**Introduction**

**Environmental health** is the branch of [public health](https://en.wikipedia.org/wiki/Public_health) concerned with all aspects of the [natural](https://en.wikipedia.org/wiki/Natural_environment) and [built environment](https://en.wikipedia.org/wiki/Built_environment) affecting human health. Environmental health is focused on the natural and built environments for the benefit of human health. The major subdisciplines of environmental health are: [environmental science](https://en.wikipedia.org/wiki/Environmental_science); environmental and occupational medicine, [toxicology](https://en.wikipedia.org/wiki/Toxicology) and [epidemiology](https://en.wikipedia.org/wiki/Epidemiology).

Other terms referring to or concerning environmental health are environmental public health, public health protection, and environmental health protection.

**Definitions**

Environmental health has been defined in a 1999 document by the World Health Organization (WHO) as: Those aspects of the human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health.

Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations

As of 2016 the WHO website on environmental health states "Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, as well as genetics."

The WHO has also defined environmental health services as "those services which implement environmental health policies through monitoring and control activities. They also carry out that role by promoting the improvement of environmental parameters and by encouraging the use of environmentally friendly and healthy technologies and behaviors. They also have a leading role in developing and suggesting new policy areas."

The term [environmental medicine](https://en.wikipedia.org/wiki/Environmental_medicine) may be seen as a medical specialty, or branch of the broader field of environmental health. Terminology is not fully established, and in many European countries they are used interchangeably.

**Disciplines**

**Five basic disciplines** generally contribute to the field of environmental health: **environmental epidemiology, toxicology, exposure science, environmental engineering, and environmental law**. Each of these disciplines contributes different information to describe problems and solutions in environmental health, but there is some overlap among them.

* [Environmental epidemiology](https://en.wikipedia.org/wiki/Environmental_epidemiology) studies the relationship between environmental exposures (including exposure to chemicals, radiation, microbiological agents, etc.) and human health. Observational studies, which simply observe exposures that people have already experienced, are common in environmental epidemiology because humans cannot ethically be exposed to agents that are known or suspected to cause disease. While the inability to use experimental study designs is a limitation of environmental epidemiology, this discipline directly observes effects on human health rather than estimating effects from animal studies.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]
* [Toxicology](https://en.wikipedia.org/wiki/Toxicology) studies how environmental exposures lead to specific health outcomes, generally in animals, as a means to understand possible health outcomes in humans. Toxicology has the advantage of being able to conduct randomized controlled trials and other experimental studies because they can use animal subjects. However there are many differences in animal and human biology, and there can be a lot of uncertainty when interpreting the results of [animal studies](https://en.wikipedia.org/wiki/Animal_studies) for their implications for human health
* [Exposure science](https://en.wikipedia.org/wiki/Exposure_science) studies human exposure to environmental contaminants by both identifying and quantifying exposures. Exposure science can be used to support environmental epidemiology by better describing environmental exposures that may lead to a particular health outcome,identify common exposures whose health outcomes may be better understood through a toxicology study, or can be used in a risk assessment to determine whether current levels of exposure might exceed recommended levels. Exposure science has the advantage of being able to very accurately quantify exposures to specific chemicals, but it does not generate any information about health outcomes like environmental epidemiology or toxicology
* [Environmental engineering](https://en.wikipedia.org/wiki/Environmental_engineering) applies scientific and engineering principles for protection of human populations from the effects of adverse environmental factors; protection of environments from potentially deleterious effects of natural and human activities; and general improvement of environmental quality
* [Environmental law](https://en.wikipedia.org/wiki/Environmental_law) includes the network of treaties, statutes, regulations, common and customary laws addressing the effects of human activity on the natural environment.

Information from epidemiology, toxicology, and exposure science can be combined to conduct a [risk assessment](https://en.wikipedia.org/wiki/Risk_assessment) for specific chemicals, mixtures of chemicals or other risk factors to determine whether an exposure poses significant risk to human health (exposure would likely result in the development of [pollution-related diseases](https://en.wikipedia.org/wiki/List_of_pollution-related_diseases)). This can in turn be used to develop and implement environmental health policy that, for example, regulates chemical emissions, or imposes standards for proper [sanitation](https://en.wikipedia.org/wiki/Sanitation). Actions of engineering and law can be combined to provide [risk management](https://en.wikipedia.org/wiki/Risk_management) to minimize, monitor, and otherwise manage the impact of exposure to protect human health to achieve the objectives of environmental health policy.

**Concerns**

Environmental health concerns include:

* [Air quality](https://en.wikipedia.org/wiki/Air_quality), including both ambient outdoor air and [indoor air quality](https://en.wikipedia.org/wiki/Indoor_air_quality), which also comprises concerns about [environmental tobacco smoke](https://en.wikipedia.org/wiki/Environmental_tobacco_smoke).
* [Biosafety](https://en.wikipedia.org/wiki/Biosafety)
* [Disaster preparedness](https://en.wikipedia.org/wiki/Disaster_preparedness) and response.
* [Climate change and its effects on health](https://en.wikipedia.org/wiki/Effects_of_climate_change_on_human_health).
* [Environmental Racism](https://en.wikipedia.org/wiki/Environmental_Racism), wherein certain groups of people can be put at higher risk for environmental hazards, such as air, soil, and water pollution. This often happens due to marginalization, economic and political processes, and ultimately, racism. Environmental racism disproportionately affects different groups globally, however generally the most marginalized groups of any given region/nation.
* [Food safety](https://en.wikipedia.org/wiki/Food_safety), including in [agriculture](https://en.wikipedia.org/wiki/Agriculture), [transportation](https://en.wikipedia.org/wiki/Transportation), [food processing](https://en.wikipedia.org/wiki/Food_processing), [wholesale](https://en.wikipedia.org/wiki/Wholesale) and [retail](https://en.wikipedia.org/wiki/Retail) distribution and sale.
* [Hazardous materials](https://en.wikipedia.org/wiki/Hazardous_materials) management, including [hazardous waste](https://en.wikipedia.org/wiki/Hazardous_waste) management, contaminated site remediation, the prevention of leaks from [underground storage tanks](https://en.wikipedia.org/wiki/Underground_storage_tank) and the prevention of hazardous materials releases to the environment and responses to emergency situations resulting from such releases.
* [Housing](https://en.wikipedia.org/wiki/House), including [substandard housing](https://en.wikipedia.org/wiki/Substandard_housing) abatement and the inspection of [jails](https://en.wikipedia.org/wiki/Jails) and [prisons](https://en.wikipedia.org/wiki/Prisons).
* Childhood [lead poisoning](https://en.wikipedia.org/wiki/Lead_poisoning) prevention.
* [Land use planning](https://en.wikipedia.org/wiki/Land_use_planning), including [smart growth](https://en.wikipedia.org/wiki/Smart_growth).
* Liquid waste disposal, including city [waste water treatment](https://en.wikipedia.org/wiki/Waste_water_treatment) plants and on-site waste water disposal systems, such as [septic tank](https://en.wikipedia.org/wiki/Septic_tank) systems and [chemical toilets](https://en.wikipedia.org/wiki/Chemical_toilet).
* [Medical waste](https://en.wikipedia.org/wiki/Medical_waste) management and disposal.
* [Noise pollution](https://en.wikipedia.org/wiki/Noise_pollution) control.
* [Occupational health](https://en.wikipedia.org/wiki/Occupational_health) and [industrial hygiene](https://en.wikipedia.org/wiki/Industrial_hygiene).
* Radiological health, including exposure to [ionizing radiation](https://en.wikipedia.org/wiki/Ionizing_radiation) from [X-rays](https://en.wikipedia.org/wiki/X-rays) or [radioactive isotopes](https://en.wikipedia.org/wiki/Radioactive_isotopes).
* Recreational water illness prevention, including from [swimming pools](https://en.wikipedia.org/wiki/Swimming_pools), spas and [ocean](https://en.wikipedia.org/wiki/Ocean) and [freshwater](https://en.wikipedia.org/wiki/Freshwater) bathing places.
* Safe [drinking water](https://en.wikipedia.org/wiki/Drinking_water).
* [Solid waste management](https://en.wikipedia.org/wiki/Solid_waste_management), including [landfills](https://en.wikipedia.org/wiki/Landfill), [recycling](https://en.wikipedia.org/wiki/Recycling) facilities, [composting](https://en.wikipedia.org/wiki/Composting) and solid waste transfer stations.
* [Toxic](https://en.wikipedia.org/wiki/Toxic) chemical exposure whether in [consumer products](https://en.wikipedia.org/wiki/Consumer_products), housing, workplaces, air, water or soil.
* [Vector control](https://en.wikipedia.org/wiki/Vector_control), including the control of [mosquitoes](https://en.wikipedia.org/wiki/Mosquitoes), [rodents](https://en.wikipedia.org/wiki/Rodents), [flies](https://en.wikipedia.org/wiki/Flies), [cockroaches](https://en.wikipedia.org/wiki/Cockroach) and other animals that may transmit [pathogens](https://en.wikipedia.org/wiki/Pathogens).

**Occupational health**

As defined by the [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) (WHO) "occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards." [Health](https://en.wikipedia.org/wiki/Health) has been defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Occupational health is a multidisciplinary field of [healthcare](https://en.wikipedia.org/wiki/Healthcare) concerned with enabling an individual to undertake their [occupation](https://en.wikipedia.org/wiki/Job), in the way that causes least harm to their health. It contrasts, for example, with the promotion of health and safety at work, which is concerned with preventing harm from any incidental [hazards](https://en.wikipedia.org/wiki/Hazards), arising in the workplace.

Occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards. The health of the workers has several determinants, including risk factors at the workplace leading to cancers, accidents, musculoskeletal diseases, respiratory diseases, hearing loss, circulatory diseases, stress related disorders and communicable diseases and others.

Employment and working conditions in the formal or informal economy embrace other important determinants, including, working hours, salary, workplace policies concerning maternity leave, health promotion and protection provisions, etc.

Since 1950, the [International Labour Organization](https://en.wikipedia.org/wiki/International_Labour_Organization) (ILO) and the [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. The definition reads:

The main focus in occupational health is on three different objectives: (i) the maintenance and promotion of workers’ health and working capacity; (ii) the improvement of working environment and work to become conducive to safety and health and (iii) development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings. The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking.

— *Joint ILO/WHO Committee on Occupational Health*

Those in the field of occupational health come from a wide range of [disciplines](https://en.wikipedia.org/wiki/Discipline_(academia)) and professions including [medicine](https://en.wikipedia.org/wiki/Medicine), [psychology](https://en.wikipedia.org/wiki/Psychology), [epidemiology](https://en.wikipedia.org/wiki/Epidemiology), [physiotherapy](https://en.wikipedia.org/wiki/Physiotherapy) and rehabilitation, [occupational therapy](https://en.wikipedia.org/wiki/Occupational_therapy), [occupational medicine](https://en.wikipedia.org/wiki/Occupational_medicine), [human factors and ergonomics](https://en.wikipedia.org/wiki/Human_factors_and_ergonomics), and many others. Professionals advise on a broad range of occupational health matters. These include how to avoid particular pre-existing conditions causing a problem in the occupation, correct posture for the work, frequency of rest breaks, preventive action that can be undertaken, and so forth.

"Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job.

The discipline covers the following key components:

1. the availability of occupational health and safety regulations

at workplace

2. the availability of active and functional occupational health and safety committee at workplace

3. monitoring and control of factory hazards to health

4. supervision and monitoring of hygiene and sanitary facilities for health and welfare of the workers

5. inspection of health safety of protective devices

6. pre-employment, periodical and special health examination.

7. performance of adaptation of work to man

8. provision of First Aid

9. health education and safety training to the worker

10. Advice to employers on the above mentioned items

11. Reporting of occupational deaths, diseases, injuries, disabilities ,hazards and their related preventive measures at working

**Interdisciplinary Relationships**

Environmental Managers: are those trying to eliminate hazards from the workplace cause many environmental problems.

Toxicology: is the science that studies poison and toxic substances and their mechanisms and effects on living organisms. In other words toxicology is the study of adverse effects of chemical on biologic systems, or when a substance has a capacity to produce undesirable physiological effect when the chemical reached a sufficient concentration at a specific site in the body.

Toxicologists: are persons who study poisoning and responsible defining quantitatively the level of exposure at which harm occurs and they also prescribe precautionary measures and exposure limitations so that normal recommended use of chemical substance does not result in excessive exposure and subsequent harm

Ergonomics: is a multidisciplinary activity dealing with the interaction between man and his total working environment plus such traditional environmental elements as atmosphere, heat, light, and sound as well as all tools and equipment of the work place.

Chemical engineers are those who design process plant, they choose values, decide on how access will be gained and how cleaning will take place.

Mechanical engineers are those who responsible for choosing materials handling systems or for specifying noise levels on machinery.

Environmental health professionals: are those who apply their knowledge and experience, understand the environmental health hazards, analyze the technical and social approaches and reduce and eliminate human exposures and health impacts.

Industrial hygienists are scientists, engineers, and public health professionals committed to protecting the health people in the workplace and the community

**Historical background of occupational health**

The work place is a potentially hazardous environment where millions of employees pass at least one-third of their life time. This fact has been recognized for a long time, although developed very slowly until 1900. There has been an awareness of industrial hygiene since antiquity.

The environment and its relation to worker health was recognized as early as the 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 sulfur. He devised a face mask made from an animal bladder to protect workers from exposure to dust and lead fumes. In the second century AD, the Greek physician, Galen, accurately described the pathology of lead poisoning and also recognized the hazardous exposures of copper miners to acid mists.

In the middle Ages, guilds worked at assisting sick workers and their families. In 1556, the German scholar, Agricola, advanced the science of industrial hygiene even further when, in his book De Re Metallica, he described the diseases of miners and prescribed preventive measures. The book included suggestions for mine ventilation and worker protection, discussed mining accidents, and described diseases associated with mining occupations such as silicosis.

Industrial hygiene gained further respectability in 1700 when Bernardo Ramazzini, known as the "father of industrial medicine," published in Italy the first comprehensive book on industrial medicine, De Morbis Artificum Diatriba (The Diseases of Workmen). The book contained accurate descriptions of the occupational diseases of most of the workers of his time. Ramazzini greatly affected the future of industrial hygiene because he asserted that occupational diseases should be studied in the work environment rather than in hospital ward

Industrial hygiene received another major boost in 1743 when Ulrich Ellenborg published a pamphlet on occupational diseases and injuries among gold miners. Ellenborg also wrote about the toxicity of carbon monoxide, mercury, lead, and nitric acid.

In England in the 18th century, Percival Pott, as a result of his findings on the insidious effects of soot on chimney sweepers, was a major force in getting the British Parliament to pass the Chimney Sweepers Act of 1788. The passage of the English Factory Acts beginning in 1833 marked the first effective legislative acts in the field of industrial safety. The Acts, however, were intended to provide compensation for accidents rather than to control their causes. Later, various other European nations developed workers' compensation acts, which stimulated the adoption of increased factory safety precautions and the establishment of medical services within industrial plants.

In the early 20th century in the U.S., Dr. Alice Hamilton led efforts to improve industrial hygiene. She observed industrial conditions first hand and startled mine owners, factory managers, and state officials with evidence that there was a correlation between worker illness and exposure to toxins. She also presented definitive proposals for eliminating unhealthful working conditions.

At about the same time, U.S. federal and state agencies began investigating health conditions in industry. In 1908, public awareness of occupationally related diseases stimulated the passage of compensation acts for certain civil employees. States passed the first workers' compensation laws in 1911. And in 1913, the New York Department of Labor and the Ohio Department of Health established the first state industrial hygiene programs. All states enacted such legislation by 1948. In most states, there is some compensation coverage for workers contracting occupational diseases.

The U.S. Congress has passed three landmark pieces of legislation related to safeguarding workers' health: (1) the Metal and Nonmetallic Mines Safety Act of 1966, (2) the Federal Coal Mine Safety and Health Act of 1969, and (3) the Occupational Safety and Health Act of 1970 (OSH Act).

Today, nearly every employer is required to implement the elements of an industrial hygiene and safety, occupational health, or hazard communication program and to be responsive to the Occupational Safety and Health Administration (OSHA) and its regulations. However, concrete approach to the control of occupational diseases became valid in most countries after the twentieth century. Emphasis was then given to the control of working hazards, and multidisciplinary approach to such effective measures in which at least triparty: the employer, the employee, and the competent authority are together participating in the problem solution. Much improvement in the workers health protection has been made in developed countries in the field of industrial hygiene and safety, and occupational medicine. There is still a long distance ahead for developing countries.

**Occupational health and development**

The health status of the workforce in every country has an immediate and direct impact on national and world economies. Total economic losses due to occupational illnesses and injuries are enormous (WHO 1999). The International Labor Organization (ILO) has estimated that in 1997, the overall economic losses resulting from work-related diseases and injuries were approximately 4-5 % ofthe world’s Gross National Product.

Workforce is a backbone of a country development. A healthy, welltrained and motivated workforce, increases productivity and generates wealth that is necessary for the good health of thecommunity at large

**Magnitude of the problem/disease**

The difficulty of obtaining accurate estimates of the frequency of work-related diseases is due to several factors.

1. Many problems do not come to the attention of health professionals and employers and, therefore, are not included in data collection systems.

2. Many occupational medical problems that do come to the attention of physicians and employers are not recognized as work related.

3. Some medical problems recognized by health professionals or employers as work- related are not reported because the association with work is equivocal and because reporting requirements are not strict.

4. Because many occupational medical problems are preventive, their very persistence implies that some individual or group is legally and economically responsible for creating or perpetuating them.

However, globally, millions of men and women work in poor and hazardous conditions. According to International Labour Organization ™ 1.2 million working peoples die of work related accident and diseases every year

™ More than 160 million workers fall ill each year due to workplace hazards

™ UN estimates 10,000,000 occupational disease cases occur each year globally, severity and frequency is greatest in developing countries.

™ Women, children and migrant workers are least protected and most affected ™ Micro and small enterprises account for over 90 % of enterprises where conditions are often very poor and theworkers particularly in the informal sectors are often excluded from all legal protection.

Reasons for these are:-

Workplace

• Unsafe building

• Old machines

• Poor ventilation

• Noise

• Inaccessible to inspection

Workers

™ Limited education

™ Limited skill and training

Employers

™ Limited financial resources

™ Low attention and knowledge

In many developing nations, death rates due to occupational accident among workers are five to six times higher than those in industrialized countries; yet, the situation in developing countries is still largely undocumented due to poor recording system.

**The common problems encountered in the development of occupational health service include:**

1. Lack of awareness among workers, employers, health planners, policy makers, health professionals and public at large.

2. Lack of trained human resource.

3. Inadequate, inaccessible, and inequitably distributed health service institutions.

4. Lack of multidisciplinary staff, absence of field-testing equipment for conducting environmental and biological monitoring of the work place and the health of the workers.

5. Insufficient budget for carrying out regular inspections, conducting research activities.

6. The characteristics of the workers, the majorities are poor, illiterate or poorly educated.

7. Poor working environment.

8. No specific regulation/ legislation on occupational healthand safety issues.

9. Unfavourable climatic condition and heavy load of endemic disease: such as bilharzia, onchocerciasis, malaria, leishmaniasis, and trypanosomiasis.

10. Absence of training institution on occupational health and safety.

11. Little or no collaboration or cooperation among stakeholders

12. Poor information exchange /net work in the area of OHS

13. Lack of multidisciplinary forum or panel

14. Absence of integration of occupational health and safety with general health service

**Principles of occupational Health and Safety**

The basic principles for the development of occupational health and safety services are as follows:

a) The service must optimally be preventive oriented and multidisciplinary.

b) The service provided should integrate and complement the existing public health service.

c) The service should address environmental considerations

d) The service should involve, participation of social lpartners and other stakeholders

e) The service should be delivered on panned approach

f) The service should base up to date information, education, training, consultancy, advisory services and research findings

g) The service should be considered as an investment contributing positively towards ensuring productivity and profitability.

**Scope of occupational health and safety**

Factory management spends large amount of expenses for health insured workers. The workers compensation expenses include medical payments (hospital and clinic treatment); partial, temporary, and permanent disability costs; death benefits; and legal costs. The cost claims may steadily rise up if the employers do not take measure to intervene the problem. The productivity of the factory will obviously decline in such situations. The role of occupational health and safety, therefore, lies in designing ways and means for cost reduction through workers proper health service provision. Occupational diseases, accidents, and death prevention are the issues to be addressed.

The scope of occupational health and safety is three-fold.

It begins with the anticipation and recognition of workers’ health problems in an industrial atmosphere. The causes of these problems may be chemical, physical, biological, psychological, and ergonomical environments.

The second scope includes evaluation of the recognized problem, which encompasses mainly data collection, analysis, interpretation, and recommendations.

Finally, the third scope involves the development of corrective actions to eliminate or limit the problem. Generally, the work frame of occupational health and safety is wide and needs multidisciplinary approach. It requires the knowledge of physics, biology, chemistry, ergonomics, medicine, Occupational Health and Safety engineering, and related sciences. It also requires public health management skills for proper communication and decision making

**Elements of the work environment**

The basic elements in an occupational setting such as a manufacturing plant, industry, or offices are four. These are:

1. The worker

2. The tool

3. The process

4. The work environment

1 The worker

In developing countries like Ethiopia, the work force has several distinct characteristics:-

1. Most people who are employed to work in the informal sectors,mainly in agriculture, or in small-scale industries, such as garages, tannery and pottery.

2. There are high rates of unemployment, some- times reaching 25% or higher. In many developing countries the rates of unemployment and under employment is increasing each year.

3. In general, workers are at greater risk of occupational hazards for a variety of reasons because of low education and literacy rates; unfamiliarity with work processes and exposures, inadequate training, predisposition not to complain about working conditions or exposures because of jobs, whether ornot they are hazardous, are relatively scarce; high prevalence of endemic (mainly infections) diseases and malnutrition; inadequate infrastructure and human resources to diagnose,treat, and prevent work - related diseases and injuries.

4. The annual per capita income for kenya is about $ 120(USD) or less per year which makes it one of the lowest in the world.

5. Vulnerable populations in any country are at even greater risks.

These groups are:

a. Women, who make up a large proportion of the work force in many developing countries and often face significant physical and psychosocial hazards in their work. Besides this they also face similar problem at home as mothers and cooks

b. Children, who account for a significant part of the work force in many developing countries, often undertake some of the most hazardous work. In many of these countries, primary education is not required and there are no legal protections against child labor.

c. Migrants - both within countries and between countries who, for a variety of reasons, face significant health and safety hazards at work.

Industrial workers constitute only a segment of the general population and the factors that influence the health of the population also apply equally to industrial workers, i.e., housing, water, sewage and refuse disposal, nutrition, and education. In addition to these factors, the health of industrial worker, in a large measure, will also be influenced by conditions prevailing in their workplace. One of the declared aims of occupational hygiene is to provide a safe occupational environment in order to safeguard the health of the workers and to set up industrial production.

The employee plays a major role in the occupational hygiene program. They are excellent sources of information on work processes, procedures and the perceived hazards of their daily operations or activities. The industrial hygienist will benefit from this source of information and often obtain innovative suggestions for controlling hazards.

Obviously there is wide variation among workers in genetic inheritance, constitutions, and susceptibility to disease. Regardless of the industrial hygienist will start his or her activities in sorting all those aspects of hazards including the worker himself.

**2 The Tool**

Tools can range from very primitive tools like a hammer, chisel, and needle, to automated equipment.

**3 The process**

In the process, materials used can be toxic. The process itself can affect the potential harmfulness of the materials. For example, the particle size or physical state (solid, liquid and gas) of potentially harmful substances can determine to a large extent what ill effects in workers may develop from those substances.

**4 The work environment.**

Occupational environment means the sum of external conditions and influences which prevail at the place of work and which have a bearing on the health of the working population. The industrial worker today is placed in a highly complicated environment and the work environment is getting more complicated as human is becoming more innovative or inventive.

Basically, there are three types of interaction in a working environment: -

1. Man and physical, chemical and biological agents.

a. The physical agents. These include excessive level of noise, heat and humidity, dust , Vibration, Electricity or lighting , Radiation etc.

b. Chemical agents. These arises from excessive air borne concentrations of

Chemical dust, Mists, Fumes, Liquids, Vapors, Gases, dust

C. The biological agents. These include: Presence of insects and rodents, ƒ Microorganisms, Poisonous plants and animals

D. Ergonomic hazards. These include excessive improperly designed tools, work areas, or work procedures. Improper lifting overreaching, poor visual conditions, or repeated motions in an awkward position can result in accidents or illnesses in the occupational environment.

**2. Man and machine**

An industry or factory uses power driven machines for the purpose of mass production. Unguarded machines, protruding and moving parts, poor electrical and machinery installation of the plant, and lack of safety measures are the causes of accidents. Working for long hours in an awkward postures or positions is the causes of fatigue, backache, diseases of joints and muscles and impairment of the workers’ health and efficiency

**3. Man and his psychosocial environment.**

There are numerous psychosocial factors, which operate at workplace. These are the human relationships among workers themselves and those in authorities over them.

Examples of psychosocial factors include:-

The type and rhythm of work.

Work stability.

Service conditions.

Job satisfaction.

Leadership style.

Security.

Workers` participation and communication.

Motivation and incentives.

The occupational environment of the worker cannot be considered apart from his domestic environment. Both are complementary to each other. The worker takes his worries to his/her home and bring to his work disturbances that has arisen in his/her home. Stress at work may disturb his sleep, just as stress at home may affect his work.

**OHSA IN KENYA**

**General OSH Policy Statement**

The MoH is committed to creating a safe work environment that promotes health and safety practices and that seeks to prevent the occurrence of hazards associated with work and the work environment, reduces exposure and mitigates effects of hazards as far as reasonably practicable. The manager within the health sector and other employees shall therefore support the implementation of this policy in accordance with their roles and responsibilities as in OSHA 2007.

They shall:

a. Implement and maintain a risk management program.

b. Establish measurable objectives and targets to continually improve occupational health and safety in the work place and reduce work related illnesses and injuries.

c. Provide information, training and facilities to enable staff, clients, contractors, visitors and stakeholders carry out their duties safely. d. Involve staff and stakeholders about decisions that may affect their health and safety in the work environment.

e. Provide adequate human and financial resources to ensure effective implementation of OSH guidelines.

f. Document and communicate OSH responsibilities for all levels of staff.

g. Communicate this policy through public displays and trainings in all health facilities in Kenya. h. Ensure that procedures are in place for accident, incident and occupational diseases reporting and management

i. Integrating OSH requirements in planning and decision making processes at all levels.

j. Provide effective occupational health and hygiene programs.

k. Provide, maintain and test contingency plans and resources for effective handling of emergencies.

**Management Responsibility**

The Manager:

a. Will ensure that the Occupational Safety and Health Policy: General Statement, Organizational Responsibilities and the detailed arrangements concerning the health, safety and welfare of all members of staff, clients, contractors, visitors and students are made known and implemented within their areas of responsibility; review the written statement of the general policy with respect to safety and health in the workplace;

b. Will carry out suitable and sufficient risk assessment to safety and health of members of staff students and others who within their area of responsibility may be affected by activities in the health sector. Where hazards are identified which cannot be eliminated, the manager will ensure that safe systems of work are designed and implemented, recorded, monitored and reviewed as necessary and results of the assessments are disseminated to the relevant persons;

c. Will ensure that members of staff undertaking secondments or work placements activities are reminded of the need to observe health and safety organizational arrangements of the secondment or placement provider;

d. Will ensure that all safety instructions, training and retraining is carried within their areas of responsibility;

e. Will participate in consultation with members of staff or their Occupational Safety and Health representatives on matters of health and safety in accordance with agreed procedures;

f. Will ensure that, in all areas under their control, regular inspections and audits are carried out;

g. Will investigate all accidents, incidents or near misses concerning health and safety with the view to identifying the cause(s) and preventing a recurrence;

h. Will participate in regular Occupations and Safety inspections of their areas of responsibility in accordance with agreed procedures;

i. Will respond to requests for information from Safety and Health representatives in accordance with statutory requirements;

j. Will be proactive in stimulating interest and enthusiasm for environment, health and safety by demonstrating their personal concern for health and safety at work through example and commitment, and encouraging those that they manage or supervise to do the same.

k. Provide pre-employment and periodic medical examination for personnel (Occupational Health Program).

l. Provision of appropriate and adequate PPE.

**Employer Responsibilities**

In addition to providing employees with a safe and healthy work environment, employers must comply with the OSHA standards:

* Inform employees about hazards through training, labels, alarms, color-coded systems, chemical information sheets, and other methods
* Keep accurate records of work-related injuries and illnesses
* Perform tests in the workplace, such as OSHA's air sampling requirements
* Provide hearing exams or other medical tests required by OSHA standards
* Post OSHA citations, injury and illness data, and the OSHA poster in the workplace where workers will see them
* Notify OSHA of all work-related fatalities within eight hours, and all work-related inpatient hospitalizations, amputations, and losses of an eye within 24 hours
* No discrimination or retaliation against a worker for using their rights under the law

**Employee**

a. Ensure their own safety and health and that of persons who may be affected by their act of commission or omission.

b. Cooperate with the employer and co-workers in their workplace to achieve safe and healthy work environment by following OSH policy guidelines and standard operating procedures

c. Make themselves familiar with the OSH policy guidelines

d. Use PPE as provided by employer to prevent risk to his/her safety and health

e. Comply with safety and health Standard Operating Procedures (SOPs)

f. Report to the supervisor of possible hazards

g. Report to supervisor on any accidents, injuries, or near misses that arise in the work place by completing the appropriate form. If an urgent action is required the situation must be reported and information forwarded to the appropriate department as soon as possible (24 hours). Report any serious and fatal accidents within 8 hours.

h. Facilitate the performance of duties given by the employer

i. Inform the supervisor of any personal condition that may increase vulnerability of occupational hazards e.g. pregnancy in a radiology unit, immunocompromised person in a TB Clinic.

j. Will make themselves aware of provision of First Aid treatment and emergency and major incidence management procedures (only trained and qualified personnel may administer first aid or manage emergency and major incidents)

k. Will not remove, interfere with or misuse anything provided in the interest of health and safety

l. Whoever receives visitors and contractors will ensure that they comply with the health and safety requirements while in health facilities.

m. Cooperate with the employer to fulfil all relevant statutory provisions e.g. preemployment and continuous medical exams**.**

**Governments’ duties**

Governments are responsible for drawing up occupational safety and health policies and making sure that they are implemented. Policies will be reflected in legislation, and legislation must be enforced. But legislation cannot cover all workplace risks, and it may also be advisable to address occupational safety and health issues by means of collective agreements reached between the social partners. Policies are more likely to be supported and implemented if employers and workers, through their respective organizations, have had a hand in drawing them up. This is regardless of whether they are in the form of laws, regulations, codes or collective agreements.

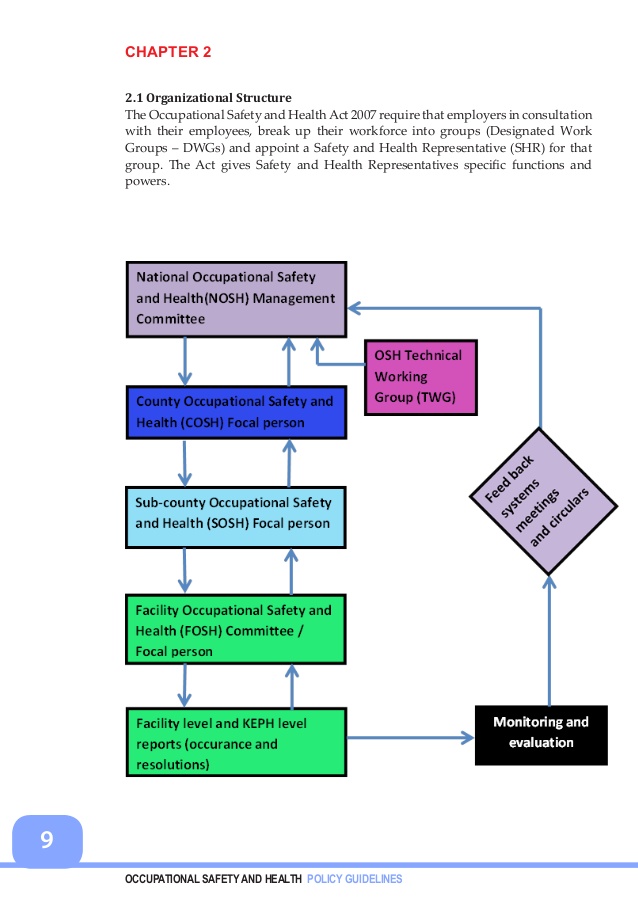
The competent authority should issue and periodically review regulations or codes of practice; instigate research to identify hazards and to find ways of overcoming them; provide information and advice to employers and workers; and take specific measures to avoid catastrophes where potential risks are high.

The occupational safety and health policy should include provisions for the establishment, operation and progressive extension of occupational health services. The competent authority should supervise and advise on the implementation of a workers’ health surveillance system, which should be linked with programmes to prevent accident and disease and to protect and promote workers’ health at both enterprise and national levels. The information provided by surveillance will show whether occupational safety and health standards are being implemented, and where more needs to be done to safeguard workers.

A concise statement that encapsulates the main purposes of occupational health is the definition provided by the joint ILO/WHO Committee. As the definition indicates, the main focus in occupational health is on three different objectives

• the maintenance and promotion of workers’ health and working capacity;

• the improvement of work and working conditions so that they are conducive to safety and health; and • the development of work organizations and preventive safety and health cultures in a direction that supports safety and health at work. Such development also promotes a positive social climate and enhances the smooth operation and possibly also the productivity of working enterprises. The term “culture” in this context means an environment reflecting the value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking.

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**Roles and Responsibilities**

**National Level Membership**

The National Occupational Safety and Health management committee (NOSH) will be chaired by the cabinet secretary or his/her nominee, and composed of 10 voting members drawn and appointed by the Cabinet Secretary from departments within the Ministry of Health (MOH), 1 union representative, 1 administrative support and co-opt not more than 3 other members as needs arises as non-voting members. Each department shall be represented by the head of department or his/her nominee. All members of the NOSH are required to attend specific health and safety training.

**Terms of Reference**

The role of the NOSH is to consider and make recommendations for compliance and improvement in the Ministry of Health on safety matters:

a. Review policies on prevention of injuries and illnesses among staff, clients, contractors and visitors;

b. Ensure employee involvement regarding OSH issues and workplace change;

c. Take lead in OSH policy guidelines review and update.

d. Capacity building of the HSRs to disseminate policies and guidelines at the County level.

e. Research on Occupational Health and Safety.

f. Receive and evaluate OSH Reports from County Health and Safety Representatives

The committee reference documents are Safety and Health Committee Rules 2004, OSHA 2007, WIBA 2007, and the MOH national guidelines on OHS and WHO OSH global plan of action 2008-2017 NOSH Committee Meetings: NOSH meetings will be held at a quarterly basis with clear documented meeting minutes. The chair can convene an ad hoc meeting on need bases

**County Health and safety (COSH) focal person**

The County Occupational Safety and Health (COSH) focal person to the Ministry of Health will coordinate OSH activities within the health sector at the County level. The focal person will provide feedback on OSH issues within the County to the Ministry of Health NOSH.

**Terms of Reference COSH focal person is mandated to**:

a. Oversee the implementation of policies and guidelines on prevention of injuries and illnesses among staff, clients, contractors and visitors of MoH facilities.

b. Ensure Legislative compliance, auditing programs and monitoring the implementation of actions incorporated in Health and Safety Plans; and performance of MoH in relation to health and safety at the County level. The COSH focal person in consultation with the national office will be responsible for capacity building of the OSH committee at facility level and disseminating policies and guidelines to the facilities.

c. Publicize, promote and ensure compliance of the policy guidelines and coordinate implementation in health facilities within their counties.

d. Provide technical support at the County to ensure compliance on all OSH polices and guidelines.

e. Coordinate OSH reports from all sub county health sector on quarterly basis and advice on corrective measures.

f. Liaise with the NOSH on specific issues or challenges touching on OSH polices/ regulations g. The reference documents are: OSHA 2007 and its relevant subsidiary legislations, WIBA 2007, and the MOH national guidelines on OSH and WHO OHS global plan of action 2008-2017

**Sub county Health and safety (SOSH) Focal person**

The Sub county Occupational Safety and Health (SOSH) focal person will coordinate OSH activities within the Sub County. The SOSH focal person will provide feedback to the COSH focal person on OSH matters. **Terms of reference**

h. Publicizing, promoting and ensuring compliance of the OSH guidelines and procedures among the staff at the Sub County level.

i. Implementing measures required for functional facility safety and health committees.

j. Monitor compliance of the OSH policy guidelines and related SOPs.

k. Responsible for capacity building and disseminating policies and guidelines at the sub county level in liaison with the COSH focal person.

l. Provide technical support to the sub county on OSH to ensure compliance on all OSH Policy guidelines m. Coordinate OSH reports from all sub county levels on a monthly basis and advice on corrective measures.

n. Coordinate inspections and internal audits for the facilities within sub county level.

o. Coordinate facility health and safety committee meetings within the sub county

p. The committee reference documents are: Safety and Health Committee rules 2004, OSHA 2007, WIBA 2007, and the MOH national guidelines on OHS and WHO OSH global plan of action 2008-2017

**Facility Level Safety committee/ focal person**

The Facility level Occupational Safety and Health (FOSH) committee will be responsible for OSH at the facility. OSH committee membership and operations will be guided as stipulated by the OSHA 2007 and the Legal Notice no 31; however this committee can integrate other existing committees e.g. Infection Protection and Control committee and Bio Safety / Biosecurity committee. The FOSH will be chaired by the Facility Head or nominee, and composed of facility members in the clinical and non- clinical departments.

**Terms of Reference**

q. Complying with the guidelines and related SOPs, and enforce corrective measures in cases of non-compliance at the facility level

r. The committee will coordinate capacity building of the facility level staff and disseminate policy guidelines at the facility level. OSH information should be provided or written as part of the in-service, continuing medical education (CME) sessions. .

s. The management of incidents and emergencies arising within the health facility

t. Review cases for rehabilitation and compensation of injured health sector employees;

u. Publicizing, promoting and enforcing the guidelines and procedures among the staff they supervise (including new staff);

v. Conducting workplace audits and risk assessments at facility levels w. Oversee compliance of facility design and building codes for new construction of facility structures, and participate in site meetings.

x. Support the procurement systems for quality and adequate PPE and other OSH supplies within the facility.

y. The committee will liaise with human resources / administration to ensure that all new staff go through induction and orientation on OSH issues.

The committee reference documents are: Safety and Health Committee rules 2004, OSHA 2007, WIBA 2007, and the MOH national guidelines on OHS and WHO OSH global plan of action 2008-2017 Meetings: OSH meetings will be held on minimum monthly basis with clear documented meeting minutes.

**Legal and Regulatory framework**

The following acts and regulations will guiding the implementation of Occupational Health and Safety guidelines in the health sector:

a. The Kenyan constitution 2010

b. Occupational Safety and Health (OSH) Act 2007

c. Work Injury Compensation WIBA 2007 Act

d. National infection prevention and control guidelines for health care services in Kenya, 2010

e. Health Care Waste Management manual ,2009

f. Environmental Management and Coordination Act, 1999

g. TB / IPC guidelines, 2009

h. HIV / AIDS Workplace policy

i. Injection Safety and Waste Management policy 2007 j. Building code 1968 k. Radiation Protection Act (Cap.243)

l. Pharmacy and Poisons Act (Cap. 244)

m. Pest Control Product Act

**Classification of OSH hazards and mitigation in the health sector**

A hazard refers to any agent, situation or condition that can cause an occupational illness or injury. It may produce serious and immediate (acute) effects or longterm (chronic) problems that affect all or only part of the body. Someone with an occupational illness may not recognise the symptoms immediately, for instance detection of noise- induced hearing loss is often difficult for the victim, until it is advanced. Additionally some occupational diseases may take long to manifest e.g. musculoskeletal disorders.

**Classifications of occupational health and safety hazards**

The various hazards which give rise to occupational injuries,diseases, disabilities or death through work may be classified as: -

**1 Biological Biological hazards**, also known as biohazards, refer to biological substances that pose a threat to the health of a worker in health care facilities and community. This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can affect human health posing a significant risk to health care and community care workers if not properly controlled.

**2 Chemical Health** care environment can house a vast array of chemicals. Examples of hazardous chemicals may include formaldehyde, used for preservation of specimens for pathology; ethylene oxide, glutaraldehyde, and paracetic acid used for sterilization; anaesthetics gases, laboratory reagents and other numerous chemicals used in healthcare. Even some drugs administered to patients can be harmful to staff if not properly handled e.g. cytotoxic drugs.

**3 Physical Physical hazards** comprise of extremes of temperatures, extremes of pressures, noise, vibration and radiation. All can be found in health care settings. Other physical agents such as ionizing and non-ionizing radiation, or other forms of radiation used on patients can be harmful to workers if not properly controlled.

**4 Ergonomic Healthcare personnel** are also exposed to many ergonomics risk factors due to the nature of their work. Common examples of ergonomic risk factors are found in jobs requiring repetitive, forceful, or prolonged exertions of the hands; frequent or heavy lifting, pushing, pulling, or carrying of heavy objects; and prolonged awkward postures. Vibration and cold may add risk to these work conditions. Jobs or working conditions presenting multiple risk factors will have a higher probability of causing a musculoskeletal problem. Environmental work conditions that affect risk include intensity, frequency and duration of activities.

**5 Mechanical**

A mechanical hazard is any hazard involving a machine or process. Equipment used in healthcare facilities if not properly installed and maintained may pose mechanical hazards. They also include situations resulting in slips, trips and falls such as wet floors, slippery finish to floors, poor handling of needles and other sharps resulting in needle stick and sharps injuries

**6 Psychosocial Hazards**

Violence, shift work, working with severely ill patients, qualitative and quantitative overload/ underload etc in the workplace can be a hazard to staff in health care and community care environment. Violence or aggression from patients, visitors, residents, staff and clients could take the form of physical, emotional and/or mental abuse. Most health care settings require some sort of shift work. Shift work can be very stressful to workers and their families. Additionally working alone, drug and alcohol abuse as well as economic factors are other forms of psychological hazards. Working with people who are seriously or even terminally ill day in and day out can be emotionally wearing. In our current economic climate, with layoffs and cutbacks, workers everywhere are carrying extra workloads, which can result in “burnout.” Since a number of people working in health care are women, conflicts with competing and changing roles in the family, as well as from work issues, can cause tremendous stress.

**1 Physical Hazards**

Physical hazards, which can adversely affect health, include noise,vibration, ionizing and non-ionizing radiation, heat and other unhealthy microclimatic conditions. Between 10 and 30% of the workforce in industrialized countries and up to 80% in developing and newly industrialized countries are exposed to a variety of these potential hazards.

Physical hazard has possible cumulative or immediate effects on the health of employees. Therefore, employers and inspectors should be alert to protect the workers from adverse physical hazards.

A. Extremes of Temperature

The work environment is either comfortable or extremely cold or hot and uncomfortable. The common physical hazard in most industries is heat. Extreme hot temperature prevails on those who are working in foundries or in those industries where they use open fire for energy. Examples of these include soap factories in large industries and in the informal sectors that use extreme heat to mold iron orprocess other materials.

Effects of hot temperature in work place include:

1. Heat Stress

Heat stress is a common problem in workplace because people in general function only in a very narrow temperature range as seen from core temperature measured deep inside the body. Fluctuation in core temperature about 2 0 C below or 3 0 C above the normal core temperature of 37.6 0  C impairs performance markedly and a health hazard exists. When this happens the body attempt to counteract by:

Increasing the heart rate

The capillaries in the skin dilate to bring more blood to the surface so that the rate of cooling is increased.

Sweating to cool the body

2. Heat stroke

Heat stroke is caused when the body temperature rises rapidly in a worker who is exposed to a work environment in which the body is unable to cool itself sufficiently. Predisposing factors for heat stroke is excessive physical exertion in extreme heat condition. The method of control is therefore, to reduce the temperature of the surrounding or to increase the ability of the body to cool itself.

3. Heat Cramp

Heat cramp may result from exposure to high temperature for a relatively long time particularly if accompanied by heavy exertion or sweating with excessive loss of salt and moisture from the body.

4. Heat Exhaustion

This also results from physical exertion in hot environment. Signs of the problem include:

Mildly elevated temperature,Weak pulse’ Dizziness Profuse sweating,Cool, moist skin, heat rash

5. Cold Stress

Cold stress could mainly be defined as the effect of the external working environment (Very low temperatures i.e. less than 6 0  C) and the resultant inability of the body to maintain a constant internal

body temperature. High airflow is a critical factor here, as it will increase cold stress effects considerably. This is commonly referred to as the wind chill factor.

Special condition that occur in cold weather

1. Trench Foot

An injury which result from long exposure of the feet to continued wet condition at temperature of freezing 10 0 C with little movement causes changes in the circulation of blood in thefeet.

Result: loss of toes or part of the feet.

Treatment: keep foot dry and worm, do exercise for good circulation.

2. Immersion foot

Immersion of foot in water that is below 10 0 C, for a prolonged time, usually in excess of 24 hours

3. Frostbite

Injury of tissue from exposure to intense cold, body parts mosteasily frostbitten is cheeks, nose, ears, chin forehead, wrists,hands and feet.

Prevention

™ Wearing the proper amount warm, loose, dry clothing.

™ Massaging the face, hand, and feet periodically topromote good circulation.

™ Troops travelling in cold weather by, particularly inthe rear of trucks should be allowed to dismount andexercise periodically to restore circulation.

™ If clothing become wet, it should be dried or changeat once.

B. Vibration Motion Conditions

Vibration causes vascular disorders of the arms and bony changes in the small bones of the wrist. Vascular changes can be detected by X-ray examination of the wrist. The most common findings is rare faction of the lunate bone.

C. Pressure –Atmospheric (high and low)

Exposure to increased atmospheric pressure (under water) leads to aseptic bone necrosis around the knee, hip and shoulder that can be detected by X-ray examination

D. Ionizing and Non-Ionizing Radiation

Radiation having a wide range of energies forms the electromagnetic spectrum, which is illustrated below. The spectrum has two major divisions: non-ionizing and ionizing radiation.

Radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons, is referred to as "non-ionizing radiation." Examples of this kind of radiation are sound waves, visible light, and microwaves.

Radiation that falls within the ionizing radiation" range has enough energy to remove tightly bound electrons from atoms, thus creating ions. This is the type of radiation that people usually think of as 'radiation.' We take advantage of its properties to generate electric power, to kill cancer cells, and in many manufacturing processes.

1. Nonionizing Radiation

We take advantage of the properties of non-ionizing radiation for common tasks:

• microwave radiation-- telecommunications and heating food

• infrared radiation --infrared lamps to keep food warm in restaurants

• radio waves-- broadcasting

Non-ionizing radiation ranges from extremely low frequency radiation, shown on the far left through the audible, microwave, and visible portions of the spectrum into the ultraviolet range.

Extremely low-frequency radiation has very long wave lengths (on the order of a million meters or more) and frequencies in the rangeof 100 Hertz or cycles per second or less. Radio frequencies have

wave lengths of between 1 and 100 meters and frequencies in the range of 1 million to 100 million Hertz. Microwaves that we use to heat food have wavelengths that are about 1 hundredth of a meterlong and have frequencies of about 2.5 billion Hertz.

2. Ionizing radiation

Ionizing radiation has many practical uses, but it is also dangerous to human health. Both aspects are treated below.

Ionizing radiation is either particle radiation or electromagnetic radiation in which an individual particle/photon carries enough energy to ionize an atom or molecule by completely removing an electron from its orbit. If the individual particles do not carry this amount of energy, it is essentially impossible for even a large flood of particles to cause ionization. These ionizations, if enough occur,can be very destructive to living tissue, and can cause DNA damage and mutations. Examples of particle radiation that are ionizing may be energetic electrons, neutrons, atomic ions or photons.

Electromagnetic radiation can cause ionization if the energy per photon, or frequency, is high enough, and thus the wavelength is short enough. The amount of energy required varies between molecules being ionized. X-rays, and gamma rays will ionize almost any molecule or atom. Far ultraviolet, near ultraviolet and visible light are ionizing to some molecules; microwaves and radio waves are non-ionizing radiation.

However, visible light is so common that molecules that are ionized by it will often react nearly spontaneously unless protected by materials that block the visible spectrum. Examples include photographic film and some molecules involved in photosynthesis.

Alpha radiation consists of helium-4 nuclei and is readily stopped by a sheet of paper. Beta radiation, consisting of electrons, is halted by an aluminium plate. Gamma radiation is eventually absorbed as it penetrates a dense material.

Ionizing radiation is produced by radioactive decay, nuclear fission and nuclear fusion, by extremely hot objects (the hot sun, e.g., produces ultraviolet), and by particle accelerators that may produce, e.g., fast electrons or protons or bremsstrahlung or synchrotron radiation.

In order for radiation to be ionizing, the particles must both have a high enough energy and interact with electrons. Photons interact strongly with charged particles, so photons of sufficiently high energy are ionizing. The energy at which this begins to happen is in the ultraviolet region; sunburn is one of the effects of this ionization.

Charged particles such as electrons, positrons, and alpha particles also interact strongly with electrons. Neutrons, on the other hand, do not interact strongly with electrons, and so they cannot directly ionize atoms. They can interact with atomic nuclei, depending on the nucleus and their velocity, these reactions happen with fast neutrons and slow neutrons, depending on the situation. Neutron radiation often produces radioactive nuclei, which produce ionizing radiation when they decay.

The negatively charged electrons and positively charged ions created by ionizing radiation may cause damage in living tissue. If the dose is sufficient, the effect may be seen almost immediately, in the form of radiation poisoning. Lower doses may cause cancer or other long-term problems. The effect of the very low doses encountered in normal circumstances (from both natural and artificial sources, like cosmic rays, medical X-rays and nuclear power plants) is a subject of current debate.

Radioactive materials usually release alpha particles which are the nuclei of helium, beta particles, which are quickly moving electrons or positrons, or gamma rays. Alpha and beta rays can often be shielded by a piece of paper or a sheet of aluminium, respectively.

They cause most damage when they are emitted inside the human body. Gamma rays are less ionizing than either alpha or beta rays, but protection against them requires thicker shielding. They produce damage similar to that caused by X-rays such as burns, and cancer through mutations. Human biology resists germline mutation by either correcting the changes in the DNA or inducing apoptosis in the mutated cell.

Non-ionizing radiation is thought to be essentially harmless below the levels that cause heating. Ionizing radiation is dangerous in direct exposure, although the degree of danger is a subject of debate. Humans and animals can also be exposed to ionizing radiation internally: if radioactive isotopes are present in the environment, they may be taken into the body. For example, radioactive iodine is treated as normal iodine by the body and used by the thyroid; its accumulation there often leads to thyroid cancer.Some radioactive elements also bioaccumulate.

Example: Electromagnetic radiation

The energy of a photon (i.e., a quantum of electromagnetic

radiation) is given by the Planck equation:E = hνwhere

E is the energy of the photon

h is Planck's constant

ν is the frequency of the photon

The wavelength of a photon is related to its frequency by theequation of a wave's velocity:

c = λν

where c is the speed of light

λ is the wavelength of light

Plugging back in and solving for the wavelength, we get,

λ = hc / E

The elements with the lowest and highest ionization potential arecesium (3.89 eV) and helium (24.6 eV), respectively. Compoundscan have low ionization potentials as well. For example, PMMA has an ionization potential of 8.1 eV. Photons with energies less than 3.89 eV (λ > 318.8 nm) are non-ionizing radiation, photons with energies greater than 24.6 eV (λ < 50.4 nm) are ionizing radiation ,and photons with energies between 3.89 eV and 24.6 eV may be either ionizing or non-ionizing radiation depending on the nature of material (e.g., cesium or helium). Visible light corresponds to photons with energies from 1.77 eV (λ = 700.6 nm) to 3.10 eV (λ =400 nm) and are thus non-ionizing electromagnetic radiation.

Ultraviolet (UV) radiation spans the energy range from 3.10 eV (UVA) to 12.4 eV (UV-C, λ = 100 nm). Because UV radiation, especially UV-C, exceeds the ionization energy of many of the elements, it isoften considered ionizing radiation rather than non-ionizing radiation.

**2.1. Uses of ionizing radiation**

Ionizing radiation has many uses. An X-ray is ionizing radiation, and ionizing radiation can be used in medicine to kill cancerous cells.

However, although ionizing radiation has many uses the overuse of it can be hazardous to human health. Shop assistants in shoe shops used to use an X-ray machine to check a child's shoe size, which would be a big treat for the child. But when it was discovered thationizing radiation was dangerous these machines were promptly removed.

**2.2 Effects of ionizing radiation upon human health**

Natural background radiation

Natural background radiation comes from four primary sources :cosmic radiation, solar radiation, external terrestrial sources, and radon.

Cosmic radiation

The earth, and all living things on it, are constantly bombarded by radiation from outside our solar system of positively charged ions from protons to iron nuclei. The energy of this radiation can farexceed energies that humans can create even in the largest particle accelerators. This radiation interacts in the atmosphere to create secondary radiation that rains down, including x-rays, muons, protons, alpha particles, pions, electrons, and neutrons.

The dose from cosmic radiation is largely from muons, neutrons, and electrons. The dose rate from cosmic radiation varies in different parts of the world based largely on the geomagnetic field, altitude, and solar cycle. The dose rate from cosmic radiation on airplanes is so high that, according to the United Nations UNSCEAR 2000 Report ,airline workers receive more dose on average than any other worker, including nuclear power plant workers.

Solar radiation

While most solar radiation is electro-magnetic radiation, the sun also produces particle radiation, solar particles, which vary with the solar cycle. They are mostly protons; these are relatively low in energy (10-100 keV). The average composition is similar to that of the Sun itself. This represents significantly lower energy particles than come form cosmic rays. Solar particles vary widely in their intensity and spectrum, increasing in strength after some solar events such as solar flares. Further, an increase in the intensity of solar cosmic rays is often followed by a decrease in the galactic cosmic rays, called a Forbush decrease after their discoverer, the physicist Scott Forbush. These decreases are due to the solar wind which carries the sun's magnetic field out further to shield the earth more thoroughly from cosmic radiation.

External terrestrial sources

Most material on earth contains some radioactive atoms, if in small quantities. But most of terrestrial non-radon-dose one receives from these sources is from gamma-ray emitters in the walls and floors when inside the house or rocks and soil when outside. The major radionuclides of concern for terrestrial radiation are potassium, uranium and thorium. Each of these sources has been decreasing in activity since the birth of the Earth so that our present dose from

potassium-40 is about ½ what it would have been at the dawn of lifeon Earth.

Radon

Radon-222 is produced by the decay of Radium-226 which is present wherever uranium is. Since Radon is a gas, it seeps out of uranium-containing soils found across most of the world and may concentrate in well-sealed homes. It is often the single largest contributor to an individual's background radiation dose and is certainly the most variable from location to location. Radon gas is the second largest cause of lung cancer in America, after smoking.

Human-made radiation sources

Natural and artificial radiation sources are identical in their nature and their effect. Above the background level of radiation exposure, the U.S. Nuclear Regulatory Commission (NRC) requires that its licensees limit human-made radiation exposure to individual members of the public to 100 mrem (1 mSv) per year, and limit occupational radiation exposure to adults working with radioactive e material to 5,000 mrem (50 mSv) per year.

The average exposure for Americans is about 360 mrem (3.6 mSv) per year, 81 percent of which comes from natural sources of radiation. The remaining 19 percent results from exposure to human-made radiation sources such as medical X-rays, most of which is deposited in people who have CAT scans. One important source of natural radiation is radon gas, which seeps continuously from bedrock but can, because of its high density, accumulate in poorly ventilated houses.

The background rate varies considerably with location, being as low as 1.5 mSv/a in some areas and over 100 mSv/a in others. People in some areas of Ramsar, a city in northern Iran, receive an annual radiation absorbed dose from background radiation that is up to 260 mSv/a. Despite having lived for many generations in these high background areas, inhabitants of Ramsar show no significant cytogenetic differences compared to people in normal background areas; this has led to the suggestion that the body can sustain much higher steady levels of radiation than sudden bursts.

Some human-made radiation sources affect the body through direct radiation, while others take the form of radioactive contamination and irradiate the body from the inside.

By far, the most significant source of human-made radiation exposure to the general public is from medical procedures, such as diagnostic X-rays, nuclear medicine, and radiation therapy. Some of the major radionuclides used are I-131, Tc-99, Co-60, Ir-192, Cs137. These are rarely released into the environment.

In addition, members of the public are exposed to radiation from consumer products, such as tobacco (polonium-210), building materials, combustible fuels (gas, coal, etc.), ophthalmic glass, televisions, luminous watches and dials (tritium), airport X-ray systems, smoke detectors (americium), road construction materials, electron tubes, fluorescent lamp starters, lantern mantles (thorium), etc.

Of lesser magnitude, members of the public are exposed to radiation from the nuclear fuel cycle, which includes the entire sequence from mining and milling of uranium to the disposal of the spent fuel. The effects of such exposure have not been reliably measured.

Estimates of exposure are low enough that proponents of nuclear power liken them to the mutagenic power of wearing trousers for two extra minutes per year (because heat causes mutation). Opponents

use a cancer per dose model to prove that such activities cause several hundred cases of cancer per year.

In a nuclear war, gamma rays from fallout of nuclear weapons would probably cause the largest number of casualties. Immediately downwind of targets, doses would exceed 300 Gy per hour. As a reference, 4.5 Gy (around 15,000 times the average annual background rate) is fatal to half of a normal population.

Occupationally exposed individuals are exposed according to the sources with which they work. The radiation exposure of these individuals is carefully monitored with the use of pocket-pen-sized

instruments called dosimeters.

Some of the radionuclides of concern include cobalt-60, caesium137, americium-241 and iodine-131. Examples of industries where occupational exposure is a concern include:

• airline crew (the most exposed population)

• Fuel cycle

• Industrial Radiography

• Radiology Departments (Medical)

• Radiation Oncology Departments

• Nuclear power plant

• Nuclear medicine Departments

• National (government) and university Research Laboratories

**2.3. The effects of ionizing radiation on animals**

The biological effects of radiation are thought of in terms of their effect on living cells. For low levels of radiation exposure, the biological effects are so small they may not be detected in epidemiological studies. The body repairs many types of radiation and chemical damage. Biological effects of radiation on living cells may result in a variety of outcomes, including:

1. Cells experience DNA damage and are able to detect and repair the damage.

2. Cells experience DNA damage and are unable to repair the damage. These cells may go through the process of programmed cell death, or apoptosis, thus eliminating the potential genetic damage from the larger tissue.

3. Cells experience a nonlethal DNA mutation that is passed on to subsequent cell divisions. This mutation may contribute to the formation of a cancer.

Other observations at the tissue level are more complicated. These include:

1. In some cases, a small radiation dose reduces the impact of a subsequent, larger radiation dose. This has been termed an 'adaptive response' and is related to hypothetical mechanisms of hormesis.

2. Cells that are not 'hit' by a radiation track but are located nearby may express damage or alterations in normal function, presumably after communication between the 'hit' cell and neighboring cells occurs. This has been termed the 'bystander effect'.

3. The progeny of a cell that survives radiation exposure may have increased probabilities for mutation. This has been termed 'genomic instability'.

Chronic radiation exposure

Exposure to ionizing radiation over an extended period of time isc alled chronic exposure. The natural background radiation is chronic exposure, but a normal level is difficult to determine due to variations. Location and occupation often affect chronic exposure.

Acute radiation exposure

Acute radiation exposure is an exposure to ionizing radiation which occurs during a short period of time. There are routine brief exposures, and the boundary at which it becomes significant is difficult to identify. Extreme examples include

• Instantaneous flashes from nuclear explosions.

• Exposures of minutes to hours during handling of highly

radioactive sources.

• Laboratory and manufacturing accidents.

• Intentional and accidental high medical doses.

The effects of acute events are more easily studied than those of chronic exposure.

**2.4. Minimizing health effects of ionizing radiation**

Although exposure to ionizing radiation carries a risk, it is impossible to completely avoid exposure. Radiation has always been present in the environment and in our bodies. We can, however, avoid undue exposure.

Although people cannot sense ionizing radiation, there is a range of simple, sensitive instruments capable of detecting minute amounts of radiation from natural and man-made sources.

Dosimeters measure an absolute dose received over a period of time. Ion-chamber dosimeters resemble pens, and can be clipped to one's clothing. Film-badge dosimeters enclose a piece of photographic film, which will become exposed as radiation passes through it. Ion-chamber dosimeters must be periodically recharged, and the result logged. Badge dosimeters must be developed as photographic emulsion so the exposures can be counted and logged; once developed, they are discarded.

Geiger counters and scintillometers measure the dose rate of ionizing radiation directly.

In addition, there are four ways in which we can protect ourselves:

Time: For people who are exposed to radiation in addition to natural background radiation, limiting or minimizing the exposure time will reduce the dose from the radiation source.

Distance: In the same way that the heat from a fire is less intense the further away you are, so the intensity of the radiation decreases the further you are form the source of the radiation. The dose decreases dramatically as you increase your distance from the source.

Shielding: Barriers of lead, concrete, or water give good protection from penetrating radiation such as gamma rays and neutrons. This is why certain radioactive materials are stored or handled underwater or by remote control in rooms constructed of thick concrete or lined with lead. There are special plastic shields which stop beta particles and air will stop alpha particles. Inserting the proper shield between you and the radiation source will greatly reduce or eliminate the extra radiation dose.

Shielding can be designed using halving thicknesses, the thickness of material that reduces the radiation by half. Halving thicknesses for gamma rays are discussed in the article gamma rays.

Containment: Radioactive materials are confined in the smallest possible space and kept out of the environment. Radioactive isotopes for medical use, for example, are dispensed in closed handling facilities, while nuclear reactors operate within closed systems with multiple barriers which keep the radioactive materials contained. Rooms have a reduced air pressure so that any leaks occur into the room and not out of it.

In a nuclear war, an effective fallout shelter reduces human exposure at least 1,000 times. Most people can accept doses as high as 1 Gy, , distributed over several months, although with increased risk of cancer later in life. Other civil defense measures can help reduce exposure of populations by reducing ingestion of isotopes and occupational exposure during war time.

One of these available measures could be the use of potassium iodide (KI) tablets which effectively block the uptake of dangerous radioactive iodine into the human thyroid gland.

E. Noise

Noise is defined as unwanted sound. Sound is any pressure variation or a stimulus that produces a sensory response in the brain. The compression and expansion of air created when an object vibrates.

Magnitude

Approximately 30 million workers are exposed to hazardous noise on the job and an additional 9 million are at risk for hearing loss from other agents such as solvents and metals. Noise-induced hearing loss is one of the most common occupational disease and the second most self-reported occupational illness or injury.

Industry specific studies reveal:

• 44% of carpenters and 48% of plumbers reported that they had a perceived hearing loss.

• 49% of male, metal/non-metal miners will have a hearing impairment by age 50 (vs. 9% of the general population) rising to 70% by age 60.

While any worker can be at risk for noise-induced hearing loss in the workplace, workers in many industries have higher exposures to dangerous levels of noise. Industries with high numbers of exposed

workers include: agriculture; mining; construction; manufacturing and utilities; transportation; and military.

Industrial Noise

Although the problem of noise was recognized centuries ago, for example Ramazini in 1700 described how workers who hammer copper have their ears injured due to exposure to the sound. The extent of the problem, which was caused by such noise, was not felt until the industrial revolution in England. The increasing mechanization in industries, farms, transport and others are likely to be more intense and sustained than any noise levels experienced outside the work place.

Industrial noise problems are extremely complex. There is no “standard " program that is applicable to all situations. However, industries are responsible to consider and evaluate their noise problems and to take steps toward the establishment of effective hearing conservation procedures.

The effectiveness of hearing conservation program depends on the cooperation of employees, supervisors, employers, and others concerned. The management responsibility is to take measurements, initiating noise control measures, undertaking the audiometer testing of employees, providing hearing protective equipment with sound policies, and informing employees of the benefits to be derived from a hearing conservation program.

General Class of Noise Exposure

There are three general classes into which occupational noise

exposure may be grouped.

1. Continuous noise: Normally defined as broadband noise of approximately constant level and spectrum to which an employee is exposed for a period of eight hours per day or 40 hours a week.

2. Intermittent Noise: This may be defined as exposure to a given broadband sound pressure level several times during a normal working day

3. Impact (impulse) type Noise: is a sharp burst of sound. A sophisticated instrumentation is necessary to determine the peak levels for this type of noise.

Effects of noise exposure

Noise is a health hazard in many occupational settings. Effects of noise on humans can be classified into various ways. For example, the effect can be treated in the context of health or medical problems owing to their underlying biological basis. Noise induced hearing loss involves damage to the structure of the hearing organ. The effects of noise on humans can be classified into two types:

Non auditory effect

Auditory effect

Non-auditory effects

This consists of fatigue, interference with communication, decreased efficiency and annoyance.

Auditory effects

Auditory effects consist of permanent or temporary hearing loss. The ear is especially adapted and most responsive to the pressure changes caused by airborne sound or noise. The outer and middle ear structures are rarely damaged by exposure to intense sound energy except explosive sounds or blasts that can rupture the ear drum and possibly dislodge the ossicular chain. More commonly, excessive exposure produces hearing loss that involves injury to the hair cells in the organ of corti within the cochlea of the inner ear.

**Noise-induced hearing loss**

Work-related hearing loss continues to be a critical workplace safetyand health issue. The National Institute for Occupational Safety and Health (NIOSH) and the occupational safety and health community named hearing loss as one of the 21 priority areas for research inthe next century. Noise-induced hearing loss is 100 percent preventable but once acquired, hearing loss is permanent and irreversible. Therefore, prevention measures must be taken by employers and workers to ensure the protection of workers' hearing.

Prevention of noise exposure

OSHA requires a five phase hearing conservation program for industry:

1. Noise Monitoring

2. Audiometric (Hearing) Testing

3. Employee Training

4. Hearing Protectors

5. Recordkeeping

F. Illumination

Good and sufficient lighting is aimed at promoting productivity, safety, health, well being and pleasant working conditions at an economical cost.

Luminance: is the brightness on an object.

Illuminance: is the amount of light, which falls on the surface. It is measured in lux.

Purpose of good lighting

• help provide a safe working environment;

• Provide efficient and comfortable seeing

• reduce losses in visual performances.

**Effects of Poor Illumination**

Some less tangible factors associated with poor illumination are important contributing causes of industrial accidents. These can include:

o direct glare

o reflected glare from the work

o dark shadows which may lead to excessive visual fatigue

o visual fatigue, it self may be a causative factor in industrial accidents

o delayed eye adaptation when coming from bright surroundings into darker ones .

**2.3.2 Mechanical Hazards**

Mechanical factors include unshielded machinery, unsafe structures at the workplace and dangerous unprotected tools are among the most prevalent hazards in both industrialized and developing countries. They affect the health of a high proportion of the workforce. Most accidents could be prevented by applying relatively simple measures in the work environment, working practices, and safety systems and ensuring appropriate behavioural and management practices. This would significantly reduce accident rates within a relatively short period of time. Accident prevention programmes are shown to have high cost-effectiveness and yield rapid results. However, ignorance of such precautions, particularly in sectors where production has grown rapidly, has led to increasing rates of occupational accidents.

Workers who use hand tools such as picks, hammers, shovels, or who habitually kneel at their work may suffer from “beat" condition of the hand, knee or elbow. Beat hand is subcutaneous cellulites, which occurs among miners and stoker caused by infection of tissues devitalized by constant bruising.

2.3.3 Chemical Hazards

Average annual world production of chemicals amounts to an estimated 400 million tones. There are between 5 to 7 million knownchemicals, however, only 70,000 to 80,000 are on the market, with 1,000 or so being produced in substantial quantities. In North America around 1,000 to 1,200 are produced annually (50 % are polymers).In Western Europe, some 150 to 200 new substances are registered each year. Of the 70,000 to 80,000 chemicals only 5 to 10 %( i.e., 500 to 7,000 should be considered hazardous; 150 to 200 of these are carcinogenic.

Chemical hazards are dependent on their amount:-

• Amount

• Concentration

• Time of exposure

• Mode of entry to the body

• Age

• Sex

• Health status

• Resistance of the exposed workers

The effects of chemical agents are as follows:

1. Asphyxiation

2. Systemic intoxication

3. Pneumoconiosis

4. Carcinogens

5. Irritation

6. Mutagencity

7. Teratogenicity

Among all chemical agents in work place the most notorious and most in contact with the skin or respiratory system that deserve attention is solvent

**Solvent**

In most occupational settings or industries a potential threat to the health, productivity and efficiency of workers is their exposure to organic solvents. Exposure to solvents occurs throughout life.

Example, organic solvent vapor inhaled by a mother could reach the fetus.

**Classification of Solvents**

The term solvent means materials used to dissolve another material and it includes aqueous or non-aqueous system. Aqueous solutions include those based in water.

Example:

Aqueous solution of acids, Aqueous solution of alkalis, Aqueous solution of detergents

Aqueous solutions have low vapor pressure thus the potential hazard by inhalation and subsequent systemic toxicity is not great.

Examples of non-aqueous solutions; Aliphatic hydrocarbons, Aromatic hydrocarbons, Halogenated hydrocarbons,Cyclic hydrocarbons.

The solvent we are concerned in occupational health and safety will include any organic liquid commonly used to dissolve other organic material.

These are: Naphtha, Mineral spirits,Alcohol,etc

**Effects of Solvents**

The severity of a hazard in the use of solvents and other chemicals

depends on the following factors.

1. How the chemical is used.

2. Type of job operation, which determines how the workers areexposed.

3. Work pattern.

4. Duration of exposure.

5. Operating temperature.

6. Exposed body surface.

7. Ventilation rates.

8. Pattern of airflow.

9. Concentrations of vapors in workroom air.

10. House keeping

1 Health Effect

The effect of solvents varies considerably with the number and type of halogen atoms (fluorine and chlorine) present in the molecules.

Carbon tetrachloride, which is a highly toxic solvent act acutely on the kidney, the liver, gastro intestinal tract (GIT). Chronic exposure to carbon tetrachloride also, damages and cause liver cancer. This solvent should never be used for open cleaning processes where there is skin contact or where the concentration in the breathing zone may exceed recommended level.

2. Fire and explosion

Using non-flammable solvents can minimize the potential for this or solvents with flash point greater than 60 degree Celsius or 140 degree Fahrenheit. However the non-flammable halogenated hydrocarbons decompose when subjected to high temperature and give off toxic and corrosive decomposition products. If flammable solvents with Flash point less than this are used precaution must be taken to:

Eliminate source of ignition such as flames, sparks, high temperature smoking etc.

Properly insulate electrical equipment when pollutants are released outdoors.

Solvent hydrocarbons are important compounds in the formation of photochemical smog. In the presence of sunlight they react with oxygen and ozone to produce Aldehyde, acids, nitrates, and other irritant and noxious compounds. The great portion of hydrocarbons contributing to air pollution originates from automobiles and industries.

**Dangerous chemical substances**

Many dangerous substances are used in industry, commerce, agriculture, research activities, hospitals and teaching establishments.

**Occupational Health and Safety**

The classification of dangerous substances is based largely on the characteristic properties of such substances and their effects on man. Legislation on this subject also requires the provision of a specific pictorial symbol on any container or package.

The following terms are used in the classification of dangerous substances in the classification, packing and labeling of dangerous substances regulations 1984.

A. Corrosion B. Oxidizing C. Harmful

D. Very toxic and toxic E. Irritant F. Highly flammable

G. Explosive

A. Corrosive

Hazard: Living tissues as well as equipment are destroyed on contact with these chemicals.

Caution: Do not breathe vapors and avoid contact with skin eyes, and clothing

B. Oxidizing

Hazard: ignite combustible material or worsen existing fire and thus make fire fighting more difficult.

Caution: Keep away from combustible material. Restrict smoking in that area.

C. Harmful

Hazard: Inhalation and insertion of or skin penetration by these substances is harmful to heath.

Caution: Avoid contact with the human body, including inhalation of vapors and in cases of malaise consult doctor.

D. Very toxic and toxic

Hazard: The substances are very hazardous to health whether breathed, swallowed or in contact with the skin and may even lead to death.

Caution: Avoid contact with human body, and immediately consult a doctor in case of malaise.

E. Irritant

Hazard: May have an irritant effect on skin, eyes and respiratory organs

Caution: Do not breathe vapors and avoid contact with skin and eye

F. Highly Flammable

Hazard: Substances with flash point less than 60 0 C or 140 0F

Caution: keep away source of ignition.

G. Explosive

Hazard: Substances which may explode under certain condition

Caution: Avoid shock, friction, sparks and heat.

Chemical Hazards Evaluation

• Toxicity assessment

• Work activity/risk assessment evaluation

• Assessment of controls effectiveness to block routes of entry

• Exposure monitoring

• Recommendations for improvement

Chemical Hazards: - Exposure Monitoring

¾ Special instruments - infrared absorption, photoionization, gasChromatography

¾ Detector tubes

¾ Air sampling and lab analysis

¾ Professional judgment

Chemical Hazards: Engineering Controlsƒ Substitution (use lower toxicity materials)

ƒ Enclose processes and otherwise engineer for lowemission / low risk

ƒ Provide local exhaust to remove airborne agents

ƒ Local exhaust ventilation

¾ Need to have even air flow for hoods

¾ Need to design for adequate capture velocity -usually about 100 feet/minute

¾ Need sufficient make up air

¾ Use ACGIH Ventilation Manual for design

Reduce exposure time

ƑBetter procedures

ƒ Training

ƒ PPE - gloves, face shields, respirators

ƒ Remote Operation

2.3.4 Biological Hazards

Many biological agents such as viruses, bacteria, parasites, fungi,moulds and organic dusts have been found to occur in occupationalexposures. In the industrialized countries around 15 % of workersmay be at risk of viral or bacterial infection, allergies and respiratorydiseases. In many developing countries the number one exposure isbiological agents.

HIV/AIDS, Hepatitis B and C viruses and other blood bornepathogens, tuberculosis infections (particularly among health careworkers), asthmas (among persons exposed to organic dust) and chronic parasitic infections (particularly among agricultural and forestry workers), are the most common occupational diseases that result from such exposures.

Exposure to biological hazards in workplace results in a significant amount of occupationally associated diseases.

Biological hazards include viruses, bacteria, fungus, parasites, or any living organism that can cause disease to human beings.

Biological hazards can be transmitted to a person through:

a. Inhalation

b. Injection

c. Ingestion

d. Contact with the skin

The contract of biohazard depends on:

a. The combination of the number of organisms in the environment.

b. The virulence of these organisms

c. The susceptibility of the individual

d. Concomitant physical/chemical stresses in the environment.

Classification of Biohazard Agents

Knowing the biohazard and their groupings is important to decide on what to do to safeguard the workers from the hazards. There are two points that are important to remember. These are:

1. Any accident involving biohazard material can result in infection.

2. When working with biological agents or materials for which Epidemiology and etiology is not known or not completely understood, it must be assumed that the materials present a biological hazard.

**Occupational Exposure to Biohazards**

The most obvious work place in which employees are subjected to hazards as a result that the work requires handling and manipulation of biological agents include: surgery, autopsy, contaminated

discharges, blood, pipettes, laboratory specimens, etc.

1. Research Laboratory

Health personnel such as laboratory technicians and scientists working on biological specimens are at risk with biological hazards in the laboratory. Specimen such as blood, pus, stool and other tissue samples may expose the workers to hazards such as HIV, Hepatitis, etc.

2. Health care facilities

Many potential biological agents exist in hospital environment.

These are bacterial infection and viral agents. Those working in laundry, housekeeping, laboratory, central supply, nursing station and dietary are highly exposed to biohazard from the patient they handle, from the specimen they collect and from the cloth, needle and pans they handle and from their general day to day activities.

A/Laundry

Workers in laundry are exposed to discharges from patients by virtue of the fact that contact with linen (bed sheet), nightdresses and washable articles that are sent to the laundry for cleaning every

day.

Control of infection or exposure is possible only if workers and hospital administration adhere to the following:

All linen should be placed in plastic or other bags at the bed side rather than carried carelessly across the corridor or through the halls to where collection bags or the laundry is collected.

Laundry bags should be color coded in order to alert laundry workers that, what is contained in the bags is potentially

When the soiled laundry item reached the laundry the contents of the bags should be emptied directly into the washing basin, machine or trough.

Employees responsible for sorting and folding linens can also be sources of infection as a result of poor personal hygiene.

Thorough hand washing and the use of rubber gloves are essential and basic infection control methods.

B/Housekeeping

Housekeepers in hospitals are the single highest group exposed to infectious biological agents.

The areas and condition of contamination are:

Contact with discarded contaminated disposable materials during g all general cleaning activities.

Widespread use of disposable materials, especially those usedin intravenous administration and blood collection.

Contaminated hypodermic needles and intravenous catheters

Dry sweeping of the floor does not remove many microbes. It rather pushes dust and other materials from one area to the other. When mops and brooms are improperly treated dust is dispersed back into the air.

C/Central Supply

The most serious problem in this department is the cleansing of surgical instruments. Grossly contaminated materials should be sterilized in an autoclave before any handling or rinsing.

Scrubbing action is much more efficient than soaking, but it is during scrubbing that exposure to biohazard is the greatest. Direct injection of microorganisms is possible if the skin is punctured with dirtyinstruments or if the skin has a lesion that comes into contact with contaminated instruments.

D/Health care staff

The possibility of exposure to infection of health care professionals that have direct contact with patients is always present. Infection can be spread in health care facilities through:-

• Patient to patient

• Patient to other staff

• Patient to his/her own family

• Patient to visitors especially if consulting with family members of the patient

Health care workers are not the only person to spread infection.

Others are

• Patient

• Waste handlers, transporters

• Laundry staffs

Poor health care waste management system hazardous to:-

• Health care workers

• Patients

• Visitors

• Community

• Environment

To avoid such contamination health care workers should:

Dispose of contaminated equipment properly so that no health hazard is exposed to infect othersHands should be thoroughly washed with soap and water after visiting each patient to minimize the chance of spreading harmful infection or organisms from patient to patient.

Gowns, masks and caps must be worn whenever necessary and removed before entering clean areas such as rest areas and lunchrooms.

E/Dietary

Staffs involved in food preparation are exposed to infection from infectious agents such as salmonella, botulism, amoeba and staphylococcus, which can result from contact with raw fish, meat, and some vegetables contaminated by sewage or human waste or dirty water.

Primary prevention against infection or contamination of the food include:

* ƒ Proper handling of food products (raw or cooked)
* ƒ Use clean hands and garments in the food processing areas
* ƒ No skin lesion of the food handlers
* ƒ Refrigeration of the food products at a safe temperature level in order to prevent growth of bacteria.
* ƒ Adequate cooking of foods.

The problem of biological hazard in health care delivery system is increasing because of:

1. Inadequate sanitation, disinfection and sterilization methods.

2. Increase in drug as well as chemical resistant strains of microbes.

3. Increase of high-risk patients (HIV/AIDS and TB).

3. Agriculture

Occupational exposures to biohazard also occur in agriculture.

There are three types of relationships in terms of disease transmission between humans and animals. These are:

Disease of vertebrate animals transmissible to human and other animals (Zoonosis)

Disease of humans transmissible to other animals (Anthropozooonois)

Disease of vertebrate animals chiefly transmissible to humans (Zooanthroponosis)

Zoonosis

It consists of viral, bacterial, rickettsial, fungal, protozoal, and helminthic disease. Among the most important through out the world are: Anthrax, brucellosis, tetanus, encephalitis, leptospirosis, rabies,and salmonellosis. The infection could enter the body through inhalation, ingestion, or through the skin or mucus membrane.

Biohazard Control Program

1. Employee health.

* ƒ Pre-placement examination for new employee.
* ƒ Periodic physical examination as part of a surveillance
* program.
* ƒ Vaccination.

2. Laboratory safety and health.

* ƒ Employee training
* ƒ Avoid if possible entering into a biohazard areas.
* ƒ Avoid eating, drinking, smoking and gum chewing in
* biohazard areas
* ƒ Wearing personal protective equipment is always advisable.

3. Biological safety cabinetTo protect workers from exposure to aerosols especially when there is contact with biohazards in laundry activities.

4. Animal care and handling

Periodic examination, disposal of manure, cleanliness, collection of medical history and treatment.

2.3.5 Ergonomic Hazards

2.3.5.1 Ergonomics

Ergonomics, also known as human engineering or human factors engineering, the science of designing machines, products, and systems to maximize the safety, comfort, and efficiency of the people who use them. Ergonomists draw on the principles of industrial engineering, psychology, anthropometry (the science of human measurement), and biomechanics (the study of muscular activity) to adapt the design of products and workplaces to people’s sizes and shapes and their physical strengths and limitations.

Ergonomists also consider the speed with which humans react and how they process information, and their capacities for dealing with psychological factors, such as stress or isolation. Armed with this complete picture of humans interact with their environment, ergonomists develop the best possible design for products and systems, ranging from the handle of a toothbrush to the flight deck of the space shuttle.

Ergonomists view people and the objects they use as one unit, and ergonomic design blends the best abilities of people and machines.

Humans are not as strong as machines, nor can they calculate as quickly and accurately as computers. Unlike machines, humans need to sleep, and they are subject to illness, accidents, or making mistakes when working without adequate rest. But machines are also limited—cars cannot repair themselves, computers do not speak or hear as people do, and machines cannot adapt to unexpected situations as humans. An ergonomically designed system provides optimum performance because it takes advantage of the strengths and weaknesses of both its human and machine components.

In general, ergonomics deals with the interaction between humans and such additional environmental elements such as heat, light, sound, atmospheric contaminants and all tools and equipment pertaining to the work place.

Ergonomics or the proper designing of work systems based onhuman factors has the following advantages:

1. There will be more efficient operations

2. There will be fewer accidents

3. There will be reduced training time

4. There will be fewer costs of operations

5. There will be more effective use of workers or personnel.

The goal of "ERGONOMICS" or human factors ranges from making work safe to humans, and increasing human efficiency and wellbeing. To ensure a continuous high level performance, work system must be tailored to human capacities and limitations measured by anthropometry and biomechanics.

2.3.5.2 Ergonomic Hazards

Between 10% and 30% of the workforce in industrial countries and between 50% and 70% in developing countries may be exposed to heavy physical workload or to unergonomic working conditions such as lifting and moving of heavy items or repetitive manual tasks.

Repetitive tasks and static muscular load are found in many industrial and service occupations. In many industrial countries musculoskeletal disorders are the main cause of both short-term and permanent work disability, which can cause economic losses that may amount to 5% of the GNP.

Most exposures can be eliminated or minimized through mechanization, improvement of ergonomics, and better organization of work and training. In particular, the growing numbers of elderly workers and the female workforce require constant vigilance from those responsible for the work organization.

Improving the conditions of the work environment and opportunities for providing workers’ health, safety and wellbeing essentially means contributing to sustainable improvement of ergonomics. Local perceptions about ergonomics in many countries have not captured headlines in the newspapers. However safe and hygienic workplaces contribute to sustainable development and this issue can be raised through proper media exposure.

**Principles of biomechanics**

It deals with the functioning of the structural element of the body and the effect of external and internal forces on various parts of the body.

Taking an example of "lifting" an object from the ground biomechanics seek relevant information:

1. What is the task to be performed (task variable)

2. Would the person be able to do the task (human variable)

3. What is the type of work environment (environmental variable)

Task variable

• Location of object to be lifted

• Size of object to be lifted

• Height from which and to which the object is to be lifted

• Frequency of lift

• Weight of object

• Working position

Human Variable

• Sex of worker

• Age of worker

• Training of worker

• Physical fitness of worker

• Body dimension of worker

Environmental variable

• Extremes of temperature (hot/cold)

• Humidity

• Air contaminants

Work physiology

People perform widely different tasks in daily work situation. These tasks must be matched with human capabilities to avoid "over loading" which may cause the employee to breakdown, suffer

reduced performance capability or even permanent damage.

**Matching people with their work**

It is important to match human capabilities with the related requirements of a given job. If the job demands are equal to the worker's capabilities or if they exceed them, the person will be under much strain and may not be able to perform the task.

**Work classification**

The work demands are classified from light work to extremely heavy in terms of energy expenditures per minute and the relative heart rate in beats per minute. For example the energy requirement for light work is 2.5 Kcal/minute and the heart rate is 90 beats rate per minute, while it was extremely heavy work energy requirement is 15 Kcal/minute and heart beat is 160/minute.

**Workstation design**

Workstation means the immediate area where the person is performing his/her duties. The goal of designing a workstation is to promote ease and efficiency of the person’s performance.

Productivity will affected if the operator is uncomfortable and the workstation is awkwardly designed.

***Workplace design***

Workplace is the establishment or department where the person or worker is performing his/her duties. The most basic requirement for a workplace is that it must accommodate the person working in it.

Specifically this means

1. The workspace for the hands should be between hip and chest height in front of the body.

2. Lower location are preferred for heavy manual work.

3. Higher locations are preferred for tasks that require close visual observations.

Another key ergonomic concept is that workplace should be designed relating the physical characteristics and capabilities of the worker to the design of equipment and to the layout of the work place.

When this is accomplished:

- There is an increase in efficiency

- There is a decrease in human error

- Consequent reduction in accident frequency.

Design is accomplished after learning what the worker's job description will be, kind of equipment to be used for that process and the biological characteristic of the person (worker).

Workspace dimension

Workspace dimension can be grouped in three basic categories:

minimal, maximal, and adjustable dimensions.

Minimal workspace provides clearance for ingress and egress in walkways and doors.

Maximal workspace dimensions permit smaller workers to see the equipment.

This is ensured by selecting workspace dimension over which a small person can reach or by establishing control forces that are small enough so that even a weak person can operate the equipment.

Adjustable dimensions permit the operator to modify the work environment and equipment so that it conforms to those individuals on particular set of anthropometric characteristics.

Effects of non ergonomic working conditions

• Tendosynovitis

• Bursitis

• Carpal tunnel syndrome

• Raynaud’s syndrome (“white fingers”)

• Back injuries

• Muscle strain

To avoid ergonomic hazards the following points should be considered:-

• Sensibility and perceptibility (visual,audible,tactile)

• Kinetic ability and muscular power or strength

• Intelligence

• Skill

• Ability to learn a new technique of skill

• Social and group adaptability

• Kinetic conditions (body size or physicalconstitution)

• Effect of environmental conditions on human ability

• Long term short term or short term adaptable limits of man(desirable or normal, compensatory or fatal)

• Reflexion and reaction patterns

• Mode of living (custom) and sex distinction

• Racial differences

• Human relationship

• Factors that affect on synthetic judgment

**2.3.6 Psychosocial hazards**

Up to 50% of all workers in industrial countries judge their work to be “mentally heavy”. Psychological stress caused by time pressure, hectic work, and risk of unemployment has become more prevalent during the past decade. Other factors that may have adverse psychological effects include jobs with heavy responsibility for human or economic concerns, monotonous work or work that requires constant concentration.

Others are shift-work, jobs with the threat of violence, such as police or prison work, and isolated work. Psychological stress and overload have been associated with sleep disturbances, burn-out syndromes, stress, nervousness and depression. There is also epidemiological evidence of an elevated risk of cardiovascular disorders, particularly coronary heart disease and hypertension.

Within the work environment emotional stress may arise from a variety of psychosocial factors, which the worker finds unsatisfactory, frustrating, or demoralizing.

For example: A peasant who migrates from the rural areas to a city will face entirely different environment if he/she start to work in an industry. In his /her rural life he used to work at his /her own speed but in the factory he may have to work continuously at speeds imposed by the needs of production.

Workers may be working in shifts that will expose them to unusual hours. They may upset their family’s life as a result of their work conditions.

Workers may be working with a person who is paid more but who is incapable of working.

Financial incentives are too low etc.

These and other stresses will have adverse psychosocial problems on workers.

Reduction of occupational stresses depends not only on helping individuals to cope with their problems but also on:

Improved vocational guidance,

Arrangement of working hours,

Job design, and work methods;

Good management.

PREVENTION AND CONTROL OF OCCUPATIONAL HEALTH AND SAFETY HAZARDS

Occupational diseases and injuries are, in principle, preventable. Among the approaches to prevent these include, developing awareness of occupational health and safety hazards among workers and employers assessing the nature and extent of hazards, introducing and maintaining effective control and evaluation measures. These approaches are undertaken by employers, workers and the government. This can range from encouragement by appropriate individuals or agencies outside the specific workplace to the promulgation and rigorous enforcement of occupational health and safety regulations. Working conditions, type of work, vocational and professional status, and geographical location of the workplace also have a profound impact on the social status and social wellbeing of workers. Historically, occupational health programmes have been developed hand-in-hand with the improvement of social conditions for underserved and unprivileged workers.

The classic occupational hygiene model of controlling a hazard, indicates that the ideal situation is to prevent exposure altogether. This is known as control at the source and utilizes substitution or enclosure of the hazard, as well as other means. If this can not be achieved, exposure should be reduced along the path, through ventilation, protective barriers, or related measures, only thirdly, should exposure be controlled at the person, using personal protective equipment, administrative controls, or other primary prevention measures such as training or even biological measures such as immunization. The final measure of controlling a hazard is secondary prevention, i.e. early detection of effects of exposure and subsequent remediation.

**Hierarchy of Prevention and control methods**

Generally, there are five major categories of prevention and control measures: elimination, substitution, engineering controls, administrative controls and personal protective equipment.

1. Elimination

Eliminating the hazard completely is the ideal solution, but it is seldom easy to achieve. Usually there are good reasons why a process or operation has to be carried out and why it has to be done in a certain way. Elimination therefore challenges to find an alternative method of achieving the same goals.

Some of the barriers commonly encountered are as follows: The quality of the product may have a service life of many years, and even a small defect in quality could cause it to fail in use. This might lead to liability claims. Sometimes quality standards may also have been set or approved by the customer or a regulatory authority.

Applications to change the production method may then be difficult or expensive. The cost of the product may be increased. Raw materials or energy costs may be higher or the production time may be increased if the new method is slower

It is important to consider workers health and safety when work processes are still in the planning stages. For example, when purchasing a machine, safety should be the first concern but not cost. Machines should confirm 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 machines that do not meet safety standards are exported to developing countries, causing workers to pay the price with accident, hearing loss from noise, etc.

1. Substitution

If a practically dangerous chemical or work processes cannot be completely eliminated, then it should be applied with a safer substitute. This could involve, for example, using less hazardous pesticides such as those based on pyrethrins (prepared from natural product), which are considered to be less toxic to humans than some other pesticides. This particular substitution is practiced in some countries because the substitute chemicals do not leave residues on food and therefore reduced long-term costs. The substituted materials may cost more to buy and may cause resistance in insects. So you can see there are many factors to be considered when choosing a chemical or chemical substitute?

It is not easy to find safer chemical substitute (in fact, no chemical should be considered completely safe). It is important to review current reports every year on the chemicals used in the work places so that safe chemicals could be considered for the future.

When looking for safer substitute a less volatile chemical is selected of a highly volatile one or solid, instead of liquid. Other examples of substitutions include using:

ƒ Less hazardous instead of toxic ones.

ƒ Detergent plus water cleaning solutions instead of organic solvents

ƒ Freon instead of methyl bromide chloride as a refrigerant

ƒ Leadless glazes in the ceramics industry

ƒ Leadless pigments in paints

ƒ Synthetic grinding wheels (such as aluminum oxide, silicon carboide) instead of sandstone wheels.

3. Engineering controls

An engineering control may mean changing a piece of machinery (for example, using proper, machine guards) or a work process to reduce exposure to a hazard; working a limited number of hours in a hazardous area ; and there are number of common control measures which are called engineering control. This includes enclosure, isolation and ventilation.

A Enclosure

If a hazardous substance or work process cannot be eliminated or substituted, then enclosure the hazard is the next best method of control. Many hazards can be controlled by partially or totally enclosing the work process. Highly toxic materials that can be released into the air should be totally enclosed, usually by using a mechanical handling device or a closed glove system that can be operated from the outside.

The plant can be enclosed and workers could perform their duties from a control room. Enclosing hazards can minimize possible exposure, but does not eliminate them. For example, maintenance workers who serve or repair these enclosed areas can be still exposed. To prevent maintenance workers from being exposed, other protective measures (such as protective clothing, respirators, proper training, medical surveillance, etc) must be used as well as safety procedures.

Machine guarding is another form of enclosure that prevent workerscoming into contact with dangerous parts of machines. Workers should receive training on how to use guarded machine safely.

Isolation

Isolation can be an effective method of control if a hazardous material can be moved to a part of work place where fewer people will be exposed, or if a job can be changed to a shift when fewer people are exposed (such as weekend or midnight shift). The worker can also be isolated from hazardous job for example by working in an air-conditioned control booth. Whether it is the job or the worker that is isolated access to the dangerous work areas should be limited to few people as much as possible to reduce exposures. It is also important to limit the length of time and the amount of substance (s) to which workers are exposed if they must work in hazardous area. For example, dust producing work should be isolated from other work areas to prevent other worker from being exposed. At the same time, workers in the dusty areas must be protected and restricted to only a short time working in those areas. Remember: isolating the work process or the worker does not

eliminate the hazard which means workers can still be exposed.

**Ventilation**

Ventilation in work place can be used for two reasons:

1) to prevent the work environment from being too hot, cold, dry or humid.

2) to prevent contaminates in the air from getting into the area where workers breathe.

Generally there are two categories of ventilation.

1. General or dilution Ventilation

2. Local Exhaust ventilation

1. General or dilution Ventilation This adds or removes air from work place to keep the concentrations of an air contaminant below hazardous level. This system uses natural convection through open doors or windows, roof ventilators and chimneys, or air movement produced by fans or blowers.

It is recommended to use the general ventilation system if the following criteria are fulfilled.

1. Small quantities of air contaminants released into the workroom at fairly uniform rate.

2. Sufficient distance between the worker and the contaminant source to allow sufficient air movement to dilute the contaminant to a safe level.

3. Only contaminant of low toxicity are being used

4. No need to collect or filter the contaminants before exhaust air is discharged into the community environment.

5. No corrosion or other damage to equipment from the diluted contaminants in the workroom area

2. Local Exhaust Ventilation

Local exhaust Ventilation is considered the classical method of control for dust, fumes, vapors and other airborne toxic or gaseous pollutants. The ventilation system captures or contains the contaminants at their source before they escape into the workroom environment. A typical system contains one or more hoods, ducts, air cleaners and a fan. Such systems remove but do not dilute like general exhaust ventilation although removal may not be 100 percent complete. This method is very useful especially for the chemical or contaminants that cannot be controlled by substitution, changing the process, isolation or enclosure. One other major advantage in such system requires less airflow than dilution ventilation system.

4. Administrative Controls

Administrative controls limits the amounts of time workers spend at hazardous job locations. Administrative control can be used together with other methods of control to reduce exposure to occupational hazards.

Some examples of administrative controls include: ƒ

Changing work schedules, for example two people may be able to work 4 hours each at a job instead of one person working for 8 hours at that job

Giving workers longer rest periods or shorter work shits to reduce exposure time ƒ

Moving a hazardous work process so that few people will be exposed ƒ

Changing a work process to a shift when fewer people are working ƒ

Workers promotion ƒ Provision of health and sanitation facilities

An example of administrative controls being used together with engineering controls and personal protective equipment is: a fourhour limit for work in a fully enclosed high noise area where ear protectors are required. Remember: administrative controls only reduce the amount of time you are exposed to hazard – they do not eliminate exposure.

5. Personal protective equipment

Personal protective equipment (PPE) is the least effective method of controlling occupational hazards and should be used only when other methods cannot control hazards sufficiently. PPE can be uncomfortable, may decrease work performance and may create new health and safety hazards. For example, ear protectors can prevent hearing warning signals, respirators can make it harder to breathe, earplugs may cause infection and leaky gloves can trap and spread hazardous chemicals against the skin. Personal protective equipment includes:

a. Eye protection Eye protection embraces spectacles, goggles and handled screens. No eye protection is effective if it is not worn. Common complaints from users are: • discomfort • restricted vision • impaired vision ( caused by misting or scratching)

1. Safety goggles

2. Face shield and gloves

Gloves are perhaps the most common personal protective equipment, being an almost automatic reaction to the idea of a hazardous agent in contact with the hands. Selection should take into account a wide range of parameters.

• The dexterity required to perform the work

• Physical protection against cuts, grazes and bruises

• Whether the wrist and arm needed protection as well.

• Permeability to chemicals

• Dust retention characteristics

3 Helmet

Protective clothing

At its simplest term protective clothing means overalls or lab coats for general-purpose use. They are intended to protect the user (or the user’s own clothing) from everyday wear, tear or dirt. There are

a number of special hazards that may be encountered against which such basic clothing may not be adequate: Corrosive liquids: could soak into the clothing and so come in contact with the skin, causing serious damages. Impermeability is an important factor here.

Dust retention: When working with powders, a fabric that holds dust could generate an airborne exposure hazard as the person moves around.

Thermal environment: normal clothing may be too warm or too cold for a particular environment. In extremes cases, chemical protective clothing might be necessary. Typically this comprises a one-piece suit made from an impervious material.

**Respiratory protective Equipment (RPE**)

In selecting RPE you should take into account: • The physical nature of contaminant- whether it is gaseous or particulate • The chemical nature of the contaminant – whether it is reactive or corrosive • Wearability and comfort factors

Hearing Protection

Hearing protection is perhaps a more descriptive term than the commonly used ear defenders since it is the hearing that is at risk, not the ears. Protection can take two forms. Ear muffs- fit over and around the ears. A fluid of foam filled cushion seals them against the head.

Earplugs – fit snugly inside the ear. There are a variety of types, including foam and soft rubber plugs. As the noise is produced over a range of frequencies the choice of hearing protection must be based on the measured spectrum of the noise to be attenuated. Choosing hearing protection is only partly a matter of finding protectors with the right attenuation. It is equally important to find ones that are comfortable and practicable for the work.

**Other administrative services**

Provision of health and sanitation facilities Workers health, physical and psychological developments are associated with the working and the external environment. The general sanitation of the industry and the healthful conditions are necessary for conserving health or to ensure the protection of occupational health safety and hygiene and measuring or providing the efficiency of the work place. Therefore, an industrial plant should satisfy the following conditions and facilities. ƒ The provision of safe potable and adequate water supply. ƒ Proper collection and disposal of liquid waste. ƒ The provision of adequate sanitary facilities and other personal services.

General cleanness and maintenance of industrial establishment of protecting good house keeping of the plant.

ƒ Maintaining good ventilation and proper lighting systems.

Water Supply

The provision of safe and adequate water supply is the most important element in industrial settings.

Water can be used for the following purposes in an industrial plant:

ƒ It may be used as raw material in the production process.

ƒ Used for cooling purposes in the machines

ƒ Used for cleaning and washing of equipment

ƒ Used by employees to keep their personal hygiene

ƒ Serve as a means for waste disposal in water carrying systems

ƒ For drinking and cooling purposes

In general the water supply should be safe, adequate and wholesome and which satisfy public health standards. The number of taps or fountains required varies from 1 for 50 men to 1 for 200 men, depending upon the plant arrangement. However the standard is an average of 1 tap or fountain for 75 persons.

**Sanitary Facilities**

Excreta disposal facilities: observation of many plants or industries indicated that latrines and toilets used by the workers are of a primitive and unsanitary nature or in some cases there are none at all.

In some countries the public health services and labor legislation lay down regulations concerning sanitary facilities to be provided including the number for male and female workers.

Example. - At least 1 suitable latrine for every 25 females - At least 1 suitable latrine for every 25 males In a factory where the number of males employed exceeds 500, it is sufficient to provide 1 toilet or latrine for every 60 males provided that sufficient urinals are provided

Washing Facilities: adequate, suitable and conveniently accessible washing facilities should be provided for employees. There should be a supply of running water; in addition soap and clean towels should be supplied and common towels should be discouraged as much as possible.

The recommended standards:-

ƒ 1 wash basin for every 15 workers for clean work

ƒ 1 wash basin for every 10 workers doing dirty work

ƒ 1 wash basin for every 5 workers handling poisonous substances or engaged in handling food stuffs

The walls of washing rooms should preferably be glazed tiles and the floor made of the same tiles or hard asphalt. The washing basin should be preferably of vitreous china.

Points to be considered in providing shower services.

ƒ All showers should be separated for male and female workers to guarantee privacy

ƒ Emergency facilities must be available where there is a danger of skin contamination by dangerous or poisonous substances ƒ Emergency shower or eye wash facility

ƒ Accessory materials

**Refuse disposal**

Proper solid waste management starting from the source to generation to the final disposal site is highly required in industries where different kinds of wastes are generated.

Industrial solid wastes may contain hazardous materials that required special precaution and procedures. But combustible solid wastes except poisonous and flammable or explosive materials can be handled in the convenient manner.

**Liquid waste collection and disposal**

Industrial liquid wastes if not properly disposed could pollute rivers, lakes, environment and drinking water supply.

Toxic liquid wastes should be diluted, neutralized and filtered, settled or other wise chemically treated before being discharged into a stream or river or on open land. Under no circumstances should be toxic, corrosive, flammable or volatile materials be discharged into a public drainage system.

Illumination/lighting

The intensity of light source is measured by the standard candle.

This is the light given by a candle, which has been agreed upon so that it is approximately uniform.

The intensity of illumination is measured by the foot-candle. This is the illumination given by a source of one candle to an area one foot away from the source.

For checking illumination, the foot-candle meter is very useful.

Inspectors in determining and measuring illumination at the factory workers bench can use it.

The window glass area of the workroom should be (usually) 15-20 % of the floor area.

Advantage of good lighting

• Safeguards eye sight

• Reduce accident and hazards

• Saves the workers time and cut down the amount of spoiled work and therefore it is economically profitable.

**Good Housekeeping and Maintenance**

This includes cleanliness of the work place, waste disposal and adequate washing, adequate toilet, clean eating facilities, and independent cloakroom. Good housekeeping play a key role in the control of occupational health hazard.

Immediate cleanup of any accidental spill of toxic materials is a very important control measure. A regular clean up schedule preferably using vacuum cleaners or using wet methods when vacuum is not available is an effective method of removing dirt that is probably laden with harmful substances form the work area.

Good house keeping is essential where solvents are store, handled and used. It is also very important to provide a cleaning and maintenance schedule to any work place so that harmful dust may not accumulate on ceilings, pipes, and other objects within the work area. Highly trained individuals under strict supervision must carry out disposal of hazardous materials.

**Facility design**

**Facility**

All facility designs and layout should be in compliance with the Building code 1968, PHA cap 242 and OSHA 2007 Part V1 and any other relevant Acts of parliament. On health, general provisions and the inputs of the user should be put into consideration by ensuring OSH committee is involved in the facility design for approvals and ensuring safety compliance.

The following general requirements should be observed as a minimum:

Cleanliness -Every work place should be kept in a clean state with good drainage, convenient sanitary facilities and without nuisance.

Overcrowding – Health care workers and patients should not be overcrowded in a room where there is risk of disease transmission through contact or respiratory route. Effort should be made to separate people with suspected infectious diseases. Some of the efforts include cough monitoring, and triaging so that such patients are attended to first.

Ventilation – Each workstation should have circulation of fresh air with adequate ventilation such as cross and through ventilation. In specialized units you can have engineered ventilation systems e.g. Negative pressure and Vacuum air conditioning. The facility has to comply with OSHA 2007 ventilation guidelines

Lighting - There should be sufficient and suitable lighting whether natural or artificial in every part of the workplace.

Drainage of Floors – Floors should be drained to ensure they are dry to avoid slips and falls. Floors should be easily washable.

Sanitary convenience - There should be a sufficient number of clean sanitary facilities with sufficient lighting for both sexes. Sanitary facilities should have hand washing areas with running water, soap/ detergent and changing rooms with accommodation for clothing not worn during working hours.

Fire Prevention – All work rooms should be provided with appropriate fire fighting appliances and adequate means of escape, in case of fire for employees.

**Isolation**

Isolation is a creation of barrier mechanical or spatial to prevent transmission of infectious diseases to or from patients, health workers and visitors (Refer to IPC guidelines 2010 page 47). The units are generally provided with barriers that minimize spread of infectious diseases to the environment and the public. Adequate ventilation can also be used to reduce the transmission of airborne infections.

Cohorting can also be used in health facilities that do not have isolation wards (IPC guidelines 2010, pg. 113).

**Workflow**

Facilities should be designed or redesigned to ensure patients move in a unilateral direction to avoid crisscrossing.

When a facility is being designed, the OSH committee should be involved to review the patient flow.

Special units should be placed appropriately within the facility master plan, e.g. theatre. morgue, laundry among others.

**Equipment**

Appropriate consideration should be made for equipment lay out within the facility.

A full list of current and anticipated equipment and their placement should be provided and considered in the facility design or redesign.

Special equipment requirements should be considered during facility design and redesign e.g. bio safety cabinets and equipment mapping and human flow should be reviewed during the design and redesign stage.

Mitigation measures should be made for equipment that emit heat and noise which is hazardous to the health care workers in compliance with OSHA 2007, hazardous substances rules of 2007, (legal notice 60), noise prevention and control rules legal notice 25 of 2005.

In all areas the job must be fitted to the worker to avoid ergonomic injuries.

Equipment with moving parts and potentially easy to fall should be guarded and chained appropriately

CCUPATIONAL HEALTH LAW

This Law provides for measures guaranteeing occupational safety and health (OSH), policies and

compensation for victims of occupational accidents and diseases; responsibilities and rights of

organisations and individuals in respect of OSH and state management for OSH.

THE OCCUPATIONAL SAFETY AND HEALTH ACT, 2007

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4―Approval of codes of practice by Director.

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7―Duty to prepare a safety and health policy statement.

8―Discrimination against employee etc.

9―Safety and health committees.

10―Duty not to charge employees for things done or provided.

11―Safety and health audits.

12―Duties of self employed persons.

13―Duties of employees.

14―Duty to report any dangerous situation.

15―Duty not to interfere with or misuse things provided pursuant tocertain provisions.

16―Prohibition against creation of hazards.

17―General duties of occupiers and self-employed to persons other thantheir employees.

18—Duties of an occupier of a place of work to persons other than hisemployees.

19―General duty of persons in control of certain premises in relation toharmful emissions into atmosphere.

20―Duties of designers, manufacturers importers etc with regard toarticles and substances for use at work.

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22―Notification of occupational diseases.

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24―Research and related activities.

25―Collection of occupation safety and health statistics.

26―Appointment of occupational safety and health officers.

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31―Functions of the technical advisory committee.

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33―Power of an occupational safety and health officer to conductproceedings.

34―Power to take samples.

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61―Construction and disposal of new machinery.

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65―Cranes and other lifting machines.

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67―Steam boilers.

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105―Premises in which steam boilers are used.

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128―Power to direct formal investigation of accidents and cases of disease.

129― Repeal and savings.

**Workers' compensation**

**Workers' compensation** (which formerly was known as **workmen's compensation** until the name was changed to make it gender neutral) is a form of insurance providing wage replacement and medical benefits to employees injured in the course of employment in exchange for mandatory relinquishment of the employee's right to sue his or her employer for the [tort](https://en.wikipedia.org/wiki/Tort) of negligence. The trade-off between assured, limited coverage and lack of recourse outside the worker compensation system is known as "the compensation bargain." One of the problems that the compensation bargain solved is the problem of employers becoming insolvent as a result of high damage awards. The system of collective liability was created to prevent that, and thus to ensure security of compensation to the workers. Individual immunity is the necessary corollary to collective liability.

While plans differ among jurisdictions, [provision](https://en.wikipedia.org/wiki/Provision_(contracting)) can be made for weekly payments in place of wages (functioning in this case as a form of [disability insurance](https://en.wikipedia.org/wiki/Disability_insurance)), compensation for economic loss (past and future), reimbursement or payment of medical and like expenses (functioning in this case as a form of [health insurance](https://en.wikipedia.org/wiki/Health_insurance)), and benefits payable to the dependents of workers killed during employment.

General damage for [pain and suffering](https://en.wikipedia.org/wiki/Pain_and_suffering), and [punitive damages](https://en.wikipedia.org/wiki/Punitive_damages) for employer [negligence](https://en.wikipedia.org/wiki/Negligence), are generally not available in workers' compensation plans, and negligence is generally not an issue in the case.

Origin and international comparison

Laws regarding workers compensation vary by country, but the Workers' Accident Insurance system put into place by [Otto von Bismarck](https://en.wikipedia.org/wiki/Otto_von_Bismarck) in 1881 is often cited as a model for Europe and later the United States.

**Statutory no-fault compensation**

Workers' compensation statutes are intended to eliminate the need for litigation and the limitations of common law remedies by having employees give up the potential for pain- and suffering-related awards, in exchange for not being required to prove [tort](https://en.wikipedia.org/wiki/Tort) (legal fault) on the part of their employer. The laws provide employees with monetary awards to cover loss of wages directly related to the accident as well as to compensate for permanent physical impairments and medical expenses.

The laws also provide benefits for dependents of those workers who are killed in work-related accidents or illnesses. Some laws also protect employers and fellow workers by limiting the amount an injured employee can recover from an employer and by eliminating the liability of co-workers in most accidents. US state statutes establish this framework for most employment. US federal statutes are limited to federal employees or to workers employed in some significant aspect of interstate commerce.[[2]](https://en.wikipedia.org/wiki/Workers%27_compensation#cite_note-2)

The exclusive remedy provision states that workers compensation is the sole remedy available to injured workers, thus preventing employees from also making tort liability claims against their employers.

**Common law remedies**In common law nations, the system was motivated by an "unholy trinity" of tort defenses available to employers, including contributory negligence, assumption of risk, and the fellow servant rule.

Common law imposes obligations on employers to provide a safe workplace, provide safe tools, give warnings of dangers, provide adequate co-worker assistance (fit, trained, suitable "fellow servants") so that the worker is not overburdened, and promulgate and enforce safe work rules.[[](https://en.wikipedia.org/wiki/Workers%27_compensation#cite_note-hood-4)

Claims under the common law for worker injury are limited by three defenses afforded employers:

* The Fellow Servant Doctrine is that employer can be held harmless to the extent that injury was caused in whole or in part by a peer of the injured worker.
* Contributory negligence allows an employer to be held harmless to the extent that the injured employee failed to use adequate precautions required by ordinary prudence.
* Assumption of risk allows an employer to be held harmless to the extent the injured employee voluntarily accepted the risks associated with the work.

The Work Injury Benefits Act, 2007

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11―Accident outside Kenya.

12―Accidents during training for or performance of emergency Services.

13―Special circumstances in which Director may refuse award.

14―Special circumstance in which the Director may order compensation.

15―Employee requiring constant assistance.

16―Substitution of compensation for other legal remedies.

17―Claims against third parties.

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19―Compensation not to be alienated.

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23―Inquiry by Director.

24―Particulars in support of claim.

25―Employee to submit to medical examination.

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30―Compensation for permanent disablement

31―Amendment of First Schedule.

32―Compensation for permanent disablement of employee in training.

33―Compensation to employee previously in receipt of compensation.

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35―Amendment of Third Schedule.

36―Payment of compensation.

37―Manner of calculating earnings.

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38―Compensation in respect of scheduled and unscheduled diseases.

39―Presumption regarding cause of occupational disease.

40―Calculation of compensation.

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42― Fixing date of occupational disease.

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46―Conveyance of injured worker.

47―Medical expenses.

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51―Objections and appeals against decisions of the Director.

52―Director‟s reply.

PART IX ― MISCELLANEOUS PROVISIONS

53―Director.

54―False Statements.

55―General Penalty.

56―Regulations.

57―Repeal of Cap.236.

58―Savings.

ENACTED by the Parliament of Kenya, as follows―

PART I ― PRELIMINARY

Short title and commencement. 1. This Act may be cited as the Work Injury Benefits Act, 2007 and shall come into operation on such date as the Minister may, by notice in the Gazette, appoint.

Interpretation. 2. In this Act, unless the context otherwise requires- Cap. 253.

“accident” means an accident arising out of and in the course and scope of an employee‟s employment and resulting in personal injury;

“Board” means the National Labour Board; “compensation” means compensation as provided for under this Act and includes medical aid and any benefit of any nature to which an employee or his dependants may be entitled to under this Act;

“capitalized value” means the total anticipated allowance over a certain period; “Council” means the National Council for Occupational Safety and Health;

“dependant” means a person defined as a dependant in section 6;

“Director” means the Director of Occupational Safety and Health Services; The

5 “earnings” means the remuneration of an employee at the time of the accident calculated in the manner set out in section 37;

“employer” means a person defined as an employer in section 4 and includes a principal; “injury” means a personal injury and includes the contracting of a scheduled disease;

“medical advisory panel” means a panel appointed from medical and occupational health and safety practitioners to advise the Director for purposes of this Act;

“medical aid” means any or all of the benefits specified in sections 45 and 47;

“medical practitioner” means a person appointed by the Director for purposes of section 48 entitled to practice in Kenya under the Medical Practitioners and Dentists Act;

“Minister” means the Minister for the time being responsible for labour matters; “periodical payments” means a periodical payment of compensation in accordance with the provisions of this Act;

“permanent disablement” means permanent injury or disfigurement;

“personal representative” means the executor or other person lawfully appointed to take charge of the estate of a deceased employee and if there is no such person so appointed, any person specially appointed under this Act to make an application on behalf of the deceased employee‟s dependants for compensation, and in other respects, to act as his personal representative for the purposes of this Act; “scheduled disease” means any disease specified in the Second Schedule;

“temporary disablement” means, a condition of temporary nature caused by an accident which results in the loss of or diminution of wage-earning capacity in the work at which such employee was employed at the time of accident; Application. 3. This Act shall apply to all employees, including employees employed by the Government, other than the armed forces, in the same way and to the same extent as if the Government were a private employer.

Meaning of employer. 4.

(1) In this Act, “employer” means any person who employs an employee and includes― (a) the legal personal representative of a deceased employer; (b) any person controlling the business of an employer; and (c) the Government.

(2) If the services of an employee are temporarily lent or let on hire to another person by an employer, the employer is deemed to continue to be the employer of the employee while the employee is working for that other person.

(3) In the case of an employee employed by a club or an association of persons, the trustees of the club or association shall be deemed to be the employer.

(4) For the purposes of the giving or receiving of statements, notices or other documents under this Act, the term “employer” includes the manager, or other duly authorized employee or agent of the employer.

Meaning of employee. 5.(1) In this Act, employee means a person who has been employed for wages or a salary under a contract of service and The Work Injury Benefits Act, 2007 7 includes an apprentice or indentured learner.

(2) Sub-section (1) applies irrespective of whether the contract is expressed or implied, is oral or in writing, and whether the remuneration is calculated by time or by work done and whether by the day, week, month or any longer period and whether the payment is in cash or recognised legal tender.

(3) The following persons shall not be regarded as employees for purposes of this Act― (a) a person whose employment is of a casual nature and who is employed otherwise than for the purposes of the employer‟s trade or business; (b) any person employed outside Kenya save as provided in section 11 of this Act; (c) a member of the employer‟s family dwelling in the employer‟s house or cartilage thereof and not for the purpose of employment; or Cap. 199. (d) a member of the Armed Forces as defined in the Armed Forces Act.

(4) Any reference in this Act to an employee who has been injured shall, when the employee is dead, include a reference to the employee‟s representative or dependants or to any other person to whom or for whose benefit compensation is payable.

Meaning of dependant. 6.

(1) In this Act “dependant” means― (a) the widow or widower of an employee;

(b) a child of the employee who has not attained the age of eighteen years including a posthumous child , a stepchild and an adopted child, adopted prior to the accident, but excluding a child who is married or who is self supporting;

(c) a parent, step-parent or an adoptive parent who adopted such employee if he adopted prior to the accident or death;

(d) a child of the employee not contemplated by paragraph (b);

(e) a brother, sister, half-brother, half-sister or parent, grandparent, or grandchild of an employee; and (f) any other person who at the time of the accident was wholly dependent upon the employee for the necessaries of life.

(2) In the case of an employee who leaves two or more widows, such widows shall be entitled to share such compensation as would be payable to a single widow of the deceased employee.

PART III ― RIGHT TO COMPENSATION

**Right to compensation.**

**10.** (1) An employee who is involved in an accident resulting in the employee‟s disablement or death is subject to the provisions of this Act, and entitled to the benefits provided for under this Act.

(2) An employer is liable to pay compensation in accordance with the provisions of this Act to an employee injured while at work. (

3) An employee is not entitled to compensation if an accident, not resulting in serious disablement or death, is caused by the deliberate and wilful misconduct of the employee.

(4) For the purposes of this Act, an occupational accident or disease resulting in serious disablement or death of an employee is deemed to have arisen out of and in the course of employment if the accident was due to an act done by the employee for the purpose of, in the interests of or in connection with, the business of the employer despite the fact that the employee was, at the time of the accident acting― (a) in contravention of any law or any instructions by or on behalf of his employer; or (b) without any instructions from his employer.

(5) For the purposes of this Act, the conveyance of an employee to or from the employee‟s place of employment for the purpose of the employee‟s employment by means of a vehicle provided by the employer for the purpose of conveying employees is deemed to be in the course of the employee‟s employment. (6) For the purposes of this section, an injury shall only be deemed to result in serious disablement if the employee suffers a degree of permanent disablement of forty percent or more.

**Accident outside Kenya. 11.**

**(1)** If an employer carries on business chiefly in Kenya and an employee ordinarily employed in Kenya is injured in an accident while temporarily deployed outside Kenya, the employee is, subject to subsection (3), entitled to compensation as if the accident had happened in Kenya.

(2) The compensation contemplated in subsection (1) shall be determined on the basis of the earnings the employee would have received if the employee had remained in Kenya. The Work Injury Benefits Act, 2007 12 (3) This section does not apply to an employee who has been deployed outside Kenya- (i) for a continuous period of twelve months or longer; or (ii) for a shorter period, if the employment outside Kenya is expected to last for more than twelve months.

(4) If an employee ordinarily employed outside Kenya by an employer that carries on business chiefly outside Kenya, is injured in an accident while temporarily deployed in Kenya, the employee is not be entitled to compensation under this Act.

(5) An employee deployed in Kenya for a continuous period of twelve months, shall be deemed to be ordinarily employed in Kenya.

**Accidents during training for or performance of emergency Services. 12.** If an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer, is engaged in any organized first aid, ambulance or rescue work, fire-fighting or other emergency service, the accident or disease is for the purposes of this Act, deemed to have arisen out of and in the course of the employee‟s employment.

**Special circumstances in which Director may refuse award. 13.** The Director may refuse to grant compensation under this Act to an employee if― (a) the employee at any time represented to the employer, knowing the information to be false, that he was not suffering from or had not previously suffered from a serious injury or occupational disease or any other serious disease, and such an accident or occupational disease was caused by, or the death resulted from or the disablement resulted from or was aggravated by, such injury or disease; or (b) in the opinion of the Director, the death was caused, or the disablement was caused, prolonged or aggravated by the unreasonable refusal or wilful neglect of the employee to submit to medical aid in respect of any injury or disease, whether caused by the accident or existing before the accident.

**Special circumstances in which the Director may order compensation. 14.** If in a claim for compensation under this Act it appears that the contract of service apprenticeship or learnership of the employee concerned is invalid, the Director may approve compensation for the claim as if the contract was valid at the time of the accident.

**Employee requiring constant assistance. 15.(1**) If an injury in respect of which compensation is payable causes disablement of such a nature that the employee is unable to perform the essential functions of life without the constant assistance of another person, the Director shall grant an allowance in addition to any other benefit provided for under this Act, towards the cost of such help as may be required for a specified period, which allowance shall be reviewed from time to time. (2) The Director may, upon the application of the employee and on good cause shown by the applicant, revise any order made in accordance with sub-section (1).

**Substitution of compensation for other legal remedies. 16**. No action shall lie by an employee or any dependant of an employee for the recovery of damages in respect of any occupational accident or disease resulting in the disablement or death of such employee against such employee‟s employer, and no liability for compensation on the part of such employer shall arise save under the provisions of this Act in respect of such disablement or death.

**Claims against third parties. 17.(**1) If an occupational accident or disease in respect of which compensation is payable, was caused in circumstances resulting in another person other than the employer concerned (in this section referred to as the „third party‟) being liable for damages in respect of such accident or disease- (a) the employee may claim compensation in accordance with this Act and may also institute action for damages in a court against the third party; and (b) the employer or insurer by whom compensation in respect of that accident or disease is payable may institute action in a court against the third party for the recovery of compensation that the employer or insurer, as the case may be, is obliged to pay under this Act. (2) In awarding damages in an action referred to in subsection (1) (a) the court shall have regard to the compensation paid in accordance with this Act. (3) In an action referred to in subsection (1) (b), the amount recoverable may not exceed the amount of damages, if any, which in the opinion of the court would have been awarded to the employee but for the provisions of this Act. (4) For the purposes of this section, compensation includes the cost of medical aid already incurred and any amount paid or payable in accordance with the provision of section 15 and, in the case of an allowance, the capitalized value of the allowance, irrespective of whether a lump sum is at any time paid in lieu of the whole or a portion of such allowance.

**Threats and compulsion. 18.** Any person who threatens an employee or in any manner compels or influences an employee to do something resulting in or directed at the deprivation of that employee‟s right to benefits in terms accordance with this Act commits an offence.

**Compensation not to be alienated. 19**.

(1) Notwithstanding any provision to the contrary in any written law, compensation shall not be― (a) assigned or pledged; (b) capable of attachment or any form of execution under a judgment or order of a court of law; or (c) set off against any debt of the person entitled to the compensation. (2) Any provision of an agreement in terms of which an employee assigns, purports to assign, relinquishes or purports to relinquish any right to benefits in accordance with this Act, shall be void.

**Compensation not to part of deceased employee‟s estate. 20.** Compensation paid under this Act for the death of an employee shall not form part of the employee‟s estate.

**PART V ― COMPENSATION**

**Compensation for temporary total or partial disablement. 28.**

(1) An employee who suffers temporary total disablement due to an accident that incapacitates the employee for three days or longer is entitled to receive a periodical payment equivalent to the employees earnings, subject to the minimum and maximum amounts fixed by the Minister from time to time, after consultation with the Council.

(2) Compensation for temporary partial disablement shall consist of a proportionate amount of the periodical payment calculated as specified in subsection (1).

(3) Periodical payments shall be made for as long as the temporary disablement continues, but not for a period that exceeds twelve months.

(4) An employee is not entitled to receive a periodical payment during any period in which the employee is receiving full pay, as provided for in the Employment Act, or any other law or contract of service. (5) The periodical payment of an employee who is receiving part payment of remuneration shall be reduced so that the employee does not receive more than the employee would otherwise have earned.

**Expiry of compensation for temporary total or partial disablement. 29.**

(1) The right to compensation for temporary, total or partial disablement expires― (a) upon the termination of the disablement or if the employee resumes work ; (b) if the employee resumes any other work at the The Work Injury Benefits Act, 2007 20 same or greater earnings; or (c) if the employee is awarded compensation for permanent disablement. (2) Notwithstanding the provisions of subsection (1), an employee may be awarded additional compensation for temporary, total or partial disablement if― (a) the disablement of the employee concerned recurs or the employer‟s health deteriorates; or (b) the employee receives further medical aid necessitating further absence from his employment, provided that such aid will reduce his disablement.

**Compensation for permanent disablement. 30**

.(1) Compensation for permanent disablement shall be calculated on the basis of ninety six months earnings subject to the minimum and maximum amounts determined by the Minister, after consultation with the Board, and set out in the Third Schedule.

(2) If an employee has sustained an injury specified in the first column of the First Schedule, the employee shall for the purposes of this Act, be deemed to be permanently disabled to the degree set out in the second column of the First Schedule.

(3) If an employee sustains an injury not specified in the First Schedule which leads to permanent disablement, the employee shall be paid such percentage of disablement in respect thereof as in the opinion of a medical doctor will not lead to a result contrary to the guidelines of the First Schedule.

(4) If an injury or serious disablement contemplated in paragraph (a) or (b) has unusually serious consequences for an employee as a result of the special nature of the employee‟s occupation, the Director may determine such higher percentage as the Director shall deem equitable. (5) No payment for temporary disablement in accordance with the provisions of section 29 shall be deducted from compensation payable under this section.

**Amendment of First Schedule. 31.** The Minister may, on the recommendation of the Director and in consultation with the Council, amend the First Schedule by notice in the Gazette: Provided that at least sixty days before any such amendment a notice shall be published in the Gazette stating- (a) the intention to amend the First Schedule and the proposed content of the amendment; and (b) inviting any person who wishes to comment on the proposed amendment to submit such comment in writing to the Director within the period specified in the notice.

**Compensation for permanent disablement of employee in training. 32**. If as a result of an accident an employee sustains permanent disablement and at the time of the accident was an apprentice or in the process of being trained in any trade, occupation or profession, the earnings of the employee shall be calculated on the basis of the earnings to which an employee would normally have been entitled if at the time of the accident the employee had been performing the same work as a person in the same occupation, trade or profession with five years experience.

**Compensation to employee previously in receipt of compensation. 33**.

(1) In awarding compensation to an employee in respect of permanent disablement or in reviewing an award of compensation, the Director may take into account any compensation awarded to the employee in accordance with this Act or any other law, to the employee as a result of the permanent disablement.

(2) If an employee has received compensation for permanent disablement in accordance with this Act and is subsequently injured in an accident resulting in further permanent disablement in respect of which compensation is payable in accordance with this Act, compensation in respect of such further permanent disablement shall be calculated, where applicable, on the basis of the earnings that the employee received at the time of any of the accidents concerned, whichever earnings are more favourable to the employee.

(3) An employee shall not be paid compensation in respect of one or more accidents if it amounts to more than the compensation payable in respect of permanent total disablement.

**Amount of compensation in case of death. 34.**

**(**1) If an employee dies as a result of an injury caused by an accident, compensation shall be paid to the dependants of the employee in accordance with the provisions of the Third Schedule, subject to the maximum and minimum amount determined by the Minister after consultation with the Council.

(2) No amount may be deducted from the compensation awarded under this section to a dependant in respect of any compensation awarded to the employee in respect of the same or any other accident.

(3) For the purposes of this section, a dependant is deemed to have been wholly financially dependent upon the employee at the time of the accident, unless the contrary is proved.

(4) In addition to the compensation payable under this section, the employer is liable to pay reasonable expenses for the funeral of the deceased employee subject to the maximum amount determined by the Minister, after consultation with the Council

**Amendment of Third Schedule. 35.** The Minister may, on the recommendation of the Director, and after consultation with the Board, amend the Third Schedule by notice in the Gazette in respect of the nature, extent, minimum and maximum amount of benefits― Provided that at least sixty days before any such amendment a notice shall be published in the Gazette – (a) of the intention to amend and the proposed content of the amendment; and (b) inviting any person who wishes to comment on the proposed amendment to submit such comment in writing to the Director within the period specified in the notice. **Payment of compensation. 36.**

(1) Compensation payable in accordance with the provisions of this Act may, for reasons deemed by the Director to be sufficient, be― (a) paid to the employee or the dependant of an employee entitled thereto, or to any other person on behalf of such employee or dependant, in instalments or in such other manner as the Director may deem fit; (b) invested or applied to the advantage of the employee or the dependants of an employee; (c) paid to the Public Trustee to be applied for the benefit of the dependants of a deceased employee; or (d) applied as specified in paragraphs (a), (b)and (c).

(2) On the death of an employee the unpaid balance of any compensation awarded to the employee does not form part of the employee‟s estate and shall be paid to the employee‟s dependants as specified in the Third Schedule.

(3) Where there is no dependant, the Director may authorise payment of the balance of the compensation to the estate of the deceased.

**Manner of calculating earnings.**

**37.(1)** In order to determine compensation, the earnings of an employee are deemed to be the monthly rate at which the employee was being remunerated by the employer at the time of the accident, including-

(a) the value of any rations, living quarters or both supplied by the employer to the employee to the date of the accident or report of disease; (b) allowances paid regularly; and (c) any overtime payment or other special remuneration of a regular nature or for work ordinarily performed; but excluding― (i) payment for intermittent overtime; (ii) payment for non-recurrent occasional services; (iii) amounts paid by an employer to an employee to cover any special expenses; and (iv) ex-gratia payments whether by the employer or any other person.

(2) If an employee‟s remuneration is not consistent or is determined in accordance with a rate calculated on the basis of work performed, the employee‟s earnings shall be calculated on the basis of average remuneration for similar work on the same conditions of remuneration for the period of twelve months prior to the accident.

(3) If by reason of the short duration of the service of an employee with his employer it is impracticable to calculate the employees earnings in such service, the earnings shall, if possible, be calculated on the basis of the amount which― (a) the employee with similar work at the same conditions of remuneration earned with another employer during the twelve months immediately prior to the accident; or (b) during the twelve months immediately prior to the accident was earned by other employees of the first-mentioned employer with similar work and on the same conditions of remuneration, or would have been earned by the employee during the previous twelve months had the employee been so employed. (4) If an employee has entered into contracts of service with two or more employers and has in terms of those contracts, worked at one time for one employer and at another time for another employer, the employee‟s earnings shall be calculated as if the earnings under all such contracts were earnings in the employment of the employer for whom the employee was working at the time of the accident.

(5) If in the opinion of the Director it is not practicable to calculate the earnings of an employee in accordance with the subsections (2), (3) and (4), the Director may calculate those earnings in such manner as the Director may deem equitable, but with due regard to the principles laid down in those provisions. (6) This section shall not be construed as prohibiting the calculation of earnings on a weekly basis, but where earnings are so calculated the monthly earnings shall be calculated, as equal to four and one third times the amount of such weekly earnings.

**WORK RELATED INJURIES AND ACCIDENTS**

**What is a work-related accident?**

A work-related accident is any unintended event that occurs in the course of work (excluding domestic work) that leads to an injury or condition.

It can also be a Dangerous Occurrence, an Occupational Disease or:

* Traffic accidents that happen at the workplace or in the course of work, e.g. a traffic accident while commuting to work on company transport.
* Accidents that are incidental to or from work, e.g. slipping and falling within the workplace but when not performing official work duties.
* Conditions of a medical nature, such as heart attacks or strokes, that may be triggered by work

**10 of the Most Common Workplace Accidents**

Each year, approximately three percent of employees in the American workforce suffer a work-related injury or illness. This is according to the [U.S. Occupational Safety and Health Administration (OSHA)](https://www.osha.gov/oshstats/commonstats.html), which also regularly releases data on the most-common causes of work-related injuries and fatalities. OSHA’s data indicate that the following are among the most common workplace accidents resulting in serious and fatal injuries:

* [Car Accidents](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/work-related-car-accidents/)
* [Small Truck and Van Accidents](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/work-related-truck-and-van-accidents/)
* [Large Truck Accidents (18-Wheelers and Tractor Trailers)](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/workers-compensation-truck-accidents/)
* [Slips, Trips and Falls](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/workplace-slips-trips-falls/)
* [Falls from Heights (Ladders, Scaffolding, Roofing, and Unprotected Falls)](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/falls-height-workplace/)
* [Hand Tool and Power Tool Accidents](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/hand-tool-power-tool-accidents/)
* [Equipment and Machinery Accidents](http://workinjurysource.com/what-you-need-to-know/types-of-accidents/heavy-equipment-machinery-accidents/)
* Lifting Accidents
* Electrocutions
* **Construction Site Accidents**
  1. Slips, Trips and Falls

This type of work accident may affect an employee in any field. Wet floors, objects in walkways, defective stairs and other hazards may cause an employee to slip, trip and/or fall. This can cause broken bones, sprains, head trauma and other injuries.

* 1. Falls from Heights

Workers in construction and other fields where they must work on elevated surfaces, such as scaffolding or ladders, may be at risk of falling. These are a common cause of workplace injuries and may have catastrophic consequences for a worker, causing brain damage, paralysis, multiple broken bones and more.

* 1. Construction Accidents

Widely recognized as one of the most dangerous fields, construction is associated with a number of different types of workplace accidents. According to the Occupational Safety and Health Administration (OSHA), the "fatal four" construction accidents are: electrocution, falls, struck-by objects and caught-in or between accidents.

* 1. Fires and Explosions

Explosions and fires are extremely serious incidents that can cause numerous injuries or fatalities, depending on the scope and environment. Workers at plants, oil fields and chemical storage facilities may be at risk of suffering injury in these accidents.

* 1. Industrial Accidents

These work-related accidents may affect plant employees, oil field workers, mill workers and manufacturing facilities. Some examples may include falls from heights, injuries caused by falling objects, electrical hazards, heavy machinery malfunction and chemical exposure.

* 1. Work-Related Auto Accidents

Employees who operate or work in close proximity to motor vehicles may experience serious injuries in auto accidents. Delivery drivers, truck drivers, construction workers and others may have workers' compensation claims for these collisions.

* 1. Heavy Machinery Accidents

When workers must perform their job duties using or working in close proximity to heavy machinery, power tools and other equipment, they may be at risk of catastrophic injuries if an accident occurs. Some examples include: machine entanglement, crush injuries, assembly line accidents, electrical accidents and equipment malfunction.

* 1. Chemical Exposure Accidents

Employees who work with hazardous chemicals could be in danger of suffering chemical burns, eye injury, respiratory injuries and neurological damage if exposed to these. Some chemicals and other hazardous substances, such as asbestos, can cause cancer and other life-threatening medical conditions if workers are exposed.

* 1. Falling Object Accidents

Workers in warehouses, at construction sites and even retail stores could be injured by falling objects. These accidents may occur if cargo, retail items, tools and other supplies are not properly secured on higher surfaces, striking and injuring workers below.

* 1. Oil Field Accidents

The oil and gas industry has a strong presence in Texas and is known as one of the most dangerous fields to work in. Roustabouts, derrick operators, rotary drill operators, pumpers and all other types of workers may be in danger of injury in accidents caused by safety violations, equipment malfunction or simply unforeseen circumstances.

**Evolution of models of accident causation**

The history of accident models to date can be traced from the 1920s through three distinct

phases ;

· Simple linear models

· Complex linear models

· Complex non-linear models.

Each type of model is underpinned by specific assumptions:

· The simple linear models assume that accidents are the culmination of a series of events or circumstances which interact sequentially with each other in a linearfashion and thus accidents are preventable by eliminating one of the causes in the linear sequence.

· Complex linear models are based on the presumption that accidents are a result of a combination of unsafe acts and latent hazard conditions within the system which follow a linear path. The factors furthest away from the accident are attributed to actions of the organisation or environment and factors at the sharp end being where humans ultimately interact closest to the accident; the resultant assumption being that accidents could be prevented by focusing on strengthening barriers and defences.

· The new generation of thinking about accident modelling has moved towards recognising that accident models need to be non-linear; that accidents can be thought of as resulting from combinations of mutually interacting variables which occur in real world environments and it is only through understanding the combination and interaction of these multiple factors that accidents can truly be understood and prevented.

1. Simple sequential linear accident models

Simple sequential accident models represent the notion that accidents are the culmination of a series of events which occur in a specific and recognisable order (Hollnagel, 2010) and now represent the “commonest and earliest model of accident research ... that describing a temporal sequence” where the “accident is the overall description of a series of events, decisions and situations culminating in injury or damage .. a chain of multiple events”

1. Heinrich’s Domino Theory

The first sequential accident model was the ‘Domino effect’ or ‘Domino theory’ (Heinrich, 1931). The model is based in the assumption that: the occurrence of a preventable injury is the natural culmination of a series of events or circumstances, which invariably occur in a fixed or logical order … an accident is merely a link in the chain.

This model proposed that certain accident factors could be thought of as being lined upsequentially like dominos. Heinrich proposed that an:

… accident is one of five factors in a sequence that results in an injury … an injury is invariably

caused by an accident and the accident in turn is always the result of the factor that immediately

precedes it. In accident prevention the bull’s eye of the target is in the middle of the sequence – an

unsafe act of a person or a mechanical or physical hazard .

Heinrich’s five factors were:

* Social environment/ancestry
* Fault of the person
* Unsafe acts, mechanical and physical hazards
* Accident
* Injury.

Extending the domino metaphor, an accident was considered to occur when one of the dominos or accident factors falls and has an ongoing knock-down effect ultimately resulting in an accident

Based on the domino model, accidents could be prevented by removing one of the factors and so interrupting the knockdown effect. Heinrich proposed that unsafe acts and mechanical hazards constituted the central factor in the accident sequence and that removal of this central factor made the preceding factors ineffective. He focused on the human factor, which he termed “Man Failure”, as the cause of most accidents. Giving credence to this proposal, actuarial analysis of 75,000 insurance claims attributed some 88% of preventable accidents to unsafe acts of persons and 10% to unsafe mechanical or physical conditions, with the last 2% being acknowledged as being unpreventable giving rise to Heinrich’s chart of direct and proximate causes

Ii Bird and Germain’s Loss Causation model The sequential domino representation was continued by Bird and Germain (1985) who acknowledged that the Heinrich’s domino sequence had underpinned safety thinking for over 30 years. They recognised the need for management to prevent and control accidents in what were fast becoming highly complex situations due to the advances in technology. They developed an updated domino model which they considered reflected the direct management relationship with the causes and effects of accident loss and incorporated arrows to show the multi-linear interactions of the cause and effect sequence. This model became known as the Loss Causation Model and was again represented by a line of five dominos, linked to each other in a linear sequence

1. Complex linear models

Sequential models were attractive as they encouraged thinking around causal series. They focus on the view that accidents happen in a linear way where A leads to B which leads to C and examine the chain of events between multiple causal factors displayed in a sequence usually from left to right. Accident prevention methods developed from these sequential models focus on finding the root causes and eliminating them, or putting in place barriers to encapsulate the causes. Sequential accident models were still being developed in the 1970’s but had begun to incorporate multiple events in the sequential path. Key models developed in this evolutionary period include energy damage models, time sequence models, epidemiological models and systemic models.

i. Energy-damage models The initial statement of the concept of energy damage in the literature is often attributed to Gibson (1961) but Viner (1991, p.36) understands it to be a result of discussions between Gibson, Haddon and others. The energy damage model is based on the supposition that “Damage (injury) is a result of an incident energy whose intensity at the point of contact with the recipient exceeds the damage threshold of the recipient

In the Energy Damage Model the hazard is a source of potentially damaging energy and an accident, injury or damage may result from the loss of control of the energy when there is a failure of the hazard control mechanism. These mechanisms may include physical or structural containment, barriers, processes and procedures. The space transfer mechanism is the means by which the energy and the recipient are brought together assuming that they are initially remote from each other. The recipient boundary is the surface that is exposed and susceptible to the energy. (Viner, 1991)

1. Time sequence models

Benner (1975) identified four issues which were not addressed in the basic domino type model: (1) the need to define a beginning and end to an accident; (2) the need to represent the events that happened on a sequential time line; (3) the need for a structured method for discovering the relevant factors involved; and (4) the need to use a charting method to define events and conditions. Viner’s Generalised Time Sequence Model is an example of a time sequence model that addresses Benner’s four requirements.

Viner considers that the structure for analysing the events in the occurrence-consequence sequence provided by the time sequence model draws attention to counter measures that may not otherwise be evident. In Time Zone 1 there is the opportunity to prevent the event occurring. Where there is some time between the event initiation and the event, Time Zone 2 offers a warning of the impending existence of an event mechanism and the opportunity to take steps to reduce the likelihood of the event while in Time Zone 3 there is an opportunity to influence the outcome and the exposed groups.

While Viner takes a strictly linear approach to the time sequence Svenson takes a more complex approach in his Accident Evolution and Barrier Function (AEB) model. The AEB model analyses the evolution of an accident as a series of interactions between human and technical systems and is visualised as a flow chart. Svenson considers that the required analysis can only be performed with the simultaneous interaction of human factors and technical experts. (Svenson, 2001)

Iii. Epidemiological models

Epidemiological accident models can be traced back to the study of disease epidemics and the search for causal factors around their development. Gordon (1949) recognised that “injuries, as distinguished from disease, are equally susceptible to this approach”, meaning that our understanding of accidents would benefit by recognising that accidents are caused by:

a combination of forces from at least three sources, which are the host – and man is the host of principal interest – the agent itself, and the environment in which host and agent find themselves.

Recognising that doctors had begun to focus on trauma or epidemiological approaches, engineers on systems, and human factors practitioners on psychology Benner (1975); considered these as only partial treatments of entire events rather than his proposed entire sequence of events. Thus Benner contributed to the development of epidemiological accident modelling which moved away from identifying a few causal factors to understanding how multiple factors within a system combined. These models proposed that an accident combined agents and environmental factors which influence a host environment (like an epidemic) that have negative effects on the organism (a.k.a. organisation)

Reason (1987) adopted the epidemiological metaphor in presenting the idea of ‘resident pathogens’ when emphasising:

the significance of causal factors present in the system before an accident sequence actually begins

… and all man-made systems contain potentially destructive agencies, like the pathogens within the

human body

The term became more widely known as ‘latent errors’, then changed to ‘latent failures’ evolving further when the term ‘latent conditions’ became preferred.

Accident prevention methods matching an epidemiological accident model focus on performance deviations and understanding the latent causes of the accident. These causes might be found in deviations or unsafe acts and their suppression or elimination can prevent the accident happening again. Errors and deviations are usually seen by OHS professionals in a negative context, and programs such as ‘safe behaviour’ methodologies attempt to ensure that strict rules and procedures are always followed. However safety prevention thinking is moving to an understanding that systems should be resilient enough to withstand deviations or uncommon actions without negative results.

Iv Systemic models

By the 1980s OHS researchers realised that previous accident models did not reflect any realism as to the true nature of the observed accident phenomenon. As noted by Benner:

one element of realism was non-linearity … models had to accommodate non-linear events. Based

on these observations, a realistic accident model must reflect both a sequential and concurrent nonlinear course of events, and reflect events interactions over time . .

This was supported by Rasmussen (1990) who, whilst quoting Reason’s (1990) resident pathogens, acknowledged that the identification of events and causal factors in an accident are not isolated but “depend on the context of human needs and experience in which they occur and by definition ... therefore will be circular” (p. 451).

Systemic accident models which examined the idea that systems failures, rather than just human failure, were a major contributor to accidents (Hollnagel, 2004) began to address some of these issues (but not non-linear concepts) and recognised that events do not happen in isolation of the systemic environment in which they occur.

Accident models also developed with further understanding of the role of humans, and in particular the contribution of human error, to safety research. A skill-rule-knowledge model of human error was developed in the earlier work of Rasmussen & Jensen (1974) and has remained a foundation concept for understanding of how human error can be described and analysed in accident investigation. Research by Rouse (1981) contributed to the understanding of human memory coding, storage and retrieval. Cognitive science came to the fore in accident research, and further work by Rasmussen (1981; 1986) and Reason (1979; 1984a; 1984b; 1984c) saw the widespread acceptance and recognition of the skillb ased, rule-based and knowledge-based distinctions of human error in operations.

Rasmussen (1990) wrote extensively on the problem of causality in the analysis of accidents introducing concepts gleaned from philosophy on the linkage between direct cause-effect, time line and accident modelling. Rasmussen explored the struggle to decompose real world events and objects, and explain them in a causal path found upstream from the actual accident where latent effects lie dormant from earlier events or acts. At this stage, Rasmussen recognised that socio-technical systems3 were both complex and unstable. Any attempt to discuss a flow of events does not take into account:

closed loops of interaction among events and conditions at a higher level of individual and organizational adaption … with the causal tree found by an accident analysis is only a record of one past case, not a model of the involved relational structure” .

In calling for a new approach to the analysis of causal connections found in accident reports Rasmussen heralded in a more complex approach to graphically displaying accidents and understanding and capturing the temporal, complex system and events surrounding accident causation.

Reason’s early work in the field of psychological error mechanisms was important in this discussion on complexity of accident causation. By analyzing everyday slips and lapses he developed models of human error mechanisms

Reason (1990) went on to address the issue of two kinds of errors: active errors and latent errors. Active errors were those “where the effect is felt almost immediately” and latent errors “tended to lie dormant in the system largely undetected until they combined with other factors to breach system defences” (p. 173).

Reason, unlike Heinrich (1931) and Bird and Germain (1985) before him, accepted that accidents were not solely due to individual operator error (active errors) but lay in the wider systemic organisational factors (latent conditions) in the upper levels of the organisation. Reason’s model is commonly known as the Swiss Cheese Model

Unlike the modelling work of Heinrich (1931) and Bird and Germain (1985), Reason did not specify what these holes represented or what the various layers of cheese represented.

The model left the OHS professional to their own investigations as to what factors within the organisation these items might be.

The “Swiss Cheese” model was only one component of a more comprehensive model hetitled the Reason Model of Systems Safety

c Complex non linear accident models

There has been considerable overlap in the development of the various conceptual approaches to accident causation. In parallel with the development of thinking around epidemiological models and systemic models the thinking around the complexity of accident causation led to non complex linear models. Key researchers in this approach have been Perrow, Leveson and Holnagel. The implications of recent discussions on complexity and ‘drift’ are briefly considered.

In the early 1980s Perrow began to argue that technological advances had made systems not only tightly coupled but inheritably complex, so much so that he termed accidents in these systems as being “normal”. Perrow’s normal accident theory postulated that tightly coupled systems had little tolerance for even the slightest disturbance which would result in unfavourable outcomes. Thus tightly coupled systems were so inherently unsafe that operator error was unavoidable due the way the system parts were tightly coupled.

Components in the system were linked through multiple channels, which would affect each other unexpectedly, and with the complexity of the system meaning that it was almost impossible to understand it .

Two new major accident models were introduced in the early 2000s with the intention of addressing problems with linear accident models):

· The Systems-Theoretic Accident Model and Process (STAMP)

· The Functional Resonance Accident Model (FRAM)

1. Systems-Theoretic Accident Model and Process (STAMP)

Leveson’s model considered systems as “interrelated components that are kept in a state of dynamic equilibrium by feedback loops of information and control” .. It emphasised that safety management systems were required to continuously control tasks and impose constraints to ensure system safety. This model of accident investigation focused on why the controls that were in place failed to detect or prevent changes that ultimately lead to an accident. Leveson developed a classification of flaws method to assist in identifying the factors which contributed to the event, and which pointed to their place within a looped and linked system. Leveson’s model expands on the barriers and defences approach to accident prevention and is tailored to proactive and leading safety performance indicators. However this model has had little up take in the safety community and is not widely recognised as having a major impact on accident modelling or safety management generally

1. Functional Resonance Accident Model (FRAM)

Erik Holnagel is one of the more forward thinking researchers in the area of accident modelling and the understanding of causal factors. While Hollnagel’s early published work centred on human/cognitive reliability and human/machine interface his more recent work Barriers and Accident Prevention (2004) challenged current thinking about accident modelling. He introduced the concept of a three dimensional way of thinking about accidents in what is now known to be highly complex and tightly coupled socio-technical systems in which people work. He describes systemic models as tightly coupled and the goals of organisations as moving from putting in place barriers and defences to focusing on systems able to monitor and control any variances, and perhaps by allowing the systems to be (human) error tolerant.

Hollnagel’s Functional Resonance Accident Model (FRAM) is the first attempt to place accident modelling in a three-dimensional picture, moving away from the linear sequential models, recognising that “forces (being humans, technology, latent conditions, barriers) do not simply combine linearly thereby leading to an incident or accident”

**Risk assessment, evaluation and management.**

Risk management

Risk means the probability of occurrence of an adverse effect from a substance on people or the environment combined with the magnitude of the consequence of that adverse effect (OSHA 2007 section 2). The purpose of risk management is to bring the risk to acceptable levels (Acceptable risk).

The process of risk management includes hazard identification, risk assessment and risk control.

Hazard Identification

There are many methods of hazard identification. For the purpose of these guidelines the following approach is recommended:

• Inspection of the workplace using a workplace inspection checklist and conducting a walk-through survey;

• Job hazard analysis;

• Reviewing the accident, incident and ill-health records;

• Asking the workers or their representatives on the hazards theyencounter

• Following the manufacturers’ instruction/ materials/ safety data sheets,and decide who might be harmed and how: Pay particular attention to young persons; persons with disabilities; inexperienced workers and lone workers.

• Develop hazard / risk register

Risk assessment

Risk assessment is a process of making a determination of how safe a situation is and then making judgement of the acceptability of a risk. The following guidelines are recommended:

When is risk assessment done?

a. Any time there is new or redeployed / transfer of staff/ equipment/ method

b. Any time there is an accident/ incident or near miss

c. At scheduled annual risk assessments

d. During maintenance activities

e. During disposal of equipment

How does one carry out risk assessment?

f. Use risk assessment tools

g. Consider whether to carry out the assessment for the whole facility/department/ machinery or specific procedure

h. Identify the gaps

i. Analyze the data generated

j. Determine if the risk is high, moderate or low.

k. Develop mitigation plans and budget

Who conducts the risk assessment?

l. OSH committee at different facility level

m. COSH Focal person

n. Sub County OSH representative

o. DOSHS approved auditors

p. Constitute a risk assessment team which should include the user in specific cases.

**Risk control**

Determine the nature and severity of the risk, who is affected and the frequency of the risk. The following methods are recommended to mitigate the risks identified:

q. Eliminate the hazard.

r. Substitute the hazard

s. Isolation

t. Use engineering controls

u. Use administrative controls

v. Use personal protective equipment (PPE)

OCCUPATIONAL MEDICINE

Occupational epidemiology

**Occupational epidemiology** is a subdiscipline of [epidemiology](https://en.wikipedia.org/wiki/Epidemiology) that focuses on investigations of workers and the workplace. Occupational epidemiologic studies examine health outcomes among workers, and their potential association with conditions in the workplace including noise, chemicals, heat, or radiation, or work organization such as schedules.

The need for evidence to inform occupational safety regulations, [workers' compensation](https://en.wikipedia.org/wiki/Workers%27_compensation) programs, and safety legislation motivated the development of public health policy, occupational epidemiology methods, and surveillance mechanisms. Occupational epidemiological research can inform [risk assessments](https://en.wikipedia.org/wiki/Risk_assessment); development of standards and other risk management activities; and estimates of the co-benefits and co-harms of policies designed to reduce risk factors or conditions that can affect human health. Occupational epidemiology methods are common to methods used in [environmental epidemiology](https://en.wikipedia.org/wiki/Environmental_epidemiology)

**Types of studies**

**Case series**

Typically occupational epidemiological investigations begin with the observation of an unusual number of cases of disease among a group of workers. When the investigation does not go further than what is referred to as identifying a disease cluster, the study is referred to as a case series report.

**Cohort studies**

In a cohort design study, a population, or cohort, of workers is compared to a control group that was not exposed to the workplace hazards being investigated. This type of study is the most accepted in the scientific community because it most closely follows experimental strategy and observes the entire population rather than a sample. In a prospective cohort study, the group examined at the time of the study is compared to a follow up with the same group in the future. The historical cohort study design begins with defining a cohort at a time in the past and following the cohort over historical time.

**Case-control studies**

Case-control studies compare the past exposure of cases with the disease to the past exposure of cases that did not have the disease. Because cohort studies require the entire population, case-control studies are a more cost-effective approach, using only the sample of workers with the disease to compare to a control.

**Cross-sectional studies**

A typical cross-sectional study involves the comparison of varying degrees of exposure and the prevalence of disease, symptoms, or physiological status. The main advantage of cross-sectional studies is that they allow collection of data on conditions which would not be recorded normally because other study designs focus on severe states of disease. This is also the biggest shortcoming of this study type because by using prevalence rather than incidence it cannot be used to make a causal inference.[5][6]

**Application**

By contributing to reduction in exposure, occupational epidemiology helps reduce health risks among workers. Using occupational epidemiological methods can also have benefits for society at large. For example, recommendations for exposure limits to benzene developed by the Expert Panel on Air Quality Standards were based on occupational epidemiology.[6]

Using meta-analysis, many occupational epidemiology studies can be synthesized in order to help set occupational exposure limits and make other kinds of policy decisions. This can also can be applied in health risk assessments, which is a method of predicting health risk based on hypothetical exposure conditions

**Occupational diesaes**

An occupational disease is a health condition or disorder (e.g., cancer, musculoskeletal disorders, post-traumatic stress, etc.) that is caused by your work environment or activities related to your work. In general, health conditions or disorders that occur among a group of people with similar occupational exposures at a higher frequency than the rest of the population are considered to be occupational diseases

Several definitions of the term “occupational disease” exist. However, for the purpose of the Protocol of 2002 to the Occupational Safety and Health Convention of International Labour Organisation (ILO), the term ‘occupational disease’ covers any disease contracted as a result of an exposure to risk factors arising from work activity” (Article 1 (b)) [[1]](https://oshwiki.eu/wiki/Introduction_to_occupational_diseases#cite_note-one-1). The ILO Employment Injury Benefits Recommendation (1964, Article 6, (1)) defines occupational diseases more precisely in the following terms: “Each Member should, under prescribed conditions, regard diseases known to arise out of the exposure to substances and dangerous conditions in processes, trades or occupations as occupational diseases.” [[2]](https://oshwiki.eu/wiki/Introduction_to_occupational_diseases#cite_note-two-2) The various definitions, however, have two main mandatory elements in common [[3]](https://oshwiki.eu/wiki/Introduction_to_occupational_diseases#cite_note-three-3)

1. the causal relationship between exposure in a specific working environment or work activity and a specific disease; and,
2. the fact that the disease occurs among the group of exposed persons with a higher frequency rate than in the rest of the population, or in other worker populations.

The causal relationship is established on the basis of clinical and/or pathological data, occupational background and job analysis, identification and evaluation of occupational risk factors and of the role of other risk factors [[4]](https://oshwiki.eu/wiki/Introduction_to_occupational_diseases#cite_note-four-4). As a general rule, the symptoms are not sufficiently characteristic to allow an occupational disease to be diagnosed without the knowledge of the physical, chemical, biological and/or other risk factors encountered in the exercise of an [occupation](https://oshwiki.eu/wiki/Sectors_and_occupations). The recognition of an occupational disease is a specific example of clinical decision-making or applied clinical epidemiology. Deciding on the pathology of a disease is not an “exact science” but rather a question of judgement based on a critical review of all the available evidence. This should include the strength of association, consistency, specificity, time sequence or biological gradient (the greater the level and duration of the exposure, the greater the severity of the diseases or their incidence)  The World Health Organisation will detail information (including diagnostic criteria) on disease with occupational origin in the 11th revision of its International Statistical Classification of Diseases and Related Health Problems (ICD11) to be released in 2015

**Further definitions concerning occupational and work-related diseases**

**Reportable occupational diseases:** Occupational diseases mentioned in national lists as part of national laws or administrative provisions liable for [compensation](https://oshwiki.eu/wiki/Workers%E2%80%99_compensation_and_economic_incentives) and subject to [prevention measures](https://oshwiki.eu/wiki/Prevention_and_control_strategies). Reported occupational diseases are reportable diseases already passed through the legally required reporting process.  
**Recognised occupational disease:** A recognised case of an occupational disease is a case accepted as such by a competent national authority in an administrative proceeding    
**Work-related diseases:** [All illnesses](https://oshwiki.eu/wiki/Burden_of_occupational_diseases) that can be caused, worsened or jointly caused by working conditions. A case of work-related illness does not necessarily refer to recognition by an authority whereas occupational diseases have a specific or a strong relation to the occupation, generally with only one causal agent while work-related diseases have a complex aetiology. Among their multiple causal agents, factors arising from the work and/or working environment play a role in the development of such diseases. A more precise distinction between occupational diseases and work-related diseases can be made by evaluating their attributable fractions. It is suggested that the attributable fraction of occupational diseases is more than 50% and less than 50% for work-related diseases

**ILO List of Occupational Diseases (revised 2010)**

The 1996 ILO code of practice claims that each government should formulate, implement and periodically review a coherent national policy and principles on the [recording, notification](https://oshwiki.eu/wiki/Reporting_and_monitoring_occupational_accidents_and_diseases_in_Europe) and investigation of occupational diseases . As a part of this policy, a national list of occupational diseases should be established. This list should comprise, to the extent possible, the diseases appearing in the ILO list of occupational diseases. The ILO list is regularly reviewed and updated at tripartite meetings of experts convened by the Governing Body of the ILO. The national lists of occupational diseases should be reviewed and updated with due regard to the most up-to-date ILO list (most currently adopted in 2010). The list includes a range of internationally recognized occupational diseases, from illnesses caused by [chemical, biological](https://oshwiki.eu/wiki/Dangerous_substances_(chemical_and_biological)) and [physical](https://oshwiki.eu/wiki/Physical_agents) agents to respiratory and [skin diseases](https://oshwiki.eu/wiki/Work-related_skin_diseases), [musculoskeletal disorders](https://oshwiki.eu/wiki/Introduction_to_musculoskeletal_disorders) and [occupational cancer](https://oshwiki.eu/wiki/Work-related_cancer). [Mental](https://oshwiki.eu/wiki/Mental_health_at_work) and behavioural disorders have also been specifically included in the ILO list. This list also has open items in all the sections dealing with all the aforementioned diseases. The open items allow the recognition of the occupational origin of diseases not specified in the list if a significant association is observed between exposure to risk factors arising from work activities and the disorders contracted by the worker. The sections and subsections of occupational diseases applied in the current list are as follows:

1. Occupational diseases caused by exposure to agents arising from work activities
   1. Diseases caused by [chemical agents](https://oshwiki.eu/wiki/Dangerous_substances_(chemical_and_biological))
   2. Diseases caused by [physical agents](https://oshwiki.eu/wiki/Physical_agents)
   3. [Biological agents and infectious or parasitic diseases](https://oshwiki.eu/wiki/Dangerous_substances_(chemical_and_biological))
2. Occupational diseases by target organ systems
   1. Respiratory diseases
   2. [Skin diseases](https://oshwiki.eu/wiki/Work-related_skin_diseases)
   3. [Musculoskeletal disorders](https://oshwiki.eu/wiki/Introduction_to_musculoskeletal_disorders)
   4. Mental and behavioural disorders
3. [Occupational cancer](https://oshwiki.eu/wiki/Work-related_cancer)
4. Other diseases

The list is not exhaustive to include every occupational disease but rather specifies those considered common to many countries. The list should, therefore, be adapted to local circumstances, and used to help prioritise occupational disease

**Identification of occupational diseases**

Determining if an exposure at the workplace (the “cause”) results in occupational disease (the “effect”) is a complex issue. Many criteria must be considered. One set of criteria that is commonly used is credited to Dr. Bradford Hill from 1965. While Bradford Hill did not intend this list to be used as a checklist, it often is. Rather, he intended these considerations as a starting point saying that “none of my nine viewpoints can bring indisputable evidence for or against the cause-effect hypothesis and none can be required as an essential element or condition. What they can do, with greater or less strength, is to help us to make up our minds on the fundamental question – is there any other way of explaining the set of facts before us, is there any other answer equally, or more, likely than cause and effect?”

**1. Strength of Association**

The stronger the association, the more likely that the relationship is causal. Heavy smoking is associated with 20 times the increased risk of lung cancer and only 2 times the increased risk of coronary heart disease. The association between smoking and lung cancer is far more likely to be causal than the association to heart disease.

**2. Consistency**

The association is consistent when the results are confirmed by different people, in different places, circumstances and times, using different experimental methods. This consideration is why many different studies need to be done before meaningful statements can be made about the causal relationship between two or more factors. For example, it required thousands of highly technical studies of the relationship between cigarette smoking and cancer before a definitive conclusion could be made that cigarette smoking increases the risk of lung cancer.

Tools like a “meta-analysis” means that studies that meet certain inclusion criteria are gathered and analyzed together. The conclusions from meta-analyses are much stronger than those from a single or a few studies.

**3. Specificity of Association**

Specificity of association means that there is a one-to-one relationship between the cause and effect, or one cause equals one effect. An example of specificity of association is mesothelioma (a form of cancer) that is believed to be only caused by asbestos exposure – it is a one to one relationship.

Specificity of association is considered by some to be the weakest criteria of causation. For example, it does not hold true for cigarette smoking and lung cancer. If you smoke you do not have a 100% chance of developing lung cancer. Likewise, if you have lung cancer, it does not mean that there it is 100% certain that you were exposed to cigarette smoke.

**4. Temporal Relationship**

The exposure must always precede (come before) the outcome or effect. This consideration is essential. If smoking is a cause of lung cancer, the smoking must occur before the cancer, not after.

**5. Biological Gradient (Dose-Response Relationship)**

Biological gradient refers to exposure levels and resulting health effects. An increase in the exposure increases the effect or disease incidence; a lower exposure decreases the effect. The presence of a dose-response relationship is strong evidence for a causal relationship. If you consider our smoking and cancer example, light smokers would be less likely to develop lung cancer than moderate smokers and both of these would be less than heavy smokers – this effect is known as a dose-response relationship.

However, a threshold may exist below which the effect of interest will not be seen. Stated another way, the exposure may be so low that the effect is not observed or is very rarely observed – this observation does not mean that the exposure does not cause the effect.

In addition, sometimes a low exposure may produce no effect, a moderate exposure may produce a beneficial effect (e.g., a drug or vitamin) and a high exposure may cause harm.

**6. Plausibility**

Plausibility asks “does the observed relationship make sense considering current scientific knowledge of the pathological processes.” For example, one may, by chance, discover an association between the price of Tim Horton’s donuts and election results in China, but there is not likely to be any logical connection between the two phenomena. Also, consider the concept of latency – was the timing of exposure and disease development biologically plausible?

**7. Coherence**

Coherence means that the association should not conflict with existing theory and knowledge. In other words, it is necessary to evaluate claims of causality within the context of the current state of knowledge within a given field and in related fields. However, remember that research that disagrees with established theory is not necessarily false; it may, in fact, force a reconsideration of accepted beliefs and principles.

The difference in Bradford Hill's definitions of plausibility and coherence is subtle. Plausibility is worded positively (an association should be in line with substantive knowledge). Coherence is verbalised negatively (the association should not conflict with substantive knowledge). Plausibility asks: "Could you imagine a mechanism that, if it had truly operated, would have produced results such as those observed?" By contrast, coherence asks: "If you assume that the established theory is correct, would the observed results fit into that theory?"

**8. Experimental Evidence**

Does experimental evidence support the cause/effect relationship? Can researchers design an experimental study to confirm the observed relationship? In a workplace setting, if the dust in the workshop is reduced or lubricating oils are changed, do you get different results? Is the frequency of associated events (asthma or skin rashes) reduced?

**9. Analogy**

With analogy, knowing that a drug like thalidomide or a virus like Rubella can cause birth defects makes us more willing to accept similar evidence when attributing these effects to a closely related drug or virus.

Current science relies on this type of consideration with information from computer generated structure-activity relationships for chemicals. This type of information helps identify the potential for harm so that expensive human population and animal studies can be more targeted or avoided completely

**factors that contribute to the development of occupational diseases**

Occupational diseases can be caused by:

* Biological agents- bacteria, viruses, fungi, parasites, insects, plants, birds, animals, humans, etc.
* Chemical agents- beryllium, lead, benzene, isocyanates, etc.
* Ergonomic issues- repetitive movements, improper set up of workstation, poor lighting, poor design of tools, etc.
* Physical agents - ionizing and non-ionizing radiation, magnetic fields, pressure extremes (high pressure or vacuum), extreme temperatures, noise, vibration, etc.
* Psychosocial issues- stress, violence, bullying, harassment, lack of recognition, etc.

There are other factors that determine the development of an occupational disease, including:

* Amount of exposure or dose entering the body
* Duration or length of exposure
* Route of entry into the body
* Toxicity of the chemical
* Removal from the body
* Biological variation (individual susceptibility)
* Effects of interaction, such as [synergism](https://www.ccohs.ca/oshanswers/chemicals/synergism.html) (e.g., smoking, alcohol use, exposure to other chemicals).

Exposure to the hazardous agent may occur only once in a while or only in very small amounts, or the exposure may be daily and/or to very large amounts. The number of weeks or years on the job may provide an estimate of the degree of exposure. In general, the higher the exposure (duration and/or amount), the higher the risk of developing a health effect.

See the OSH Answers documents [What Makes Chemicals Poisonous?](http://www.ccohs.ca/oshanswers/chemicals/poisonou.html) and [How Workplace Chemicals Enter the Body](http://www.ccohs.ca/oshanswers/chemicals/how_chem.html) for more information.

**Most Common Occupational Illnesses**

Accidents in the workplace can happen when we least expect them, despite proper safety training and precautions. While some workplaces are more prone to accidents, including construction, factories, and other industrial environments, office workers can also suffer from injuries such as overexertion or repetitive stress injuries. Regardless of how you were injured, any type of work-related illness or injury is eligible for workers’ compensation. If you have been injured at work or suffered a disease, talk to an attorney about how to file a claim.

Below is a list of some of the most common workplace injuries that give rise to workers’ compensation claims.

**Skin Disorders**

Workers who are required to be outdoors for prolonged periods of time have a greater likelihood of having skin cancer. Examples of occupations that require outdoor work include roofers, construction workers, agricultural workers, and more.

Skin diseases can also be caused by exposure to dangerous and harsh chemicals. Painters, cleaners, mechanics, and construction workers are all examples of employees who are in contact with toxic chemicals daily.

Common skin diseases experienced by workers can include:

Eczema

Skin cancer

Skin infections

Contact dermatitis

Rashes

Ulcers

Skin inflammations

**Respiratory Illnesses**

Respiratory problems are common in occupations that are exposed to toxic chemicals. Many workers who work in an industrial setting or on construction sites breathe in dangerous chemicals every day, which can aggravate allergies or cause serious conditions such as mesothelioma.

Examples of respiratory conditions that may be covered under workers’ comp:

Mesothelioma

Pneumonitis

Tuberculosis

Occupational asthma

Silicosis

Pharyngitis

Chronic obstructive pulmonary disease (COPD)

Hearing Loss

Workers who are around loud machinery and excessive noise throughout the day typically experience some type of hearing loss as they age. Despite the use of earmuffs or earbuds, hearing loss is still very common in jobs such as construction work is often accelerated by the exposure to noise.

You will need to undergo a hearing evaluation by a medical professional to help you determine the extent of your injury. In many cases, workers’ compensation may be able to cover the cost of a hearing aid.

Overexertion

Overexertion and injuries caused by strains are common across all industries. From healthcare workers who carry people or heavy objects daily to construction workers who haul heavy materials across construction sites, overexertion is considered one of the top reasons for workers’ comp claims. Workers in warehouses and factories who perform repetitive tasks are also at risk of overexertion.

Common injuries associated with overexertion:

Hernias

Leg injuries

Ankle sprains

Shoulder and back injuries

Joint injuries

**Diseases of the respiratory system**

The respiratory tract and skin are readily accessible to noxious factors in the environment; not surprisingly they account for a high proportion of all work -related disease. The vulnerability of the respiratory organs is increased by the large volume of air, readily contaminated by aerosols, gases and vapours in the workplace, that moves in and out of the lungs. Nevertheless, the possible types of response -acute reaction, chronic inflammation, progressive fibrosis, malignant disease -are limited and nonspecific.

Acute reaction Illness of rapid onset may result from the inhalation of materials that are either active or inactive biologically, the former giving rise to irritative, inflammatory, or asthmatic symptoms and the latter to asphyxia. A number of toxic substances are absorbed through the respiratory tract (e.g., carbon monoxide, cyanides, and many solvents) but have systemic rather than local effects. A few microbial pathogens cause serious pneumonitis in persons whose work brings them into close contact with animals or animal products.

**Q fever and ornithosis** remain common and widespread infections in such groups as farmers, poultry keepers, slaughtermen, hide and wool workers, and employees in zoos, pet shops and animal houses. **Pneumonic plague and anthrax**, with similar epidemiological features, are now virtually unknown in the industrialized countries but no doubt still occur in less developed parts of the world.

Soil infected with Coccidioides immitis and Histoplasma capsulatum continues to cause acute and chronic lung disease in farmers, migrant workers, and construction workers over wide geographical areas, and tuberculosis remains a risk for persons, particularly in the health services, whose work exposes them to infection. In all these diseases, the dominating factors are climatic or socioeconomic. Acute respiratory infections find conditions conducive to rapid spread where large groups of workers live in barracks; such occupational situations may require special measures from the health services. The asphyxiants (e.g., nitrogen, methane, carbon dioxide) and respiratory irritants (e.g., chlorine, ammonia, phosgene, oxides of nitrogen and sulfur, and several heavy metal compounds) are present in a considerable variety of gases and fumes encountered in mining, diving, agriculture, firefighting, and in the chemical and metal industries. Their effects are direct and proportional to their toxicity and the amounts 44 liberated. The epidemiology is generally that of "accident liberated. The epidemiology is generally that of "accident occurrences ", mediated primarily by human error and preventable by appropriate safety procedures.

Finally, there is the growing problem of occupational asthma and allergic alveolitis, the mechanisms of which remain obscure. Whereas most diseases reflect both the "toxicity" and the "dose" of the etiological agent(s) and the susceptibility of the individuals exposed, in the asthma -alveolitis group of illnesses susceptibility appears to be related to a state of hypersensitivity that develops after a latent period of months or years. Virtually all organic products of animal, vegetable, or microbial origin are capable of giving rise to this type of disease reaction in exposed workers; the occupations affected are therefore numerous, especially in the farming, lumber, food, textile, antibiotic and detergent industries. In addition, there are a number of chemicals not of organic origin -formaldehyde, isocyanates, platinum salts, acid anhydrides -that appear exceptionally potent causes of occupational asthma. These substances are encountered mainly in the manufacture and use of foam products, paints, plastics and resins, in soldering, and in medical laboratories. Some are so potent that virtually all persons exposed eventually develop symptoms. The occupational asthmas have received little systematic epidemiological study, partly because their full importance has only recently been recognized and partly because of difficulties in case identification and because affected workers tend to remove themselves from exposure. There is some evidence that familial atopy (often vaguely defined) may influence susceptibility; on the other hand, age, sex, and cigarette smoking, do not appear to be factors of importance. A useful review of acute reactions to inhaled agents is given by Weill & Hendrick.

**Chronic inflammation** Workers in many heavy industries- mines, quarries, foundries, coal distillation, textile mills, building products factories, etc. -are exposed to respirable dust, some of which is fibrogenic and /or carcinogenic. These workers are often exposed also to irritant gases and fumes and to adverse conditions of temperature and humidity; most of them smoke cigarettes, some heavily. Chronic bronchitis and emphysema are highly prevalent among such workers, leading to respiratory symptoms and functional impairment, disability, and eventually to excess mortality from cardiorespiratory disease. For many years, epidemiological surveys have sought to disentangle this complex etiological maze but still without complete success. The failure to settle these questions is largely due to the fact that (a) most of the surveys have been cross -sectional rather than longitudinal, making it difficult to interpret the sequence of preceding events, and (b) the pathological processes in question are directly observable only at autopsy (and in only a selected proportion of deaths) when the dynamic interpretation is even more difficult. Certain points are fairly clear, however. In British and American coalminers, cough, phlegm, and reduction in forced expiratory volume are related to both dust exposure and cigarettes smoked, with evidence that the effects are additive (6). The same appears broadly true of American and British cotton textile workers (7, 8) and up to a point, of chrysotile miners and millers (9). What is much less certain is whether dust -induced occupational bronchitis, in the absence of cigarette smoking or significant pulmonary fibrosis, leads to emphysema with its more serious effects on respiratory function and life expectancy.

**Progressive fibrosis**

Fibrosis of the lung, with or without fibrosis and thickening of the pleura, results from exposure to a variety of particulate and fibrous mineral dusts. The classical example is silicosis, a serious and sometimes fatal disease of miners, quarrymen, and many other groups (foundry - men, stone- cutters, pottery workers, etc.) who are exposed to respirable crystalline silica. The risk of the disease is directly related to dust concentration, and mortality is due to the cardiorespiratory effects of massive pulmonary fibrosis resulting in part from coexistent tuberculosis.

The third major group of dust diseases is associated with the fibrous silicates (asbestos, talc, and mica) and possibly with some nonfibrous silicates, such as kaolin and Fuller's earth . For practical purposes, asbestosis is the main problem, a diffuse interstitial fibrosis of the lung often accompanied by pleural thickening. Prevalence surveys, using chest radiography and function tests, have shown that some degree of asbestosis is present in a high proportion of workers exposed for long periods in poorly controlled conditions of asbestos production, manufacturing, and application. Fibre concentration and duration of exposure seem to be the principal determinants ; age, sex, smoking habit, and fibre type have all been shown not to be important variables. The progression of this disease is usually slow and insidious, increasing fibrosis leading to increasing breathlessness and to death from cardiorespiratory causes in a small proportion of cases. Rapid deterioration associated with advanced massive fibrosis, as seen in coalminers and persons with silicosis, is unusual, perhaps because there is no clear interaction with tuberculosis. Fibrosis has been shown to progress in a proportion of subjects after withdrawal from asbestos exposure (18); the same is probably true with the other fibrogenic dusts. There is now evidence from longitudinal surveys that, in both asbestos workers and coal miners, radiological changes at work are each in their own way good predictors of life expectancy and cause of death .

**Neoplasms**

Exposures at work to a number of agents- asbestos, compounds of arsenic, nickel and chromium, coke -oven fumes, and ionizing radiation -have all been shown to increase the risk of respiratory cancer, particularly of the bronchus. Beryllium and cadmium are also under suspicion. The amphiboles, crocidolite and amosite, carry a substantial risk of malignant tumours of the pleura and peritoneum, chrysotile carries a much smaller one. In addition, some cases of cancer of the nasal sinuses and possibly of the larynx are related to occupation. Respiratory cancer in asbestos workers has been very fully investigated. Many well designed cohort studies have shown substantial excess mortality with all types of fibre and in a variety of industries where asbestos is produced, manufactured, and applied.

Asbestos is very widely used in modern industrial societies and the fact that the exposure response relationship appears linear and without a threshold has important implications for control (23); so too has the interaction between asbestos and cigarette smoking, which appears at least additive and, in some circumstances, multiplicative .

While ionizing radiation increases the risk of malignant disease at several sites, probably also in a linear manner with dose, excess lung cancer has been observed mainly in miners exposed to the inhalation of radon daughters.

**Diseases of the circulatory system**

Heart disease is the major cause of disability and death in industrial communities today, but the role of occupational factors in its causation has been little explored.

**Coronary arteriosclerotic heart disease** is commoner in some occupational groups than in others. This does not necessarily imply a causal relationship to occupation, for such risk factors as cigarette smoking, physical inactivity, obesity, and, in particular, stress are often features of the lifestyle of employees in certain occupations. However, the lifestyle may also be dictated by the occupation. The hypothesis that physical activity at work affords protection against ischaemic heart disease was first investigated by Morris and was found to hold for bus drivers and bus conductors, although it may be that these groups were inadequately matched with regard to characteristics other than physical activity. However, other studies, such as one concerned with the role of physical activity in reducing coronary mortality among American long -shoremen (30) show a remarkably consistent relationship between mortality and inactivity, even within the same social class.

Employment status was found to be a stronger predictor of the risk of dying from coronary heart disease than any of the more familiar risk factors. The prevalence of angina pectoris and of electrocardiographic abnormalities was also found to be substantially higher in men in the lowest employment grade (32).

A randomized controlled trial was performed in industry to assess the effectiveness of a programme aimed at preventing heart disease by the control of risk factors (33). Advice was given on dietary reduction of plasma cholesterol concentration, stopping or reducing smoking, weight reduction, daily exercise, and treatment of hypertension. The trial showed that coronary risk factors can be changed in a working population, but the changes obtained were not large and were not sustained. There is evidence for a possible causal association between certain toxic agents in the working environment and coronary arteriosclerotic heart disease. Workers exposed to carbon disulfide, as in the manufacture of rayon and carbon tetrachloride, have experienced an increased mortality (34) associated with hypertension and hyperlipidaemia (35). Carbon monoxide, which is atherogenic in rabbits and monkeys, is believed to be a causal factor in arteriosclerotic heart disease in cigarette smokers (36). In a prevalence study of angina in Finnish foundry workers (37), the highest rate was found in smokers with carbon monoxide exposure, and the lowest rate in nonsmokers without such exposure. Munitions workers exposed to glyceryl trinitrate and other organic nitrates have been shown to have an increased mortality, believed to result from coronary artery spasm, following reexposure after a short period of absence from work (38). An increased risk of cardiovascular and cerebrovascular disease has been shown in a case -control study of Swedish explosives workers (39). Sudden death from cardiac dysrhythmia has been associated with exposure to a number of halogenated hydrocarbons, in particular trichloroethylene, trichloroethane, and fluorocarbon aerosol propellants. Many workers are exposed to these compounds, but appropriate epidemiological studies have not been performed. Of the metals, cobalt used as a foaming agent in beer has caused epidemics of cardiomyopathy with high mortality, including some cases among brewery employees (40). An increased mortality from cerebrovas- cular disease was observed in lead battery workers in England (41). Although chronic nephropathy as a sequel to lead poisoning has been documented, there is no evidence of increased mortality from hypertension in lead battery and smelter workers (42). Cadmium has been implicated as a possible causal factor in hypertension, higher levels of cadmium having been found postmortem in the kidneys of hypertensive patients as compared with normotensive subjects (43). Raised blood cadmium levels have also been observed in a group of untreated hypertensive subjects compared with normotensive controls (44) but a larger study failed to show an association between blood cadmium and hypertension (45). Extensive use of vibratory hand tools may lead to the development of Raynaud's syndrome, known in industry as vibration white finger. The condition is seen frequently in workers engaged in chain sawing, grinding, chipping with pneumatic tools, and swaging. Quarrymen, miners, and others handling pneumatic drills, hammers, and chisels are also affected. In one study, 85 % of chain sawyers were affected, but prevalence rates in different groups have varied widely (46).

**Diseases of the digestive system**

Diseases of the digestive system are common and of great economic importance. During the present century, duodenal ulcer increased in industrialized countries until the 1940s and then declined. It has been considered to be related to stress, and an increased prevalence has been observed in occupations thought to be stressful. Doll et al. (47) found a higher than expected frequency of duodenal ulcers in foremen and executives. In a study of air traffic controllers, considered to be in a stressful occupation compared with second -class airmen taken as 49 controls, the air traffic controllers experienced an excess risk of developing peptic ulcer and were affected at a younger age than the controls (48). The problem of obtaining an objective measure of stress in relation to work is, however, considerable. In a longitudinal study, nervous strain at work was found to relate both to predisposition to anxiety and to the workers' own report of day -to -day activities in their job.

Type B hepatitis is an important health hazard in health care personnel, especially among those working in hospital laboratories, and in dialysis and oncology departments

Cirrhosis of the liver, while not an occupational hazard in the ordinary sense, is far more common in some social groups than in others.

In the United Kingdom, for example, standardized mortality rates are generally higher among the more affluent whereas in the Unites States, where alcohol has been cheap, unskilled workers have the highest rates (e.g., the standardized mortality rate in the United Kingdom is 96, while in the United States it is 148) (53). Among the occupations with the highest mortality from cirrhosis are barmen and publicans, seamen, company directors, and medical practioners (54). Other risk factors for cirrhosis are certain fungal toxins such as aflatoxin, drugs that stimulate enzyme systems in the liver, and chemical exposures.

Chronic arsenic poisoning has been followed by cirrhosis, which has been observed in Moselle vintners using arsenical sprays. Arsenic, thorotrast, and vinyl chloride have given rise to the rare haemangiosarcoma of the liver, of which not more than 200 cases have been reported worldwide. Haemangiosarcoma of the liver in a worker exposed to vinyl chloride monomer in the polymerization process was first reported in the United States in 1974. Since then, haemangiosarcoma and also hepatic fibrosis and cirrhosis have been reported from vinyl chloride polymerization plants in many countries. In Great Britain, a register set up in 1974 has collected 34 cases in which diagnostic criteria for haemangiosarcoma of the liver were fulfilled. Two of these occurred in vinyl chloride workers, and eight were attributable to past exposure to thorium dioxide. There was possible exposure to vinyl chloride in four other cases and the survey also suggested a possible increased risk in the electrical and plastics fabrication industries (55). Mention has been made of primary malignant mesothelial tumours resulting from exposure to asbestos, of which the amphiboles are most hazardous. About half the occupationally related cases are peritoneal, perhaps due to ingestion of fibre at work, particularly in the insulation and heating trades (56). Asbestos work is also associated with cancer of the gastrointestinal tract; however, the evidence is much less consistent than for bronchial cancer, gastrointestinal cancers being observed in some cohorts but not in others. Possibly they occur only when there is interaction with some other as yet unidentified factor(s) (22). Finally, there are grounds for suspecting an increased risk of digestive cancers in coalminers. Occupational mortality statistics in Great Britain have shown high standardized mortality rates for many years and there is some supporting evidence from epidemiological studies in the United States (57).

**Urinary tract disease**

Toxic chemicals encountered in the workplace may lead to glomerular or tubular damage or, after a latent interval, to cancer of the urinary tract or bladder. Acute tubular necrosis resulting in renal failure has followed the absorption of inorganic salts of mercury and other heavy metals, ethylene glycol, tetrachlorethane, and carbon tetrachloride. In France, carbon tetrachloride was once the commonest cause of acute renal failure because of its widespread use

. An increased prevalence of proteinuria has been observed in mercury workers compared with a control group, with a significant correlation between urinary mercury excretion and protein concentration (59). In some cases, more severe glomerular damage following exposure to mercury has led to the nephrotic syndrome, probably with an immune complex pathogenesis. Following absorption, cadmium accumulates in the renal cortex giving rise to tubular proteinuria and other defects of tubular reabsorption, including hypercalciuria. Renal stone formation has been described in cadmium workers and, in a few instances, osteomalacia . Tubular proteinuria, with an increased excretion of ß2- microglo- bulin, and in some cases a glomerular type proteinuria have been observed, mainly in workers exposed to cadmium for more than 25 years, whose cadmium concentration in blood exceeded 10 u g /litre and that in urine 10 mg /kg creatinine (62). Taking urinary ß2- microglobulin excretion as the earliest indicator of an adverse effect, Kjellström et al. (63) reported a prevalence of about 20 % tubular proteinuria in a group of workers in a cadmium -nickel battery plant with 6 -12 years' exposure to cadmium at a level of 50 µ g /m3 air. However, atmospheric cadmium concentration may have been higher in the earlier years. Epidemiological studies have revealed widespread renal tubular dysfunction in cadmium -polluted areas of Japan. Again, taking ß2 -microglobulin as an indicator of effect, Kjellström et al. (64) estimated that longterm ingestion of about 0.15 mg cadmium per day in food was associated with a higher prevalence of proteinuria than in their reference groups. Excessive lead absorption from occupational exposure has also given rise to tubular dysfunction and to interstitial nephropathy, progressing to renal failure and sometimes associated with gout. Exposure to a number of hydrocarbons has been associated with the development of chronic glomerulonephritis (65). That certain aromatic amines may give rise to bladder cancer has been recognized for over 80 years. Those at risk include workers in the synthetic dyestuff, chemical, and rubber industries exposed to ßnaphthylamine, 4- aminodiphenyl, benzidine and other chemically similar compounds. Workers in the British rubber industry showed a large excess of bladder cancer in cohort studies (66). Routine occupational mortality statistics failed to reveal the problem because of the small number of workers involved. The tumours, frequently multifocal in origin and involving the epithelium on the renal pelvis and ureters as well as the bladder, with a latent interval most frequently between 15 51 and 20 years, characteristically occurred at younger ages than non - occupational bladder cancer. All 15 distillers of ß- naphthylamine at one plant developed bladder cancer and the risk in other workers was extremely high. Following Case's study, the chemical industry withdrew certain rubber additives and, in the United Kingdom in 1967, the known carcinogenic chemicals referred to above were brought under strict control. A survey was subsequently conducted in which the records of over 40 000 men employed for at least one year in the rubber and cablemaking industries were observed for 8 years. In comparing the mortality pattern for 1972 -1974 with that for 1968 -1971, a significant excess of deaths from bladder cancer was found throughout the industry, including firms where exposure to acknowledged bladder carcinogens had not occurred (67). The excess bladder cancer deaths were found in workers in the tyre sector, and in those employed by footwear manufacturers and footwear suppliers. Occupational bladder cancer is, therefore, a continuing problem. Kipling & Waterhouse (68) surveyed the records of 248 workers exposed to cadmium oxide dust for a minimum period of one year. They found 4 cases of prostatic cancer where the expected figure, based on regional rates, was computed at 0.58. A cohort mortality study of smelter workers exposed to cadmium fumes and cadmium oxide dust showed a significant excess mortality from prostatic cancer 20 years after initial exposure (69), and two smaller studies in Sweden showed a similar trend. To date, 14 cases of prostatic cancer have been noted in cadmium workers, compared with 5.4 expected. However, in a large cohort study of cadmium -exposed workers in England, no excess mortality from prostatic cancer has been observed (70).

**Diseases of the musculoskeletal system**

The extent to which occupation gives rise to disorders of the skeletal system has been little investigated in population -based studies. In addition to the varied and extensive effects of accidental trauma, low back pain and osteoarthrosis are common conditions and a major cause of lost working time. Back pain is very common in both manual and sedentary workers, but in heavy manual workers, such as miners, dockers and nurses, it is an important cause of disability.

Osteoarthrosis of the spine, hips, or knees is particularly common in heavy manual workers and the interphalangeal joints are affected in workers such as tailors, where Heberden's nodes produce a characteristic deformity. Disabling osteoarthrosis of the hip, knee, or shoulder also occurs as a sequel to aseptic necrosis of bone in workers under increased atmospheric pressure, where the infarcted area is in proximity to the joint and involves the articular cartilage. In a study of septic necrosis of bone in a large group of British commercial divers, the prevalence of definite bone lesions had increased from less than 1 % in 1975 to 4.8 % in 1979. Joint damage had developed in 14.5 % of divers with potentially disabling juxta- articular lesions. While no bone damage was seen in men 52 who had never been deeper than 30 metres, almost one quarter of the men who had dived to 300 metres had such lesions (71). Osteoarthrosis, in particular of the elbow and wrist joints, is seen in workers who handle vibrating tools, both with and without associated Raynaud's phenomenon. These and other heavy manual workers may have multiple small areas of decalcification in the carpal bones. In one series, such changes were seen on X -ray in over 40 % of a large workforce (72). Acro -osteolysis has occurred in workers engaged in the polymeriz- ation of vinyl chloride, in particular those whose work entailed the manual cleaning of the pressure vessels, where intermittent exposure to the monomer fume was high. Cystic lesions in the terminal phalanges of the fingers and toes and sometimes in the patella and sacroiliac bones, together with Raynaud's phenomenon and scleroderma -like changes in the skin of the hands, were found in about 3 % of exposed workers (73). An epidemiological study of over 5000 employees in polymerization plants in North America revealed only 25 definite cases, with a further 16 under suspicion (74). All employees who worked at the time of the survey, or in the past, in any capacity in plants manufacturing polyvinyl chloride were included; workers exposed to very low levels probably contributed little to the prevalence rate.

Housemaid's knee, or prepatellar bursitis, is a descriptive term for one of a large number of conditions characterized by a collection of synovial fluid in bursae subjected to repeated friction or pressure. The most important of these are the beat disorders of miners, involving the elbow or the knee, where the bursae are liable to become infected and where subcutaneous cellulitis may occur. Such a cellulitis may also involve the hand in boilermen as well as in miners. Although declining, these conditions continue to be important causes of sickness absence. In Great Britain, in 1978, there were 936 new spells of certified incapacity from the beat disorders for which injury benefit was payable under the Prescribed Diseases Regulations, compared with 1505 new spells in 1973. Repetitive movement of the hands is required in many occupations, for example by carpenters, braiders, typists, and telegraphists (75). The tendon sheath or the musculotendinous junction of the most used muscles may become inflamed, with fluid exudation, giving rise to an incapacitating tenosynovitis. The most commonly affected are the radial extensors and the abductors of the wrist and thumb. These muscles were involved in 77 % of a group of 544 cases, the majority of which came from a motor vehicle assembly plant (75). The main etiological factors were: occupational change necessitating unaccustomed movement (27 %), resumption of work after absence (21 %), and repetitive stereotyped movement (16.5 %). In 1978, in Great Britain, there were 3428 new spells of certified incapacity for injury benefit, making tenosynovitis the second most frequent cause of certified incapacity after occupational dermatitis.

**Skin disease**

Industrial skin diseases are common and have major social and economic implications. In Great Britain, in 1978, there were over 7000 new 53 spells of certified incapacity for industrial skin disease for which injury benefit was payable under the Prescribed Diseases Regulations (61 0 of total), compared with nearly 11 000 (67 0 of total) in 1973.

Industrial skin diseases have accounted, on average, for more than twice as many working days lost as all the other prescribed occupational disorders together (77). A wide range of agents in the working environment may be involved; these may be classified as (a) mechanical, e.g., trauma, friction, or pressure; (b) physical, e.g., temperature, radiation; (c) biological, e.g., plant or animal contact, insects, microorganisms; and (d) chemical, e.g., both organic and inorganic compounds. Whether a disorder of the skin develops is dependent not only on the pattern and intensity of exposure but also on individual susceptibility, atopy, and skin pigmentation. Ultraviolet light is a potent carcinogen when acting on the unprotected skin (78).

Fair -skinned and poorly pigmented seamen, farmers, and other workers exposed to high -intensity sunlight in the tropics have a high incidence of skin cancer in comparison with pigmented races. An atopic diathesis has a complex relationship to industrial skin disease. Thus, nursing would not be a suitable occupation for a young person with a history of eczema because of the greater risk of developing not only an allergic but also an irritant contact dermatitis. Repeated friction or mechanical pressure on the skin gives rise to the beat disorders or to cellulitis (mentioned also under diseases of the musculoskeletal system).

Erythema of the skin with pruritus occurs if the skin is chilled during decompression, and gangrene of the finger tips may accompany Raynaud's phenomenon associated with the handling of vibrating tools. The effects of exposure to ionizing radiation were dramatically demonstrated by the pioneer radiologists early this century, who developed chronic X -ray dermatitis, post- irradiation telangiectasis, and eventually skin cancer. Many plants, fruits and vegetables cause contact dermatitis affecting a wide range of workers. Among the most potent are those belonging to the Anacardiaceae and the Primulaceae, and certain woods such as South African boxwood.

A large number of chemicals give rise not only to contact dermatitis, but also to leukoderma (hydroquinone derivatives), to acne (dioxin and other chlorinated hydrocarbons), and some to skin cancer. Irritant contact dermatitis is more prevalent than allergic contact dermatitis, the common irritants being skin cleansers, acids, alkalis, oils, and organic solvents. Of the common industrial allergens, chromate is the most widespread affecting males, the most frequent source being cement. Nickel allergy is more common in women, sensitization often occurring from non -occupational sources, such as jewellery and fastenings. In an epidemiological study of contact dermatitis in North America, 1200 subjects were tested against 16 allergens (79). The most common sensitizers observed were nickel sulfate, followed by potassium dichromate, thiomersal, and paraphenylene diamine, the latter being a component of hair dyes. Epoxyresins and chemicals used in rubber, such as antioxidants and accelerators, are also common allergens.

Contact dermatitis is especially common in coalmining, metal manufacturing, and in the leather, chemical, and textile industries. Scrotal cancer in chimney sweeps was described over 200 years ago by Percival Pott; subsequently scrotal and other skin cancers were reported in cotton mule spinners exposed to shale oil, and more recently, in automatic machine operators whose clothing and skin becomes contaminated with mineral oils (80). However, chimney sweeps may still experience an increased cancer risk. A cohort study among chimney sweeps employed for many years in Sweden has shown a significant excess mortality from cancer of the lung and oesophagus, as well as from chronic respiratory disease (81). Tar, pitch, and creosote have produced warty growths in the skin followed by neoplastic change. The common factor in these exposures is the presence of carcinogenic polycyclic hydrocarbon compounds, such as benzo[a]pyrene. Workers exposed to arsenicals may develop contact dermatitis or, following more prolonged exposure, hyperkeratosis of the palms and soles, warts, melanosis, and patchy depigmentation commonly called "raindrop" pigmentation. Epidemiological studies have indicated an association between skin cancer, often multifocal in origin, and heavy exposure to inorganic arsenicals via medication, contaminated drinking water, or occupational exposure (82).

**Diseases of the nervous system and sense organs**

Occupational factors are associated with a broad spectrum of disorders affecting both the central nervous system -causing organic and also behavioural manifestations -and the peripheral nerves. **Hearing loss**

The commonest adverse effects of occupational factors are mechanical and acoustic trauma, the former in construction, transport and mining, and the latter throughout heavy industry. In the United Kingdom, the construction industry accounts for about 300 cases of deafness per million workers per year . Central nervous system effects Work under increased atmospheric presure can have complex effects on the function of the central nervous system. Air breathed under increased pressure has adverse effects on performance and narcotic properties attributed to nitrogen. Other inert gases also give rise to narcosis, related to their lipid solubility . The high -pressure nervous syndrome is characterized by electroencephalographic abnormalities and tremors (85). However, the most serious effects occur in decompression sickness with nervous system involvement in 8 -35 % of reported cases. As the entire central nervous system is at risk, any neurological lesion may 55 occur, the most serious effect being permanent paraplegia. Not uncommon amongst divers are visual manifestations and a disturbance of vestibular function with vertigo, nausea, vomiting, and nystagmus known as "the staggers ". Carbon monoxide is the most frequent cause of death from poisoning, because of its ubiquitous nature. Those who survive may be left with permanent cortical and extrapyramidal system damage. Traffic policemen, blast furnace workers, and others are exposed to carbon monoxide at lower concentrations that may give rise to impaired performance of tasks requiring perceptual and motor skills. Of the metals, lead, mercury, and manganese have specific central effects.

Acute encephalopathy may be the presenting feature in lead poisoning, but industrial cases are now rare. Tetraethyl lead poisoning is a toxic organic psychosis that has occurred in workers handling leaded petrol, but again, because of preventive measures, such poisoning is now rare. Workers in manganese mines and mills have developed psychotic symptoms followed by extrapyramidal involvement, with akinesia, rigidity, and tremor. The relationship between the level of exposure and biological effects of manganese was studied in a group of workers employed in the production of ferro- alloys (87). Sixty -two (17 %) manganese alloy workers showed some signs of neurological impairment, mainly tremor at rest, but this prevalence did not correlate well with mean manganese concentrations at the workplace. The inhalation of mercury vapour may lead to an acute psychosis or to a Parkinsonian syndrome. More commonly, however, it causes a milder mental disturbance known as erithism, which, in the past, was so frequently seen in the felt hat industry that the expressions "mad as a hatter" and "hatter's shakes" passed into everyday speech. The short- chain aliphatic mercury compounds synthesized primarily as seed dressings produce a specific disorder characterized by selective cerebral cortical and cerebellar damage. The condition was initially described in formulators of seed dressings, but in more recent years a similar condition known as Minimata disease, caused by an environmental pollutant from an industrial source, has gained importance and a large- scale epidemic of methyl mercury poisoning has been traced to the ingestion of contaminated bread (88).

Aluminium, bismuth, and organotin compounds have also given rise to encephalopathy, again in isolated cases in industry, but in epidemic proportions in other population groups. Many organic compounds, some volatile and frequently used as solvents, have a narcotic effect when inhaled and in lower concentrations depress the level of conciousness, affecting initially the higher mental functions. Some have other toxic effects, too, such as carbon tetrachloride affecting the liver and kidneys, trichlorethylene producing cranial nerve damage, methyl bromide giving rise to encephalopathy and neuropathy, and methyl alcohol acting on the optic nerve. Subjective changes in mood and some slowing of reaction time have been observed in studies of behavioural effects in workers exposed to a variety of organic solvents, and there is some evidence that lasting brain damage may occur (89). 56 **Effects on peripheral nerves**

Toxic neuropathies account for only a small proportion of all peripheral neuropathy, most of which has an obscure etiology. Of the metals, inorganic lead gives rise to a motor neuropathy affecting principally the extensors of the wrist and fingers, the classical lead palsy. Lower exposures have caused subclinical dysfunction of peripheral nerves.

Arsenic and thallium can give a mixed motor and sensory neuropathy, the former after a single large exposure and the latter delayed in onset, progressive, and accompanied by central effects. A number of organic compounds have also caused neuropathy.

Workers preparing acrylamide polymer from the monomer have been affected and a mixed neuropathy has also followed exposure to carbon disulfide.

N- hexane is a commonly used solvent that was believed to be responsible for a symmetrical, distal, largely motor neuropathy affecting a large group of Japanese workers employed on cementing sandals . A high prevalence of poly - neuropathy in shoe and leather workers in Italy was attributed to exposure to a variety of solvents which were not identified.

Other workers have developed neuropathy following the practice of glue- sniffing. An outbreak of symmetrical, mainly motor, peripheral neuropathy involved 79 workers at a plant for the manufacture of plastic- coated printed fabrics where no previously known neurotoxic agent had been used (. The cause of the outbreak was traced, after an epidemiological study on over 1000 workers exposed to 275 different chemicals, to the substitution in a solvent mixture of the apparently innocuous methyl n -butyl ketone for the previously used methyl isobutyl ketone. Numbness and pain are frequent complaints in workers who have contracted vibration white finger. In one field study of forest workers in Finland using chain saws over a period of 10 -15 years, subclinical neuropathy was found in about one half of the workers examined (94). Delay in nerve conduction in the forearms was considered to be due to partial demyelination of the peripheral nerves.

**Blood diseases**

Ionizing radiation and a large number of chemical substances encountered in the working environment may cause disorders of the formed elements of the blood and their precursors. However, host sensitivity plays an important part in determining outcome.

A haemoglobinopathy or genetically determined glucose -6- phosphate dehydrogenase deficiency in certain subjects may lead to a haemolytic crisis following the absorption of doses quite harmless to normal persons. Exposure to high doses or ionizing radiation produces an immediate fall in the lymphocyte count, followed by a fall in granulocyte and platelet counts with a more gradual fall in the erythrocyte count.

Aplastic anaemia or agranulocytosis may supervene, or alternatively proliferation of cellular elements may occur, in particular giving rise to acute or chronic myelogenous leukaemia. In the case of leukaemia, a linear doseresponse curve has been demonstrated, although in the very low dose range quantitative data are insufficient to determine whether this relationship still holds. In the luminizing industry, the ingestion of traces 57 of radioactive substances has resulted in aplastic anaemia and osteogenic sarcoma. Lower doses of radiation have produced chromosome abnormalities in circulating lymphocytes. Both reduced and increased haemopoietic activity has been observed following industrial exposure to benzene, either in the pure form or as a component of solvent mixtures which, in their effects, can be described as radiomimetic. Over the past 50 years, many reports have associated benzene exposure with the subsequent development of non -lymphocytic leukaemia. Epidemiological studies suggest such an association , but a causal relationship has yet to be convincingly demonstrated. Many chemical exposures can give rise to haemolysis. Arsine is formed whenever arsenic, often present in traces in scrap metal recovery, comes into contact with acids or nascent hydrogen. It can cause massive haemolysis, giving rise to jaundice and secondary renal failure, following almost always an unsuspected exposure. A variety of nitro and amino organic compounds, such as nitrobenzene and analogues, trinitrotoluene and aniline also cause haemolysis. These compounds are readily absorbed through the skin. In addition to haemolysis, nitro and amino compounds of the aromatic series also produce methaemoglobinaemia, imparting a characteristic blue colour to the skin and inhibiting oxygen transport to the tissues.

Excessive exposure to inorganic lead produces a mild or moderate anaemia as a result of both haemolysis and inhibition of haem synthesis. More sensitive indicators of early and reversible lead effects are erythrocyte zinc protoporphyrin in the blood or ô- amino -laevulinic acid in the urine. These parameters have been measured extensively in epidemiological studies on lead- exposed workers. An important cause of a severe chronic anaemia in many parts of the world, especially in the tropics, is infestation with hookworm (ankylostomiasis), known as miners' or tunnel workers' anaemia. This parasitic infestation is especially common in South East Asia where it affects agricultural workers, in particular labourers in rice fields, in contact with damp soil. Schistosomiasis also gives rise to anaemia through chronic blood loss.

**Reproductive effects**

Men and women are exposed to a similar range of occupational hazards but, by virtue of their childbearing function, women experience additional occupational health risks mainly affecting the fetus. Although concern has been expressed about possible adverse effects of occupational factors on fertility in both women and men, no such effects have so far been observed with certainty. Menstrual, breast, and genital changes have been found in women who manufacture oral contraceptives.There are reports of delayed menarche and amenorrhoea in dancers and menstrual disorders in airline stewardesses (99, 100). Like other young women who leave home to work, nurses are notoriously liable to amenorrhoea. 58 Although there is little direct evidence in human subjects, experimental research has demonstrated the teratogenicity of very many physical and chemical agents potentially present in the working environment.

That chromosomal aberrations can occur in occupationally exposed persons is suggested by their presence in lymphocytes cultured from the blood of women who worked in laboratories and a rotoprinting factory, and from the blood of their newborn children (102). Hospital employees, especially those who use X -ray apparatus outside the radiology department, may be exposed to ionizing radiation, with attendant risks in pregnancy, if monitoring is not strictly applied.

Another "physical" agent, hypoxia, known to be teratogenic in experimental animals, constitutes a possible hazard for female flight staff in early pregnancy. An increase in the rate of spontaneous abortions with or without a rise in congenital malformations has been reported following a variety of chemical exposures: in anaesthetic rooms (103, 104), in hospital laboratories (105), following exposure of fathers to vinyl chloride (106), and in those living around a Swedish smelter (107). In Finland, there is now systematic surveillance of maternal occupations in relation to outcome of pregnancy and the findings to date indicate a number of statistically significant associations (108 -110). For example, exposure to styrene and laundry work, and employment in the pharmaceutical industry came under suspicion as causes of abortion; telephone operators, teachers, gardeners, and cooks had high malformation rates; and farming and the food industry were associated in offspring. These associations mean little in themselves but merit further investigation. An association has also been reported between exposure during pregnancy to organic solvents and both central nervous defects (111) and oral clefts (112). Lead is known to cross the placental barrier and has long been considered toxic to the fetus; it has been suggested (113) that maternal exposure may affect fetal mental development. Certain infective agents -rubella virus, toxoplasma, and cytomegalovirus -cause specific developmental abnormalities; teachers, school staff, animal minders and others may thus be at increased risk in pregnancy from these infections (114). Work, health and wellbeing In a paper on the impact of unemployment, Johoda (115) argued that "if there is more to work than making a living, there should be more to the lack of work than the reduction of one's standard of living ". Not all societies share the same work ethic, but this premise probably holds in most industrialized countries. For better or worse, there may even be some empirical correlation between the process of socioeconomic development and acquisition of this attitude to work. Johoda went on to argue that since pay and conditions are on balance negative factors, employment must have powerful compensatory advantages. She identified five possibilities: (a) an imposed time structure; (b) shared ex59 periences and contacts; (c) transcendent goals and purposes; (d) personal status and identity; and (e) enforced activity. These same "advantages" are clearly anathema to more contemplative philosophies! However, if one accepts that "psychological supports are more or less enduring requirements for all of us ", it follows that enforced unemployment is indeed a terrible evil, more serious in its direct and indirect effects than even the most soul- destroying and alienating assembly line piecework. However, unemployment also leads to poverty and this in turn to morbidity and mortality from diseases well known to be associated with it (116). In addition, there is evidence that serious emotional problems and psychosomatic disease may result directly from job loss (117 -119). The beneficial effects of the "enforced activity" mentioned above must surely be more than psychological. A considerable body of presumptive epidemiological evidence supported by common sense and the pattern of evolution all suggest that regular and demanding exercise sufficient to maintain physical fitness will retard the development of arterial disease, reduce mental stress, limit undue obesity, and promote sound sleep. It is certainly hard to believe that, within reason, hard exercise is bad. We should therefore regard with some concern the fact that, despite the obvious need to remove the back -breaking tasks of the bad old days, work in the industrialized world is becoming less and less physically demanding. There remains the more general question of the quality of working life, a subject of growing interest in socially advanced industrial countries. Dull and repetitive work that offers no scope for personal initiative or sense of achievement is of concern on two accounts. Such jobs are associated with absenteeism and high labour turnover, strikes and low morale, poor quality work, and reduced productivity. In the present health context, there is every reason to believe that work satisfaction is a prerequisite for a full and healthy life and that its absence is associated with high accident rates, anxiety and depression, frustration and stress. However, the scientific evidence for all this is scanty, no doubt because the required epidemiological research is difficult to design and conduct. The reader is referred to a recent review of this field (120).

**Medical surveillance**

Introduction Medical surveillance means a planned programme of periodic examination, which may include clinical examinations, biological monitoring, biological effect monitoring or medical tests of persons employed by a designated health practitioner or by an occupational medical practitioner. (OSHA 2007 section 2) Medical surveillance shall be provided by a designated health practitioner, occupational medical practitioners for the primary prevention of occupational injuries and illnesses, including a review of occupational and medical history, physical examinations, diagnostic, performance testing and vaccinations

**Purpose of medical surveillance**

To ascertain the health status of the employees pre-employment, during and after employment

To determine the health status of the employee before transfer to another work area.

To determine the job placement within an organization.

To ensure that those who have had occupational medical conditions or exposures are attended to early enough to prevent any complication.

To provide information that would help in determining and justifying worker compensation. The findings from the medical surveillance should be recorded in the risk register (OSHA -2007 guidance for Occupational Health Services in health facility.)

**Elements of Medical Surveillance**

a. Pre-employment and pre-placement medical examination- This examination is to ensure that the employee is fit to undertake the job without risk to himself or his colleagues. The baseline medical examination conducted at the start of employment will define the initial health status: subsequent examinations will be used to evaluate the evident health effects of the work environment and other working conditions.

b. Periodic Occupational Health surveillance - This consists of examinations conducted periodically to identify vulnerable groups among the stafwhich can be of immense value to prevention. The frequency and types of examinations will be determined for each vulnerable group based on nature of work, ages and sex of the group members.

c. Return to work/ post sickness absence examination- This is to ensure that an employee who has been absent with a medical condition for a considerable length of time is fit to undertake his/her usual job. On the other hand, it will facilitate the rehabilitation or temporary or permanent resettlement of those who are not fit to return to their usual occupations.

d. Exit medical examination- This is to provide data on employees at the point of exit from a particular occupation or workplace. The advantage to employees is that it provides the opportunity for employees with ailments which have a causal relationship to any factor in the work environment to continue to receive assistance for managing it after they have left the employment or moved on to another schedule.

**General Guidelines**

A. Medical surveillance should assure that the worker’s physical abilities fit the specific requirements of the job and he/she remains fit throughout his/ her working life.

B. In record keeping, reporting and certification, professional ethics on confidentiality and respect for human rights shall be the guiding principles.

C. Medical information will not be passed on to unauthorized parties, unless with the written consent of the individual concerned.

D. The Kenya health care facilities should request that an employee undertakes a medical assessment based solely on impaired ability to perform the requirements of the job.

E. All costs associated with the medical assessments will be borne by the employer

**Vaccination**

The MoH will implement a comprehensive occupational vaccination programme for its employees who handle patients. Due to the risks of contracting infectious diseases from the work environment, all staff and potential staff members will be made aware and provided with appropriate vaccination. The most important diseases to be vaccinated against includes Hepatitis B and Tetanus however other diseases where occupationally are relevant should be considered.

For staff who have not been vaccinated in childhood (e.g. by virtue of their country of origin), vaccination against Tuberculosis and Poliomyelitis and recall for boosters. Vaccination will be carried out at pre-employment and as required for the work area.

The following guidelines shall be considered: j. Determine if the employee had received the primary vaccinations

. Avail vaccine.

Administer the prerequisite vaccinations depending on work area requirement (the employee has right to decline the vaccination but that should be documented).

The COSH focal person should identify the vaccination centres for the employees and ensure they are manned by qualified medical staff with training in vaccination.

The employees shall be sensitized on where, when and what vaccines.

Document the vaccination history.

Management of occupational exposure in health care setting Exposure means amount of a work place agent that has reached an individual worker (external dose) or has been absorbed into the individual worker (absorbed dose). (OSHA 2007 section 2.)

Purpose for management of occupational exposure:

To identify the type of exposure

To determine the population exposure level( low, medium, high)

To determine the population exposed

To plan on the post exposure practices of reducing/ eliminating exposures

To put in preventive and control measures to avoid / minimize future exposures

Training of all the personnel/ workers at risk