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The Occupational Environment:

Its Evaluation, Control, and Management

3rd edition

Volume 1

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Edited by
Daniel H. Anna, PhD, CIH, CSP

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Preface

By Daniel H. Anna, PhD, CIH, CSP

Since the publication of the Second Edition of *The Occupational Environment: Its Evaluation, Control, and Management* in 2003, the role of the industrial hygienist has continued to evolve and expand. The scope of responsibilities for most industrial hygienists now includes at least some aspects of safety, environmental, sustainability, quality, security, emergency response, or part of another ancillary discipline. But, even with all of these changes, one thing has remained constant — the need for qualified, trained professionals who can anticipate, recognize, evaluate, and control potential health hazards that arise in and from the workplace. The increasing reliance on technology, the expanding world of nanotechnology, the continuing globalization of business and industry, and the changing definition of "workplace" all contribute to the complexities of potential exposures and the challenges of assessing risk of exposure. Terms like exposure risk assessment and management have become part of the language used to describe traditional industrial hygiene responsibilities to a broader international audience.

The evolution of the profession played a role in the development of this edition, and, in turn, hopefully the revised content will play a significant role in preparing IHs for success in the continually evolving work environment. It was essential to incorporate changes because this book serves as a primary textbook for courses that help to prepare future IH, EHS and other related professionals. Beyond the classroom, this book has traditionally served as a fundamental reference for a broad range of topics within the scope of IH related competencies. But with the increasing complexities of the profession and the increasing scope of competencies required to protect worker health, this book can only serve as the starting point for many of the topics presented. In many chapters, the authors have added recommended resources to consult for additional information.

Nearly 120 authors contributed to this edition. New chapters were added to address nanotechnology, professional ethics, IH issues in construction, and the AIHA® Value Strategy. Almost half of the chapters were written or revised by new authors. Most of the other chapters had significant changes and updates to the content.

The most obvious physical difference in this edition is the split into two volumes. Many users of the previous edition commented on the book being "entirely too big" to transport. The decision to divide the book into two parts resulted from the user feedback and the fact that this edition has too many pages to reliably bind into a single volume. Separating the content was a tremendous challenge; countless iterations were considered. In the end the chapters were grouped loosely around chemical hazards, physical hazards and management/program aspects. Many of the relationships between chapter content and chapter location have been maintained from the previous editions. Although this edition is provided in two volumes, it should be considered a single book.

It is an honor to be associated with this edition, to be the first person to read all of the chapters, and to know how many people will benefit from the wealth of information contained in *The Occupational Environment — Its Evaluation, Control and Management.*

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Outcome Competencies

After completing this chapter, the reader should be able to:

1. Define the underlined terms used in this chapter.
2. Describe the rationale for developing and adhering to a professional code of ethics.
3. Discuss the history of the professional code of ethics for industrial hygiene.
4. Compare and contrast the two codes of ethics that are most relevant to the practice of industrial hygiene.
5. Explain the enforcement process used by ABIH.
6. Apply the ethical decision making model to case scenarios.
7. Demonstrate ways to operationalize the ethical behaviors in challenging cases.

Key Terms

American Board of Industrial Hygiene (ABIH) • aspirational code • care-based principle • code of ethics • enforceable code • ethical dilema • Kantian principle • member ethical principles • utilitarian principle

Prerequisite Knowledge

Prior to beginning this chapter, the reader should review the following chapters.

Chapter Number	Chapter Topic
1	History and the Philosophy of Industrial Hygiene

Key Topics

I. Rationale for Professional Codes of Ethics
II. Current Industrial Hygiene Ethical Codes and Guiding Principles
III. ABIH and the Enforcement Process
IV. Avoiding Ethical Conflicts
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Industrial Hygiene Professional Ethics

2

Thomas C. Ouimet, MPH, MBA, CIH, CSP; Ann Bracker, MPH, CIH; Alan Leibowitz, CIH, CSP; David C. Roskelley, MSPH, CIH, CSP and Jeff V. Throckmorton, CIH

Rationale for Professional Codes of Ethics

As collective technical knowledge has grown over the past century, there has been a steady movement toward specialization in technical fields. This trend has led to the development of professions, or groups that have acquired highly technical specialized knowledge, through academic study, internships and sometimes a mentoring process. Members of professions have traditionally received prestige, respect and social status in society and are often better compensated than occupations that are not considered professions.

Because their knowledge is specialized and difficult for lay people to acquire, professions are self-governing and society has allowed them a great deal of autonomy in the way they operate, certainly more than it allows the practitioners of trades or managers of businesses. Members of a profession typically set their own standards of practice, regulate entry into their profession, discipline their own members, and function with fewer constraints than others. This is the case in the field of industrial hygiene where professionals develop sampling methodologies, set occupational exposure standards, create entry requirements, i.e., set criteria for sitting for the American Board of Industrial Hygiene (ABIH) certification exam, and discipline members through the ABIH ethics review process. In many areas in which IHs practice, the profession has defined acceptable practice standards. This autonomy is justified because society in general does not possess the specialized knowledge of the profession and therefore is not in a position to create standards for practitioners, define practices or discipline members. Only members of the profession who possess the specialized knowledge, can perform these functions. In return for this autonomy, society has high expectations for members of professions. Members of

Why do Ethics come into play and why are ethics important?

Certain behavior in society is regulated. Stealing and physically abusing others are examples of behavior that society has strict laws prohibiting. Many aspects of an industrial hygienist's professional life are dictated by various government regulations. On the opposite end of the spectrum from regulated behavior is free will, where there are no constraints over how one behaves. In this domain, people are all free to do whatever they wish and act according to their free will. Ethics comes into play in between these two domains — regulated behavior and free will. It belongs to the domain where no regulations (i.e., "the law") apply but, if certain actions were taken, some closely held values would be subverted or be diminished in some way. It is in this middle ground that ethical issues arise and difficult decisions about how to behave are made. Difficult professional ethical decisions must be guided by an understanding of our collective professional values as well as our personal values. If someone does not make good professional ethical choices, their careers and pro-

History — Industrial Hygiene Professional Code of Ethics

In 1968, the first Code of Ethics for Professional Practice was developed by the American Academy of Industrial Hygiene (AAIH) Ethics Committee. The officers and councilors of the Academy accepted the code that year without taking further action. This code was further refined in the mid-1970s with the assistance of the American Board of Industrial Hygiene (ABIH) and after receiving comments from the Academy membership in 1978 was voted on and adopted. The code provided standards of ethical conduct to be followed by industrial hygienists as they practice their profession and serve employees, employers, clients, and the general public. This code was adopted in 1981 by the AIHA® and ACGIH®, thus extending coverage to most industrial hygiene practitioners.

In 1991, the four industrial hygiene organizations organized the Code of Ethics Task Force and charged them with revising the code, supplementing it with supporting interpretive guidelines, recommending methods to educate members about ethical conduct and recommending disciplinary procedures and mechanisms for enforcement. The leadership felt that industrial hygiene practice had changed since 1978 (the numbers of members practicing as consultants was increasing dramatically) and this raised new ethical issues for the profession that should be addressed in the code.

The report of the task force was presented to the four boards in October 1993, a final draft of a revised code of ethics was presented at the 1994 American Industrial Hygiene Conference and Exposition (AIHce), and by January 1995, all four organizations had approved the new code. In 1995, the industrial hygiene organizations approved the formation of the Joint Industrial Hygiene Ethics Education Committee (JIHEEC), the purpose of which is to conduct educational activities for industrial hygienists and promote an understanding of the code of ethics within the industrial hygiene community. A formal ethical complaint review and disciplinary process could not be agreed upon and was not established.

Beginning in 2006, a Joint Ethics Task Force was established and consisted of representatives of the four original chartering organizations (AIHA®, ACGIH®, AIH, and ABIH), the JIHEEC, and an attorney with experience in writing professional codes of ethics. The primary goal of this task force was to revise and renew the existing code of ethics, with a special emphasis placed upon enforcement. The need to sharpen and refine code language and wording were considered a key component of the task force's mission.

This effort resulted in the development of two new codes, the "American Board of Industrial Hygiene Code of Ethics," and the "Joint Industrial Hygiene Associations Member Ethical Principles," both of which were adopted in May of 2007 and presented to the general membership at the 2007 AIHce in Philadelphia. The membership-based organizations (AIHA®, ACGIH®, and AIH) recognizing that they were not in an enforcement position, adopted the joint code, leaving the issue of enforcement to ABIH.

professions are expected to serve the public good, to set higher standards of conduct for their members than are required of others, and to enforce a higher degree of discipline on themselves than others do. The trade-off granted by society is that it imposes less social control on the condition that the profession is self-regulating and self-disciplinary.

The standards to which members of a profession are to hold themselves are expressed in a professional code of ethics. The code is written and enforced by an organization representing the profession. In the case of industrial hygiene, the professional is the Certified Industrial Hygienist (CIH) and the organization representing the profession for code enforcement purposes is the ABIH. The rationale is that the profession itself is in the best position to know how its members should behave, the areas where ethical lapses can occur, and is most likely to become aware of violations of the standards it sets. In addition, the profession is in the best position to censure or dismiss from its ranks those who do not live up to the profession's standards. The autonomy and benefits that society bestows upon members of the profession are only justifiable if the members live up to this code and the profession adequately disciplines itself.

To fulfill its obligation to society, it's essential for the profession's ethical code to meet certain requirements. It must identify behavior that is unacceptable and that if expressed by a practitioner would lead to sanctioning by the profession. In other words, the code cannot just be a set of ideals but must identify unacceptable behavior

and be enforceable. The code must also address those aspects of the profession that create the greatest opportunity for its members to act unethically or in a manner inconsistent with the public good. It cannot simply focus on unlawful behavior or ethical breaches that apply widely in society. Finally, the code must be focused on promoting the public good and particularly the interests of those served and impacted by the profession.

Current Industrial Hygiene Ethical Codes and Guiding Principles

There are several ethical codes and guidelines which are of particular significance to the practicing industrial hygienist. These are the "American Board of Industrial Hygiene Code of Ethics," and the "Joint Industrial Hygiene Associations Member Ethical Principles." Another code, the "International Code of Ethics for Occupational Health Professionals," established by the International Commission on Occupational Health is also of interest as it serves as an example of another type of code, an aspirational code, for the practicing industrial hygienist.

There are different ways in which professional codes can be interpreted and used. This is a significant consideration, one which needs to be established early on in the mind of the practitioner in the application of any code. That is, how do you best use a professional code? Should a code be the law? Should it be a set of guidelines? Is it a means by which the profession establishes a baseline standard of practice? Or is it the intention of the code to "raise the bar," for the profession or be aspirational? A professional code can be all of these things. In the most pure sense, however, a professional code is a definition of the baseline "standard of care" for the profession.

As practicing industrial hygienists, and certainly as certified industrial hygienists, there are two codes with which we should be most familiar: The "American Board of Industrial Hygiene Code of Ethics," and the "Joint Industrial Hygiene Associations Member Ethical Principles," both of which were adopted in May of 2007. These documents are available on the AIHA® and ABIH websites. The former, the ABIH code, is enforceable and binding upon all CIHs as well as applicants seeking to take the CIH exam. The latter, the "Joint Association" principles, have been adopted by AIHA®, ACGIH®, and the Academy, and establish guidelines for the members of those organizations. It is intended to be complementary to the enforceable code, set expectations and standards for the members of these associations, educate members as well as the public, and help all industrial hygiene practitioners understand their ethical responsibilities. Both codes describe an expectation that individuals will maintain high standards of integrity and professional conduct, accept responsibility for their actions, continually seek to enhance their professional capabilities, practice fairness and honesty, and encourage others to act in a professional manner consistent with the certification standards and responsibilities set forth in the codes. Each code is divided into two sections. The first describes an industrial hygienist's responsibility to professional organizations (AIHA®, ACGIH®, AIH, and ABIH), the profession, and the public and the second describes responsibilities to clients, employers and employees.

In a 2006 communication with ABIH, Richard Goldberg, an attorney who specializes in the development of codes of ethics for professional organizations, discussed the logic behind having two separate codes. The ABIH, is a credentialing organization, and therefore serves important public and professional protection purposes. It must carefully regulate the use of its certifications and related public representations. The conduct of a certificant or candidate may bear directly on his/her fitness to practice with an ABIH certification. A primary method of such regulation is the adoption of a code of ethics which permits the organization to discipline certificants and candidates who violate conduct rules. The need to regulate the conduct and activities of association members, although important, is not as compelling. In contrast to ABIH certificants, IH associations' members do not represent themselves to the public as being certified or otherwise qualified by the organization to practice (i.e., having met specific, validated professional skills and knowledge requirements). Rather, the professional associations operate to support and develop the profession, including the

promotion of applicable practice standards. To support this mission and better the profession, the IH associations have developed a body of guidelines and principles intended to promote appropriate professional behavior and development of their respective memberships.

A detailed comparison between the code and member ethical principles is beyond the scope of this section. However, a brief inspection of the two documents will reveal that they are almost identical, with one difference being that the "Joint Association" member ethical principles contains a few more sections. Careful comparison will also reveal that there are a number of subtle differences in wording between the two documents. This comes from the fact that some ethical concepts may be desirable, but tricky to enforce within the framework of an administrative review, the setting in which the enforceable ABIH code has to live. One example of this difference is found in the inclusion of paragraphs C.2 and C.3 of the "Joint Association" ethical principles, copied below:

C.2. "Inform appropriate management representative and/or governmental bodies of violations of legal and regulatory requirements when obligated or otherwise clearly appropriate."

C.3. "Make reasonable efforts to ensure that the results of industrial hygiene assessments are communicated to exposed populations."

The use of words such as "appropriate," "otherwise clearly appropriate," "reasonable efforts," and so on do not present a strong foundation for an enforceable code and therefore will not be found in the code.

But once one has entered the world of "ethical principles" as opposed to enforceable code elements, what is appropriate in the standard? And how far does one go? Some codes contain statements that would be difficult if not impossible for the professional to comply with 100% of the time. These are intended to describe behavior to which professionals should aspire. A code that contains statements of this type, which can be quite thought provoking as well as controversial, is the "International Code of Ethics for Occupational Health Professionals," established by the International Commission on Occupational Health.

The International Commission on Occupational Health, founded in 1906, claims 2,000 professionals in 93 countries. Arguably more robust than the "Joint Association" ethical principles, it consists of 18 pages and twenty six "shall" statements, including explanatory language in an introduction and preface. It is not an enforcement-based code, and the wording of it would make it potentially problematic to serve as such. It is also broader in scope, addressing the concept of an "occupational health professional." Its phrasing and considerations could be considered more "worker focused." It is mentioned here as it represents a different and more globally-based view of ethical considerations for the "occupational health professional." The code itself is found at the web site for the International Commission on Occupational Health, and may be freely reproduced as long as the source is indicated. Two excerpts from it follow which reflect its more aspirational elements:

- "Occupational health professionals must request that a clause on ethics be incorporated in their contract of employment."
- "…occupational health professionals must regularly and routinely, whenever possible, visit the workplaces and consult the workers and the management of the work that is performed."

It is an interesting document for individuals who are seeking a wider perspective on the issue of ethics for IH professionals, especially if looking at an international venue.

ABIH and the Enforcement Process

To enforce the code, the ABIH has established a formal ethical complaint review and disciplinary process. However, before initiating an ethics review it is hoped that every effort will be made to resolve the ethical concern privately between the parties involved. The administrative review process can be both detailed as well as time consuming, and can represent a substantial effort on the part of ABIH. Although it is necessary and important to police and maintain the integrity of the profession, ABIH hopes that members will use both wisdom and judgment in any filing action. It is a serious matter, and treated as such.

Outcome Competencies

After completing this chapter, the reader should be able to:

1. Describe how construction differs from other sectors with regard to occupational exposures and disease.
2. Summarize types of construction.
3. Identify chemical, biological, and physical exposures of concern that may be present in various construction processes and tasks.
4. Recognize how exposure assessment strategies in construction may be similar to, or differ from, those in other settings, and the importance of obtaining both qualitative and descriptive data.
5. Explain examples of engineering, administrative, and personal protective equipment controls in construction, and the potential advantages and disadvantages of each.
6. Understand the basic tiers of management involved in typical construction projects.
7. Discuss the importance of training to construction hygiene and safety.
8. Develop an understanding of how construction hazards are regulated.
9. Recognize the value of prevention through design (P+D).

Key Terms

Abrasive blasting • apprenticeship • arsenic • asbestos • beryllium • bricklayer • cadmium • cement • concrete • confined space • contractor • dermal • dust • epoxies • ergonomics • fibers • fume • grinding • hazard communication • hearing loss • hexavalent chromium • ironworker • lead • local exhaust ventilation • manganese • masonry • metals • mold • noise-induced • nonionizing radiation • OSHA • painting • pipefitter • plumber • sawing • silica • solvents • subcontractor • substitution • task • terrazzo • vibration • welding • worker rotation

Note to readers: There are additional key terms underlined within the chapter.

Prerequisite Knowledge

Basic biology, basic chemistry, basic math, basic physics, introductory industrial hygiene, introductory knowledge of industrial/construction processes and tools, basic safety management

The user is also referred to the following chapters:

Chapter Number	Chapter Topic
18	Indoor Air Quality
24	Noise, Vibration, and Ultrasound
30	Ergonomics
39	Personal Protective Clothing
46	Confined Spaces

Key Topics

I. What Makes Construction Different for the Practicing Industrial/Occupational Hygienist
II. Types of Construction
III. Anticipating Health Hazards by Construction Occupations and Trades
IV. Construction Health Hazard Recognition
  A. Chemical Hazards — Metal Fumes and Dust
  B. Silica, Asbestos, and Man-made Mineral Fibers
  C. Solvents
  D. Skin Hazards
  E. Physical Agents
  F. Biological Hazards
  G. Confined Spaces in Construction
V. Exposure Assessment in Construction: Challenges and Alternative Approaches
VI. Controlling Construction Health Hazards
VII. Management, Communication, and Training
  A. Incorporating Health and Safety Requirements into Construction Contracts
  B. Prevention through Design (PtD): Health and Safety During the Design and Pre-Construction Phases
  C. A Word about Maintenance and Rehabilitation Work in Industrial Settings
  D. Integrating Hazard Analysis and Prevention into Skills Training
VII. Regulatory Perspective

Industrial Hygiene Issues in Construction

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By Barbara L. Epstien, MPH, CIH; John D. Meeker, ScD, CIH; Pam Susi, MSPH; C. Jason McInnis, MHSc, ROH, CRSP and James W. Platner, PhD, CIH

What Makes Construction Different for the Practicing Industrial / Occupational Hygienist?

Introduction

Construction is change. There are no continuous production processes or assembly lines subject to routine exposure monitoring, incremental improvements and regular verification of control effectiveness. Every structure or project is unique, and the workforce and tasks being performed often change daily, if not hour by hour. Many of the tasks and the occupational health hazards found on construction sites are similar to those found in general industry, including exposures to welding fumes, solvent vapors, noise, and ergonomic concerns. However, employment is transient, so workers may be employed by a large number of employers over the course of their career, if not in a single year. This constantly changing and mobile nature of construction work presents numerous, unique challenges when it comes to anticipating, recognizing, evaluating, and controlling associated occupational health hazards.

Construction involves complex and dynamic multi-employer organizational structures that pose challenges to communication and occupational safety and health management systems. Organization of work, safety culture and management systems are largely built from scratch with each project. Multi-tiered subcontracting relationships also complicate communication between employers and can muddy the lines of responsibility for controlling hazards or shift liability to lower-tier subcontractors who may fail to adequately control risk. This, along with often complex scheduling and the sequential process of multiple subcontractors and crafts involved in each phase of the job, translates into numerous different trades working in close proximity at any given time, which necessitates the additional consideration of bystander exposures. This can extend beyond the various other subcontractors on a jobsite and may involve those in nearby buildings or adjacent occupied spaces within a building being renovated and even to the general public. Exposures to hazardous chemical and physical agents are often brief, intermittent, and may be extremely high or variable, making it difficult to accurately characterize exposures.[1,2] Add to that the variability of jobsite settings, from work performed outdoors in the open (e.g., exposure to extremes in temperature as well as to biological hazards such as those from animals, insects, and allergic reactions to poisonous plants), to working in enclosed, restricted, or confined spaces. This diversity additionally challenges the traditional approach to the development and implementation of effective controls. Still other concerns are found in renovation, repair, and demolition work, where managing worker exposures requires consideration of existing materials, coatings, structural constraints, and process hazards.

This chapter is dedicated to the unique challenges of construction. While other chapters in this book provide detailed discussion on the wide variety of subjects germane to the profession, this chapter focuses on application of the principles of health hazard anticipation, recognition, evaluation, and

control in construction. The chapter starts with an overview of the construction industry, then provides examples of different construction occupations, work settings, and/or tasks to illustrate where the industrial hygienist might encounter certain hazards. The special needs of exposure assessment and control in construction are explored and the pragmatic adaptations to traditional approaches in evaluating and managing hazardous exposures are discussed. For example, there is increasing evidence that intermittent high-peak exposures associated with a relatively small number of tasks may contribute a significant portion of a construction worker's full shift time-weighted average exposure. In addition, more research has focused on identifying important task variables or exposure determinants in estimating exposure risk and targeting control technologies. Logically, then, task-based intervention and control measures can be an effective approach to mitigating hazards.

Magnitude of the Problem

The construction industry bears a disproportionate number of work-related deaths resulting from work related injuries. In 2005, although construction accounted for only 8% of the overall workforce, it experienced approximately 22% of the total number of occupational fatalities.[3] This trend continues even though recent safety initiatives have emphasized prevention of fatal falls and electrocutions in very high risk occupations like structural steel erectors (ironworkers) and electrical power line installers (power installers). Construction workers also bear a disproportionate burden for occupational illnesses such as asbestosis and silicosis and are consistently over-represented among elevated lead levels in state blood lead registries. While some construction tasks such as sand blasting or asbestos removal have been recognized as hazardous for many years, recognition of many other occupational health hazards has fallen behind in the awareness of safety hazards in construction. As a result, occupational hygiene in construction is a relatively fresh arena and industrial hygiene professionals are a rare presence on most jobsites.

For a variety of reasons industrial hygiene practice and the application of engineering control measures in the construction industry has lagged behind general industry. Construction is dominated by small employers; approximately 80% have less than 10 employees, nearly one quarter of the workforce is self employed, and an unknown fraction works for cash in a growing informal sector that is often made up of undocumented workers. However, the majority of construction *workers* are still employed by somewhat larger contractors, with 61% of employees working for contractors with 20 or more employees.[3]

Although occupational disease remains poorly characterized in this population, there is a substantial amount of evidence that many construction workers face a higher risk of occupational disease and cancers than in other industry sectors.[1,2,4–16] Elevated occupational exposures, and to a lesser extent, the efficacy and feasibility of various control options, are increasingly well documented in construction.[1,4] Journal articles on hazards and controls for general construction have been published along with sector and hazard specific information for highway construction[5,6], ceiling and wall texturing[7], crystalline silica from concrete[8–14], welding and thermal cutting fumes[2], vitreous fibers[15], chromated copper arsenate (CCA) treated wood dust[17], tunneling dust and gas[18], lead[19,20], isocyanates in polyurethanes[21,22], in residential construction[16], construction site clean-up[23], water-based paints[24], organic solvents[25] and other agents and tasks. Translation of these and similar findings into changes in work site practices and materials across the industry presents significant challenges.

Implementation of control strategies in construction can be more difficult than in other industries and there may be an over reliance on respiratory protection and other personal protective technologies as a result. The Bureau of Labor Statistics (BLS) and National Institute for Occupational Safety and Health (NIOSH) reported that in 2001 nearly 10% of construction workers used respirators as part of employer-required programs over a 12-month period, second only to mining and compared to about half of that (4.8%) among manufacturing employers. Figure 47.1 illustrates this practice, showing the most common hazards for which respirators were used in construction in 2001. However, the development and implementation of effective respiratory

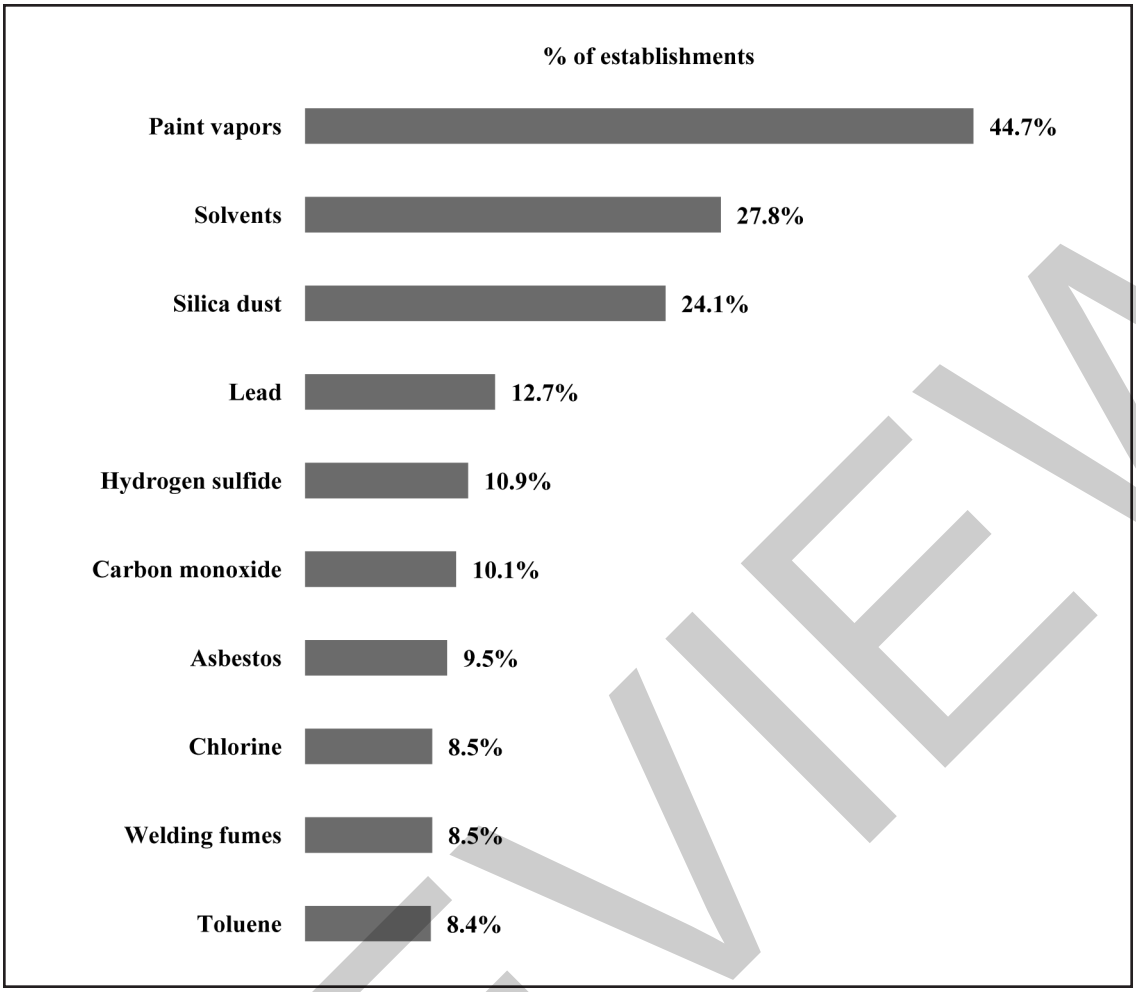

Figure 47.1 — Common hazards Identified with respirator use, by construction establishments, 2001 (BLS/NIOSH, 2003).

protection programs is lacking, with only one-half of those employers providing training as mandated by the Occupational Safety and Health Administration (OSHA).[26] Understandably, managing respirator programs for a transient workforce presents its own challenges.

Types of Construction

Construction is a large, dynamic, complex industry and an important segment of the economy. Construction workers build roads, homes, schools, and workplaces. They also build, repair, renovate, and maintain the structures and facilities that generate power, process chemicals, refine oil, and produce consumer goods, as well as the buildings where people go to shop, eat, and transact everyday business. The goal of this chapter is not to provide an in-depth description of the entire construction sector, but rather provide a brief overview of the types of construction worksites and work activities an industrial hygienist might encounter, the various occupations involved, and the health hazards to which those workers may be exposed.

Rarely is there only one employer on a construction jobsite; the typical multi-employer organizational structure is one of the complicating factors that make exposure assessment and control so challenging. On a construction project of any size or duration there are typically many tiers of management. Starting at the top is the owner or client who wishes to build, renovate, maintain, or demolish a structure; he or she then contracts with a general contractor or project manager who in turn may contract with multiple sub-contractors. While management activities may occur at a fixed place of business, for many contractors there are typically multiple, concurrent project sites underway at any given time. Given

the decentralized nature of construction, workers and employers further down the communication chain may or may not receive effective hazard communication regarding prevention efforts that may have been initiated at the top. Project durations vary, which presents an additional challenge to industrial hygienists. Larger construction projects may last for a number of years, but many more are measured in months and some may be as short as a few days.

While new construction presents many opportunities for exposures to chemical and physical agents, renovation and demolition of existing structures and facilities introduces added concerns about existing materials, coatings, and structural constraints such as, enclosed, restricted, or confined spaces with minimal or no ventilation. While new construction has trended away from the use or installation of some legacy hazards, such as asbestos and lead-based paint, these materials still present a significant concern when demolishing, renovating or maintaining older buildings and structures. The removal and handling of hazardous materials and waste as part of remediation or abatement work requires special precautionary work practices and protective equipment. As in new construction, multiple trades are involved in renovation and maintenance work, and often work side by side. In addition, some renovation and maintenance work in occupied buildings also may present concerns for building occupants. Finally, working in operational industrial facilities introduces construction workers to process hazards of the host facility.

For purposes of characterizing economic activity, the construction sector has historically been divided into three major categories.(27)[1]

Construction of Buildings

The building construction sub-sector may encompass new work, additions, alterations, maintenance, and repairs and includes residential and nonresidential (industrial, commercial, institutional) buildings. Typically this work is performed by a number of subcontractors who may be coordinated by a general contractor or project manager.

Heavy and Civil Engineering Construction

This sub-sector primarily is engaged in the construction of large engineered projects, often public works such as highways and other roadways, bridges, tunnels, and dams. It also encompasses private utilities and pipelines. A large variety of trades will work on these projects; however, much of the work involves basic trades such as laborers, carpenters, and operating engineers engaged in earth moving, foundation and form work, and steel erection.

Specialty Trade Contractors

This sub-sector is comprised of a variety of specialized, skilled trades who perform a wide array of construction and renovation activities involving both interior and exterior building components. Specialty trade contractors are usually subcontracted by general contractors or project managers, but may also be hired directly by the property owner (especially in remodeling or repair work). Most of their work is performed on the jobsite although some prefabrication work may be performed in a shop and then transported to the site. This is often the case with sheet metal work, for example.

Anticipating Health Hazards by Construction Occupations and Trades

There are dozens of trades that make up the building construction workforce, from the highly visible carpenter framing homes in suburbia to the less evident boilermaker bolting or welding pressure vessel structures together in industrial facilities. A list of

[1] These categories correspond to the major construction groups or sub-sectors as described by both the Standard Industrial Classification (SIC) system, which was developed in the 1930s and used for more than 60 years with numerous revisions throughout that time, and the North American Industry Classification System (NAICS), which was developed in the 1990s through a collaborative effort by the United States, Canada, and Mexico and adopted in 1997. In 2002, the SIC system was retired and replaced by NAICS, which more accurately represents new and emerging industries as well as changing definitions within industries. While the transition poses some challenges for researchers, the NAICS use of a strictly production-oriented framework and a six-digit structure versus the four-digit structure of the SIC allows for greater flexibility.