CHAPTER 1

Industrial Hygiene

1.1 History

There has been an awareness of industrial hygiene since antiquity. The environmental and its relation to worker health was recognised as early as fourth century BC when Hippocrates noted lead toxicity in the mining industry, in the first century AD, Pliny the Elder, a Roman scholar, perceived health risks to those working with zinc and sulphur. He devised a face mask made from an animal bladder to protect workers from exposures of copper miners to acid mists.

In **1713 Bernardino Ramazzini** published the first book that could be considered a complete treatise on occupational diseases, **De Morbis Artificum Diatriba**. From his own observations he accurately described scores of occupations, their hazards, and resulting diseases. Although he recommended some specific as well as general preventive measures (workers should cover their faces to avoid breathing dust), most of his control recommendations were therapeutic and curative. While he had a vast knowledge of the literature of his time, it has been suggested that many of the works he cited were of questionable scientific validity, and some were more myth than science and should have been recognized as such even in Ramazzini's time. Because of his prestige these fanciful notions must have received wide acceptance and because his book was so admired, **Ramazzini's** influence may have stifled progress in his field during a period when great advances were being made in other branches of medicine. Nevertheless, his cautions to protect workers and his admonition that any doctor called on to treat patients of the working class ask "What occupation does he follow?" earned him the appellation "**Father of Industrial Medicine**".

For more than 100 years following **Ramazzini's** work, no significant additions to the literature on occupational medicine were published. In the nineteenth century two physicians, **Charles T. Thackrah** in **England** and **Benjamin W. McCready** in **America**, began the modern literature on the recognition of occupational diseases. **McCready's** book, On the Influence of Trades, Professions, and Occupations in the United States, in the Production of Disease, is generally recognized as the first work on occupational medicine published in the United States. The recognition of a causal link between workplace hazards and disease was a key step in the development of the practice of industrial hygiene. The observations by physicians, from Hippocrates to Ramazzini and extending into the twentieth century, of the relationship between work and disease Vernon E. Rose, Dr PH, CIH, CSP, PE History and Philosophy of Industrial Hygiene of occupational medicine.

Fig. 1.1 Bernardino Ramazzini

The crystallization of the practice of the profession can be traced to simultaneous developments in Great Britain and the

United States in the late nineteenth and early twentieth centuries. While legislation controlling working conditions was enacted in England beginning in 1802, the early laws were considered totally ineffective, as no proper system of inspection or enforcement was provided.

The **British Factories Act of 1864**, however, required the use of dilution ventilation to reduce air contaminants, while the 1878 version specified the use of exhaust ventilation by fans. The real watershed in industrial medicine and hygiene, however, came in the **British Factories Act of 1901**, which provided for the creation of regulations to control dangerous trades. The development of regulations created the impetus for investigation of workplace hazards and enforcement of control measures. In the **United States in 1905**, the Massachusetts Health Department appointed health inspectors to evaluate dangers of occupations, thus establishing government's role in the nascent field of occupational health. It has been suggested that industrial hygiene did not "emerge as a unique field of endeavour until quantitative measurements of the environment became available.

But in **1910** when **Dr. Alice Hamilton** went, in her own words, "as a pioneer into a new, unexplored field of American medicine, the field of industrial disease Worker exposures to many hazards (e.g., lead and silica) were so excessive and resulting diseases so acute and obvious, the "evaluation" step of industrial hygiene practice required only the sense of sight and an understanding of the concept of cause and effect. This "champion of social responsibility" for worker health and welfare not only presented substantial evidence of a relationship between exposure to toxins and ill health, but also proposed concrete solutions to the problems she encountered.

On an individual basis, Dr. Hamilton's work, which comprised not only the recognition of occupational disease, but the evaluation and control of the causative agents, should be considered as the initial practice of industrial hygiene, at least in the United States. It should be appreciated that many of the early practitioners of industrial hygiene were physicians who, like Alice Hamilton, were interested not only in the diagnosis and treatment of illnesses in industrial workers, but also in hazard control to prevent further cases. These physicians working with engineers and other scientists interested in public health and environmental hazards took the knowledge and insights developed over several millennia from **Hippocrates to Ramazzini, Thackrah and McCready**, and began the process of deliberately changing the work environment with the goal of preventing occupational diseases. What or who then can be designated as representing the origin of the profession? Is there any one person who deserves the title “Founder of Industrial Hygiene”? Certainly, if the name of one individual is sought, that of Alice Hamilton shines like a beacon. But think back to more than 10,000 years ago at the end of the Stone Age, when occupations began to form with the grinding of stone, horn, bone, and ivory tools with sandstone, and with pottery making and linen weaving. Envision a thoughtful worker who suffered from the musculoskeletal problems associated with grinding, made adjustments to his working conditions, and passed the ideas on to co-workers. Recognizing ergonomic problems and solving them would qualify him as an early industrial hygiene practitioner. If that scenario can be imagined, perhaps it is also conceivable that tens of thousands of years ago there was a huntress who recognized the signs and symptoms of anthrax in the bison her group had killed and who made the connection between earlier kills of diseased animals and sickness in members of her tribe. If she then warned her companions of the hazard involved and sought to avoid diseased animals, would she not qualify as one of the founders of the industrial hygiene profession?

If the basic philosophy of the profession is understood, protection of the health and well-being of workers and the public through anticipation, recognition, evaluation, and control of hazards arising in or from the workplace, then the rich tapestry that chronicles the history of industrial hygiene can be imagined. It began when one person recognized a work hazard and took steps not only for self protection, but also for protection of fellow workers. This is the origin and essence of the profession of industrial hygiene.

Historical Events in Industrial Hygiene

1,000,000 BC - Australopithecus used stones as tools and weapons. Flint snappers suffered cuts and eye injuries; bison hunters contracted anthrax.

10,000 BC - Neolithic man began food producing economy and the urban revolution in Mesopotamia. At end of Stone Age, grinding of stone, horn, bone, and ivory tools with sandstone; pottery making, linen weaving. Beginning of the history of occupations.

5000 BC - Copper and Bronze Age - metal workers released from food production. Metallurgy- the first specialized craft.

370 BC - **Hippocrates** dealt with the health of citizens, not workers, but did identify lead poisoning in miners and metallurgists. 50 AD Plinius Secundus (Pliny the Elder) identified use of animal bladders intended to prevent inhalation of dust and lead fume.

200 AD - **Galen** visited a copper mine, but his discussions on public health did not include workers' disease.

Middle Ages No documented contributions to the study of occupational diseases.

1473- **Ellenborg** recognized that the vapours of some metals were dangerous and described the symptoms of industrial poisoning from lead and mercury with suggested preventive measures.

1500 - **In De Re Metallica** (1556), Georgius Agricola described every facet of mining, smelting, and refining, noting prevalent diseases and accidents, and means of prevention including the need for ventilation. Paracelsus (1567) described respiratory diseases among miners with an excellent description of mercury poisoning. Remembered as the father of toxicology. "All substances are poisons . . . the right dose differentiates a poison and a remedy."

1665 - Workday for mercury miners at Idria shortened.

1700 - **Bernardino Ramazzini**, "Father of occupational medicine," published De MorbisArtificumDiatriba, (Diseases of Workers) and examined occupational diseases and "cautions." He introduced the question, "Of what trade are you?"

1775 - **Percival Pott** described occupational cancer among English chimney sweeps, identifying soot and the lack of hygiene measures as a cause of scrotal cancer. The result was the Chimney-Sweeps Act of 1788.

1830 - **Charles Thackrah** authored the first book on occupational diseases to be published in England. His views on disease and prevention helped stimulate factory and health legislation. Medical inspection and compensation were established in 1897.

1900s - **Dr. Alice Hamilton** investigated many dangerous occupations and had tremendous influence on early regulation of occupational hazards in the United States. In 1919 she became the first woman faculty member at Harvard University and wrote exploring the Dangerous Trad.

1902–1911 - Federal and then state (Washington) legislation covering workers' compensation. By 1948 all states covered occupational diseases. First survey in the United States of the extent of occupational disease conducted by the Illinois Occupational Disease Commission. Massachusetts appointed health inspectors to evaluate dangers of occupations.

1910 - First national conference on industrial diseases in the United States.

1912 - **U.S. Congress** levied prohibitive tax on the use of white phosphorus in making matches.

1913 - **National Safety Council** organized. New York and Ohio established first state industrial hygiene agencies.

1914 - **USPHS** organized a Division of Industrial Hygiene and Sanitation. American Public Health Association organized section on industrial hygiene.

1916 - **American Association of Industrial Physicians** and Surgeons formed. American Medical Association held first symposium on industrial hygiene and medicine. 1922 Harvard established industrial hygiene degree program.

1928–1932 - Bureau of Mines conducted toxicological research on solvents, vapours, and gases.

1936 - Walsh-Healy Act required companies supplying goods to government to maintain safe and healthful workplaces.

1938 - National (later American) Conference of Governmental Industrial Hygienists formed.

1939 - American Industrial Hygiene Association organized. American Standards Association and ACGIH prepared first list (maximum allowable concentrations) of standards for chemical exposures in industry.

1941–1945 - Expanded industrial hygiene programs in states. 1941 Bureau of Mines authorized to inspect mines.

1952 - Prof M.N.Rao was the first Indian from Andhra Pradesh who was deputed to International Labour Organisation (ILO) convention to present the Occupational Health status in India.

1960 - American Board of Industrial Hygiene organized by AIHA and ACGIH.

1966 - Metal and Non-metallic Mine Safety Act.

1968 - Professional Code of Ethics drafted by AAIH. Code adopted by all four industrial hygiene associations by 1981.

1969 - Coal Mine Health and Safety Act. 1970 Occupational Safety and Health Act.

1977 - Federal Mine Safety and Health Act. 1992–present Efforts to significantly amend OSH Act. 1995 Revised Professional Code of Ethics adopted by all four industrial hygiene associations.

Fig. 1.2 A Portrait of Paracelsus (1567) Who is Remembered as the Father of Toxicology

Fig. 1.3 Dr. Alice Hamilton

Science of industrial hygiene flourished in many countries, the United States provided the fertile ground for the development of the profession as it exists today. As the industrial revolution, propelled by the Civil War, progressed in the nineteenth century, individuals began to observe serious health and safety problems (recognition). They also considered the effects on workers (evaluation) and made changes in the work environment (control) to lessen the effects observed. Although these efforts may have resulted in improved worker health and safety, their application was not recognized as the practice of industrial hygiene until the early 1900s. In addition to a chronological listing, these activities also illustrate the concepts of the profession— i.e., recognition, evaluation, and control— which may help to better describe today's practice of industrial hygiene.

1.2 Definitions

Health: Health may be defined as

1. **The state of being free from illness or injury**
2. **A person's mental or physical condition**

3. As defined by World Health Organization (WHO), it is a "**State of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity**"
4. **"The ability to adapt and self-manage"** in the face of social, physical, and emotional challenges
5. **Absence of disease**
6. **The condition of being sound in body, mind or sprit especially freedom from physical disease or pain**

1.2.1 Health

1.2.1.1 The Determinants of Health

Introduction: Many factors combine together to affect the health of individuals and communities. Whether people are healthy or not, is determined by their circumstances and environment. To a large extent, factors such as where we live, the state of our environment, genetics, our income and education level, and our relationships with friends and family all have considerable impacts on health, whereas the more commonly considered factors such as access and use of health care services often have less of an impact.

The determinants of health include:

- **The social and economic environment**
- **The physical environment**
- **The person's individual characteristics and behaviours**

The contexts of people's lives determine their health, and so blaming individuals for having poor health or crediting them for good health is inappropriate. Individuals are unlikely to be able to directly control many of the determinants of health. These determinants or things that make people healthy or not include the above factors, and many others

- ***Income and social status*** - higher income and social status are linked to better health. The greater the gap between the richest and poorest people, the greater the differences in health
- ***Education*** – low education levels are linked with poor health, more stress and lower self-confidence

- ***Physical environment*** – safe water and clean air, healthy workplaces, safe houses, communities and roads all contribute to good health. Employment and working conditions – people in employment are healthier, particularly those who have more control over their working conditions
- ***Social support networks*** – greater support from families, friends and communities is linked to better health. Culture - customs and traditions, and the beliefs of the family and community all affect health
- ***Genetics*** - inheritance plays a part in determining lifespan, healthiness and the likelihood of developing certain illnesses. Personal behaviour and coping skills – balanced eating, keeping active, smoking, drinking, and how we deal with life's stresses and challenges all affect health
- ***Health services*** - access and use of services that prevent and treat disease influences health
- ***Gender*** - Men and women suffer from different types of diseases at different ages

Fig. 1.4 The determinants of health

1.2.1.2 The spectrum of health and illness

To describe health as the absence of disease is inadequate and unsatisfying. We have defined diseases for the last four hundred years or so according to the presence of certain lesions, or the presence of "abnormal" readings measured by instruments of investigation. Illness is a related, but different, term from disease. It is used mainly to refer to the experience of being unwell, incorporating our concept of disease, but actually describing the subjective experience of a person. Only a person can tell you they feel nauseated, or that they have pain. Instruments won't reveal those phenomena.

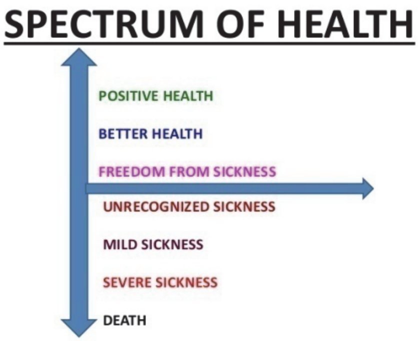


Fig. 1.5 Spectrum of health and illness

1.2.1.3 Factors Effecting Health

1. Social and economic factors
2. Environmental factors (Health)
3. Personal factors
4. Hereditary factors

1. Social and Economic Factors: It depends upon

- Income
- Employment and working conditions
- Food security
- Environment and housing
- Early childhood development
- Education and literacy

2. **Environmental factors (Health):** Environmental health risks are factors outside of the body that can affect a person's wellbeing and influence their behaviour. Examples include the quality of a person's air, food and water supply or their exposure to hazardous materials. Preventing or reducing the risk of illness, injury or disease in the community is essential to good environmental health.

   Examples of environmental health risks

   Environmental health covers many different factors in a person's surroundings. These can include:

   - ***Air pollution*** – for example, smog, wood smoke and mould.
   - ***Water quality*** – for example, grey water, tank water, fluoridation and drought.
   - ***Food quality*** – for example, contamination and nutrition.
   - ***Chemicals*** – for example, pesticides, farm chemicals, arsenic and CCA treated timber.
   - ***Metals*** – for example, exposure to lead, mercury and cadmium.
   - Diseases from animals and insects (vector borne) – for example, dengue fever, hendra virus, lyssavirus, Ross River fever and malaria.
   - Infectious diseases – for example, viral infections like swine flu.

3. **Personal factors:** Personal factors are those which relate to a particular individual and can have an effect on how they act and behave. This obviously has repercussions for overall health and safety as factors such as their attitude, motivation and ability to do the task will all influence the way they work and how. Whilst some personal factors may be ingrained into the person's character and be extremely difficult or even impossible to change, there will be others which can be influenced.

4. **Hereditary Factors:** You might already have a general understanding about heredity that – it is carried from parents to their children and will affect the health and physical characteristics of children. But do you want to know more about what heredity is and how it affects the

health and other physical and mental characteristics? Then we answer in detail to your questions.

We know that genes play an important role in determining our physical characteristics. But to know how genes work, let's get into some biology facts. Cells in human body contain a substance called deoxyribonucleic acid (DNA). DNA is wrapped together to form structures called chromosomes.

1.2.2 Hygiene

Industrial hygiene has been defined as "that science and art devoted to the anticipation, recognition, evolution, and control of those environmental factors or stresses arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among citizens of the community".

1.2.3 Hazard

A hazard is a situation that poses a level of threat to life, health, property, or environment. Most hazards are dormant or potential, with only a theoretical risk of harm; however, once a hazard becomes "active", it can create an emergency situation. A hazardous situation that has come to pass is called an incident. Hazard and possibility interact together to create risk.

Classification of Hazard

Classification of hazard

1. Physical hazard
2. Chemical hazard
3. Biological hazard
4. Ergonomic hazard
5. Psychological hazard

1. ***Physical hazard*:** A physical hazard is a type of occupational hazard that involves environmental hazards that can cause harm with or without contact. Physical hazards include ergonomic hazards, radiation, heat and cold stress, vibration hazards, and noise hazards.

Engineering control are often used to mitigate physical hazards.

Physical hazards are a common source of injuries in many industries. They are perhaps unavoidable in certain industries, such as construction and mining, but over time people have developed safety methods and procedures to manage the risks of physical danger in the workplace. These include excessive levels of ionizing and no ionizing electromagnetic radiation, noise, vibration, illumination, and temperature

In occupations where there is exposure to ionizing radiation, time, distance, and shielding are important tools in ensuring worker safety. Danger from radiation increases with the amount of time one is exposed to it; hence, the shorter the time of exposure the smaller the radiation danger.

Distance also is a valuable tool in controlling exposure to both ionizing and non-ionizing radiation. Radiation levels from some sources can be estimated by comparing the squares of the distances between the worker and the source. For example, at a reference point of 10 feet from a source, the radiation is 1/100 of the intensity at 1 foot from the source.

Shielding also is a way to protect against radiation. The greater the protective mass between a radioactive source and the worker, the lower the radiation exposure.

No ionizing radiation also is dealt with by shielding workers from the source. Sometimes limiting exposure times to no ionizing radiation or increasing the distance is not effective. Laser radiation, for example, cannot be controlled effectively by imposing time limits. An exposure can be hazardous that is faster than the blinking of an eye. Increasing the distance from a laser source may require miles before the energy level reaches a point where the exposure would not be harmful.

Noise, another significant physical hazard, can be controlled by various measures. Noise can be reduced by installing equipment and systems that have been engineered, designed, and built to operate quietly; by enclosing or shielding noisy equipment; by making certain that equipment is in good repair and properly maintained with all worn or unbalanced parts replaced; by mounting noisy equipment on special mounts to reduce vibration; and by installing silencers, mufflers, or baffles.

Substituting quiet work methods for noisy ones is another significant way to reduce noise, for example, welding parts rather than riveting them. Also, treating floors, ceilings, and walls with acoustical material can reduce reflected or reverberant noise. In addition, erecting sound barriers at adjacent work stations around noisy operations will reduce worker exposure to noise generated at adjacent work stations.

It is also possible to reduce noise exposure by increasing the distance between the source and the receiver, by isolating workers in acoustical booths, limiting workers' exposure time to noise, and by providing hearing protection. OSHA requires that workers in noisy surroundings be periodically tested as a precaution against hearing loss.

Another physical hazard, radiant heat exposure in factories such as steel mills, can be controlled by installing reflective shields and by providing protective clothing.

2. ***Chemical hazard*****:** Most people automatically associate chemicals with scientists in laboratories, but chemicals are also found in many of the products we use at work and at home. While they have a variety of beneficial uses, chemicals can also be extremely harmful if they are misused.

   Here are some examples of commonly used household products that can damage your health or cause a fire or explosion if used incorrectly:

   - cleaning products such as toilet cleaners, disinfectants, mildew remover and chlorine bleach
   - art supplies, such as paint thinner and pottery glazes
   - garage supplies, such as parts degreasers and cleaning solvents
   - office materials, such as photocopier toner

   Harmful chemical compounds in the form of solids, liquids, gases, mists, dusts, fumes, and vapors exert toxic effects by inhalation (breathing), absorption (through direct contact with the skin), or ingestion (eating or drinking). Airborne chemical hazards exist as concentrations of mists, vapors, gases, fumes, or solids. Some are toxic through inhalation and some of them irritate the skin on contact; some can be toxic by absorption through the skin or through ingestion, and some are corrosive to living tissue.

The degree of worker risk from exposure to any given substance depends on the nature and potency of the toxic effects and the magnitude and duration of exposure.

Information on the risk to workers from chemical hazards can be obtained from the Material Safety Data Sheet (MSDS) that OSHA'S Hazard Communication Standard requires be supplied by the manufacturer or importer to the purchaser of all hazardous materials. The MSDS is a summary of the important health, safety, and toxicological information on the chemical or the mixture's ingredients. Other provisions of the Hazard Communication Standard require that all containers of hazardous substances in the workplace have appropriate warning and identification.

3. ***Biological hazard*:** These include bacteria, viruses, fungi, and other living organisms that can cause acute and chronic infections by entering the body either directly or through breaks in the skin. Occupations that deal with plants or animals or their products or with food and food processing may expose workers to biological hazards. Laboratory and medical personnel also can be exposed to biological hazards. Any occupations that result in contact with bodily fluids pose a risk to workers from biological hazards.

   Sources of biological hazards may include bacteria, viruses, insects, plants, birds, animals, and humans. These sources can cause a variety of health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer and so on. Sources of biological hazards may include bacteria, viruses, insects, plants, birds, animals, and humans. These sources can cause a variety of health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer and so on.

   In occupations where animals are involved, biological hazards are dealt with by preventing and controlling diseases in the animal population as well as proper care and handling of infected animals. Also, effective personal hygiene, hands and forearms, helps keep worker risks to a minimum.

In occupations where there is potential exposure to biological hazards, workers should practice proper personal hygiene, particularly hand washing. Hospitals should provide proper ventilation, proper personal protective equipment such as gloves and respirators, adequate infectious waste disposal systems, and appropriate controls including isolation in instances of particularly contagious diseases such as tuberculosis.

4. ***Ergonomic hazard*:** An ergonomic hazard is a physical factor within the environment that harms the musculo-skeletal system. Ergonomic hazards include themes such as monotonous repetitive movements, manual handling, workplace/job/task design, uncomfortable workstation height and poor body positioning.

   The science of ergonomics studies and evaluates a full range of tasks including, but not limited to, lifting, holding, pushing, walking, and reaching. Many ergonomic problems result from technological changes such as increased assembly line speeds, adding specialized tasks, and increased repetition; some problems arise from poorly designed job tasks. Any of those conditions can cause ergonomic hazards such as excessive vibration and noise, eye strain, repetitive motion, and heavy lifting problems. Improperly designed tools or work areas also can be ergonomic hazards. Repetitive motions or repeated shocks over prolonged periods of time as in jobs involving sorting, assembling, and data entry can often cause irritation and inflammation of the tendon sheath of the hands and arms, a condition known as carpal tunnel syndrome.

   Ergonomic hazards are avoided primarily by the effective design of a job or jobsite and better designed tools or equipment that meet workers' needs in terms of physical environment and job tasks. Through thorough worksite analyses, employers can set up procedures to correct or control ergonomic hazards by using the appropriate engineering controls (e.g., designing or re-designing work stations, lighting, tools, and equipment); teaching correct work practices (e.g., proper lifting methods); employing proper administrative controls (e.g., shifting workers among several different tasks, reducing production demand, and increasing rest breaks); and, if necessary, providing and mandating personal protective equipment. Evaluating working conditions from an ergonomics standpoint involves looking at the total physiological and psychological demands of the job on the worker. Overall, industrial hygienists point out that the benefits of a well-designed, ergonomic work environment can include increased efficiency, fewer accidents, lower operating costs and more effective use of personnel.

In sum, industrial hygiene encompasses a broad spectrum of the working environment. Early in its history OSHA recognized industrial hygiene as an integral part of a healthful work setting. OSHA places a high priority on using industrial hygiene concepts in its health standards and as a tool for effective enforcement of job safety and health regulations. By recognizing and applying the principles of industrial hygiene to the work environment, America's workplaces will become more healthful and safer.

5. ***Psychological hazard*:** Psychosocial hazards include but aren't limited to stress, violence and other workplace stressors. Work is generally beneficial to mental health and personal wellbeing. It provides people with structure and purpose and a sense of identity. It also provides opportunities for people to develop and use their skills, to form social relationships, and to increase their feelings of self-worth.

   There are circumstances, however, in which work can have adverse consequences for health and wellbeing. Risks to psychological health at work may arise from organizational or personal factors, with the major factors being poor design of work and jobs, poor communication and interpersonal relationships, bullying, occupational violence and fatigue. Risks to psychological health due to work should be viewed in the same way as other health and safety risks and a commitment to prevention of work-related stress should be included in an organization's health and safety policies.

   A psychological hazard is any hazard that affects the mental well-being or mental health of the worker and may have physical effects by overwhelming the individual coping mechanisms and impacting the workers ability to work in a healthy and safe manner. Although these issues have been around for many years, psychosocial hazards are only now being recognized as potential workplace hazards. The hazards generally are not from physical things that you can see (like a saw blade) or smell (like paint). Rather, many of these hazards come about as a result of interactions with others. In some cases, the hazard is brought into the workplace from the home. There are often no obvious outward signs of the effects of exposure and the methods to control these hazards are somewhat different than methods used to control other traditional workplace hazards.

The types of issues or concerns included in this category are:

- Fatigue and hours of work
- Technological changes
- Stress and critical incident stress
- Bullying including cyber bulling/harassment
- Workplace violence and abuse

1.2.4 Occupational Disease

An occupational disease is any chronic ailment that occurs as a result of work or occupational activity. It occurs as a result of exposure to physical, chemical, biological and psychological factor in the work place.

- Occupational diseases have a long latent period
- Most occupational diseases cannot be treated be prevented
- All occupational diseases can

Some of the well-known Occupational disease are as follows

- Silicosis
- Asbestosis
- Bagassosis
- Byssinosis
- Dermatitis
- Anthrax

- Pneumoconiose
- Lead poisoning
- Occupational cancer

1.3 Control Measure

1. Elimination
2. Substitution
3. Engineering Controls
4. Administrative Controls
5. Personnel Protective Equipment (PPE)

To control the hazards there are four principles in general. Elimination of the best option, if elimination is not possible then substitution should be Engineering control is applied to control hazards by engineering modifications in the process. The last principle advocates the administrative control by making some administrative mechanism in the workplace to keep away hazards from human and workplace.

The application of all four control measures with the use of personal protective equipment (PPEs) reduces the hazards significantly in workplace and outside of the unit.

1.3.1 Elimination

The most effective control measure is to control hazards at the source by eliminating the hazard. Eliminate hazards at the "development stage" it is important to consider health and safety aspects when work processes are still in the planning stages. For example, when purchasing machines, safety should be the first concern, not cost. Machines should conform to national safety standards — they should be designed with the correct guard on them to eliminate the danger of a worker getting caught in the machine while using it. Machines that are not produced with the proper guards on them may cost less to purchase, but cost more in terms of accidents, loss of production, compensation, etc. Unfortunately, many used machines that do not meet safety standards are exported to developing countries, causing workers to pay the price with accidents, hearing loss from noise, etc.

The above figure is one example for accident when machine guard is eliminated, in other words, a hazard of an accident could be eliminated by providing the machine guard.

Any avoidable exposure to dangerous substances should be eliminated.

Some hints on where to look

- Regarding hazards caused by the process
- Open processes, e.g. painting big surfaces, Mixing/ compounding in open containers/vessels
- Processes generating dusts, vapours or fumes or dispersing liquids in the air e.g. welding, spraying paint
- Related to the substance
- If you cannot change the work process, try to eliminate or avoid the exposure for substances that
- Increase fire and explosion risks;
- Leads to high exposure of workers
- Results in exposure to many workers
- Are volatile, e.g., organic solvents
- Are dispersed in the air (aerosols, dust)
- Cause acute health risks, e.g., poisons, corrosives and irritants

- Cause chronic health risks, such as allergens, substances toxic for reproduction and others
- Are covered by specific national regulations imposing restrictions of use in the workplace
- Have already caused problems in your enterprise (health problems, accidents orother incidents);
- Cause occupational diseases
- Make regular health monitoring (medical examination of workers) necessary
- Can be absorbed through the skin or substances for which the use of personal protective equipment impairing workers (e.g. inhalation protection) is necessary

1.3.2 Substitution

Substitution of currently-used materials with less hazardous materials is one of the most effective ways of eliminating or reducing exposure to materials that are toxic or pose other hazards. A hazard is the source of danger or injury. A hazard includes any chemical or material that has the ability or a property that can cause an adverse health effect or harm to a person under certain conditions. Risk, on the other hand, is the probability or chance that exposure to a chemical hazard will actually cause harm to a person or cause an adverse effect.

Other occupational hygiene methods for controlling employee exposure to chemicals include isolation, enclosure, local exhaust ventilation, process or equipment modification, good housekeeping, administrative controls and personal protective equipment. All these methods reduce or eliminate the risk of injury or harm by interrupting the path of exposure between the hazardous material and the worker. Substitution removes the hazard at the source.

Why should the substitute material be chosen very carefully?

Extreme care must be taken to ensure that one hazard is not being exchanged for another, especially one that could even be a more serious hazard. Before deciding to replace a chemical, one must know the risks of the chemical to the employees, the environment, and the risks for damage to equipment and facilities. If the risks are serious, then alternatives should be considered and their risks must also be understood.

The selection of a substitute can be a very complex process. In large organizations the selection process may involve a committee with representatives from engineering, purchasing, industrial hygiene, safety, maintenance, research and development, environmental control, waste management, shipping and the supervisors and workers who directly work with the material. In smaller organizations, one person may carry out many of these functions.

Substitution Process

General considerations

Substitution may be an isolated event in a company or it may be part of a more systematic approach or policy at company/sector or local/regional level.

It should be integrated in the general policies and plans of companies, making good use of existing knowledge within the companies and of the relations with external stakeholders (partners, authorities, shareholders, supply chain, clients).

Making substitution part of the preventive culture of the company helps to identify problems earlier - spotting opportunities, acting in a coherent way and gaining broader support.

Multidisciplinary teams are generally needed, depending on the nature and complexity of the substitution. Such teams should include preventive services and occupational physicians, technical personnel, and workers representatives.

Workers have to be informed, encouraged and involved in identifying possible substitutions and discussing the appropriateness of their implementation, as well as when putting them into practice. The fact that substitution is a change (sometimes an innovation) may be stimulating in some cases, but in others it will challenge companies' and workers´ capacities to adapt, to change mindsets, and to control things while under development. Information exchange along the supply chain or at sector level can promote substitution initiatives and share practical experience.

The right timing for substitution is influenced by the availability and the costs of substitution. Big companies can afford to make a competitive advantage of putting on the market or using a new and safer alternative, even while prices are still high. Small companies might need to wait for prices to go down.

A critical issue is the current state of knowledge on the long-term effects of substances. In some notorious cases, like asbestos, chemicals were proven unsafe after many years of intensive use. Such cases make it hard to decide on implementing alternatives, especially when they are not supported by long-term epidemiological studies. Constant improvement of laboratory tests and modeling methods are expected to provide more reliable data and in shorter time. A precautionary approach is recommended, and substitution by unknown substances should be avoided until clarification is forthcoming, in particular if the current risk is low and may not justify such a step.

A risk assessment for the alternative should determine if risk is reduced, and what protective measures are required. An alternative will rarely be the safest for all hazard endpoints. Decision on what alternative to adopt should consider which hazard is more likely to generate high risks levels, and which one the company is better able to control. As well as chemical risks, other risks should also be considered that could impact negatively on health and safety (e.g. risk of fire and explosion risks). The impact on the main working processes and on auxiliary activities like maintenance should be considered, as well as the consequences of possible accidents. Working procedures, protective and preventive measures already in place may need to be amended or supplemented. Companies could develop purchasing procedures to select for safer chemicals and products as they become available.

The principle of substitution to avoid chemicals of high concern can also be applied to the design of new products or processes, which is a preferable preventive approach.

Substitution Steps

The following steps are general and indicative, and can be adjusted, if appropriate, to bring about the desired result:

- ***Organising a working group*:** Insure appropriate representation of workers and employers, and integrate all required expertise. Include those directly involved in using/producing the substance (technicians, workers). Make a work plan with well-defined roles for all stages. Take measures to ensure an efficient information flow between the group, the rest of the company and its stakeholders. Maintain a collaborative, open–minded atmosphere.
- ***Defining the problem*:** List the substances to be substituted. Be clear on why you make these choices. Priorities substitutions according to legal provisions, company policy and stakeholder perspective. Define the function that a substance has and how it is integrated in the rest of the process/product. List the required conditions for this function to perform adequately (temperature, acidity, pressure, chemical compatibility, etc.). An alternative should fit these conditions, or the system/product will need to be changed, to a greater or lesser degree. Define what quality the substance gives to the process or to the final product. If that quality is not actually necessary needed (e.g. some commercial attributes) the substance may be eliminated. Otherwise, an alternative is needed.
- ***Setting substitution criteria*:** Set criteria for selecting possible alternatives. Initially, fewer (pre)screening criteria may be used. This would eliminate at an early stage those alternatives that are not safe enough CMRs and substances of equivalent concern, such as endocrine disruptors, also sensitizers or neurotoxin ants should not be chosen as alternatives. Other criteria may be added to differentiate between alternatives that have passed the screening criteria. Cost, availability on the local market, and other advantages may be considered.
- ***Searching for alternatives*:** Solutions may be found inside the company. Searching other sources is also important. Alternatives already developed and implemented may lower innovation costs and risks. Internet sources, official reports, supplier chain, professional or sectorial associations or authority representatives may provide

useful information. Another approach is to ask the supplier to formulate a safer alternative. Some companies offer support in selecting the right product, or may even be willing to reformulate the initial one (especially for important clients).

- ***Assessing and comparing alternatives*:** Assess all alternatives using the same method or tool to allow for comparison. Select those alternatives that best fit the nature and dimension of the problem and that provide indeed an overall risk reduction.
- ***Experimenting on pilot scale*:** Try substitution on a smaller scale to see if it lives up to expectations in terms of safety, technical and environmental performance. Compare costs against those initially forecast, and estimate if feasible when transposed at full scale.
- ***Implementing, Re-evaluating*:** Plan carefully for full scale implementation. Evaluate the risks (see also: Risk Assessment Tool) and take appropriate measures. Review as necessary the supply chain, training needs, monitoring (see also: Air Monitoring), and other procedures.

The table below provides some examples:

Instead of	Consider
Carbon tetrachloride (causes liver damage, cancer)	1,1,1-trichloroethane, dichloromethane
Benzene (causes cancer)	Toluene, cyclohexane, ketones
Pesticides (causes various effects on body)	"Natural" pesticides such as pyrethrums
Organic solvents (causes various effects on body)	Water-detergent solutions
Leaded glazes, paints, pigments (causes various effects on body)	Versions that do not contain lead
Sandstone grinding wheels (causes severe respiratory illness due to silica)	Synthetic grinding wheels such as aluminium oxide

Remember, however, that you need to make sure the substitute chemical or substance is not causing any harmful effects and to control and monitor exposures to make sure that the replacement chemical or substance is below occupational exposure limits.

Another type of substitution includes using the same chemical but to use it in a different form. For example, a dry, dusty powder may be a significant inhalation hazard but if this material can be purchased and used as pellets or crystals, there may be less dust in the air and therefore less exposure.

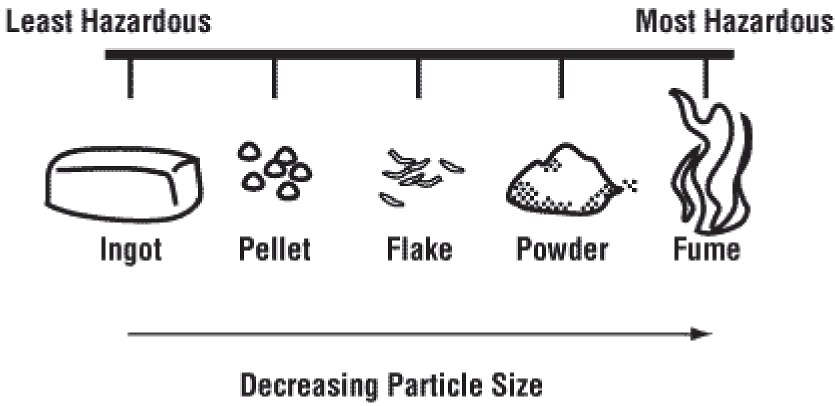


Fig. 1.6 Hazard based on size

When substituting, be very careful that one hazard is not being traded for another. Before deciding to replace a chemical/substance with another, consider all the implications and potential risks of the new material.

Elimination or substitution can lead to

- Improved immediate and long-term health of the workers exposed to the dangerous substance;
- Reduced pollution of the environment;
- Reduced costs to the enterprise by:
- Lowering sickness absence,
- Spending less on control measures,
- Reduced cost in compliance with environmental legislation,
- Saving money on fire and explosion protection,
- Lower consumption of a product,
- Using cheaper materials,
- More efficient work processes

The variety of substitutions and their context are presented in the examples below.

Construction sector - substitution by non chemical alternative - personal initiative in an SME:

A worker in a SME proposed the use of an electric, infrared (IR) heater to soften old paint, instead of the usual chemical procedure for stripping, based on dichloromethane. Initially, the proposal had nothing to do with occupational safety or environmental protection. The IR stripper was easier to transport, store and use than the chemicals. The substitution was well received by co-workers, who soon also noticed the OSH advantages. Moreover, unlike torch stripers, the IR device does not develop temperatures that volatilize hazardous components such as lead; nor does it create dusts, like mechanical methods (e.g. blasting). When the SME proposed it in its next subcontract offer as a “green solution”, it made a good impression on the contractor and the beneficiary.

Health care sector - substitution by product changes (packaging) and organizational measures - part of a broader risk reduction plan.

As part of the process to eliminate mercury in health care units, a hospital decided to use thimerosal free vaccines. Thimerosal (or thiomersal) is a mercury-containing preservative that stabilizes vaccines. Using preservative free vaccines meant changing the supplying procedure: single vials instead of multiple vial vaccines were used, and the storing time was shortened. The hospital reduced chemicals risks and hazardous wastes waste, and patients that rejected vaccines containing mercury were reassured.

Chemical industry - substitution by chemical - large company.

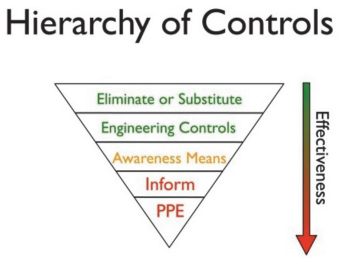
One of the biggest manufacturers of chemicals synthesized 1,2-Cyclohexane dicarboxylic acid diisononyl ester (DINCH) as an alternative to phthalate plasticisers such as bis(2-ethylhexyl)phthalate (DEHP) which is classified as reprotoxicant and endocrine disruptor in the EU and as possibly carcinogenic to humans by the International Agency for Research on Cancer. Released in 2002, it has been used successfully in sensitive applications such as medical devices, children’s products, and food. Today it is one of the most used alternatives to phthalate plasticisers.

Other examples are:

- Electric motors instead of diesel or petrol engines to eliminate hazardous exhaust fumes;
- "Dust-free" cutting or grinding equipment;
- Dip or brush instead of spray painting;
- Covered containers to carry materials which produce air contaminants.
- Use a vacuum cleaning when cleaning up toxic dust. Never sweep toxic dust-sweeping puts the dangerous dust back into the air where you can breathe it.

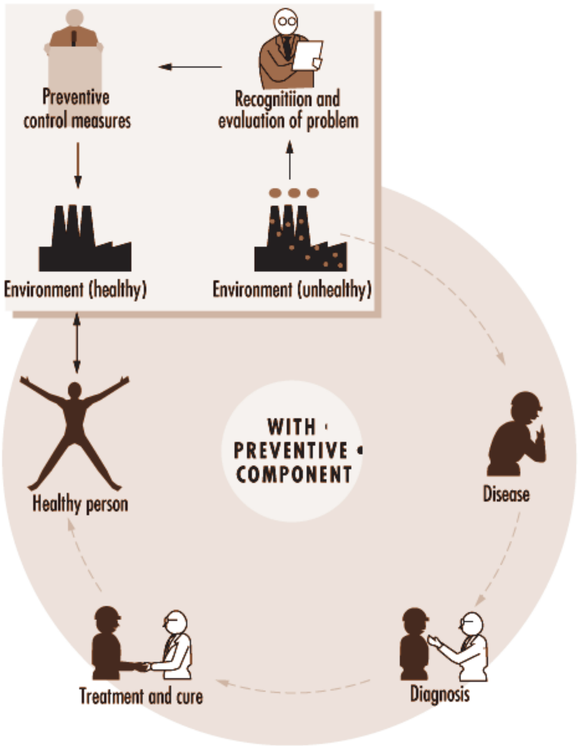
- Demolition of structure using mechanical sheers; combined with the safe work practice of spraying water will significantly reduce worker exposure to harmful dust.

1.3.3 Change in the Process



Change the Process

If there are no reliable substitutes for dangerous chemicals, then you can consider changing the way the process is carried out. It may be possible to change the process so that it makes the handling of substances safer. Example: using a wet method to control dust; or steam cleaning instead of solvents. Hand operated controls on the production line should be closer so that workers do not have to bend or stretch.



Mechanise the Process

Certain dangerous work can be automated. This will prevent workers from going near the dangerous substance or process.

Example: Instead of manual dipping of metal parts in a degreaser, one can use an automatic parts process.

Measurements for Control

Measurements with the purpose of investigating the presence of agents and the patterns of exposure parameters in the work environment can be extremely useful for the planning and design of control measures and work practices. The objectives of such measurements include:

- Source identification and characterization
- Spotting of critical points in closed systems or enclosures (e.g., leaks)
- Determination of propagation paths in the work environment
- Comparison of different control interventions
- Verification that reparable dust has settled together with the coarse visible dust, when using water sprays
- Checking that contaminated air is not coming from an adjacent area.

Direct-reading instruments are extremely useful for control purposes, particularly those which can be used for continuous sampling and reflect what is happening in real time, thus disclosing exposure situations which might not otherwise be detected and which need to be controlled. Examples of such instruments include: photo-ionization detectors, infrared analysers, aerosol meters and detector tubes. When sampling to obtain a picture of the behaviour of contaminants, from the source throughout the work environment, accuracy and precision are not as critical as they would be for exposure assessment.

Measurements are also needed to assess the efficiency of control measures. In this case, source sampling or area sampling are convenient, alone or in addition to personal sampling, for the assessment of workers' exposure. In order to assure validity, the locations for "before" and "after" sampling (or measurements) and the techniques used should be the same, or equivalent, in sensitivity, accuracy and precision.

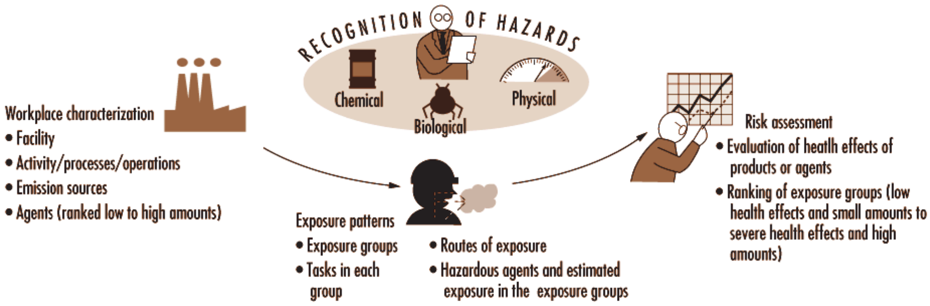


Fig. 1.7 Recognition of Hazards

Occupational Health

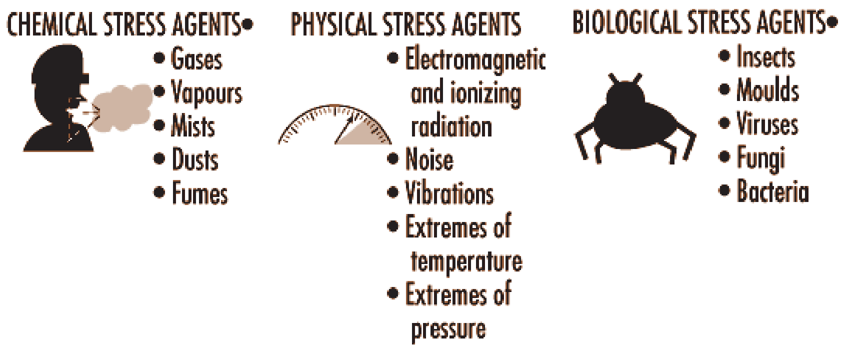


Fig. 1.8 Occupational Health stress agents

These stress removed in industrial and construction areas for better health.

Workplace Assessment Methods

Although there are many aspects to occupational hygiene work the most known and sought after is in determining or estimating potential or actual exposures to hazards. For many chemicals and physical hazards, occupational exposure limits have been derived using toxicological, epidemiological and medical data allowing hygienists to reduce the risks of health effects by implementing the "Hierarchy of Hazard Controls". Several methods can be applied in assessing the workplace or environment for exposure to a known or suspected hazard.

Occupational hygienists do not rely on the accuracy of the equipment or method used but in knowing with certainty and precision the limits of the equipment or method being used and the error or variance given by using that particular equipment or method. Well known methods for performing occupational exposure assessments can be found in "A Strategy for Assessing and Managing Occupational Exposures".

The main steps outlined for assessing and managing occupational exposures:

- Basic Characterization (identify agents, hazards, people potentially exposed and existing exposure controls).
- Exposure Assessment (select occupational exposure limits, hazard bands, relevant toxicological data to determine if exposures are "acceptable", "unacceptable" or "uncertain")
- Exposure Controls (for "unacceptable" or "uncertain" exposures)
- Further Information Gathering (for "uncertain" exposures)
- Hazard Communication (for all exposures)
- Reassessment (as needed) / Management of Change.

Need for Re-Validation

There are many changes that could lead to a need to re-validate a control measure or combination of control measures. Examples include:

System failure

If monitoring or verification identifies failures for which a process deviation cause cannot be identified, re-validation may be needed. Non-compliance with monitoring or verification criteria may indicate a need for a change in the parameters (i.e., the selection and specification of the control measures) on which the design of the food safety control system is based. A system failure may also result from an inadequate hazard analysis and may require re-validation.

Process changes

The introduction in the food safety control system of a new control measure, technology or a piece of equipment that is likely to have a decisive impact on the control of the hazard may necessitate that the system or parts of it be re-validated.

Similarly, changes made in product formulation or the application of current control measures (e.g. time/temperature changes) may result in the need for re-validation of control measures.

New scientific or regulatory information:

- Re-validation may be needed if the hazard associated with a food or ingredient changes as a result of higher concentrations of hazards than originally encountered and accounted for in the design
- A change in response of a hazard to control (e.g. adaptation)
- 10 Decision criteria should take into account the uncertainty and variability associated with the validation methodology and the performance of the control measure or combination of control measure

Isolation

Definition - What does Isolation mean?

Isolation, in the context of databases, specifies when and how the changes implemented in an operation become visible to other parallel operations. Transaction isolation is an important part of any transactional system. It deals with consistency and completeness of data retrieved by queries unreflecting a user data by other user actions. A database acquires locks on data to maintain a high level of isolation.

Enclosed operations

Isolation of the source of exposure can be accomplished through actual physical enclosure, preferably separate rooms or buildings, and closed doors. The direction of airflow must be into the restricted area from the cleaner areas. Therefore, the isolated area must be under negative pressure compared to surrounding areas. This is accomplished by exhausting extra air from the isolated area to the outdoors using fans in either general or local exhaust ventilation.

Exhaust air must be decontaminated before release to the outdoors. There should be no connections between the isolated area and other areas via the ventilation system, ceiling plenums, pipe chase ways, openings in walls, etc.

Regulated areas

As a further precaution, regulated areas can be established around enclosed operations with access only to a limited number of essential employees. Entrances to regulated areas should be posted informing workers that the areas may be entered only by authorized personnel and the special procedures, such as wearing respirators that must be followed in the regulated area. A roster of employees entering and leaving the regulated area should be kept. No smoking, eating, drinking, chewing tobacco or gum, or applying cosmetics is permitted in regulated areas. Air locks with interlocked doors add an extra measure of isolation. Computerized card readers and doors with alarms prevent unauthorized entry.

Isolation by time

The amount of time employees spend in isolated or regulated areas should be minimized. A hazardous operation can sometimes be performed during the second or third shift to reduce the number or workers potentially exposed.

Glove boxes

Glove boxes are usually small units that have two or more ports in which arm-length rubber gloves are mounted. The worker places her hands in these gloves to perform tasks inside the box. Construction materials vary widely, depending on the intended use. Clear plastic is frequently used because it allows visibility of the work area and is easily cleaned. Glove boxes generally operate under negative pressure so that any air leakage is into the box. Exhaust air must be decontaminated. Because these units have low airflow, scrubbing or absorption of exhaust air can be accomplished with little difficulty.

Enclose workers

Workers can be protected by enclosure in a special isolated booth or room from which they can observe and control an operation using chemicals. One disadvantage of this method is the social isolation of the worker. Worker enclosures should be as roomy and comfortable as possible. They should be provided with heating and air conditioning and provided with clean air from an uncontaminated location. They should be under positive pressure to keep out contamination.

Isolate Best practice

- Requirements must be established for conducting these activities in job instructions or method descriptions, for instance.
- It is important that somebody is responsible for process isolation, and that this person approves the start of isolation. This person will also coordinate the sequence of activities if several people are responsible for the isolation job.
- The people doing the job must discuss and understand the underlying philosophy of the isolation plan before starting work. This could be accomplished, for example, by the responsible operations supervisor going through and explaining the plan to the relevant personal.

Execution

- A physical barrier must always be in place to prevent actuator-controlled valves from changing position. The isolation method must be sufficiently secure to provide assurance that for example a loss of power or air will not change the valve position.
- Because of the above, a quality-assured overview with tag number showing how each valve is to be isolated should be available for each individual platform/facility. This overview will form the basis for executing isolations.
- Tagging campaigns. Ensuring that all equipment – not only valves, but also connections and other relevant items – is tagged represents a crucial requirement. Tagging campaigns should accordingly be pursued. This work can possibly be outsourced to contractors.
- Consequences of missing tags. A lack of tagging should generate a requirement for physical checking the plant. This must be done by at least two people.
- Setting specific expertise requirements for those doing the isolation is important. (Similar requirements must apply for those verifying isolations.)

- If isolation and leak testing are conducted in parallel, these, activities must be performed systematically (finishing work on one barrier/component before continuing to the next).
- A system must be in place for labelling the involved, equipment, checking that isolation has been carried out and has not been altered by others. - Labels must be hung on the equipment as the isolation process proceeds. A system must be in place to ensure that the quantity of labels and the number on each 11 accords with the isolation plan. This will help to ensure that no items on the plan are overlooked. Example: a dedicated printer connected to the WP system.
- Locking. Some companies have routines for locking valves so that their position cannot be inadvertently changed by others (see below).
- Isolation should be carried out at a time when sufficient peace and quiet prevails for a thorough job to be done.
- The list of break sections must be updated if breaking of flanges or removal of plugs forms part of the isolation process. This list must be a dynamic document which specifies at any given time which points (both flanges and plugs) have been broken.

Purging

Purging should always be done before work starts on hydrocarbon equipment. That also applies to work on safety valves.

Bledding

- Common specifications should apply for all hoses, so thatusing the “wrong” one will not have significant consequences.
- Requirements must be set for the way the hose ends are to be secured so that they do not dance around in the event of a leak.
- Proposals on best practice for bleeding have been prepared (see below).
- Criteria on what is to be regarded as a safe area for bleeding must be prepared for each facility.
- Requirements must be established for the way verification

Verify Isolations

- Is to be performed
- Verification must always be required, even if the isolation only embraces a few valves
- Measures to ensure that the verifier is conscious of their role are recommended. Efforts must be made to achieve the best possible verification

Approved Isolations

- It is important that the responsible operations supervisor Approve isolations have expertise about the systems involved in the isolation.
- Examples of checkpoints which the responsible operations supervisor must verbally ensure have been performed are provided in an appendix to this document.

Demonstrate Zero Energy

Routines must be in place to demonstrate zero energy for the person who is to do the job. This involves, for example, demonstrating that the system is depressurised by opening and closing a valve, trying to start pumps which have been disconnected and which form part of the isolation, and so forth

Enclosure and Isolation

- These methods aim to keep the chemical "in" and the worker "out" (or vice versa).
- An enclosure keeps a selected hazard "physically" away from the worker. Enclosed equipment, for example, is tightly sealed and it is typically only opened for cleaning or maintenance. Other examples include "glove boxes" (where a chemical is in a ventilated and enclosed space and the employee works with the material by using gloves that are built in), abrasive blasting cabinets, or remote control devices. Care must be taken when the enclosure is opened for maintenance as exposure could occur if adequate precautions are not taken. The enclosure itself must be well maintained to prevent leaks.
- Isolation places the hazardous process "geographically" away from the majority of the workers. Common isolation techniques are to create a contaminant-free booth either around the equipment or around the employee workstations.

Isolation and Enclosure

The principal of isolation is frequently envisioned as being limited to installation of a physical barrier between hazardous operation and the workers. However isolated can be provided without a physical barrier by appropriate use of time and distance.

1.3.4 Reduce Exposure Time

There is a simple relationship between the length of time a person is exposed to a hazardous substance and the dose of substance that they receive: double the time, double the dose; half the time, half the dose. It is therefore sensible to minimize the time period over which people work with hazardous substances, especially where those substances can have an acute effect. Exposure may also be limited by occupational exposure limits.

1.3.5 Enclosure and Segregation

It may be necessary to totally enclose the hazardous substance. The aim here is to isolate the hazard physically so that nobody is exposed to it. This might be done by total enclosure or containment of the hazard. e.g. creating an acoustic enclosure of a noisy machine to reduce the noise reaching those nearby.

Segregation is simply placing the hazard in an inaccessible location. It might be stored in a segregated storage area and used in an area away from other work processes and unauthorized personnel.

1.3.6 Wet Method

Wet method is one of the oldest and effective methods for controlling exposures to dust is the practice of wetting or spraying the operation or dusty area to clean by use of sprinkler system. Such wet methods are common at dusty construction sites, in sand casting operations and at quarrying operations. Sweeping operation in plants can be performed more cleanly and with less dust generation by wetting the area before sweeping. This can also make it easier to collect and prepare the material for proper disposal. It is a very effective method to control employee exposure during asbestos handing, removal, cutting, and cleanup except where the use of wet method are not feasible or will create safety hazards.

Some studies have shown that wet cutting methods can reduce average repairable dust levels by up to 94%. However, if an Employer determines that the use of a wet saw in a particular circumstance is not feasible, and the brick, concrete block or Masonry must be cut dry, and then the employer would be required to explore other engineering control options. Dust collection systems can be used, but they are typically not sufficient to reduce exposures below permissible limits and employees will usually need to be protected with appropriate respirators as well; monitoring the air will confirm exposure.

1.3.7 Local Exhaust Ventilation

Local exhaust ventilation (LEV) is an engineering system frequently used in the workplace to protect employees from hazardous substances. Local exhaust ventilation (LEV) is only one of many engineering control options that may be used to remove and prevent employee exposure to vapor, mist, dust or other airborne contaminants. To have an effective system it is important that it is well designed and installed, used correctly and properly maintained.

Ventilation is a method of control that strategically "adds" and "removes" air in the work environment. Ventilation can remove or dilute an air contaminant if designed properly. Local exhaust ventilation is very adaptable to almost all chemicals and operations. It removes the contaminant at the source so it cannot disperse into the workspace and it generally uses lower exhaust rates than general ventilation (general ventilation usually exchanges air in the entire room).Local exhaust ventilation is an effective means of controlling hazardous exposures but should be used when other methods (such as elimination or substitution) are not possible.
A local exhaust ventilation system consists of these basic parts:

- **Hoods** - A hood that captures the contaminants generated in the air (at the source). Collection point for gathering the contaminated air into the system.
- **Duct** - Ductwork that carries the contaminated air to the air cleaning device, if present or to the fan (away from the

source).To transport the extracted air to the purifying device or the outside atmosphere.

- **Fan** - A fan which draws the air from the hood into the ducts and removes the air from the workspace. The fan must overcome all the losses due to friction, hood entry, and fittings in the system while producing the intended flow rate.
- **Air purifying device** - Air cleaning devices may also be present that can remove contaminants such as dust), gases and vapours from the air stream before it is discharged or exhausted into the environment depending on the material(s) being used in the hood. Such as charcoal filters are often used to remove organic chemical contaminants.

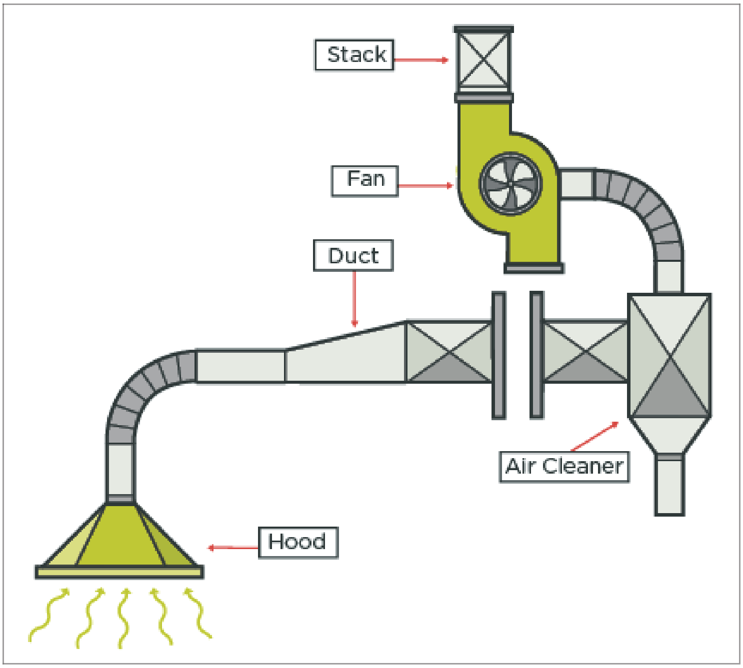


Fig. 1.9 Local Exhaust Ventilation

The design of a ventilation system is very important and must match the particular process and chemical or contaminant in use. Expert guidance should be sought. It is a very effective control measure but only if it is designed, tested, and maintained properly. Because contaminants are exhausted to the outdoors, you should also check with your local environment ministry or municipality for any environmental air regulations or bylaws that may apply in your area.

1.3.8 Dilution Ventilation

Dilution ventilation operates by diluting the contaminant concentration in the general atmosphere to an acceptable level by changing the air efficiently in the workplace over a given period of time. This system is intended to remove gas contaminants (sometimes fumes) and keep the overall concentration of any contaminants to below the occupational exposure limits (OEL).

Dilution ventilation is appropriate where

- The OEL of the harmful substance is high
- The rate of formation of the gas or vapour is slow
- Operators are not in close contact with contamination generation point.
- If a powered system is used, fans must be appropriately sited. If the contaminant is
- **Lighter than air**, it will naturally rise up inside workrooms and can be extracted at a high level.
- **Heavier than air**, it will sink to the floor and low level extraction will be appropriate.