.

One such case occurred during the reign of Rameses II (circa 1500 BC), who undertook a major construction project, the Ramesseum. To ensure the maintenance of a workforce sufficient to build this huge temple bearing his name, Rameses created an industrial medical service to care for the workers. They were required to bathe daily in the Nile and were given regular medical examinations. Sick workers were isolated.<sup>5</sup>

The Romans were vitally concerned with safety and health, as can be seen from the remains of their construction projects. The Romans built aqueducts, sewerage systems, public baths, latrines, and well-ventilated houses.<sup>6</sup>

As civilization progressed, so did safety and health developments. In 1567, Philippus Aureolus produced a treatise on the pulmonary diseases of miners. Titled *On the Miners' Sickness and Other Miners' Diseases*, the treatise covered diseases of smelter workers and metallurgists and diseases associated with the handling of and exposure to mercury. Around the same time, Georgius Agricola published his treatise *De Re Metallica*, emphasizing the need for ventilation in mines and illustrating various devices that could be used to introduce fresh air into mines.<sup>7</sup>

The eighteenth century saw the contributions of Bernardino Ramazzini, who wrote *Discourse on the Diseases of Workers*. Ramazzini drew conclusive parallels between diseases suffered by workers and their occupations. He related occupational diseases to the handling of harmful materials and to irregular or unnatural movements of the body. Much of what Ramazzini wrote is still relevant today.<sup>8</sup>

The Industrial Revolution changed forever the methods of producing goods. According to J. LaDou, the changes in production brought about by the Industrial Revolution can be summarized as follows:

- Introduction of **inanimate power** (i.e., steam power) to replace people and animal power
- Substitution of machines for people
- Introduction of new methods for converting raw materials
- Organization and specialization of work, resulting in a division of labor<sup>9</sup>

These changes necessitated a greater focusing of attention on the safety and health of workers. Steam power increased markedly the potential for life-threatening injuries, as did machines. The new methods used for converting raw materials also introduced new risks of injuries and diseases. Specialization, by increasing the likelihood of boredom and inattentiveness, also made the workplace a more dangerous environment.

## MILESTONES IN THE SAFETY MOVEMENT

Just as the United States traces its roots to Great Britain, the safety movement in this country traces its roots to England. During the Industrial Revolution, child labor in factories was common. The hours were long, the work hard, and the conditions often unhealthy and unsafe. Following an outbreak of fever among the children working in their cotton mills, the people of Manchester, England, began demanding better working conditions in the

factories. Public pressure eventually forced a government response, and in 1802 the Health and Morals of Apprentices Act was passed. This was a milestone piece of legislation: It marked the beginning of governmental involvement in workplace safety.

When the industrial sector began to grow in the United States, hazardous working conditions were commonplace. Following the Civil War, the seeds of the safety movement were sown in this country. Factory inspection was introduced in Massachusetts in 1867. In 1868, the first barrier safeguard was patented. In 1869, the Pennsylvania legislature passed a mine safety law requiring two exits from all mines. The Bureau of Labor Statistics (BLS) was established in 1869 to study industrial accidents and report pertinent information about those accidents.

The following decade saw little new progress in the safety movement until 1877, when the Massachusetts legislature passed a law requiring safeguards for hazardous machinery. This year also saw passage of the Employer's Liability Law, establishing the potential for **employer liability** in workplace accidents. In 1892, the first recorded safety program was established in a Joliet, Illinois, steel plant in response to a scare caused when a flywheel exploded. Following the explosion, a committee of managers was formed to investigate and make recommendations. The committee's recommendations were used as the basis for the development of a safety program that is considered to be the first safety program in American industry.

Around 1900, Frederick Taylor began studying efficiency in manufacturing. His purpose was to identify the impact of various factors on efficiency, productivity, and profitability. Although safety was not a major focus of his work, Taylor did draw a connection between lost personnel time and management policies and procedures. This connection between safety and management represented a major step toward broad-based safety consciousness.

In 1907, the U.S. Department of the Interior created the Bureau of Mines to investigate accidents, examine health hazards, and make recommendations for improvements. Mining workers definitely welcomed this development, since more than 3,200 of their fellow workers were killed in mining accidents in 1907 alone.<sup>10</sup>

One of the most important developments in the history of the safety movement occurred in 1908 when an early form of **workers' compensation** was introduced in the United States. Workers' compensation actually had its beginnings in Germany. The practice soon spread throughout the rest of Europe. Workers' compensation as a concept made great strides in the United States when Wisconsin passed the first effective workers' compensation law in 1911. In the same year, New Jersey passed a workers' compensation law that withstood a court challenge.

The common thread among the various early approaches to workers' compensation was that they all provided some amount of compensation for on-the-job injuries regardless of who was at fault. When the workers' compensation concept was first introduced in the United States, it covered a very limited portion of the workforce and provided only minimal benefits. Today, all 50 states have some form of workers' compensation that requires the payment of a wide range of benefits to a broad base of workers. Workers' compensation is examined in more depth in Chapter 7.

The Association of Iron and Steel Electrical Engineers (AISEE), formed in the early 1900s, pressed for a national conference on safety. As a result of the AISEE's efforts, the first meeting of the **Cooperative Safety Congress (CSC)** took place in Milwaukee in 1912. What is particularly significant about this meeting is that it planted the seeds for the eventual establishment of the NSC. A year after the initial meeting of the CSC, the **National Council of Industrial Safety (NCIS)** was established in Chicago. In 1915, this organization changed its name to the National Safety Council. It is now the premier safety organization in the United States.

From the end of World War I (1918) through the 1950s, safety awareness grew steadily. During this period, the federal government encouraged contractors to implement and maintain a safe work environment. Also during this period, industry in the United States arrived at two critical conclusions: (1) there is a definite connection between quality and safety, and (2) off-the-job accidents have a negative impact on productivity. The second

conclusion became painfully clear to manufacturers during World War II when the call-up and deployment of troops had employers struggling to meet their labor needs. For these employers, the loss of a skilled worker due to an injury or for any other reason created an excessive hardship.<sup>11</sup>

The 1960s saw the passage of a flurry of legislation promoting workplace safety. The Service Contract Act of 1965, the Federal Metal and Nonmetallic Mine Safety Act, the Federal Coal Mine and Safety Act, and the Contract Workers and Safety Standards Act all were passed during the 1960s. As their names indicate, these laws applied to a limited audience of workers.

These were the primary reasons behind passage of the **Occupational Safety and Health Act (OSH Act)** of 1970 and the Federal Mine Safety Act of 1977. These federal laws, particularly the OSH Act, represent the most significant legislation to date in the history of the safety movement. During the 1990s, the concept of Total Safety Management (TSM) was introduced and adopted by firms that were already practicing Total Quality Management (TQM). TSM encourages organizations to take a holistic approach to safety management in which the safety of employees, processes, and products is considered when establishing safe and healthy work practices.

At the turn of the century, workplace violence including terrorism began to concern safety and health professionals. In addition, the twenty-first century saw a trend in which older people were returning to work to supplement their retirement income. This trend led to a special emphasis on the safety and health of older workers. A more recent trend is greater concern of U.S. companies for the safety and health of employees in foreign countries that manufacture goods that are sold in the United States.

The Superfund Amendments and Reauthorization Act was passed by Congress in 1986, followed by the Amended Clean Air Act in 1990; both were major pieces of environmental legislation.

Figure 1–1 summarizes some significant milestones in the development of the safety movement in the United States.

## TRAGEDIES THAT HAVE CHANGED THE SAFETY MOVEMENT

Safety and health tragedies in the workplace have greatly accelerated the pace of the safety movement in the United States. Four of the most significant events in the history of the safety and health movement were the **Hawk’s Nest tragedy**, **asbestos menace**, the **Bhopal tragedy**, and factory fire in Bangladesh. This section explains these three milestone events and their lasting effects on the safety and health movement in the United States.

### Hawk’s Nest Tragedy

In the 1930s, the public began to take notice of the health problems suffered by employees who worked in dusty environments. The Great Depression was indirectly responsible for the attention given to an occupational disease that came to be known as *silicosis*. As the economic crash spread, business after business shut down and laid off its workers. Unemployed miners and foundry workers began to experience problems finding new jobs when physical examinations revealed that they had lung damage from breathing silica. Cautious insurance companies recommended preemployment physicals as a way to prevent future claims based on preexisting conditions. Applicants with silica-damaged lungs were refused employment. Many of them sued. This marked the beginning of industry-wide interest in what would eventually be called the “king” of occupational diseases.

Lawsuits and insurance claims generated public interest in silicosis, but it was the Hawk’s Nest tragedy that solidified public opinion in favor of protecting workers from this debilitating disease.<sup>12</sup> A company was given a contract to drill a passageway through a mountain located in the Hawk’s Nest region of West Virginia (near the city of Gauley Bridge). Workers spent as many as 10 hours per day breathing the dust created by drilling and blasting. It turned out that this particular mountain had an unusually high silica

1867	Massachusetts introduces factory inspection.
1868	Patent is awarded for first barrier safeguard.
1869	Pennsylvania passes law requiring two exits from all mines, and the Bureau of Labor Statistics is formed.
1877	Massachusetts passes law requiring safeguards on hazardous machines, and the Employer's Liability Law is passed.
1892	First recorded safety program is established.
1900	Frederick Taylor conducts first systematic studies of efficiency in manufacturing.
1907	Bureau of Mines is created by the U.S. Department of the Interior.
1908	Concept of workers' compensation is introduced in the United States.
1911	Wisconsin passes the first effective workers' compensation law in the United States, and New Jersey becomes the first state to uphold a workers' compensation law.
1912	First Cooperative Safety Congress meets in Milwaukee.
1913	National Council of Industrial Safety is formed.
1915	National Council of Industrial Safety changes its name to National Safety Council.
1916	Concept of negligent manufacture is established (product liability).
1936	National Silicosis Conference convened by the U.S. Secretary of Labor.
1970	Occupational Safety and Health Act passes.
1977	Federal Mine Safety Act passes.
1986	Superfund Amendments and Reauthorization Act pass.
1990	Amended Clean Air Act of 1970 passes.
1996	Total safety management (TSM) concept is introduced.
2000	U.S. firms begin to pursue ISO 14000 registration for environmental safety management.
2003	Workplace violence and terrorism are an ongoing concern of safety and health professionals.
2007	Safety of older people reentering the workplace becomes an issue.
2010	Off-the-job safety becomes an issue.
2014	Pressure on foreign companies that produce goods sold in the United States to improve their safety standards.

**FIGURE 1-1** Milestones in the safety movement.

content. Silicosis is a disease that normally takes 10 to 30 years to show up in exposed workers. At Hawk's Nest, workers began dying in as little time as a year. By the time the project was completed, hundreds had died. To make matters even worse, the company often buried an employee who died from exposure to silica in a nearby field without notifying the family. Those who inquired were told that their loved one left without saying where he was going.

A fictitious account of the Gauley Bridge disaster titled *Hawk's Nest*, by Hubert Skidmore, whipped the public outcry into a frenzy, forcing Congress to respond.

This tragedy and the public outcry that resulted from it led a group of companies to form the Air Hygiene Foundation to conduct research and develop standards for working in dusty environments. Soon thereafter, the U.S. Department of Labor provided the leadership necessary to make silicosis a compensable disease under workers' compensation in most states. Today, dust-producing industries use a wide variety of administrative controls, engineering

controls, and personal protective equipment to protect workers in dusty environments. However, silicosis is still a problem. Approximately 1 million workers in the United States are still exposed to silica every year, and 250 people die annually from silicosis.

### Asbestos Menace

Asbestos was once considered a “miracle” fiber, but in 1964, Dr. Irving J. Selikoff told 400 scientists at a conference on the biological effects of asbestos that this widely used material was killing workers. This conference changed how Americans viewed not just asbestos, but also workplace hazards in general. Selikoff was the first to link asbestos to lung cancer and respiratory diseases.<sup>13</sup>

At the time of Selikoff’s findings, asbestos was one of the most widely used materials in the United States. It was found in homes, schools, offices, factories, ships, and even in the filters of cigarettes. Selikoff continued to study the effects of asbestos exposure from 1967 to 1986. During this time, he studied the mortality rate of 17,800 workers who had been exposed to asbestos. He found asbestos-related cancer in the lungs, gastrointestinal tract, larynx, pharynx, kidneys, pancreas, gall bladder, and bile ducts of workers.

Finally, in the 1970s and 1980s, asbestos became a controlled material. Regulations governing the use of asbestos were developed, and standards for exposure were established. Asbestos-related lawsuits eventually changed how industry dealt with this tragic material. In the 1960s, industry covered up or denied the truth about asbestos. Now, there is an industry-wide effort to protect workers who must remove asbestos from old buildings and ships during remodeling, renovation, or demolition projects.

### Bhopal Tragedy

On the morning of December 3, 1984, over 40 tons of methyl isocyanate (MIC) and other lethal gases, including hydrogen cyanide, leaked into the northern end of Bhopal, killing more than 3,000 people in its aftermath.<sup>14</sup> After the accident, it was discovered that the protective equipment that could have halted the impending disaster was not in full working order. The refrigeration system that should have cooled the storage tank was shut down, the scrubbing system that should have absorbed the vapor was not immediately available, and the flare system that would have burned any vapor that got past the scrubbing system was out of order.<sup>15</sup>

The International Medical Commission visited Bhopal to assess the situation and found that as many as 50,000 other people had been exposed to the poisonous gas and may still suffer disability as a result. This disaster shocked the world. Union Carbide Corporation, the owner of the chemical plant in Bhopal, India, where the incident occurred, was accused of many things, including the following:

- **Criminal negligence.**
- **Corporate prejudice.** Choosing poverty-stricken Bhopal, India, as the location for a hazardous chemical plant on the assumption that few would care if something went wrong.
- **Avoidance.** Putting its chemical plant in Bhopal, India, to avoid the stricter safety and health standards of the United States and the Occupational Safety and Health Administration (OSHA) in particular.

In February 1989, India’s Supreme Court ordered Union Carbide India Ltd. to pay \$470 million in compensatory damages. The funds were paid to the Indian government to be used to compensate the victims. This disaster provided the impetus for the passage of stricter safety legislation worldwide. In the United States, it led to the passage of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986.

### Factory Fire in Bangladesh

In November 2012, a garment-factory fire in Bangladesh killed 112 employees. The magnitude of the tragedy was enhanced when it was discovered that the factory produced