Core Competencies For the Practice of Industrial/Occupational Hygiene

Contributors

This document was originally prepared in 2012 as a joint effort of the Academy of Industrial Hygiene (AIH), the American Industrial Hygiene Association (AIHA®), the American Conference of Governmental Industrial Hygienists® (ACGIH®), and the American Board of Industrial Hygiene® (ABIH®). A volunteer team of industrial hygienists nominated by their respective boards created an outline of the essential competencies required for the practice of industrial hygiene. The 2018 version is the first revision of the original document and was revised by a group of volunteers selected from individuals who self-nominated through a solicitation by AIHA®. The team was ably assisted by the Academic Special Interest Group within AIHA® and representatives from ABIH® and ACGIH®, with several other industrial hygienists providing comments through a peer review process. The following people were members of the team which updated this document.

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Introduction

Background

This document updates the original work of representatives of the boards of AIHA® (American Industrial Hygiene Association), AIH (Academy of Industrial Hygiene), ABIH® (American Board of Industrial Hygiene), and ACGIH® (American Conference of Governmental Industrial Hygienists), who in 2009 defined the knowledge and skills for the subject matter areas tested by ABIH®. In 2012, these representatives differentiated each core competency by practitioner level and compared the core competencies to those specified under ABET, the Council on Education for Public Health (CEPH) accredited programs and those offered by Occupational Hygiene Training Association (OHTA). All four boards approved the original 2012 set of competencies for the practice of industrial hygiene in North America.

Purpose

This updated version of the Core Competencies for the Practice of Industrial/Occupational Hygiene (IH/OH) builds upon the technical proficiencies included in the previous edition and adds functional components which will help to ensure successful job performance. It outlines the essential knowledge, skills, and abilities which an IH/OH, working at different levels of practice, should possess.

Many audiences will find this document useful. Students can gain an understanding of the discipline and prepare for a career in IH/OH. Academic programs can use it to design, review and update curricula. Employers will find it useful in creating career paths within their respective organizations for those assigned to IH/OH positions by setting expectations for knowledge and skill development. Finally, individual practitioners may use it as a guide to further their own professional and career development.

AIHA offers a complementary program to the Core Competencies which is useful to those seeking to build upon their knowledge, skills and abilities for career growth. This program, called the IH Professional Pathway™, was created from a desire to align Association resources and development opportunities with the various career stages of the profession. The resulting program encourages and supports the attainment of credentials such as certifications and registrations.

The IH Professional Pathway™ defines two development tracks—technical and management—with benchmarks for achievement at each career stage. Each track also encompasses elements of leadership at each stage. The competencies in the foundation, fundamentals, and application categories outlined in this document map to the technical track of the IH Professional Pathway™. Those at the foundation level are usually mastered prior to employment in the field during the Student/Intern level while those at the fundamentals level are usually mastered in the early stages of the career during the Student/Intern and Early Career Professional levels. The competencies in the functional category also map to the leadership and management

aspects of the IH Professional Pathway™ and are mastered throughout the career stages with increasing levels of experience and application of the skills and knowledge. The scope of the practice may broaden in both professional pathways to include related fields, such as environmental and safety, in addition to IH/OH. This document only addresses the competencies and skills necessary for a career in IH/OH. While some of these apply to areas related to the practice of IH/OH, other sources of information should be checked for the competencies and skills applicable to those other fields. Figure 1 represents a typical career path in IH/OH, although it is possible to move back and forth between the management and technical tracks. More information about IH/OH as a career and the IH Professional Pathway™ is available on the AIHA website at the following link -> https://www.aiha.org/publications-and-resources/IHProPath/Pages/default.aspx

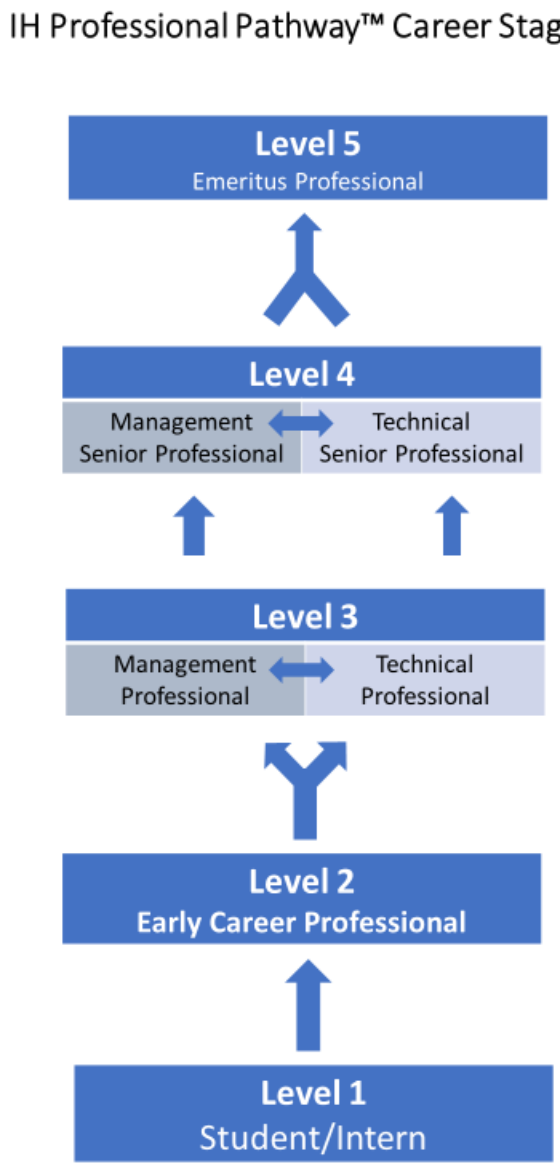

Figure 1 - IH Career Stages
American Industrial Hygiene Association, IH Professional Pathway™

In addition to the IH Professional Pathway™ information, the AIHA has three Professional Development committees which also offer assistance at various stages in the IH/OH profession. The first is for Student and Early Career Professionals and provides peer coaching and networking opportunities for those just starting out in IH/OH (link -> https://www.aiha.org/get-involved/VolunteerGroups/Pages/Students-and-Early-Career-Professionals-Committee.aspx). Another is the Mentoring and Professional Development Committee which sponsors a mentorship program to connect members at the lower levels of the pathway with more seasoned professionals (link -> https://www.aiha.org/get-involved/VolunteerGroups/Pages/Mentoring-and-Professional-Development-Committee.aspx). The third, the Career and Employment Services Committee, assists members in identifying employment/career opportunities and provides forums within AIHA to enhance interviewing, job search, and career transition skills for all stages of an IH's/OH's career (link -> https://www.aiha.org/get-involved/VolunteerGroups/Pages/Career-and-Employment-Services-Committee.aspx).

Definition of Industrial/Occupational Hygiene

The practice of worker health protection is called *industrial hygiene (IH)* in the United States and *occupational hygiene (OH)* throughout most of the rest of the world. For the purpose of this document, both terms are considered equivalent. IH is generally defined as the art and science dedicated to the anticipation, recognition, evaluation, control, and confirmation of environmental stressors in or arising from the workplace that may result in injury, illness, impairment, or affect the well-being of workers and members of the community. These stressors are divided into the categories biological, chemical, physical, ergonomic, and psychosocial.

The mission of the American Industrial Hygiene Association (AIHA) is "empowering those who apply scientific knowledge to protect all workers from occupational hazards." The British Occupational Hygiene Society (BOHS) defines occupational hygiene as "the science behind minimising the risk of ill health due to the workplace" and occupational hygienists "use science and engineering to prevent ill health caused by the work environment – specialising in the assessment and control of risks to health from workplace exposure to hazards." The International Occupational Hygiene Association (IOHA) refers to occupational hygiene as the discipline of anticipating, recognizing, evaluating, and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large. The term "OH" (used in the U.K. and Commonwealth countries as well as much of Europe) is synonymous with IH (primarily used in the U.S. and other countries that received initial technical support or training from U.S. sources). The term "IH" traditionally stems from the construction, mining, and manufacturing industries, but has expanded to include all types of employment. Similarly, OH evolved to mean all types of employment, such as those originally described for IH as well as financial and support service industries and refers more generally to "occupation" or "work." The concepts of IH/OH can be applied to protection of all people potentially exposed to health hazards, not just those at work. Many other professions have emerged from the original field of IH/OH including toxicologists, ergonomists, sanitarians and health physicists.

The field of IH/OH is based in robust and validated scientific methodology. However, the practice of IH/OH often requires professional experience in identifying hazards, determining the potential for exposures, and ascertaining risk in the workplace and community. This aspect of IH/OH is often referred to as the "art" of IH/OH and is used in a similar sense to the "art" of medicine. In fact, IH/OH may be considered an aspect of preventive medicine, in that its goal is to prevent occupational injury, illness and disease. IH/OH also intersects with risk management, risk assessment, engineering, product stewardship and industrial safety, since it too, seeks "safe" systems, procedures, or methods to be applied in the workplace or to the environment to reduce the risk of exposure.

Ethics

A core value for all IHs/OHs is ethical behavior. The AIHA and ACGIH have jointly issued a set of member ethical principles which guide the practice of IH for their members. Additionally, the ABIH has an enforceable Code of Ethics for all CIH (Certified Industrial Hygienist) credential holders, applicants, and examinees.

IHs/OHs are expected to maintain high standards of integrity and professional conduct, accept responsibility for their actions, continually seek to enhance their professional capabilities, practice with fairness and honesty, and encourage others to act in a professional manner consistently. IHs/OHs lead by example.

IHs/OHs are obligated to follow appropriate health and safety procedures when performing professional duties to protect clients, employers, employees, and the public from conditions where injury and damage are reasonably foreseeable. They deliver competent services with objective and independent professional judgment in decision-making and provide services only when qualified.

The Case for Industrial/Occupational Hygiene

Strong IH/OH programs that prevent injury, illness and disease are an investment in the well-being, profitability and competitive advantage of a company. The best IH/OH programs are fully integrated into their respective businesses. Poor working conditions, especially those that result in a negative impact on the health of workers and customers, can damage a company's reputation.

In its fact sheet Occupation and Cancer, the American Cancer Society® estimates that about 4% of cancers in the U.S. are work-related, and approximately 20,000 cancer deaths and 40,000 new cases of cancer each year in the U.S. are attributable to occupation. From a global perspective, the International Labour Organization (ILO, 2004, 2005a,b, 2013) estimates that each year a total of 160 million new cases of work-related illness occur globally (35 million due to exposure to chemicals) and 2 million lives are lost to occupational disease (3% of all deaths). Just four selected occupational risks (workplace carcinogens, airborne particulates, ergonomic stressors, and noise) are responsible worldwide for 37% of back pain, 16% of hearing loss,

13% of chronic obstructive pulmonary disease, 11% of asthma, 9% of lung cancer, and 2% of leukemia and caused 538,000 deaths worldwide (Fingerhut, et. al., 2005). The human cost of this daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated to be 4 percent of global Gross Domestic Product each year (Takala, et. al., 2012).

The effective practice of IH/OH benefits workers, employers and customers, resulting in:

- Improved worker health, morale, and increased life expectancy
- Decreased absenteeism and turnover
- Reduction in the number of people who need to leave employment early because of injury or illness
- Lower social and health care costs as well as maximized worker potential
- More efficient working processes with technological improvements and increased productivity, improved operational efficiency, increased capacity, and higher quality products
- Increased revenues, decreased costs, faster time to market, increased market share, and improved customer retention

Expertise Profile

IH/OH is the art and science of preventing illness and disease from occupational exposures. IH/OH practitioners come from varied backgrounds. They can be chemists, engineers, biologists, physicists, physicians, nurses, and other professionals, all of whom have chosen to apply their skills to protecting the health of workers. IH/OH is multidisciplinary, so IHs/OHs must acquire a broad and solid knowledge base across all of these fields and more. A strong foundation in basic science and math is fundamental to the successful practice of IH/OH. Common to all practitioners is a core of knowledge that can only be described as "IH/OH," the practice of which is a strategic approach to identifying, assessing and managing health hazards which arise from work. Another aspect of IH/OH is the ability to communicate effectively and to work well with others across all levels of an organization.

Employment Profile

The National Institute for Occupational Safety and Health (NIOSH) of the United States conducted an assessment of the future need for occupational safety and health professionals (NIOSH, 200-2000-08017, Task Order 18 National Assessment of the Occupational Safety and Health Workforce, 2011). The agency estimated that as of 2011, the most current year for which information is available, there were over 7,300 employees with the primary occupation of IH/OH employed in the U.S. Of these individuals, 41% had received a bachelor's degree, while 51% had also earned a master's degree, 9% a doctorate, and 61% held a professional

certification in IH/OH.

Respondents were asked to indicate whether they expected to hire professionals in each of the occupational safety and health (OS&H) disciplines of interest over the next 5 years.

The assessment reported that employers expected to hire over 25,000 occupational safety and health professionals over the next 5 years (both new positions and replacement of staff who leave). NIOSH stated that the estimates of future hiring of OS&H professionals are likely to be underestimated, for two (possibly related) reasons. First, data collection for this survey took place during a time of significant uncertainty and relatively high unemployment in the U.S. economy. Second, predicting how many professionals (of any type) an establishment will need to hire over the next few years was a difficult task for many respondents. In fact, many respondents told NIOSH that they simply did not know if they expected to hire any OS&H professionals. Those employers who reported an expectation to hire within a given discipline often did not report a specific number of persons they expect to hire. Tracking IH/OH employment is often challenging in that most professionals working in industrial settings administer both safety and IH/OH programs. Fortunately, employers have reported satisfaction with entry level OS&H graduates from both disciplines. NIOSH also reported that "For future hires, employers for some disciplines seemed to desire that new OS&H graduates also have training in non-core competencies and in other OS&H areas." Therefore, it's important that AIHA continually review and revise its core competencies to ensure meeting the expectation of the profession and employers alike. Non-core competencies referred to by NIOSH could include training in other related areas such as environmental and engineering that would be encountered during the practice of OS&H as an EHS generalist.

Figure 2 represents the wide variety of industries, government agencies, consulting practices, academic institutions, and affiliated fields in which IHs/OHs are employed.

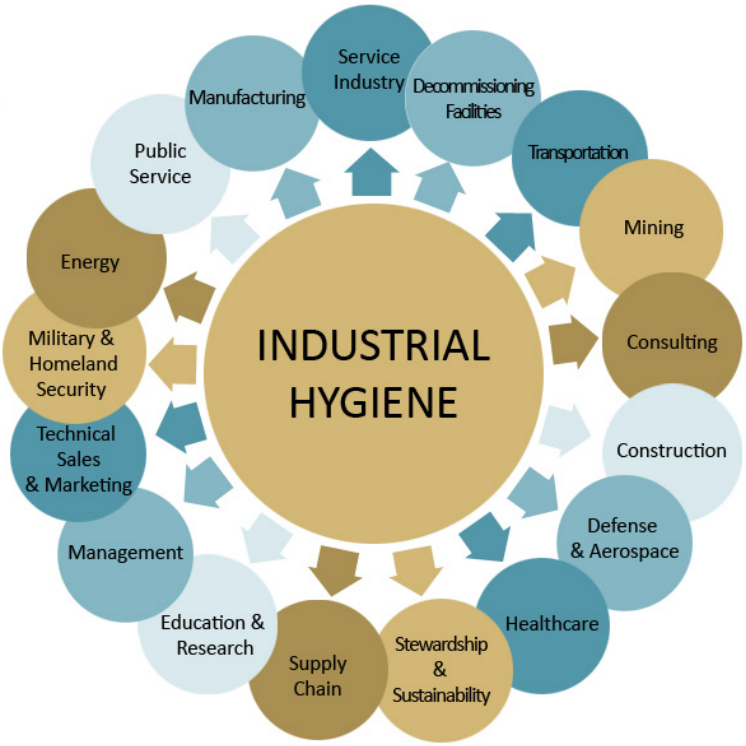

Figure 2 - Employment Opportunites for Industrial/Occupational Hygienists

Core Competencies Defined

Technical Core Competencies

The IH/OH must develop knowledge across many different areas. Figure 3 shows how the IH/OH starts with foundational courses in basic science and math, progresses to courses in more in-depth fundamental scientific areas and finally, applies that knowledge and work experience to perform risk assessments, manage risk and communicate the risk to protect worker health.

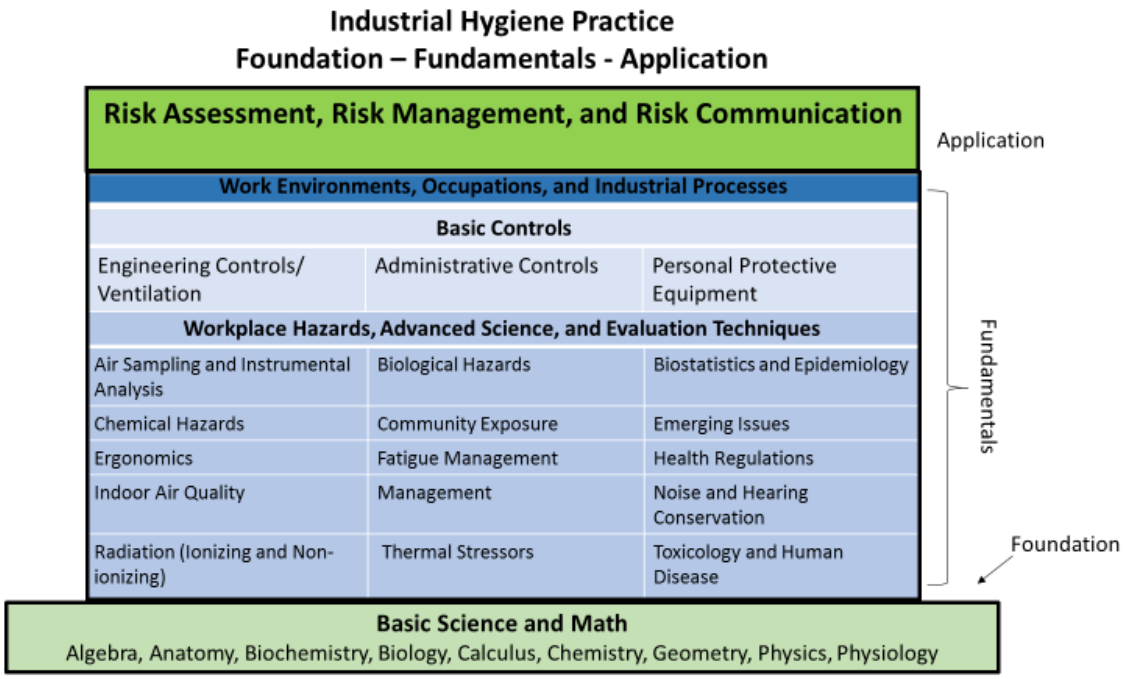

Figure 3 - Industrial Hygiene Practice Technical Competency

Foundation for Industrial/Occupational Hygiene

Basic Science and Math

The IH/OH must know and be able to apply scientific concepts from the fields of general chemistry, organic chemistry, biochemistry, analytical chemistry, physical chemistry, biology, anatomy, physiology, physics, mathematics, and statistics. This includes being able to describe the physical properties of substances, such as reactivity, combustibility, and flammability and the study of matter, its motion through space and time, and concepts such as energy and forces. IH/OH work involves performing calculations related to gas laws, airborne concentrations, units of measures and conversions, pressure and temperature adjustments and logarithmic scales.

Fundamentals of Industrial/Occupational Hygiene

Workplace Hazards, Advanced Science and Evaluation Techniques

Air Sampling and Instrumental Analysis

The IH/OH must develop appropriate sampling strategies. This includes being able to select and describe the advantages and disadvantages of using the various types of air sampling instruments and the collection of full-shift, task-based, and grab samples. The IH/OH should be able to describe the principles and application of laboratory analytical procedures and identify the appropriate methods of detection for sample analyses (e.g., gas chromatography, spectrophotometry, atomic absorption spectrophotometry, etc.). An important element of analytical chemistry is the ability to demonstrate knowledge of instrument calibration and

evaluate quality assurance practices.

Biological Hazards

The IH/OH must recognize biological agents associated with potential occupational exposure such as viruses, bacteria, fungi, molds, allergens, toxins from biological sources, bloodborne pathogens, and infectious diseases that are potentially harmful to humans and other biological organisms. Once identified, the IH/OH must be able to evaluate the potential exposures to the biohazards and recommend controls to reduce or eliminate those exposures.

Biostatistics and Epidemiology

Statistical analysis is key to understanding large sets of data (e.g. exposure monitoring) and discovering underlying patterns and trends. The IH/OH must be able to understand, apply, interpret and draw conclusions from descriptive and inferential statistics. These same concepts are also applied in epidemiology and the IH/OH must be able to demonstrate knowledge of the principles and techniques used to study the distribution of occupationally induced diseases, physiological conditions, and factors in workplaces and other environments that influence their frequency. This may include interpreting and evaluating prospective and retrospective epidemiology studies, morbidity and mortality data, and integrating knowledge applicable to human health from toxicology studies (e.g. animal experimental studies).

Chemical Hazards

The IH/OH must be able to apply scientific and technical knowledge to minimize the potential for human exposure to natural, controlled, accidental, and intentional releases of chemical agents (solids, liquids and gases) into the occupational and non-occupational environment with emphasis on exposures related to work. IHs/OHs specify approaches to prevent, control, and remediate chemical exposure from inhalation, skin absorption, ingestion and injection of chemicals into the body. IHs/OHs should also be able to recognize physical hazards of chemicals, such as flammability, combustibility, and explosivity and be familiar with chemicals which may cause simple or chemical asphyxiation.

Community Exposure

The concepts practiced in IH/OH also apply to community exposures to health hazards. The IH/OH must be able to describe general and technical topics related to ambient air quality, air cleaning technology, emission source sampling, atmospheric dispersion of pollutants, ambient air monitoring, and health and environmental effects of air pollution. It is also helpful to be familiar with peripheral disciplines such as emergency planning and response, water pollution, hazardous waste, and environmental fate and transport to provide support to others working in those areas.

Emerging Issues

The IH/OH must keep current with new technology being introduced into the workplace such as nanotechnology, 3D printers, robotics, biological engineering and synthetic biology. The IH/OH must be able to understand the potential hazards presented by the new technologies and what exposure pathways exist. The IH/OH must keep current with literature and understand possible impacts on human health and significance of artificial biological pathways, organisms or devices and

how the toxicity of engineered nanoparticles will depend on the physical and chemical properties of the particle.

Ergonomics

Ergonomics is an important part of keeping people healthy at work. The IH/OH must be able to identify, evaluate, and recommend controls to mitigate ergonomically stressful jobs using principles from anthropometry, human factors engineering, biomechanics, work physiology, human anatomy, occupational medicine, and facilities engineering to prevent injuries and illnesses and improve the efficiency and comfort of workers.

Fatigue Management

IHs/OHs need to understand the scientific basis of fatigue, sleep cycles, circadian rhythms and fatigue physiology and be familiar with the risk factors associated with fatigue and their appropriate mitigation.

Health Regulations

It is critical that IHs/OHs be familiar with the laws and regulations that impact worker health in the jurisdiction of their work. For example, in the United States, the Occupational Safety and Health Act (OSHAct) is the law that empowers OSHA to promulgate regulations about health and safety hazards and specifies actions employers must take to protect workers. States and most countries also have similar laws and regulations. The IH/OH must be able to interpret and apply those regulations by developing and implementing appropriate programs within the workplace to ensure compliance.

Indoor Air Quality

The IH/OH must have a basic understanding of how the air quality within and around buildings and structures can impact the health and comfort of occupants. The IH/OH must be knowledgeable of the factors that affect IAQ including poor ventilation (lack of fresh, outside air), problems controlling temperature, high or low humidity, recent remodeling that may impact air flow, and other activities in or near a building that can affect the quality of the air in the building. The IH/OH should be familiar with common indoor pollutants such as dust from construction or renovation, mold, cleaning supplies, pesticides, or other airborne chemicals (including small amounts of chemicals that may be released from building materials over time) and how to mitigate them.

Management

An effective IH/OH must be able to describe methods to acquire, allocate, and control resources to accomplish anticipation, recognition, evaluation and control of workplace hazards. This includes understanding and applying principles of cost-benefit analysis, auditing, investigation methods, data management and integration, establishment of policies, planning, delegation of authority, accountability, business acumen, risk communication, organizational structure and culture, and decision-making.

The IH/OH must possess the ability to recognize system level properties that result from dynamic interactions among human and social systems and how they affect the relationships among individuals, groups, organizations, communities, and the environment.

Noise and Hearing Loss Prevention

The IH/OH must be able to demonstrate knowledge of and apply principles of the physics of noise and vibration to conduct appropriate measurements to evaluate worker exposure, to identify situations with the potential to cause noise-induced hearing loss or vibration-related injury, and to recommend methods to eliminate or control excessive exposure. The IH/OH must also be able to demonstrate knowledge of the anatomy and physiology of the ear with respect to hearing and the development of hearing loss. The IH/OH should be able to evaluate audiograms and audiometric testing programs and work closely with those who administer the audiometric testing.

Radiation (Ionizing and Non-Ionizing)

IHs/OHs must be knowledgeable about radiation and its hazards relative to human health. The IH/OH must be able to apply knowledge of ionizing radiation including the physical characteristics, health and biological effects associated with exposure to alpha, beta, gamma, neutron, and x-radiation and recommend controls based on measurement and evaluation of exposure. The IH/OH must also be able to apply knowledge of non-ionizing radiation including the physical characteristics, potential hazards, and health effects of exposure to electromagnetic fields, static electric and magnetic fields, lasers, radio frequencies, microwaves, ultraviolet, visible, infrared radiation, and illumination to recommend controls based on measurement and evaluation of exposure.

Thermal Stressors

The IH/OH must be able to describe heat and cold strain pathophysiology and hypo- and hyper-thermic enviromarkers and biomarkers, recommend comprehensive heat and cold strain prevention programs, and recognize special human risk factors for temperature-induced disorders and deaths. The IH/OH must be able to recognize a thermal stress-related emergency and demonstrate knowledge of appropriate medical/first aid care.

Toxicology and Human Disease

The IH/OH must demonstrate knowledge of the principles of toxicology, including symptomatology; pharmacokinetics; mode of action; additive, synergistic, and antagonistic effects; routes of entry; absorption; metabolism; excretion; target organs; toxicity testing protocols; aerosol deposition and clearance in the respiratory tract; carcinogenic, mutagenic, teratogenic, and reproductive hazards. The IH/OH must be able to apply the toxicological principles to evaluating and predicting health effects from exposures to single contaminants, mixtures of contaminants, and natural and synthetic agents. This involves being familiar with various acute and chronic human disease pathologies (e.g. irritation, fibrosis, mutations, carcinogenic mechanisms and genetic damage) and being able to relate these pathologies to occupational exposures.

Basic Controls

The IH/OH must understand the application of the hierarchy of controls (see Figure 4) with initial emphasis on avoidance or elimination (e.g. prevention through design) and then on mitigation of the hazard. Control at the highest level of the hierarchy as possible should always be the goal of the IH/OH. Controls may be applied at the source, along the path to the worker or at the location of the worker but application at the source is usually preferred. Incorporating controls at the design phase is almost always most effective both from a cost and operational standpoint.

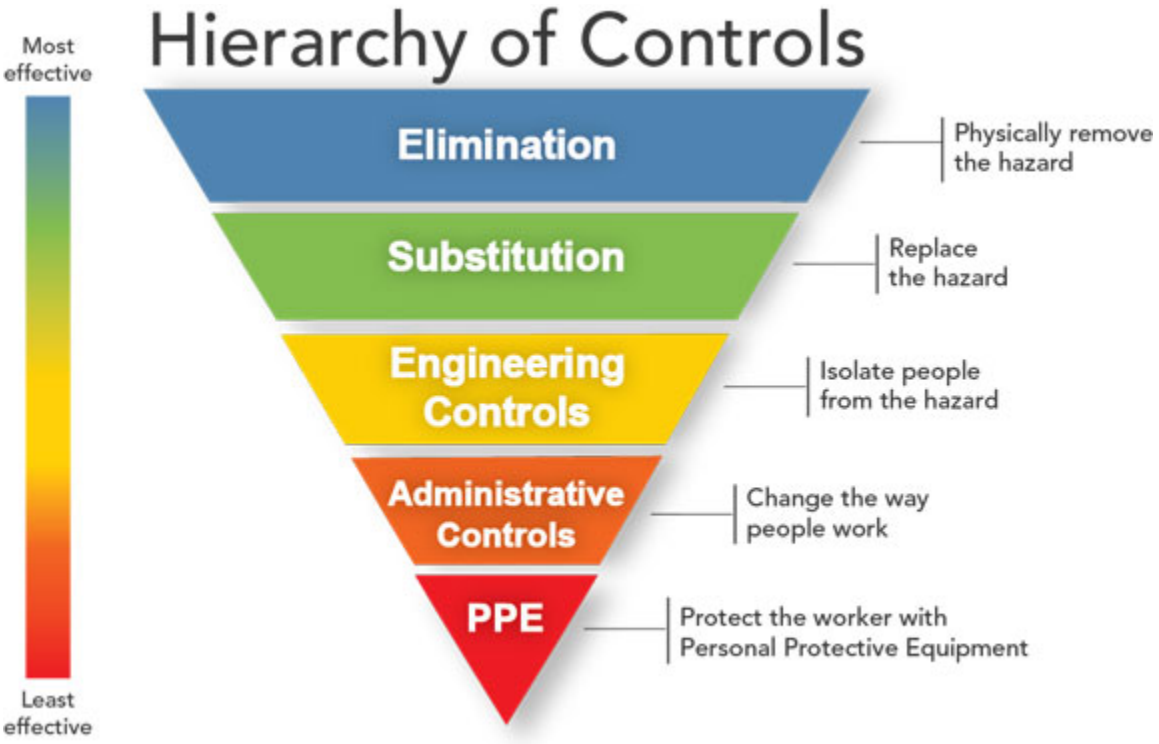

Figure 4 - Hierarchy of Controls
from US National Institute for Occupational Safety and Health, Centers for Disease Control

Elimination

The first choice and most effective control is to avoid it through the design process or to eliminate the hazard, that is, to remove the hazard from the workplace.

Substitution

The next level in the hierarchy of controls is substitution of a hazard with something less hazardous. This could mean replacing a hazardous chemical with a less hazardous one, or changing the equipment or machine to one which is better safeguarded. When replacement with a less hazardous chemical or equipment is not possible, the IH/OH should move down the hierarchy to establish control of exposure at the next level.

Engineering Controls/Ventilation

The IH/OH should be able to recommend and apply process change engineering principles, local exhaust ventilation, dilution ventilation, and isolation to control chemical, biological, and physical exposures. Application of these principles requires knowledge of the mechanics of airflow, ventilation measurements, design, in-plant air circulation and recirculation, air cleaning technology, lower and upper explosion limits and related calculations.

Administrative Controls

IHs/OHs should know how work practice controls such as changes in work procedures (e.g. written safety and health policies or rules), supervision, timing of work (i.e. schedules), and training may be applied to reduce the duration, frequency, and severity of exposure to workplace hazards.

Personal Protective Equipment

The IH/OH should understand that personal protective equipment (PPE) should be considered the last line of defense, as a temporary measure until engineering controls can be installed or as a supplement to other controls. IHs/OHs recommend and evaluate use of personal protective equipment to control exposures and provide guidance on the selection, use, care, and limitations of the equipment. The IH/OH must be knowledgeable about respirator fit testing, breathing air specifications, material permeability, eye protection, and skin protection.

Work Environments, Occupations, and Industrial Processes

To be effective, the IH/OH should be able to anticipate, recognize, evaluate, control and confirm workers' and others' exposures associated with specific industries, occupations and/or processes. This requires applying knowledge and skills to address hazards that can potentially cause related diseases and/or dysfunctions from exposures such as confined space entry, spray painting, welding, abrasive blasting, vapor degreasing, foundry operations, hazardous waste site remediation, and indoor environmental conditions.

Application of Knowledge to Protect Worker Health

The culminating objective of IH/OH is to apply all of the knowledge gained in the foundation and fundamental courses and job experience to protect worker health. The following figure describes the process that is used to manage the risks associated with work. As noted previously, there is an ongoing loop of anticipating, recognizing, evaluating and controlling hazards, confirming that the controls are effective and communicating that information to continuously improve the protection of worker health. Figure 5 illustrates the iterative process of decision-making in IH/OH.

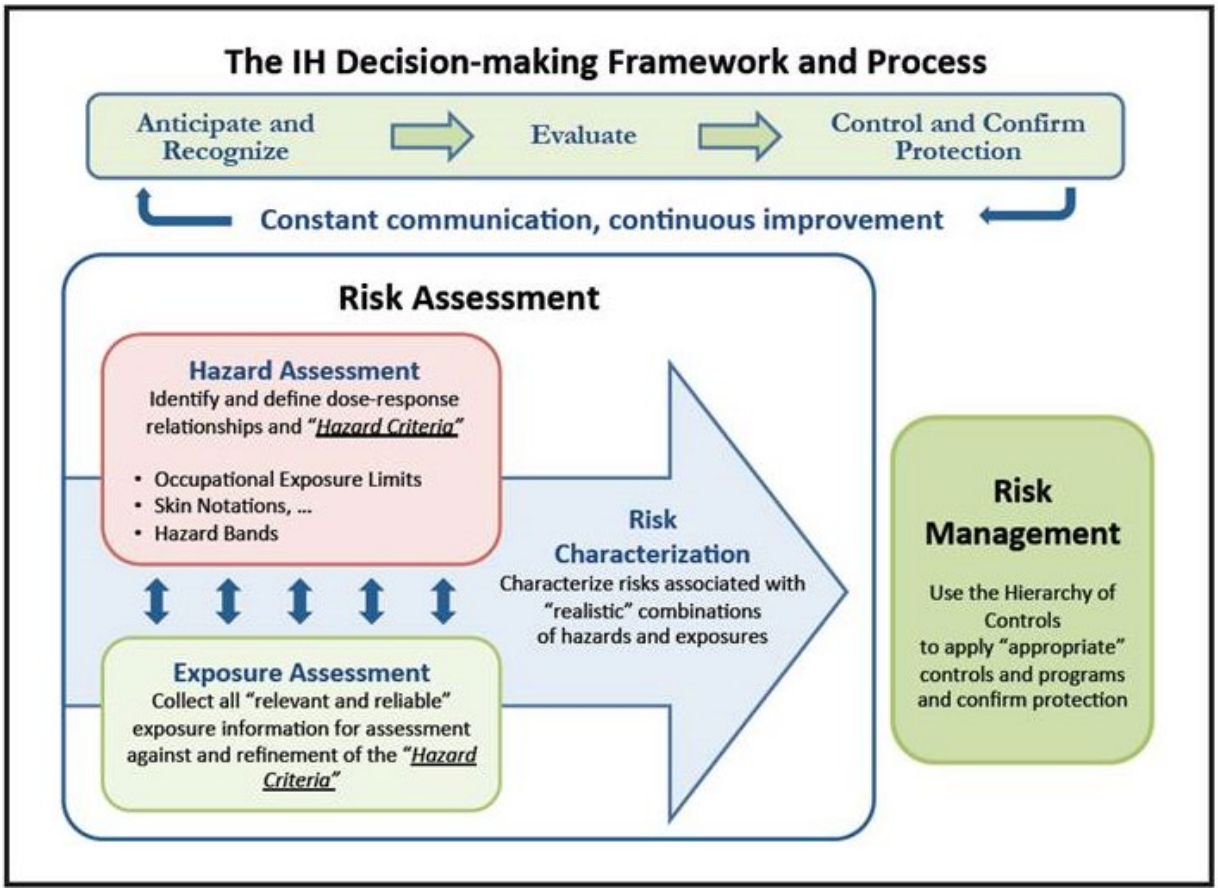

Figure 5 - The Industrial Hygiene Decision-making Process and Framework
American Industrial Hygiene Association, A Strategy for Assessing and Managing Occupational Exposures, 4th Edition

Risk Assessment

Much of IH/OH work falls under the umbrella of risk assessment. Risk assessment includes both assessment of the hazards and an assessment of the exposure to those hazards. Then, the IH/OH characterizes the risks and determines what is acceptable and what is not acceptable. The hierarchy of controls is applied, with the support of the line organization, to manage the unacceptable risks to levels which are considered acceptable.

As noted above, this includes both assessment of the hazards and an assessment of the potential exposure to those hazards. In addition to a basic understanding of the manufacturing and business processes, the IH/OH must demonstrate knowledge of the principles of health risk analysis including:

- establishing an exposure assessment strategy
- collecting basic characterization information (workplace, workforce, and agents)
- assessing exposures to the work force
- prioritizing health risks
- estimating (qualitative exposure assessment) or measuring (quantitative exposure assessment) the magnitude, frequency and duration of exposure to a hazard, along with the number and characteristics of the population exposed

- describing the sources, pathways, routes, and the uncertainties associated with the assessment

Risk Characterization

Once the hazards and exposures have been identified and assessed, the IH/OH must implement monitoring and control strategies for unacceptable exposures. This may involve scheduling and performing periodic reassessments as necessary to fully characterize the exposure. All assessments and risk characterizations must be thoroughly documented.

Risk Management and Communication

The IH/OH must clearly articulate and communicate the health risk information to all levels of the organization. Once exposures are characterized, the IH/OH must work with the line organization to develop and implement programs appropriate to the control strategies. The IH/OH also provides worker training on the hazards and controls.

Functional Core Competencies

Although not part of the rubrics tested during the certification process for IHs/OHs, there are functional core competencies or "soft skills" that help to make an IH/OH successful at all of the career stages described in the IH Professional Pathway™. Some of these are described below.

Collaborative Teamwork

Team work means working together as a cohesive group and respecting each person's opinions and contributions. Building diverse teams helps to improve diversity of thought and impact. Teams go through different stages as they evolve and recognizing these stages will help the team to bond as a group. A good team leader ensures that everyone is engaged and there is mutual accountability for the outcomes. Being a contributing team member and working collaboratively with the other team members are critical.

Communication

The ability to clearly communicate with all levels of an organization will help the IH/OH succeed. This includes the ability to translate technical information into language and concepts that can be understood by anyone without the technical background of the IH/OH. Knowing how to convey the appropriate message to different target audiences that addresses the needs of each is essential to success.

Creative Thinking/Innovation

Successful IHs/OHs spend time thinking about new things or new ways to do things. This is especially important when improving exposure controls or dealing with difficult employee relations issues. Even when there is an established solution, the successful IH/OH continues to

think about the issues and seek new approaches.

Influencing/Advocacy Skills

IHs/OHs often need to work with people over whom they do not have direct administrative responsibility. The ability to share concepts, influence and give clear direction to workers, leadership, operations, businesses, or external parties on IH/OH topics is critical. Teaching and role modeling ethical behaviors in all aspects of IH/OH work can influence others. It is important to develop a working understanding of the business, operations, public perspectives and business impact, as well as the technical aspects of the work when approaching IH/OH issues, and then use influence techniques so that sound decisions result.

Leadership/Management

At the professional level of practice, an IH/OH must demonstrate strong leadership skills both to lead people that he/she may manage but also to drive IH/OH programs within the organization. This usually involves having vision, clarity in strategy, thought and delivery, being transparent and honest, having passion and enthusiasm for the subject, maintaining a positive attitude, delegating tasks and supporting those to whom the work has been delegated.

Lifelong Learning

IHs/OHs have an obligation to continually seek enhancement of their technical and professional capabilities for effective practice of exposure risk assessment and risk management. The breadth of the field and constantly emerging workplace hazards (e.g. nanotechnology, 3D printers, and new biological agents) necessitate the on-going pursuit of knowledge. Capability building consists of a multitude of methods including formal and non-formal types of education, training, and experience. Individuals should be motivated to engage in lifelong learning in the key competencies ultimately needed for serving workers, the public, employers, clients, and the IH/OH profession.

Listening Skills

Good listening skills are important for an IH since they are key to all communication, especially in building trust. Understanding people's concerns and business issues is critical and only possible when the IH/OH is receptive to all input and listens carefully to everything that is said. This is important not only when trying to gain an understanding of what the possible exposures are and ensuring that workers' concerns are acknowledged and addressed, but also in gaining the respect of management. Engaging workers and actively listening to their input can help the IH/OH understand work practices and can provide ideas about effective controls. When workers feel they are part of the solution, it can empower them and they are more apt to use the control strategy.

Negotiation Skills

IHs/OHs are often faced with complex situations involving potentially conflicting needs. The IH/OH needs to seek to understand all perspectives including those of workers and management. Being knowledgeable of everyone's perspectives will enable the IH/OH to work

toward development of collaborative solutions that will result in consensus and a successful outcome among all stakeholders.

Planning and Organization

Being organized and managing time effectively are essential to the IH/OH. Since it is likely many work activities will be occurring simultaneously, planning the work and arranging the resources will facilitate efficiency. Communication of the plan will help to ensure that all stakeholders have a mutual understanding of the intended outcomes.

Problem-Solving

The IH/OH must possess the ability to use analytical and critical thinking skills to work with the line organization to evaluate a problem and to make decisions. A logical and methodical approach is best for IH/OH. For example, the IH/OH will need to be able to draw on his/her academic or subject knowledge to identify solutions of a practical or technical nature.

Professional Demeanor

IHs/OHs should always act professionally. This includes maintaining a professional appearance and attitude, treating others with dignity and respect, being emotionally mature, being accountable for personal actions and completing assigned tasks on-time.

Project Management

Project management involves tying everything together to ensure the successful completion of a project. Setting clear milestones and coordinating the work activities are important, not only when leading a project, but when participating in projects being managed by others.

Relationship Building

Building relationships is an important element of IH/OH work. It facilitates communication and getting things done. Relationships are based upon trust, technical competence, experience, consistent performance and mutual understanding. Good work relationships are critical for the IH/OH. The ability to seek and develop common interests helps to improve interactions and improve communication. This could also involve building virtual relationships with colleagues located elsewhere and connecting through social media.

Strategic Thinking

An effective IH/OH must be able to see the "big picture". To think strategically, a person must be able to use both sides of their brain, the logical (left) and the creative (right). An IH/OH must be able to think clearly, look toward the future and put a plan in place to reach the desired goal. Another aspect of strategic thinking is to understand how decisions may impact the business and the workers.

Key Definitions

Certificate

A certificate is often given when a student passes an exam or completes a course. Certificates can also be administered by an educational institution and can be either a short course or a series of academic, short, or professional development courses culminating in a certificate, similar, but not equivalent to a diploma. It certifies that something being stated in the certificate has been completed. Certificate programs are usually shorter duration in comparison to a diploma and are not necessarily related to graduation requirements. A certificate often shows that the recipient has mastered a skill.

Diploma

A diploma is a document issued by an educational institution at the completion of a course of study stating that the recipient has completed the requirements. Diplomas also can confer an academic degree to the recipient. Courses toward an academic degree are usually longer in duration than certificate courses.

Associate Degree

Associate degrees are conferred by community colleges and some colleges and universities on completion of a college-level course of study and are typically 2-year programs. Associate degree credits may be transferrable to a bachelor's degree. In some countries, a college diploma is equated with an associate degree.

Baccalaureate (Bachelor's) Degree

A Bachelor's degree represents a higher level of education in comparison to a Diploma and Certificate. A bachelor's degree is awarded to a student on completion of a prescribed college or university education (typically a 4-year program).

Technician

Technician is a job title given to persons who are trained to assist professionals and paraprofessionals with task-specific assignments. Technicians may collect air samples, operate direct-reading instruments, and provide other services based on specific training received and instructions received from professionals and paraprofessionals.

Practitioner (Paraprofessional)

Practitioner, sometimes referred to as a paraprofessional, is a job title given to persons in various

occupational fields who are trained to assist professionals but are not themselves licensed or certified at a professional level by a certification body recognized by the National Accreditation Recognition Committee of IOHA. The IH/OH practitioner performs tasks requiring significant knowledge and skill in the IH/OH field, such as conducting worker exposure monitoring and, in some cases, may even function independently of a professional IH/OH but may not be involved in the breadth of IH/OH practice nor have the level of responsibility of a professional IH/OH certified by examination. The IH/OH practitioner requires a certain level of education that can be obtained from an accredited university or equivalent. Additional training in specific skill sets that provide additional career paths to the IH/OH practitioner can also be obtained. IH/OH practitioners may also serve as team leaders or project managers.

Professional

Professional is a job title given to persons who have obtained a baccalaureate or graduate degree in IH/OH, public health, safety, environmental sciences, biology, chemistry, physics, or engineering or who have a degree in another area that meets the standards set forth in the next section, Knowledge and Skill Sets of IH/OH Practice Levels, and has had 4 or more years of practice. Alternatively, this title is given to persons who have earned a Diploma of Professional Competence in Occupational Hygiene from the Occupational Hygiene Training Association (OHTA).

One significant way of demonstrating professional competence is to achieve certification by a 3rd party whose certification scheme is recognized by the International Occupational Hygiene Association (IOHA) such as the American Board of Industrial Hygiene (ABIH). (see Appendix for list of certification schemes that have been recognized by the IOHA National Accreditation Recognition (NAR) Committee.)

Knowledge and Skill Sets of Industrial Hygiene Practice Levels

There are three basic levels of practice in IH/OH. The knowledge and skills for each level are described with each building upon the previous level, that is, a practitioner should possess the knowledge and skills of both the practitioner and the technician, and a person working at the professional level should possess the knowledge and skills of the technician and the practitioner in addition to those described for professional practice.

Technician

Knowledge:

An IH/OH technician must have a minimum of a high school diploma with basic knowledge of biology, mathematics, physics, and chemistry with specific training or receipt of a Certificate in a IH/OH-related specific area or areas of practice. The technician should have basic knowledge of

the hierarchy of controls, sampling techniques, properties of hazardous materials, and personal protective equipment.

Skills:

The IH/OH technician should be able to:

- Take instruction and work effectively under the direction of an IH/OH practitioner or professional
- Conduct basic Internet searches to obtain relevant data and use IH/OH-related software as required to complete their assigned tasks
- Understand and follow sampling methods for chemical, biological, radiological, and physical hazards
- Perform instrument calibration on direct reading instruments and air sampling pumps
- Compare sampling results with applicable standards
- Input sampling information into electronic recordkeeping systems
- Understand and apply information contained in Safety Data Sheets
- Perform tasks related to IH/OH programs (e.g. conduct respirator fit testing under the direction of the respirator program administrator)
- Demonstrate effective verbal and written communication skills
- Demonstrate proper use of personal protective equipment

Practitioner (Paraprofessional)

Knowledge:

An IH/OH Practitioner, sometimes called a paraprofessional, should have a baccalaureate or graduate degree in any related scientific field or an associate degree in safety, health, or the environment with at least four courses (with 12 semester hours or 18 quarter hours) in IH/OH from an accredited university or equivalent (i.e., 160 certificate hours). Alternatively, completion of the intermediate level courses from ohlearning.com will provide a good foundation for work at this level.

Skills:

An IH/OH practitioner should be able to:

- Complete basic computer tasks such as data entry and participate in virtual conferences and webinars
- Research relevant data using reference materials and World-wide Web
- Understand and follow sampling methods for chemical, biological, radiological, and physical hazards
- Perform instrument calibration on direct reading instruments and air sampling pumps
- Compare sampling results with applicable standards
- Understand and apply information contained in Safety Data Sheets
- Know and understand the rationale and application of the hierarchy of controls
- Demonstrate effective oral and written communication skills

- Select appropriate personal protective equipment
- Review IH/OH reports, inform employers or supervisors of the results and give a broad interpretation of those results

Professional

Knowledge and Experience:

A professional IH/OH should be a graduate of a regionally accredited college or university with one of the following:

- A baccalaureate or graduate degree in IH/OH, public health, safety, environmental sciences, biology, chemistry, physics, or engineering, or
- Any other bachelor's degree program that contains at least 60 semester hours of creditable subjects with at least 15 of those hours at the upper level (junior, senior, or graduate level) and at least four courses (with 12 semester hours or 18 quarter hours) in IH/OH. Creditable subjects are undergraduate or graduate level courses in science, mathematics, engineering, and science-based technology, and
- Four years of practice after graduation, or
- Receipt of the Diploma of Professional Competence in Occupational Hygiene, or
- Professional certification by an IH/OH organization whose certification scheme is recognized by the IOHA NAR Committee (e.g. CIH by ABIH and Registered Occupational Hygienist [ROH] by the Canadian Registered Board of Occupational Hygienists [CRBOH])

Skills:

The professional IH/OH should be able to:

- Use spreadsheets, use statistical analysis programs, develop presentation materials, communicate by email and use word processing programs.
- Research information pertaining to the business or operation using appropriate tools and references (e.g., Internet resources, regulations, standards, and industry information to obtain general risk data).
- Develop and implement programs to protect worker health including appropriate training.
- Evaluate business and operations data (e.g., monitoring and surveillance data, injury and illness data, incident reports, and safety and health programs) by comparing the data against internal history as well as national or industry standards in order to recognize and define risks.
- Conduct surveys of the business or operation in accordance with accepted survey methodology (e.g., observing the facility, referring to process flow charts, verifying safety and health systems, programs and documentation, and interviewing employees and management) to recognize hazards and recommend controls.
- Interpret survey data and assess risk using established analytical techniques to prioritize corrective actions.
- Determine and articulate recommended actions/controls to reduce risk to an acceptable level.
- Communicate the results of surveys to management with appropriate documentation to educate management about risks and to recommend and justify appropriate actions for managing current and potential loss scenarios.

- Communicate the identified hazard control measures (e.g., recommend engineering, administrative, and personal protective equipment controls) by identifying essential resources and implementation strategies to manage risk.
- Design and implement controls as appropriate (e.g., organize committees; plan, conduct, or provide training; maintain records; collect data; collaborate with contractors; select equipment; and manage respirator, confined space entry, lock out/tag out, and other safety and health programs) to manage risk.

Technical Core Competency Breakdown by Level of Practice

The following tables summarize the information presented earlier in the text and show the expected proficiency by technical core competency for each level of practice.

Administrative Controls and Personal Protective Equipment			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Recommend and evaluate effectiveness of administrative controls including written procedures, scheduling strategies, worker rotation and training.	Implement scheduling strategies and established worker rotation practices. Audit to ensure that written procedures are being followed.	Describe regulatory constraints on use of scheduling strategies and worker rotation. Conduct worker safety and health training.	Evaluate the use and limitations of scheduling strategies and worker rotation as an exposure control method. Provide input and help to develop written procedures to minimize worker exposure. Develop and deliver worker training on hazards and appropriate use of controls.
Recommend and evaluate use of personal protective equipment to control dermal exposures using the principles governing selection, use, care, and limitations of the equipment.	Identify user concerns about protective clothing and dermal protection.	Conduct personal protective equipment hazard assessments. Recognize the interaction between the worker, task, and materials when selecting PPE.	Establish a dermal/exposure personal protective equipment management program.
Recommend and evaluate use of personal protective equipment to control inhalation exposures using the principles governing selection, use, care and limitations of the equipment.	Identify user concerns about respiratory protection.	Conduct respirator hazard assessments. Recognize the interaction between the worker, task, and materials when selecting PPE.	Establish a respiratory protection management program.
Apply knowledge of respiratory protection including fit testing and breathing air specifications.	Conduct and document respirator fit tests. Collect breathing air samples following established protocols.	Interpret fit test and breathing air results.	Serve as respirator program administrator. Select appropriate respirators and develop appropriate test systems and protocols.
Apply knowledge of material permeability, eye protection, and dermal protection training.	Recognize limitations of PPE to provide worker protection.	Describe the limitations of protective equipment devices and materials, and conduct training.	Define and conduct PPE training objectives and content. Troubleshoot PPE failures.

Air Sampling and Instrumental Analysis			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Determine appropriate sampling strategy.	Appropriately apply a sampling strategy for specified contaminants, settings, and conditions.	Develop and determine appropriate application of sampling strategy for limited compounds.	Design and evaluate sampling strategies for multiple contaminants or stressors.
Select and describe the advantages and disadvantages of using the various types of air sampling instruments and the collection of full-shift, task-based and grab samples.	Describe the appropriate air sampling instrument for full-shift, task-based, and grab samples.	Select the appropriate instrument to collect full-shift, task-based, and grab samples.	For a selected instrument, describe the advantages and disadvantages for its use in the collection of full-shift, task-based, and grab samples.
Select appropriate air sampling/analytical methods	Be familiar with NIOSH and other occupational exposure sampling/analytical methods and be able to follow the instructions in the methods.	Be able to specify appropriate air monitoring method and understand the analytical sensitivity of the method to ensure that proper sample volumes are collected	Review available air sampling/analytical methods and identify applicable methods for the hazards present at the site. Work with analytical chemists to validate methods as appropriate.
Describe principles and application of laboratory analytical procedures and appropriate methods of detection for sample analyses (e.g. gas chromatography, spectrophotometry, atomic absorption, spectrophotometry).	Recognize which laboratory analytical instrument and which method is required for applicable sample analysis.	Apply the specific knowledge about analytical techniques in choosing how to analyze for a specific contaminant.	Determine options for selection and use of different laboratory analytical procedures, instruments, and methods to provide a broad range of detection and measurement of target compounds.
Demonstrate knowledge of instrument calibration and quality assurance practices.	Conduct appropriate calibration of instruments appropriate for sampling strategy.	Conduct appropriate instrument calibration and interpret results in alignment with sample strategy.	Evaluate and modify instrument calibration in keeping with quality assurance practices for sampling validation.

Basic Science and Math			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Know and apply scientific concepts from the fields of general chemistry, organic chemistry, biochemistry, analytical chemistry, physical chemistry, biology, anatomy, physiology, physics, mathematics, and statistics.	Recognize basic concepts of chemistry, biology, anatomy, physiology, physics, mathematics, and statistics.	Explain key concepts and problem-solving processes in chemistry, biology, anatomy, physiology, physics, mathematics, and statistics.	Apply critical thinking and problem-solving skills in chemistry, biology, anatomy, physiology, physics, mathematics, and statistics.
Be knowledgeable about physical properties of substances, such as reactivity, combustibility, and flammability.	Understand the effects of these physical properties on potential human exposures and the workplace.	Apply the specific principles about physical properties to evaluate and prevent exposures.	Interpret the various physical properties to determine options for exposure control for a variety of chemicals.
Perform calculations related to gas laws, airborne concentrations, units of measures and conversions, and pressure and temperature adjustments.	Recognize the relationship of pressure and temperature on potential exposure. Perform basic calculations.	Explain key concepts and apply problem-solving processes to convert units of measures and to make adjustments.	Interpret results from air sampling calculations and apply them to the sampling program (e.g. to establish appropriate sampling strategies and storage conditions)

Biological Hazards			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Identify biological agents such as viruses, bacteria, fungi, molds, allergens, toxins, recombinant products, bloodborne pathogens, and infectious diseases that are potentially harmful to humans and other biological organisms. Evaluate potential exposures and recommend appropriate controls.	Appropriately apply a sampling strategy for a specified contaminant.	Develop and determine appropriate application of sampling strategy for limited number of biohazards. Determine if controls are needed to reduce or prevent exposure.	Design and evaluate sampling strategies for multiple types of biohazards. Design and implement controls to reduce or prevent exposures.

Biostatistics and Epidemiology			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Demonstrate knowledge of the principles and techniques used in epidemiology to study the distribution of occupationally induced diseases and physiological conditions and factors in workplaces that influence their frequency.	(Intentionally left blank)	Understand relative risk and differences in relevance of cohort, case, and animal studies for the use of assessing risk.	Interpret relative risk and differences in relevance of cohort, case, and animal studies for the use of assessing risk. Using this information, identify studies that best identify exposure risk.
Interpret and evaluate prospective and retrospective studies, morbidity and mortality, and animal experimental studies using data and data distribution knowledge of statistical and non-statistical data.	(Intentionally left blank)	Select and review appropriate studies to understand health effects associated with exposure to a specific compound.	Interpret field studies, experimental studies, and morbidity and mortality studies to establish appropriate control measures and to assess risk to cohort.

Chemical Hazards			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Understand toxic characteristics of hazardous materials and wastes and the concepts of dose-response relationships.	Understand classes of chemical hazards by characteristics (e.g., toxic, flammable, reactive, and explosive).	Understand potential adverse interactions or effects.	Analyze complex interactions. Apply knowledge of effects of exposure, dose-response relationships, and disease potential. Conduct risk assessments associated with flammable and combustible materials.
Specify approaches to prevent, control, and remediate chemical exposure.	Understand the categories of basic exposure control methods.	Calculate/estimate and interpret potential exposures from exposure assessment measurements and potential methods to reduce exposures.	Design, develop, implement, and evaluate controls to reduce or prevent exposures to toxic and/or ignitable materials.

Community Exposure			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Describe general and technical topics related to ambient air quality, air cleaning technology, emission source sampling, atmospheric dispersion of pollutants, ambient air monitoring, and health and environmental effects of air pollution.	Understand basic principles related to emission sampling and health effects of air pollution.	Understand potential adverse interactions or effects of emissions.	Design, develop, and implement emission source sampling and air monitoring programs. Implement controls to prevent community exposure.
Be familiar with peripheral disciplines such as emergency planning and response, water pollution, hazardous waste, and environmental fate and transport.	Understand emergency preparedness and response program.	Participate in planning and managing emergency response programs	Help to develop site emergency response health and safety plans and work with emergency responders on controls to reduce their exposure risk

Emerging Issues			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Keep current with new technology being introduced into the workplace and appropriate controls to protect human health.	Be aware of new health hazards that are introduced into the workplace and their control strategies.	Help to implement programs designed to control exposures to emerging health hazards.	Understand exposure pathways of emerging hazards. The IH/OH must keep current with literature and understand possible impacts on human health. Develop and implement programs as appropriate.

Engineering Controls/Ventilation			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Recommend and apply local exhaust ventilation, dilution ventilation, isolation, and process change engineering principles to control chemical, biological, and physical exposures.	Able to use proper test equipment to verify local exhaust equipment (such as hoods) complies with expected standards. Verify dilution ventilation equipment is functioning as designed.	Review design drawings and verify that dilution ventilation and local exhaust equipment meets the necessary exhaust rates in compliance with ASTM and other recognized standards.	Design local and dilution exhaust system to properly provide protection for biological, chemical, and physical exposure including ignitable atmospheres. Incorporate appropriate monitoring equipment for variable airflow systems to ensure exposure levels are not exceeded.
Knowledge of the mechanics of airflow, ventilation measurements, design, in-plant air circulation and recirculation, air cleaning technology, and related calculations.	Identify the components of a ventilation system. Properly operate and read test instruments and report results.	Interpret airflow and ventilation measurements and compare to accepted standards. Inspect ventilation system components to identify causes of deviations from standards.	Design and supervise installation of necessary and appropriate ventilation equipment, including air cleaning components for dilution and local exhaust systems. Provide necessary design components for air quality consideration, including temperature, humidity, and adequate make-up air.

Ergonomics			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Identify, evaluate, and recommend controls to mitigate ergonomically stressful jobs using principles from anthropometry, human factors engineering, biomechanics, work physiology, human anatomy, occupational medicine, and facilities engineering for the purpose of preventing injuries and illnesses.	Recognize ergonomic risk factors such that one can identify ergonomically stressful jobs and potential controls to reduce ergonomic risk factors.	Apply specific principles of anthropometry, human factors engineering, biomechanics, work physiology, human anatomy, occupational medicine, and facilities engineering to analyze ergonomically stressful jobs.	Evaluate and recommend the most effective controls to mitigate ergonomically stressful jobs.

Fatigue Management			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Understand the scientific basis of fatigue, sleep cycles, circadian rhythms and fatigue physiology and be familiar with the risk factors associated with fatigue and their appropriate mitigation.	Be able to recognize the signs and symptoms of fatigue.	Be familiar with the risk factors association with fatigue and their mitigation and review shift schedules and overtime practices to ensure they are compliant with the fatigue management program.	Describe the scientific basis of fatigue, sleep cycles, circadian rhythms and fatigue physiology. Develop and implement a fatigue management program.

Health Regulations			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Be familiar with applicable regulations at the national, state/province, and local level that protect worker health and safety.	Be able to recognize compliance and non-compliance and take action accordingly.	Assist in program implementation and worker training. Audit effectiveness of programs.	Interpret regulations and develop programs to comply with the regulations.

Indoor Air Quality			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Be knowledgeable of the factors that affect IAQ including poor ventilation (lack of fresh, outside air), problems controlling temperature, high or low humidity, recent remodeling that may impact air flow, and other activities in or near a building that can affect the quality of the air in the building.	Take basic measurements such as temperature and humidity and collect samples as instructed.	Conduct inspections to identify conditions which could lead to poor air quality. should be familiar with common indoor pollutants such as dust from construction or renovation, mold, cleaning supplies, pesticides, or other airborne chemicals.	Develop and implement an IAQ program and be able to review ventilation systems

Management			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Describe methods to acquire, allocate, and control resources to accomplish anticipation, recognition, evaluation and control of workplace hazards in an effective and efficient manner.	Appropriately schedule monitoring and other tasks. Solicit information and feedback to make work adjustments.	Develop and determine appropriate application of IH/OH programs.	Design strategies to acquire, allocate, and manage resources for assessment and control programs.
Apply principles of cost-benefit analysis, auditing, investigation methods, data management and integration, establishment of policies, planning, delegation of authority, accountability, business acumen, risk communication, organizational structure and culture, and decision making.	Conduct work site assessments, evaluate results against standards, communicate sampling results, and determine further steps.	Select and apply appropriate tools to assess workplace hazards. Analyze results and make recommendations for improvement.	Evaluate effectiveness of IH/OH program, communicate results to management, and establish policies and procedures.
Possess the ability to recognize system-level properties that result from dynamic interactions among human and social systems and how they affect the relationships among individuals, groups, organizations, communities, and the environment.	Recognize the basic interaction between similar exposure groups and multiple types of exposures.	Apply the specific principles of systemic interactions to improve IH/OH programs.	Design, develop, and interpret the testing of hypotheses to assess the effects of various interactions for program improvement.
Follow a code of ethics.	Follow work assignments, honestly communicate results and concerns, and understand limitations.	Recognize limitations of scope of practice.	Follow ethics code of the NAR-recognized certification board in country of practice.

Noise and Hearing Loss Prevention			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Demonstrate knowledge of and apply principles of the physics of noise and vibration to conduct appropriate measurements to evaluate worker exposure.	Know how to calibrate and use equipment to determine worker noise exposure.	Develop and determine appropriate sampling strategy for assessing worker exposure to noise.	Interpret results of worker noise exposure with respect to compliance with standards and potential for hearing loss.
Identify situations with the potential to cause noise-induced hearing loss or vibration-related injury, and recommend methods to eliminate or control excessive exposure.	Recognize situations where workers are at risk of excessive noise exposure.	Select the appropriate instrument and method to monitor noise exposure to use as the basis of control.	Develop and implement strategy to ensure valid information is obtained to design and recommend measures to eliminate worker exposure to excessive noise.
Demonstrate knowledge of the anatomy and physiology of the ear with respect to the development of impaired hearing.	Explain the mechanics of incurring hearing loss.	Describe the relationship between the physics of noise and its consequences with respect to the auditory system.	Recommend and ensure implementation of specific controls and hearing loss prevention measures to protect workers from noise.
Evaluate audiograms and audiometric testing programs.	Interpret an audiogram.	Determine that audiometric testing procedures and an audiometric testing program are valid and appropriate.	Recommend when audiometric testing and/or an audiometric testing program are warranted, and evaluate effectiveness in preventing hearing loss.

Radiation (Ionizing and Nonionizing)			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Apply knowledge of the physical characteristics and the health and biological effects associated with exposure to alpha, beta, gamma, neutron, and x-radiation to recommend controls based on measurement and evaluation of exposure.	List major health effects associated with exposure to different forms of ionizing radiation. Understand the categories of basic radiation exposure control methods. Use proper instrumentation to collect exposure measurements.	Calculate/estimate and interpret potential exposures from field measurements. Identify radiation sources and potential methods to reduce exposures.	Design, develop, implement, and evaluate controls to reduce or prevent exposures.

Radiation (Ionizing and Nonionizing)			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Apply knowledge of the physical characteristics, potential hazards, and health effects of exposure to electromagnetic fields, static electric and magnetic fields, lasers, radio frequencies, microwaves, ultraviolet, visible, and infrared radiation and illumination to recommend controls based on measurement and evaluation of exposure.	Understand the health effects associated with exposure to different forms of nonionizing radiation. Understand the categories of basic radiation exposure control methods. Use proper instrumentation to collect exposure measurements.	Calculate/estimate potential exposures from field measurements. Identify radiation sources and potential methods to reduce exposures.	Design, develop, implement and evaluate controls to reduce or prevent exposures.

Risk Assessment, Risk Management and Risk Communication			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Demonstrate knowledge of the principles of health risk analysis.	Understand the principles of health risk analysis and application of a sampling strategy for relevant information gathering. Identify health hazards at the workplace.	Evaluate the degree of exposures to workplace health hazards and evaluate the adequacy of existing control measures.	Participate in overall risk analysis and management of a health hazard, process or workplace, and contribute to the establishment of priorities for risk management (i.e., recommending further appropriate control measures to prevent or reduce risk, implementing monitoring and control strategies for unacceptable exposures, and communicating health risk exposures to workers).

Thermal Stressors			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Describe thermal strain pathophysiology and hypo- and hyperthermic enviromarkers and biomarkers, recommend comprehensive thermal strain prevention programs, and recognize special human risk factors for heat- and cold-related disorders and deaths.	Understand the risk factors associated with the development of a thermal stress illness.	Evaluate the workplace to identify risk factors associated with the development of heat- and cold-related disorders.	Develop and implement comprehensive thermal strain prevention programs.

Thermal Stressors			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Demonstrate knowledge of medical/first aid care in case of emergency.	Identify and differentiate symptoms associated with various thermal-related disorders. Apply appropriate first aid treatments.	Develop training programs to increase worker awareness. Prepare appropriate emergency procedures.	Evaluate work environments to predict the likelihood of workers developing a thermal stress-related illness. Evaluate, revise, and implement thermal stress programs and training. Develop and implement preventive controls.

Toxicology / Human Disease			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Demonstrate knowledge of the principles of toxicology, including symptomatology; pharmacokinetics; mode of action; additive, synergistic and antagonistic effects; routes of entry; dose response; absorption; metabolism; excretion; target organs; toxicity testing protocols; aerosol deposition and clearance in the respiratory tract; and carcinogenic, mutagenic, teratogenic, and reproductive hazards.	Recognize the primary acute and chronic effects of specific materials based on information provided on Safety Data Sheets.	Interpret toxicological information provided on Safety Data Sheets and other standard sources. Convey effects to workers in an organized manner that workers can understand and apply to protect themselves.	Review and apply scientific literature to develop proper toxicological information to be used on Safety Data Sheets and to develop worker hazard training programs. Interpret results of in vivo and in vitro toxicological studies and their application to human health.
Apply the toxicological principles to evaluate and predict health effects from exposures to single contaminants, mixtures of contaminants, and natural and synthetic agents.	Interpret labels and Safety Data Sheets and communicate the hazards to workers using the Global Harmonized System (GHS) of classifying and labeling of chemicals.	Explain each of the components of the GHS. Apply the definitions to chemicals found in the workplace.	Categorize a new chemical using the GHS based on collected data or data available in the scientific literature. Review exposure data of employees to evaluate potential adverse effects and recognize when employees may be exhibiting effects from exposure.
Apply the toxicological principles to evaluate and predict health effects from exposures to single contaminants, mixtures of contaminants, and natural and synthetic agents.	Have basic understanding of occupational diseases caused by hazards in the workplace and refer questions to professionals in the organization	Be able to answer basic questions about occupational disease and be knowledgeable about specific target organ effects of the chemicals present in the workplace.	Recognize occupational disease and link it to a workplace agent. Review epidemiology literature. Explain the biological characteristics of chronic diseases and the burden they represent worldwide and how the interaction of genetics, lifestyle, and environment influence the health of a population.

Work Environments and Industrial Processes			
CORE COMPETENCY	TECHNICIAN	PRACTITIONER	PROFESSIONAL
Anticipate, recognize, evaluate, control and confirm protection of workers' and others' exposures associated with specific industries and/or processes.	Recognize and understand that in different work environments and industrial processes, the health and well-being of workers have the potential of being affected by the occurrence (real or potential) of chemical, physical, and biological agents and other stresses, and their interactions with other factors.	Apply principles and practices to address hazards that can potentially cause related diseases and/or dysfunctions from exposures to specific industrial processes (e.g. confined space entry, spray painting, welding, abrasive blasting) and work environments (e.g. foundry operations, hazardous waste site remediation and indoor environmental conditions).	Work effectively on a multidisciplinary team to investigate or evaluate work processes and methods from the point of view of the possible generation and release/propagation of potentially harmful agents and other factors, with the aim of eliminating exposures or reducing them to acceptable levels.

The Future of Industrial Hygiene

IHs/OHs help minimize risks associated with exposure to health hazards presented by work activities. Improvements in science and technology will increase the ability to control and reduce risks and may also enable IHs/OHs to identify some risks that were not recognized in the past. Changes in the workplace (e.g. nanotechnology, robotics) and in the work force (e.g. aging workforce, diversity in the workforce) will continue to pose challenges and drive improvements in worker protection stimulating the need for IH/OH expertise.

A career in IH/OH is promising. As long as people work, there will be a need to protect their health. Public concern about risk to worker health and well-being will continue to grow. Increased access to information will lead to broader recognition that illnesses and premature deaths are preventable by some degree of human control. IHs/OHs serve a dual role to promote the well-being of people and provide the science to protect them while they work.

Abbreviations/ Acronyms

3D	Three dimensional
ABET	ABET, Inc. (originally incorporated as the Accreditation Board for Engineering and Technology, Inc. and now known by just its acronym)
ABIH	American Board of Industrial Hygiene
ACGIH	American Conference of Governmental Industrial Hygienists
AIH	Academy of Industrial Hygiene (decommissioned in 2014)
AIHA	American Industrial Hygiene Association
BOHS	British Occupational Hygiene Society
CEPH	Council on Education for Public Health
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
CRBOH	Canadian Registration Board of Occupational Hygienists
CSP	Certified Safety Professional
IH	Industrial Hygiene or Industrial Hygienist
ILO	International Labour Organization
IOHA	International Occupational Hygiene Association
NAR	National Accreditation Recognition
NIOSH	National Institute for Occupational Safety and Health (United States)
OH	Occupational Hygiene or Occupational Hygienist
OHL	Occupational Hygiene Learning
OHTA	Occupational Hygiene Training Association
OS&H	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (United States)
PPE	Personal Protective Equipment
ROH	Registered Occupational Hygienist
UK	United Kingdom
US	United States

References

ABET – www.abet.org

American Board of Industrial Hygiene – www.abih.org

American Cancer Society – https://www.cancer.org/

American Conference of Governmental Industrial Hygienists – www.acgih.org

American Industrial Hygiene Association – www.aiha.org

British Occupational Hygiene Society - http://www.bohs.org/

Canadian Registration Board of Occupational Hygienists - http://www.crboh.ca/

Council on Education for Public Health (CEPH) - https://ceph.org/

International Labour Organization – http://www.ilo.org/global/lang--en/index.htm

International Occupational Hygiene Association - http://ioha.net/

National Institute for Occupational Safety and Health - https://www.cdc.gov/niosh/

Occupational Hygiene Training Association – http://www.ohlearning.com/

Appendix

Comparison of Core Competencies with Accrediting Bodies and Other Providers

Higher education programs may be accredited by external organizations such as ABET and CEPH. Other training may be obtained from certificate programs such as that defined within the OHTA. This section compares the list of core competencies for the practice of IH/OH with these three organizations. If the program includes specific training in a core competency area, there is an "X" in that column under the name of the external organization.

Required Knowledge Area	ABET	CEPH	OHTA
Air Sampling and Instrumental Analysis • Determine appropriate sampling strategy. • Select and describe the advantages and disadvantages of using the various types of air sampling instruments and the collection of full-shift, task-based, and grab samples. • Describe principles and application of laboratory analytical procedures and appropriate methods of detection for sample analyses (e.g., gas chromatography, spectrophotometry, atomic absorption spectrophotometry). • Demonstrate knowledge of instrument calibration and quality assurance practices.	X		X
Basic Science • Know and apply scientific concepts from the fields of o General chemistry o Organic chemistry o Biochemistry o Analytical chemistry o Biology o Anatomy o Physiology o Physics o Mathematics o Statistics • Describe physical properties of substances, such as o Reactivity o Combustibility o Flammability • Perform calculations related to gas laws, airborne concentrations, units of measures and conversions, and pressure and temperature adjustments.	X	X	

Biohazards Identify biological agents such as • Viruses • Bacteria • Fungi • Molds • Allergens • Toxins • Recombinant products • Bloodborne pathogens • Infectious diseases that are potentially harmful to humans and other biological organisms.	X		
Biostatistics and Epidemiology • Demonstrate knowledge of the principles and techniques used in epidemiology to study the distribution of occupationally induced diseases and physiological factors in workplaces that influence their frequency. • Interpret and evaluate prospective and retrospective studies, morbidity and mortality, and animal experimental studies using data and data distribution knowledge of statistical and non-statistical data.	X	X	
Chemical Hazards • Apply scientific and technical aspects to natural, controlled, accidental, and intentional releases of chemical agents into occupational and non-occupational environments. • Understand toxic characteristics of hazardous materials and wastes and the concepts of dose-response relationships. • Specify approaches to prevent, control, and remediate chemical exposure.	X	X	X
Community Exposure • Describe general and technical topics related to ambient air quality, air cleaning technology, emission source sampling, atmospheric dispersion of pollutants, ambient air monitoring, and health and environmental effects of air pollution. • Be familiar with peripheral disciplines such as emergency planning and response, water pollution, hazardous waste, and environmental fate and transport.	X	X	
IH/OH Controls/Ventilation • Recommend and apply local exhaust ventilation, dilution ventilation, isolation, and process change engineering principles to control chemical, biological, and physical exposures. • Application of these principles requires knowledge of the mechanics of airflow, ventilation measurements, design, in-plant air circulation and recirculation, air cleaning technology, and related calculations.	X		X
Ergonomics Identify, evaluate, and recommend controls to mitigate ergonomically stressful jobs using principles from: • Anthropometry • Human factors engineering • Biomechanics • Work physiology • Human anatomy • Occupational medicine • Facilities engineering for the purpose of preventing injuries and illnesses.	X		X

Health Risk Analysis and Hazard Communication • Demonstrate knowledge of the principles of health risk analysis. • Establish an exposure assessment strategy. • Collect basic characterization information (workplace, work force, agents). • Assess exposures to the work force. • Prioritize health risks. • Implement monitoring and control strategies for unacceptable exposures. • Schedule and perform periodic reassessments as necessary. • Document and communicate health risk exposures.	X	X	X
Management Describe methods to acquire, allocate, and control resources to accomplish o Anticipation o Recognition o Evaluation and control of workplace hazards in an effective and efficient manner. Apply principles of o Cost-benefit analysis o Auditing o Investigation methods o Data management and integration o Establishment of policies o Planning o Delegation of authority o Accountability o Business acumen o Risk communication o Organizational structure and culture o Decision making • Process the ability to recognize system level properties that result from dynamic interactions among human and social systems and how they affect the relationships among individuals, groups, organizations, communities, and the environment. • Follow a code of ethics.	X		
Noise and Hearing Loss Prevention • Demonstrate knowledge of and apply principles of the physics of noise and vibration to conduct appropriate measurements to evaluate worker exposure to identify situations with the potential to cause noise-induced hearing loss or vibration-related injury, and to recommend methods to eliminate or control excessive exposure. • Demonstrate knowledge of the anatomy and physiology of the ear with respect to the development of impaired hearing. • Evaluate audiograms and audiometric testing programs.	X		X
Non-Engineering Controls • Recommend and evaluate use of personal protective equipment to control exposures using the principles governing selection, use, care, and limitations of the equipment. • Apply knowledge of respirator fit testing, breathing air specifications, material permeability, eye protection, dermal protection, training, and the use of worker rotation as an administrative control.	X		

Raciation, Nonionizing and Ionizing Apply knowledge of the physical characteristics, potential hazards, and health effects of exposure to: • Electromagnetic fields; • Static electric and magnetic fields; • Lasers; • Radio frequencies; • Microwaves; • Ultraviolet; • Visible, and • Infrared radiation and illuminations to recommend controls based on measurement and evaluation of exposure. • Alpha, beta, gamma, neutron and x-ray radiation	X		
Thermal Stressors • Describe heat strain pathophysiology and hypo- and hyperthermic enviromarkers and biomarkers. • Recommend comprehensive heat strain prevention programs and recognize special human risk factors for heat-related disorders and deaths. • Demonstrate knowledge of medical/first aid care in case of emergency.	X		X
Toxicology • Demonstrate knowledge of the principles of toxicology including: o Symptomatology o Pharmacokinetics o Mode of action o Additive o Synergistic and antagonistic effects o Routes of entry o Absorption o Metabolism o Excretion o Target organs o Toxicity testing protocols o Aerosol deposition o Clearance in the respiratory tract o Carcinogenic, mutagenic, teratogenic and reproductive hazards • Apply the toxicological principles to evaluating and predicting health effects from exposures to single contaminants, mixtures of contaminants, and natural and synthetic agents.	X		
Work Environments and Industrial Processes • Anticipate, recognize, evaluate and control of workers' and others' exposures associated with specific industries and/or processes. • Apply knowledge and skills to address hazards that can potentially cause related diseases and/or dysfunctions from exposures such as confined space entry, spray painting, welding, abrasive blasting, vapor degreasing, foundry operations, hazardous waste site remediation, and indoor environmental conditions.	X		

ABET, Inc., is the recognized accreditor for college and university programs in applied science, computing, engineering, and technology. Among the most respected accreditation organizations in the United States, ABET has provided leadership and quality assurance in higher education for over 75 years. ABET accredits over 3100 programs at more than 600 colleges and universities worldwide.

The program must demonstrate that graduates have necessary knowledge, skills, and attitudes to competently and ethically implement and practice applicable scientific, technical, and regulatory aspects of IH/OH. To this end, graduates will be prepared to anticipate, recognize, evaluate, and control exposures of workers and others to physical, chemical, biological, ergonomic, and psychosocial factors, agents, and/or stressors that can potentially cause related diseases and/or dysfunctions. More specifically, graduates must be able to:

(a) identify agents, factors, and stressors generated by and/or associated with defined sources, unit operations, and/or processes;

(b) describe qualitative and quantitative aspects of generation of agents, factors, and stressors;

(c) understand physiological and/or toxicological interactions of physical, chemical, biological, and ergonomic agents, factors, and/or stressors with the human body;

(d) assess qualitative and quantitative aspects of exposure assessment, dose-response, and risk characterization based on applicable pathways and modes of entry;

(e) calculate, interpret, and apply statistical and epidemiological data;

(f) recommend and evaluate engineering, administrative, and personal protective equipment controls and/or other interventions to reduce or eliminate hazards;

(g) demonstrate an understanding of applicable business and managerial practices;

(h) interpret and apply applicable occupational and environmental regulations;

(i) understand fundamental aspects of safety and environmental health;

(j) attain recognized professional certification.

CEPH

The Council on Education for Public Health (CEPH) is an independent agency recognized by the U.S. Department of Education to accredit schools of public health and public health programs offered in settings other than schools of public health. These schools and programs prepare students for entry into careers in public health. The primary professional degree is the Master of Public Health (MPH), but other master's and doctoral degrees are offered.

The areas of knowledge basic to public health include the following:

- Biostatistics – collection, storage, retrieval, analysis, and interpretation of health data; design and analysis of health-related surveys and experiments; and concepts and practice of statistical data analysis
- Epidemiology – distribution and determinants of disease, disabilities, and death in human populations; the characteristics and dynamics of human populations; the natural history of disease; and the biologic basis of health
- Environmental health sciences – environmental factors, including biological, physical, and chemical factors that affect the health of a community
- Health services administration – planning, organization, administration, management, evaluation, and policy analysis of health and public health programs

- Social and behavioral sciences – concepts and methods of social and behavioral sciences relevant to the identification and solution of public health problems

OHTA

The Occupational Hygiene Training Association (OHTA) was formed to promote better standards of occupational hygiene practice throughout the world. OHTA develops training material that it makes freely available on its website, ohlearning.com, for use by students and training providers. OHTA also promotes an international qualifications framework so that all hygienists are trained to a consistent, high standard recognized in all participating countries by Approved Training Providers (ATPs).

Its training programs have been internationally reviewed by professional hygienists and tutors to ensure high quality and consistency.

OHTA has a Memorandum of Understanding with AIHA to develop and market the materials as part of the AIHA training offering. NIOSH and OHTA have also recently signed an agreement that provides for expert assistance from NIOSH in developing and reviewing the training materials.

The free, public-domain educational resources from OHTA are located on its website (see above). Increasingly, materials are being translated and some courses are available in languages other than English, such as Spanish, Mandarin, French, Portuguese, Arabic, Russian. The materials are based around a series of courses on various IH/OH topics. Each module includes a full student manual, course guides, slide packs and details of practical workshops.

The courses are set at various levels with one suitable for those with no prior experience; seven at Practitioner (Para-professional) level suitable for initial training or continuing professional development; and a number under development as advanced study for experienced IH/OH.

Qualified IHs/OHs can be approved as training providers to offer the one-week courses including a student assessment and certificate of course completion.

Satisfactory completion of 6 courses can lead to an International Certificate in Occupational Hygiene ICertOH that serves as a benchmark for the Practitioner (Para-professional) or a stepping-stone toward full certification. ABIH accepts the courses as prior educational experience toward the requirements for sitting for the CIH certification exam.

The scheme recognizes the following three levels of qualification:

1. Technician – the designated Foundation level course in the OHTA system, W201, covers the basic principles of occupational hygiene. For successful completion of it, an Award of Successful Course Completion is given. The Foundation level provides core knowledge to develop a career in occupational hygiene.
2. Practitioner (Para-professional) – the designated Intermediate level courses are for those who have studied the technical knowledge and practical skills needed to undertake occupational hygiene in the workplace. Those who successfully complete the

6 OHTA modules are eligible to sit for the International Certificate in Occupational Hygiene (ICertOH). The certificate demonstrates technical knowledge and practical skills in identifying health hazards, assessing occupational exposure, and testing control measures. It is suitable for Technicians and Practitioners who carry out measurements and testing in workplaces. The qualification has been designed so that it can be recognized by national associations as contributing to their own requirements for accreditation.

3. Advanced level – courses for those who achieve the levels of knowledge and skill expected of a professional hygienist. These courses are designed for the professional to complement existing academic programs by focusing only on industry specific topics to familiarize the student with the technology and process of specific industries and the hazards and controls that may be encountered.

The courses use a formative approach to learning that makes assessment an integral part of the learning process. The scheme can thus serve the needs of students from early technician training through to professional development. It encourages a process of "spiral learning," where materials are studied to progressively higher levels.

It is important to note that the international qualifications cover the core science and practice of IH/OH but do not cover the details of local legislation or local custom and practice. Hence, national associations may impose additional requirements before recognizing hygienists with international qualifications to practice in their country.

The available courses are provided on the ohlearning.com website.